Appendix B: Conservation Elements

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B-1.1 Conceptual Models

Documents containing the completed conceptual models for CEs are provided as separate documents from this appendix, due to their length. There are four documents- one each for the terrestrial coarse-filter, aquatic coarse-filter, landscape species, and species assemblage CEs. These documents are housed on the BLM data portal. The file names for each are as follows:

CBR_ConceptualModels_TerrestrialCoarseFilterCEsSept_2012_final.pdf
CBR_ConceptualModels_AquaticCoarseFilterCEsSept_2012_final.pdf
CBR_ConceptualModels_LandscapeSpeciesSept_2012_final.pdf
CBR_ConceptualModels_SpeciesAssemblagesSept_2012_final.pdf

B-1.1.1 Selection Criteria and Categorization for Species CEs

The "fine-filter" includes species that, due to their conservation status and/or specificity in their habitat requirements, are likely vulnerable to being impacted or lost from the ecoregion unless resource management is directed towards their particular needs. For species to be addressed in this assessment, we proposed, and the AMT accepted, several selection criteria for their inclusion and treatment in the assessment. These criteria include:

a. All taxa listed under Federal or State protective legislation for all or a portion of their range within the REA (including species, subspecies, or designated subpopulations)
b. Full species with NatureServe Global Conservation Status rank of G1-G3[1]
c. Full species or subspecies listed as BLM Special Status and those listed by applicable SWAPs with habitat included within the ecoregion
d. Full species and subspecies scored as *Vulnerable* within the ecoregion according to the NatureServe Climate Change Vulnerability Index (CCVI)[2].

One additional species, mule deer (*Odocoileus hemionus*), was included as a desired conservation element. Table B - 1 includes a current list of species meeting criteria a-d above for the CBR ecoregion. A total of 565 taxa are listed for this ecoregion.

We have established several distinct approaches to treating species that meet established criteria for inclusion in the REA. These include:

a) ***Species assumed to be adequately represented indirectly through the assessment of major "coarse filter"*** ecological systems of the ecoregion. Habitat requirements for these species align closely with coarse filter CEs. While typically uncommon, these selected "fine-filter" CEs have a moderate probability of being found among any extant and high-quality occurrence of the affiliated coarse filter element across the majority of the ecoregion, but a very low probability of being found in any other environment. For example, species strongly affiliated with desert springs may be adequately treated in the REA through assessment of desert springs themselves. Individual species to be treated within these coarse filter CEs are flagged within the overall list of species CEs (Table B - 1).
b) ***Species assumed to be adequately represented indirectly as ecologically-based assemblages***. That is, due to similar group behavior and habitat requirement, a

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[1] See http://www.natureserve.org/explorer/ranking.htm for NatureServe Conservation Status Rank definitions
[2] See http://www.natureserve.org/prodServices/climatechange/ccvi.jsp for more on the NatureServe CCVI

recognizable species assemblage is defined and treated as the unit of analysis. These species do not correspond to the a)-group above because they are typically affiliated with specialized components of the major coarse filter CEs (e.g., sandy soils and localized outcropping among one of the desert scrub systems) and/or are not reliably affiliated with any one of the coarse filter CEs. Examples include migratory bird stopover sites, and carbonate rock outcrops; these will be treated as multi-species assemblages. Individual species to be treated as part of these assemblages are flagged within the overall list of species CEs (Table B - 1).

c) ***Landscape Species which should be best addressed as individuals*** in the assessment. These include vertebrate species with moderate to large home ranges that tend to include a diversity of coarse filter CEs as important habitat components. These species occur over large proportions of the ecoregion and have habitat requirements that are clearly distinct from all other taxa of concern.

d) ***Local Species of concern that have very narrow distributions;*** typically limited to one BLM management jurisdiction. This also included species that do not fall within categories a-c. Individual species treated as Local are so indicated in Table B - 1.

A habitat-relationships database was developed that facilitated documentation of current knowledge for most candidate species CEs. Information captured within this database provides a reference for placement of each species into the above-mentioned categories for treatment within the REA. The database contains lists of the candidate taxa, coarse filter ecosystems, and species assemblages, as well as a list of habitat attributes that can be used for developing species assemblages. Each taxon can be assigned to one or more ecosystems, assemblages, or habitat attributes, using the approach that best suits that taxon within the ecoregion. It was anticipated that this database will contribute towards subsequent BLM ecoregional direction and management phases where specialized knowledge of habitat requirements for at-risk species is desired.

Biologists from the Nevada Natural Heritage Program used the database to designate a species to either a coarse filter or a species assemblage, based on the knowledge of experts within the program as well as known distributions. Throughout the ecoregion, there are certain groups of species that naturally occur in certain habitats but those habitats are spread throughout multiple ecosystems. For example, cave and mine-roosting bats can be found throughout the ecoregion in a variety of habitats, from high elevations to low elevations as long as there is a suitable cave or mine to occupy. Using expert knowledge of such groups, biologists created some 20 species assemblages. Further review of the available data resulted in reducing this list to 9 species assemblages for spatial distribution modeling and assessment. Species that were strongly affiliated with a coarse filter were assigned to a coarse filter rather than a species assemblage. Species associated predominantly with “wet” sites were *a priori* assumed would all readily fall within either a coarse filter or an assemblage. As input to this expert-attribution process, GIS layers were used of the coarse filters and overlaid with known rare species occurrences. Habitat descriptions from published sources were also used and compared to coarse filter descriptions.

Table B - 1. Final list of species treated in the Central Basin & Range REA, with assessment approach identified. Landscape species are listed first; then the table is sorted by species found predominantly in upland habitats, by animals then plants, then by informal taxonomy and scientific name. Wetland associated species are listed secondly, animals then plants, by informal taxonomy and then by scientific name.

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Landscape	Birds	Cooper's Hawk	Accipiter cooperii	No	Yes	G5	CA		PS	1
Landscape	Birds	Sage Sparrow	Amphispiza belli	No	Yes	G5	NV, UT		MV	5
Landscape	Birds	Golden Eagle	Aquila chrysaetos	No	Yes	G5	CA	CA, UT	PS	15
Landscape	Birds	Ferruginous Hawk	Buteo regalis	No	Yes	G4	CA, ID, NV, UT	UT	PS	165
Landscape	Birds	Swainson's Hawk	Buteo swainsoni	No	Yes	G5	CA, ID, NV	CA	PS	161
Landscape	Birds	Greater Sage-Grouse	Centrocercus urophasianus	Yes	Yes	G3	CA, ID, NV, UT	CA, UT	HV	99
Landscape	Birds	Northern Harrier	Circus cyaneus	No	Yes	G5	CA			4
Landscape	Birds	Prairie Falcon	Falco mexicanus	No	Yes	G5	CA		PS	41
Landscape	Birds	Bald Eagle	Haliaeetus leucocephalus	No	Yes	G5	CA, ID, NV, UT	CA, UT	PS	121
Landscape	Birds	Loggerhead Shrike	Lanius ludovicianus	No	Yes	G4	CA, NV		PS	1
Landscape	Birds	Clark's Nutcracker	Nucifraga columbiana	No	Yes	G5				
Landscape	Birds	Sage Thrasher	Oreoscoptes montanus	No	Yes	G5	UT		MV	1
Landscape	Birds	Savannah Sparrow	Passerculus sandwichensis	No	Yes	G5				
Landscape	Birds	Brewer's Sparrow	Spizella breweri	No	Yes	G5	CA, ID, NV, UT		MV	13
Landscape	Birds	Columbian Sharp-tailed Grouse	Tympanuchus phasianellus columbianus	No	Yes	T3	CA, NV		MV	59
Landscape	Mammals	Pygmy Rabbit	Brachylagus idahoensis	No	Yes	G4	CA, ID, NV, UT	CA, UT	EV	330
Landscape	Mammals	Big Brown Bat	Eptesicus fuscus	No	No	G5		NV		48
Landscape	Mammals	White-tailed Jackrabbit	Lepus townsendii	No	Yes	G5			PS	26
Landscape	Mammals	Mule Deer	Odocoileus hemionus	No	Yes	G5	NV, UT	CBR, MBR	PS	
Landscape	Mammals	Desert Bighorn Sheep	Ovis canadensis nelsoni	No	Yes	T4	CA, NV	CA	PS	14
Landscape	Mammals	Brazilian Free-tailed Bat	Tadarida brasiliensis	No	Yes	G5			PS	53
Landscape	Mammals	Kit Fox	Vulpes macrotis	Yes	Yes	G4	NV, UT	UT	PS	89
Landscape	Reptiles	Northern Rubber Boa	Charina bottae	No	No	G5	UT		PS	46
Landscape	Reptiles	Great Basin Collared Lizard	Crotaphytus bicinctores	No	Yes	G5	ID, NV		PS	1
Landscape	Reptiles	Common Kingsnake	Lampropeltis getula	No	No	G5	UT			11
Landscape	Reptiles	Coachwhip	Masticophis flagellum	No	No	G5	UT			13
Landscape	Reptiles	Western Patch-nosed Snake	Salvadora hexalepis	No	No	G5	UT		PS	12
Landscape	Reptiles	Northern Sagebrush Lizard	Sceloporus graciosus graciosus	No	No	T5	CA	AZ, CA		2
Species generally found in upland habitats										
Local	Ants, Wasps, & Bees	Lassen Chrysidid Wasp	Argochrysis lassenae	No	No	G1				1
Coarse Filter	Ants, Wasps, & Bees	A Montane Ant	Formica microphthalma	No	No	G2				7
Assemblage	Ants, Wasps, & Bees	Dune Honey Ant	Myrmecocystus snellingi	No	No	G2				10
Local	Ants, Wasps, & Bees	An Ant	Neivamyrmex nyensis	No	No	G1				
Local	Ants, Wasps, & Bees	Borrego Parnopes Chrysidid Wasp	Parnopes borregoensis	No	No	G1				2
Local	Ants, Wasps, & Bees	An Ant	Stenamma wheelerorum	No	No	G1				2

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Coarse Filter	Birds	Northern Goshawk	Accipiter gentilis	No	Yes	G5	CA, NV, UT	CA, UT	MV	112
Coarse Filter	Birds	Sharp-shinned Hawk	Accipiter striatus	No	Yes	G5	CA		PS	
Coarse Filter	Birds	White-throated Swift	Aeronautes saxatalis	No	Yes	G5	NV		PS	
Local	Birds	Grasshopper Sparrow	Ammodramus savannarum	No	Yes	G5	CA, ID, UT	UT		16
Local	Birds	American Pipit	Anthus rubescens	No	Yes	G5				
Local	Birds	Short-eared Owl	Asio flammeus	No	Yes	G5	CA, ID, NV, UT	UT	PS	100
Local	Birds	Long-eared Owl	Asio otus	No	Yes	G5	CA			10
Local	Birds	Western Burrowing Owl	Athene cunicularia hypugaea	No	Yes	T4	NV	AZ	PS	230
Coarse Filter	Birds	Juniper Titmouse	Baeolophus ridgwayi	No	Yes	G5	ID			
Assemblage	Birds	Cassin's Finch	Carpodacus cassinii	No	Yes	G5	NV		PS	
Coarse Filter	Birds	Swainson's Thrush	Catharus ustulatus	No	Yes	G5			PS	
Local	Birds	Vaux's Swift	Chaetura vauxi	No	Yes	G5	CA			
Local	Birds	Lark Sparrow	Chondestes grammacus	No	Yes	G5	CA			
Local	Birds	Lesser Nighthawk	Chordeiles acutipennis	No	Yes	G5				5
Assemblage	Birds	Evening Grosbeak	Coccothraustes vespertinus	No	Yes	G5				11
Assemblage	Birds	Olive-sided Flycatcher	Contopus cooperi	No	Yes	G4	CA, NV		IL	
Assemblage	Birds	Dusky Grouse	Dendragapus obscurus	No	Yes	G5	NV		PS	
Coarse Filter	Birds	Black-throated Gray Warbler	Dendroica nigrescens	No	Yes	G5	UT			
Local	Birds	Bobolink	Dolichonyx oryzivorus	No	Yes	G5	NV, UT	UT	PS	33
Local	Birds	Gray Catbird	Dumetella carolinensis	No	Yes	G5				7
Local	Birds	Dusky Flycatcher	Empidonax oberholseri	No	Yes	G5	NV			
Coarse Filter	Birds	Gray Flycatcher	Empidonax wrightii	No	Yes	G5				2
Local	Birds	Merlin	Falco columbarius	No	Yes	G5	CA, ID			
Local	Birds	Peregrine Falcon	Falco peregrinus	No	Yes	G4	ID, NV, UT		PS	73
Coarse Filter	Birds	Pinyon Jay	Gymnorhinus cyanocephalus	No	Yes	G5	ID, NV		PS	11
Local	Birds	Yellow-breasted Chat	Icteria virens	No	Yes	G5	CA		PS	7
Local	Birds	Black Rosy-finch	Leucosticte atrata	No	Yes	G4	ID, NV, UT		HV	9
Local	Birds	gray-crowned rosy-finch	Leucosticte tephrocotis	No	Yes	G5	NV		HV	
Assemblage	Birds	Red Crossbill	Loxia curvirostra	No	Yes	G5	ID			
Coarse Filter	Birds	Lewis's Woodpecker	Melanerpes lewis	No	Yes	G4	CA, ID, NV, UT	UT	PS	14
Local	Birds	Lincoln's Sparrow	Melospiza lincolnii	No	Yes	G5				
Coarse Filter	Birds	MacGillivray's Warbler	Oporornis tolmiei	No	Yes	G5				
Coarse Filter	Birds	Mountain Quail	Oreortyx pictus	No	Yes	G5	ID, NV		PS	17
Assemblage	Birds	Flammulated Owl	Otus flammeolus	No	Yes	G4	CA, ID		PS	12
Local	Birds	Fox Sparrow	Passerella iliaca	No	Yes	G5	NV			
Coarse Filter	Birds	Blue Grosbeak	Passerina caerulea	No	Yes	G5	ID			30
Assemblage	Birds	Band-tailed Pigeon	Patagioenas fasciata	No	Yes	G4	UT		PS	23

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Local	Birds	White-headed Woodpecker	Picoides albolarvatus	No	Yes	G4	CA, ID, NV		PS	
Local	Birds	American Three-toed Woodpecker	Picoides dorsalis	No	Yes	G5	ID, UT	UT	IL	9
Coarse Filter	Birds	Downy Woodpecker	Picoides pubescens	No	Yes	G5				
Coarse Filter	Birds	Green-tailed Towhee	Pipilo chlorurus	No	Yes	G5			PS	
Coarse Filter	Birds	Black-capped Chickadee	Poecile atricapillus	No	Yes	G5	CA			
Coarse Filter	Birds	Vesper Sparrow	Pooecetes gramineus	No	Yes	G5	NV	NV		
Assemblage	Birds	Ruby-crowned Kinglet	Regulus calendula	No	Yes	G5				
Local	Birds	Golden-crowned Kinglet	Regulus satrapa	No	Yes	G5				
Local	Birds	Bank Swallow	Riparia riparia	No	Yes	G5	CA	CA	MV	6
Local	Birds	Broad-tailed Hummingbird	Selasphorus platycercus	No	Yes	G5	UT		PS	2
Local	Birds	Rufous Hummingbird	Selasphorus rufus	No	Yes	G5	CA, NV		PS	
Assemblage	Birds	Pygmy Nuthatch	Sitta pygmaea	No	Yes	G5	ID			
Coarse Filter	Birds	Red-naped Sapsucker	Sphyrapicus nuchalis	No	Yes	G5				
Coarse Filter	Birds	Red-breasted Sapsucker	Sphyrapicus ruber	No	Yes	G5	CA, NV		PS	
Coarse Filter	Birds	Williamson's Sapsucker	Sphyrapicus thyroideus	No	Yes	G5	UT		PS	10
Coarse Filter	Birds	Lesser Goldfinch	Spinus psaltria	No	Yes	G5	ID			
Coarse Filter	Birds	Chipping Sparrow	Spizella passerina	No	Yes	G5	CA			
Coarse Filter	Birds	Calliope Hummingbird	Stellula calliope	No	Yes	G5			PS	
Coarse Filter	Birds	Tree Swallow	Tachycineta bicolor	No	Yes	G5				
Coarse Filter	Birds	American Robin	Turdus migratorius	No	Yes	G5				
Coarse Filter	Birds	Eastern Kingbird	Tyrannus tyrannus	No	Yes	G5				22
Coarse Filter	Birds	Orange-crowned Warbler	Vermivora celata	No	Yes	G5				
Coarse Filter	Birds	Virginia's Warbler	Vermivora virginiae	No	Yes	G5	CA, ID, NV, UT		PS	1
Coarse Filter	Birds	Gray Vireo	Vireo vicinior	No	Yes	G4	CA, NV, UT	CA	PS	2
Coarse Filter	Birds	White-crowned Sparrow	Zonotrichia leucophrys	No	Yes	G5				
Local	Butterflies & Skippers	Desert Green Hairstreak	Callophrys comstocki	No	No	G2				
Local	Butterflies & Skippers	Small Wood-Nymph	Cercyonis oetus alkalorum	No	No	T1		NV		3
Local	Butterflies & Skippers		Cercyonis oetus pallescens	No	No	T1		NV		2
Local	Butterflies & Skippers	Carson Valley Wood Nymph	Cercyonis pegala carsonensis	No	No	T2		NV		32
Local	Butterflies & Skippers	White River Wood Nymph	Cercyonis pegala pluvialis	No	No	T2		NV		23
Local	Butterflies & Skippers	Giuliani's Blue	Euphilotes ancilla giulianii	No	No	T3		NV		7
Local	Butterflies & Skippers	Shield's Blue	Euphilotes ancilla shieldsi	No	No	T1		NV		6
Local	Butterflies & Skippers	Square Dotted Blue	Euphilotes battoides fusimaculata	No	No	T1		NV		2
Local	Butterflies & Skippers	Baking Powder Flat Blue	Euphilotes bernardino minuta	No	No	T1		NV		9
Local	Butterflies & Skippers	Dotted Blue	Euphilotes enoptes primavera	No	No	T1		NV		2
Local	Butterflies & Skippers	Sand Mountain Blue	Euphilotes pallescens arenamontana	No	No	T1		NV		5
Local	Butterflies & Skippers	Honey Lake Blue	Euphilotes pallescens calneva	No	No	T1		NV		5

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Local	Butterflies & Skippers	Mattoni's Blue	Euphilotes pallescens mattonii	No	No	T1		NV		11
Local	Butterflies & Skippers	Rice's Blue	Euphilotes pallescens ricei	No	No	T1		NV		14
Local	Butterflies & Skippers	Koret's Checkerspot	Euphydryas editha koreti	No	No	T3		NV		17
Local	Butterflies & Skippers	Mono Lake Checkerspot	Euphydryas editha monoensis	No	No	T2		NV		20
Local	Butterflies & Skippers	White Mountains Skipper	Hesperia miriamae longaevicola	No	No	T1		NV		21
Local	Butterflies & Skippers	Railroad Valley Skipper	Hesperia uncas fulvapalla	No	No	T1		NV		9
Local	Butterflies & Skippers	Railroad Valley Skipper	Hesperia uncas grandiosa	No	No	T1		NV		2
Local	Butterflies & Skippers	Small Blue	Philotiella speciosa septentrionalis	No	No	T1		NV		2
Local	Butterflies & Skippers	Steptoe Valley Checkerspot	Phyciodes cocyta arenacolor	No	No	T1		NV		6
Local	Butterflies & Skippers	San Emigdio Blue	Plebulina emigdionis	No	No	G2				1
Local	Butterflies & Skippers	Bleached Sandhill Skipper	Polites sabuleti sinemaculata	No	No	T1		NV		2
Local	Mammals	Pallid Bat	Antrozous pallidus	No	Yes	G5	CA	CA		86
Coarse Filter	Mammals	Ringtail	Bassariscus astutus	No	No	G5	NV		PS	6
Local	Mammals	Townsend's Big-eared Bat	Corynorhinus townsendii	No	Yes	G4	CA, ID, NV, UT	CA, UT	PS	262
Local	Mammals	Utah Prairie Dog	Cynomys parvidens	Yes	Yes	G1	UT			31
Assemblage	Mammals	Desert Kangaroo Rat	Dipodomys deserti	No	No	G5	NV, UT		PS	2
Local	Mammals	Merriam's Kangaroo Rat	Dipodomys merriami	Yes	No	G5				12
Coarse Filter	Mammals	Panamint Kangaroo Rat	Dipodomys panamintinus	No	No	G5	NV			
Coarse Filter	Mammals	Spotted Bat	Euderma maculatum	No	Yes	G4	CA, ID, NV, UT	CA, UT	PS	50
Assemblage	Mammals	Northern Flying Squirrel	Glaucomys sabrinus	No	Yes	G5	NV, UT		PS	21
Assemblage	Mammals	Wolverine	Gulo gulo	No	Yes	G4	CA, ID, UT			52
Assemblage	Mammals	Silver-haired Bat	Lasionycteris noctivagans	No	No	G5	CA		PS	52
Coarse Filter	Mammals	Western Red Bat	Lasiurus blossevillii	No	Yes	G5	CA, NV, UT	UT	PS	6
Assemblage	Mammals	Hoary Bat	Lasiurus cinereus	No	No	G5	CA, NV		IL	36
Local	Mammals	Sagebrush Vole	Lemmiscus curtatus	No	No	G5	NV		HV	
Local	Mammals	Sierra Nevada Snowshoe Hare	Lepus americanus tahoensis	No	Yes	T3	CA		PS	4
Local	Mammals	Canadian Lynx	Lynx canadensis	Yes	Yes	G5	ID, UT			1
Local	Mammals	Sierra Marten	Martes americana sierrae	No	No	T3	CA			38
Local	Mammals	Fisher - West Coast Distinct Population Segment	Martes pennanti pop. 1	Yes	No	T2				11
Assemblage	Mammals	Dark Kangaroo Mouse	Microdipodops megacephalus	No	Yes	G4	NV, UT	UT	HV	31
Assemblage	Mammals	Pale Kangaroo Mouse	Microdipodops pallidus	No	Yes	G3	NV		MV	2
Local	Mammals	Owens Valley Vole	Microtus californicus vallicola	No	No	T1	CA	CA		13
Local	Mammals	Pahranagat Valley Vole	Microtus montanus fucosus	No	Yes	T2	NV		PS	12
Local	Mammals	Western Small-footed Myotis	Myotis ciliolabrum	No	No	G5	CA, NV	AZ, CA	PS	139
Assemblage	Mammals	Long-eared Myotis	Myotis evotis	No	No	G5	CA	AZ, CA	IL	121
Assemblage	Mammals	Little Brown Myotis	Myotis lucifugus	No	No	G5	CA, NV	AZ	IL	26

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Local	Mammals	Fringed Myotis	Myotis thysanodes	No	Yes	G4	CA, ID, NV, UT	AZ, CA, UT	IL	45
Assemblage	Mammals	Long-legged Myotis	Myotis volans	No	No	G5	CA	AZ		162
Local	Mammals	Yuma Myotis	Myotis yumanensis	No	No	G5	CA, UT	CA		44
Local	Mammals	Cliff Chipmunk	Neotamias dorsalis	No	Yes	G5	ID			2
Local	Mammals	Least Chipmunk	Neotamias minimus	No	Yes	G5				
Local	Mammals	American Pika	Ochotona princeps	No	Yes	G5	NV, UT		MV	307
Local	Mammals	Western Pipistrelle	Parastrellus hesperus	No	Yes	G5				53
Local	Mammals	Brush Deermouse	Peromyscus boylii	No	No	G5	NV		PS	
Coarse Filter	Mammals	Picon Deermouse	Peromyscus truei	No	No	G5	ID			
Coarse Filter	Mammals	Broad-footed Mole	Scapanus latimanus	No	No	G5	NV		PS	
Assemblage	Mammals	Western Gray Squirrel	Sciurus griseus griseus	No	Yes	T5				
Local	Mammals	Mt. Lyell Shrew	Sorex lyelli	No	No	G2	CA			13
Coarse Filter	Mammals	Merriam's Shrew	Sorex merriami	No	No	G5	ID, UT			1
Local	Mammals	Merriam's Shrew	Sorex merriami leucogenys	No	No	T5	NV		PS	7
Coarse Filter	Mammals	montane shrew	Sorex monticolus	No	No	G5	NV		MV	
Local	Mammals	Preble's Shrew	Sorex preblei	No	Yes	G4	NV, UT	UT	PS	8
Local	Mammals	Inyo Shrew	Sorex tenellus	No	No	G3	NV		PS	10
Local	Mammals	Trowbridge's Shrew	Sorex trowbridgii	No	No	G5	NV		PS	3
Coarse Filter	Mammals	Vagrant Shrew	Sorex vagrans	No	No	G5	NV		PS	
Local	Mammals	Wyoming Ground Squirrel	Spermophilus elegans	No	No	G5	UT			
Local	Mammals	Piute Ground Squirrel	Spermophilus mollis	No	No	G5	ID			1
Coarse Filter	Mammals	Rock Squirrel	Spermophilus variegatus	No	Yes	G5	ID			5
Local	Mammals	American Badger	Taxidea taxus	No	No	G5	CA			15
Local	Mammals	Botta's Pocket Gopher	Thomomys bottae	No	No	G5			MV	2
Local	Mammals	Fish Spring Pocket Gopher	Thomomys bottae abstrusus	No	No	TH	NV		MV	1
Local	Mammals	San Antonio Pocket Gopher	Thomomys bottae curtatus	No	No	TH	NV		MV	2
Local	Mammals	Mountain Pocket Gopher	Thomomys monticola	No	No	G5	NV		PS	3
Local	Mammals	Townsend's Pocket Gopher	Thomomys townsendii	No	No	G4	ID			
Local	Mammals	American Black Bear	Ursus americanus	No	Yes	G5				
Local	Mammals	Red Fox	Vulpes vulpes	No	Yes	G5				
Local	Mammals	Sierra Nevada Red Fox	Vulpes vulpes necator	No	Yes	T2	CA, NV		PS	21
Coarse Filter	Mammals	Western Jumping Mouse	Zapus princeps	No	No	G5	NV		PS	39
Local	Millipedes & Centipedes	A Millipede	Polydesmus cavicola	No	No	G1				1
Assemblage	Other Beetles	Crescent-dune Aegialian Scarab Beetle	Aegialia crescenta	No	No	G1				2
Assemblage	Other Beetles	Hardy's Aegialian Scarab Beetle	Aegialia hardyi	No	No	G1				5
Local	Other Beetles	Crescent Dune Aphodius Scarab Beetle	Aphodius sp. 2	No	No	G1		NV		

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Local	Other Beetles	Sand Mountain Aphodius Scarab Beetle	Aphodius sp. 3	No	No	G1		NV		
Assemblage	Other Beetles	A Beetle	Coenonycha pygmaea	No	No	G1				5
Local	Other Beetles	Nelson's Miloderes Weevil	Miloderes nelsoni	No	No	G2				2
Local	Other Beetles	Saline Valley Snow-front Scarab Beetle	Polyphylla anteronivea	No	No	G1				1
Local	Other Beetles	Spotted Warner Valley Dunes Scarab Beetle	Polyphylla avittata	No	No	G2				2
Assemblage	Other Beetles	Crescent Dune Serican Scarab Beetle	Serica ammomenisco	No	No	G1				2
Assemblage	Other Beetles	Humboldt Serican Beetle	Serica humboldti	No	No	G1				2
Assemblage	Other Beetles	Sand Mountain Serican Scarab Beetle	Serica psammobunus	No	No	G1				5
Local	Reptiles	Plateau Striped Whiptail	Aspidoscelis velox	No	No	G5	UT			5
Coarse Filter	Reptiles	Zebra-tailed Lizard	Callisaurus draconoides	No	Yes	G5	UT	UT		28
Local	Reptiles	Speckled Rattlesnake	Crotalus mitchellii	No	Yes	G5	UT	UT	PS	1
Local	Reptiles	Ring-necked Snake	Diadophis punctatus	No	Yes	G5	ID, UT		MV	28
Local	Reptiles	Sierra Alligator Lizard	Elgaria coerulea palmeri	No	Yes	T4	NV		PS	8
Local	Reptiles	Long-nosed Leopard Lizard	Gambelia wislizenii	No	No	G5	NV, UT		PS	19
Coarse Filter	Reptiles	Sonoran Mountain Kingsnake	Lampropeltis pyromelana	No	Yes	G4	NV, UT		HV	19
Local	Reptiles	Milksnake	Lampropeltis triangulum	No	No	G5	UT			33
Local	Reptiles	Pygmy Horned Lizard	Phrynosoma douglasii	No	No	G5	NV		MV	
Local	Reptiles	Short-horned Lizard	Phrynosoma hernandesi	No	No	G5	NV		PS	
Local	Reptiles	Desert Horned Lizard	Phrynosoma platyrhinos	No	No	G5	NV		PS	3
Coarse Filter	Reptiles	Western Skink	Plestiodon skiltonianus	No	No	G5	UT			
Local	Reptiles	Long-nosed Snake	Rhinocheilus lecontei	No	Yes	G5	ID, UT		PS	18
Local	Reptiles	Common Chuckwalla	Sauromalus ater	No	Yes	G5	CA, NV, UT	UT	MV	9
Local	Reptiles	Groundsnake	Sonora semiannulata	No	Yes	G5	ID, UT			13
Local	Reptiles	Smith's Black-headed Snake	Tantilla hobartsmithi	No	No	G5	UT		PS	9
Local	Reptiles	Common Gartersnake	Thamnophis sirtalis	No	No	G5	UT		PS	31
Local	Spiders & other Chelicerates	A Cave Obligate Harvestman	Hesperonemastoma packardi	No	No	G1				1
Local	Terrestrial Snails	Sierra Ambersnail	Catinella stretchiana	No	No	G3				
Local	Terrestrial Snails	Cross Snaggletooth	Gastrocopta quadridens	No	No	G2				
Local	Terrestrial Snails	Southern Tightcoil	Ogaridiscus subrupicola	No	Yes	G1				1
Local	Terrestrial Snails	Eureka Mountainsnail	Oreohelix eurekensis	No	Yes	G1				4
Local	Terrestrial Snails	Lyrate Mountainsnail	Oreohelix haydeni	No	Yes	G2				19
Assemblage	Terrestrial Snails	Whitepine Mountainsnail	Oreohelix hemphilli	No	No	G2				2
Local	Terrestrial Snails	Mill Creek Mountainsnail	Oreohelix howardi	No	No	G1				4

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Assemblage	Terrestrial Snails	Goshute Mountainsnail	Oreohelix loisae	No	No	G2				7
Assemblage	Terrestrial Snails	Schell Creek Mountainsnail	Oreohelix nevadensis	No	No	G1				10
Local	Terrestrial Snails	Brian Head Mountainsnail	Oreohelix parawanensis	No	Yes	G1				2
Local	Terrestrial Snails	Deseret Mountainsnail	Oreohelix peripherica	No	Yes	G2				15
Local	Terrestrial Snails	Ogden Rocky Mountainsnail	Oreohelix peripherica wasatchensis	No	Yes	T1				1
Local	Terrestrial Snails	Santa Rita Ambersnail	Succinea grosvenori	No	No	G5		AZ		3
Local	Terrestrial Snails	Rustic Ambersnail	Succinea rusticana	No	No	G2		AZ		2
Local	Tiger Beetles	Mojave Giant Tiger Beetle	Amblycheila schwarzi	No	No	G3				1
Local	Tiger Beetles	Maricopa Tiger Beetle	Cicindela oregona maricopa	No	No	T3		AZ		14
Coarse Filter	Conifers & relatives	Bristlecone Pine	Pinus longaeva	No	Yes	G4				
Local	Ferns & relatives	Common Moonwort	Botrychium lunaria	No	No	G5			HV	
Local	Flowering Plants	Passey's Onion	Allium passeyi	No	No	G1				5
Local	Flowering Plants	Wheeler's Angelica	Angelica wheeleri	No	No	G2				10
Local	Flowering Plants	Beckwith's Rockcress	Arabis beckwithii	No	No	G2				4
Coarse Filter	Flowering Plants	Bodie Hills Rockcress	Arabis bodiensis	No	No	G2		CA, NV		51
Local	Flowering Plants	Unequal Rockcress	Arabis dispar	No	No	G3				27
Local	Flowering Plants	Grouse Creek Rockcress	Arabis falcatoria	No	No	G1				9
Local	Flowering Plants	Elko Rockcress	Arabis falcifructa	No	No	G1		NV		2
Local	Flowering Plants	Wasatch Range Rockcress	Arabis lasiocarpa	No	No	G3				20
Local	Flowering Plants	Ophir Rockcress	Arabis ophira	No	No	G1				41
Local	Flowering Plants	Pinzl's Rockcress	Arabis pinzliae	No	No	G2				20
Local	Flowering Plants	Darwin Rock Cress	Arabis pulchra var. munciensis	No	No	T4		CA		5
Local	Flowering Plants	Shockley's Rockcress	Arabis shockleyi	No	No	G3				53
Local	Flowering Plants	Eastwood's Milkweed	Asclepias eastwoodiana	No	No	G2		NV		113
Local	Flowering Plants	Purple Milkvetch	Astragalus agrestis	No	No	G5		CA		1
Local	Flowering Plants		Astragalus ampullarioides	Yes	No	G1				5
Local	Flowering Plants	Silverleaf Milkvetch	Astragalus argophyllus var. argophyllus	No	No	T4		CA		9
Local	Flowering Plants		Astragalus avonensis	No	No	G1				1
Local	Flowering Plants	Beatley's Milkvetch	Astragalus beatleyae	No	No	G2				82
Assemblage	Flowering Plants	Callaway Milkvetch	Astragalus callithrix	No	No	G3			MV	29
Local	Flowering Plants	Ground-crescent Milkvetch	Astragalus chamaemeniscus	No	No	G2				3
Local	Flowering Plants	Cima Milkvetch	Astragalus cimae var. cimae	No	No	T2		NV		6
Coarse Filter	Flowering Plants	Margaret's Rushy Milkvetch	Astragalus convallarius var. margaretiae	No	No	T2		NV		25
Local	Flowering Plants	Pagumpa Milkvetch	Astragalus ensiformis var. gracilior	No	No	T1		NV		2
Local	Flowering Plants	Peck Station Milkvetch	Astragalus eurylobus	No	No	G2		NV		14
Assemblage	Flowering Plants	Geyer's Milkvetch	Astragalus geyeri var. geyeri	No	No	T4		CA		18
Local	Flowering Plants	Gilman's Milkvetch	Astragalus gilmanii	No	No	G2				7

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Coarse Filter	Flowering Plants	Inyo Milkvetch	Astragalus inyoensis	No	No	G3				2
Local	Flowering Plants	Long Valley Milkvetch	Astragalus johannis-howellii	No	Yes	G2		CA, NV		29
Coarse Filter	Flowering Plants	Fish Slough Milkvetch	Astragalus lentiginosus var. piscinensis	Yes	No	T1		CA		4
Local	Flowering Plants	Mono Milkvetch	Astragalus monoensis	No	Yes	G2		CA		24
Assemblage	Flowering Plants	Charleston Milkvetch	Astragalus oophorus var. clokeyanus	No	No	T2		NV		52
Assemblage	Flowering Plants	Lavin's Egg Milkvetch	Astragalus oophorus var. lavinii	No	No	T2		CA, NV		87
Local	Flowering Plants	Pink Egg Milkvetch	Astragalus oophorus var. lonchocalyx	No	No	T2		NV		31
Local	Flowering Plants	Rydberg's Milkvetch	Astragalus perianus	No	No	G3				4
Local	Flowering Plants	Pinyon Milkvetch	Astragalus pinonis	No	No	G2				4
Assemblage	Flowering Plants	Tonopah Milkvetch	Astragalus pseudiodanthus	No	No	G2		CA, NV		41
Coarse Filter	Flowering Plants	Winged Milkvetch	Astragalus pterocarpus	No	No	G3				55
Local	Flowering Plants	Pulsifer's Milkvetch	Astragalus pulsiferae var. coronensis	No	No	T3		CA		2
Local	Flowering Plants	Pulsifer's Milk Vetch	Astragalus pulsiferae var. pulsiferae	No	No	T2		CA, NV		34
Local	Flowering Plants	Lamoille Canyon Milkvetch	Astragalus robbinsii var. occidentalis	No	No	T2		NV		77
Local	Flowering Plants	Silver Reef Milkvetch	Astragalus straturensis	No	No	G2				22
Local	Flowering Plants	Toquima Milkvetch	Astragalus toquimanus	No	No	G2		NV		33
Local	Flowering Plants	Currant Milkvetch	Astragalus uncialis	No	No	G2		NV		36
Local	Flowering Plants	Welsh's Milkvetch	Astragalus welshii	No	No	G2				2
Coarse Filter	Flowering Plants	Mud-flat Milkvetch	Astragalus yoder-williamsii	No	Yes	G3		NV		3
Coarse Filter	Flowering Plants	Bonneville Saltbush	Atriplex bonnevillensis	No	No	G2				
Local	Flowering Plants	Inyo County Mariposa-lily	Calochortus excavatus	No	No	G3		CA		67
Local	Flowering Plants	Intermountain Evening-primrose	Camissonia megalantha	No	No	G3		NV		32
Coarse Filter	Flowering Plants	Nevada Evening-primrose	Camissonia nevadensis	No	No	G3				24
Local	Flowering Plants	Tushar Paintbrush	Castilleja parvula	No	No	G2				13
Local	Flowering Plants	Reveal's Indian-paintbrush	Castilleja revealii	No	No	G2				3
Local	Flowering Plants	Barneby's Caulanthus	Caulanthus barnebyi	No	No	G2				72
Local	Flowering Plants	Jaeger's Caulostramina	Caulostramina jaegeri	No	No	G1		CA		9
Local	Flowering Plants	Barren Valley Collomia	Collomia renacta	No	No	G1		NV		3
Local	Flowering Plants	Compact Cat's-eye	Cryptantha compacta	No	No	G2				14
Local	Flowering Plants	Yellow-white Catseye	Cryptantha ochroleuca	No	No	G1				1
Local	Flowering Plants	Bristle-cone Cryptantha	Cryptantha roosiorum	No	Yes	G1		CA		9
Local	Flowering Plants	Welsch's Cat's-eye	Cryptantha welshii	No	No	G3				1027
Assemblage	Flowering Plants	Bodie Hills Cusickiella	Cusickiella quadricostata	No	No	G2		CA		50
Local	Flowering Plants	Intermountain Wavewing	Cymopterus basalticus	No	No	G2		NV		26
Coarse Filter	Flowering Plants	Gray Wavewing	Cymopterus cinerarius	No	No	G2				7
Local	Flowering Plants	Coulter's Biscuitroot	Cymopterus coulteri	No	No	G3				35
Local	Flowering Plants	Toiyabe Spring-parsley	Cymopterus goodrichii	No	No	G1		NV		19

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Local	Flowering Plants	Jone's Wavewing	Cymopterus jonesii	No	No	G2				16
Local	Flowering Plants	Cedar Breaks Biscuitroot	Cymopterus minimus	No	No	G1				3
Local	Flowering Plants	Sanicle Biscuitroot	Cymopterus ripleyi var. saniculoides	No	No	T3		CA		59
Local	Flowering Plants	Clustered Lady's-slipper	Cypripedium fasciculatum	No	No	G4		CA		4
Local	Flowering Plants	July Gold	Dedeckera eurekensis	No	Yes	G2		CA		27
Assemblage	Flowering Plants	Desert Whitlow-grass	Draba arida	No	No	G2				50
Local	Flowering Plants	White Mountain Draba	Draba californica	No	No	G3				2
Local	Flowering Plants	Sweetwater Mountains Draba	Draba incrassata	No	No	G3				20
Local	Flowering Plants	Kass's Rockcress	Draba kassii	No	No	G1				4
Local	Flowering Plants	White Mountains draba	Draba monoensis	No	No	G1				10
Local	Flowering Plants	Pennell's Draba	Draba pennellii	No	No	G2				30
Coarse Filter	Flowering Plants	Mountain Whitlow-grass	Draba sphaeroides	No	No	G2				24
Local	Flowering Plants	White Mountain Draba	Draba subumbellata	No	No	G3				5
Local	Flowering Plants	Engelmann's Hedgehog Cactus	Echinocereus engelmannii var. armatus	No	Yes	T2				
Assemblage	Flowering Plants	Nevada Willowherb	Epilobium nevadense	No	No	G2		NV		23
Local	Flowering Plants	Gilman Goldenweed	Ericameria gilmanii	No	No	G1		CA		1
Assemblage	Flowering Plants	Cave Mountain Fleabane	Erigeron cavernensis	No	No	G2				12
Local	Flowering Plants	Mound Daisy	Erigeron compactus	No	No	G2				16
Local	Flowering Plants	Starved Daisy	Erigeron miser	No	No	G2				1
Assemblage	Flowering Plants	Sheep Fleabane	Erigeron ovinus	No	No	G2		NV		18
Local	Flowering Plants	Ibex Buckwheat	Eriogonum ammophilum	No	No	G1				18
Local	Flowering Plants	Wind-loving Buckwheat	Eriogonum anemophilum	No	No	G2		NV		86
Local	Flowering Plants	Ruby Valley Buckwheat	Eriogonum argophyllum	No	Yes	G1				2
Assemblage	Flowering Plants	Beatley's Buckwheat	Eriogonum beatleyae	No	No	G2		NV		89
Assemblage	Flowering Plants	Darin Buckwheat	Eriogonum concinnum	No	No	G2		NV		36
Local	Flowering Plants	Darrow's Buckwheat	Eriogonum darrovii	No	No	G2				23
Assemblage	Flowering Plants	Churchill Narrows Buckwheat	Eriogonum diatomaceum	Yes	Yes	G1		NV		70
Local	Flowering Plants	Limestone Buckwheat	Eriogonum eremicum	No	No	G2				21
Assemblage	Flowering Plants	Holmgren's Buckwheat	Eriogonum holmgrenii	No	No	G1				17
Local	Flowering Plants	Lewis' Buckwheat	Eriogonum lewisii	No	No	G2		NV		81
Local	Flowering Plants	Logan Buckwheat	Eriogonum loganum	No	No	G2				11
Local	Flowering Plants	Panamint Mountains Buckwheat	Eriogonum microthecum var. panamintense	No	No	T2		CA		4
Local	Flowering Plants	Slender Buckwheat	Eriogonum microthecum var. schoolcraftii	No	No	T2		CA, NV		13
Local	Flowering Plants	Son's Buckwheat	Eriogonum natum	No	No	G2				15
Local	Flowering Plants	Deeth buckwheat	Eriogonum nutans var. glabratum	No	No	T2		NV		19
Local	Flowering Plants	Wire-stem Buckwheat	Eriogonum pharnaceoides var. cervinum	No	No	T2		NV		16

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Local	Flowering Plants	A Buckwheat	Eriogonum phoeniceum	No	No	G1				6
Local	Flowering Plants	Altered Andesite Buckwheat	Eriogonum robustum	No	No	G2		NV		410
Local	Flowering Plants	Lahontan Basin Buckwheat	Eriogonum rubricaule	No	No	G3				12
Local	Flowering Plants	Frisco Buckwheat	Eriogonum soredium	No	No	G1				6
Assemblage	Flowering Plants	Tiehm's Buckwheat	Eriogonum tiehmii	No	No	G1		NV		31
Local	Flowering Plants	Viviparous Foxtail Cactus	Escobaria vivipara var. rosea	No	Yes	T3				
Assemblage	Flowering Plants	Sunnyside Green-gentian	Frasera gypsicola	No	Yes	G1		NV	HV	105
Local	Flowering Plants	Kingston Bedstraw	Galium hilendiae ssp. kingstonense	No	No	T2		CA		10
Local	Flowering Plants	Northern Gentian	Gentianella amarella	No	No	G5			MV	
Assemblage	Flowering Plants	Nye Gilia	Gilia nyensis	No	No	G3				77
Local	Flowering Plants	Goldenrod Snakeweed	Gutierrezia petradoria	No	No	G3				24
Local	Flowering Plants	Deep Creek Stickseed	Hackelia ibapensis	No	No	G1				2
Local	Flowering Plants	Sharsmith's Stickseed	Hackelia sharsmithii	No	No	G3				26
Assemblage	Flowering Plants	Utah Sunflower	Helianthus deserticola	No	No	G2				38
Local	Flowering Plants	White Mountains Horkelia	Horkelia hispidula	No	No	G2				21
Coarse Filter	Flowering Plants	Sierra Valley Ivesia	Ivesia aperta var. aperta	No	No	T2		CA, NV		72
Assemblage	Flowering Plants	Rock Purpusia	Ivesia arizonica var. saxosa	No	No	T1		NV		10
Coarse Filter	Flowering Plants	King's Ivesia	Ivesia kingii var. kingii	No	No	T2		CA		15
Local	Flowering Plants	Plumas Ivesia	Ivesia sericoleuca	No	No	G2		CA		28
Assemblage	Flowering Plants	Webber Ivesia	Ivesia webberi	Yes	Yes	G2		CA, NV		46
Assemblage	Flowering Plants	Waxflower	Jamesia tetrapetala	No	No	G2		NV		42
Local	Flowering Plants	Ostler's Pepper-grass	Lepidium ostleri	No	No	G1				4
Assemblage	Flowering Plants	Owyhee Prickly-phlox	Leptodactylon glabrum	No	No	G2		NV		6
Local	Flowering Plants	Tunnel Springs Mountain Bladderpod	Lesquerella goodrichii	No	No	G2				5
Assemblage	Flowering Plants	Hitchcock's Bladderpod	Lesquerella hitchcockii	No	No	G3				23
Local	Flowering Plants	Snake Range Bladderpod	Lesquerella pendula	No	No	G2				38
Local	Flowering Plants	Bryce Bladderpod	Lesquerella rubicundula	No	No	G3				4
Local	Flowering Plants	Maguire's Bitteroot	Lewisia maguirei	No	No	G1				31
Local	Flowering Plants	Sage-like Loeflingia	Loeflingia squarrosa ssp. artemisiarum	No	No	T2		NV		21
Assemblage	Flowering Plants	Packard's Desert-parsley	Lomatium packardiae	No	No	G2		NV		3
Local	Flowering Plants	Mono Lake Lupine	Lupinus duranii	No	No	G2		CA		36
Local	Flowering Plants	Holmgren Lupine	Lupinus holmgrenianus	No	No	G2		NV		9
Local	Flowering Plants	Mcgee Meadows Lupine	Lupinus magnificus var. hesperius	No	No	T2		CA		2
Local	Flowering Plants	Father Crowley's Lupine	Lupinus padre-crowleyi	No	Yes	G2				11
Local	Flowering Plants	lilliput lupine	Lupinus uncialis	No	No	G4		CA		
Assemblage	Flowering Plants	Pioche Blazingstar	Mentzelia argillicola	No	No	G1		NV		9

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Local	Flowering Plants	Arapien Stickleaf	Mentzelia argillosa	No	No	G2				17
Local	Flowering Plants	Inyo balzingstar	Mentzelia inyoensis	No	No	G2		CA		17
Assemblage	Flowering Plants	Smooth Stickleaf	Mentzelia mollis	No	No	G2		NV		6
Assemblage	Flowering Plants		Mentzelia tiehmii	No	No	G1		NV		227
Local	Flowering Plants	Eggleaf Monkeyflower	Mimulus ovatus	No	No	G1				31
Local	Flowering Plants	Bashful Four-o'clock	Mirabilis pudica	No	No	G3				10
Local	Flowering Plants	Rydberg's Musineon	Musineon lineare	No	No	G2				47
Local	Flowering Plants	Sand Cholla	Opuntia pulchella	No	Yes	G4		NV		115
Assemblage	Flowering Plants	Nevada Oryctes	Oryctes nevadensis	No	No	G2		NV	MV	179
Local	Flowering Plants	Beaver Mountain Groundsel	Packera castoreus	No	No	G1				3
Local	Flowering Plants	Podunk Groundsel	Packera malmstenii	No	No	G1				2
Local	Flowering Plants	Ligulate Feverfew	Parthenium ligulatum	No	No	G3		NV		2
Local	Flowering Plants	dwarf lousewort	Pedicularis centranthera	No	No	G4		CA		
Local	Flowering Plants	Simpson's Hedgehog Cactus	Pediocactus simpsonii	No	Yes	G4				3
Assemblage	Flowering Plants	Dune Beardtongue	Penstemon arenarius	No	No	G2		NV		67
Local	Flowering Plants	Red Canyon Beardtongue	Penstemon bracteatus	No	No	G2				3
Local	Flowering Plants	Tunnel Springs Beardtongue	Penstemon concinnus	No	No	G3		NV		26
Local	Flowering Plants	Cordelia's Penstemon	Penstemon floribundus	No	No	G1		NV		56
Local	Flowering Plants	Ben Franklin's Beardtongue	Penstemon franklinii	No	No	G1				3
Local	Flowering Plants	Charleston Beardtongue	Penstemon leiophyllus var. francisci-pennellii	No	No	T2		NV		17
Local	Flowering Plants	Mt. Moriah Beardtongue	Penstemon moriahensis	No	No	G1				28
Local	Flowering Plants	Low Beardtongue	Penstemon nanus	No	No	G3				43
Assemblage	Flowering Plants	Pahute Mesa Beardtongue	Penstemon pahutensis	No	No	G3		NV		103
Coarse Filter	Flowering Plants	Lahontan Beardtongue	Penstemon palmeri var. macranthus	No	No	T2		NV		47
Local	Flowering Plants	Petiolate Beardtongue	Penstemon petiolatus	No	No	G2		AZ		8
Local	Flowering Plants	Pinyon Penstemon	Penstemon pinorum	No	No	G1				10
Local	Flowering Plants	Broadleaf Beardtongue	Penstemon platyphyllus	No	No	G2				33
Assemblage	Flowering Plants	Kawich Range Beardtongue	Penstemon pudicus	No	No	G1		NV		16
Assemblage	Flowering Plants	Rhizome Beardtongue	Penstemon rhizomatosus	No	No	G1				17
Local	Flowering Plants	Wassuk Beardtongue	Penstemon rubicundus	No	No	G2		NV		45
Local	Flowering Plants	Tidestrom Beardtongue	Penstemon tidestromii	No	No	G2				14
Local	Flowering Plants	Shoshone Beardtongue	Penstemon tiehmii	No	No	G1		NV		8
Local	Flowering Plants	Tushar Range Beardtongue	Penstemon tusharensis	No	No	G2				5
Local	Flowering Plants	Ward Beardtongue	Penstemon wardii	No	No	G2				49
Local	Flowering Plants	Inyo Rock Daisy	Perityle inyoensis	No	No	G2		CA		6
Local	Flowering Plants	Hanaupah rock daisy	Perityle villosa	No	No	G1		CA		1

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Assemblage	Flowering Plants	a Phacelia	Phacelia filiae	No	No	G2		NV		10
Local	Flowering Plants	Southwestern Phacelia	Phacelia glaberrima	No	No	G3			MV	
Local	Flowering Plants	Inconspicuous Scorpionweed	Phacelia inconspicua	No	Yes	G2		NV		7
Local	Flowering Plants	Inyo Phacelia	Phacelia inyoensis	No	No	G3		CA		20
Assemblage	Flowering Plants	Mono County Phacelia	Phacelia monoensis	No	No	G3		CA		72
Local	Flowering Plants	Death Valley Roundleaf Phacelia	Phacelia mustelina	No	No	G2		CA, NV		17
Local	Flowering Plants	Utah Phacelia	Phacelia utahensis	No	No	G2				11
Local	Flowering Plants	Clustered Popcorn-flower	Plagiobothrys glomeratus	No	No	G2		NV		28
Local	Flowering Plants	Parish's Popcorn-flower	Plagiobothrys parishii	No	No	G1				14
Local	Flowering Plants	Mason's Skypilot	Polemonium chartaceum	No	No	G1				23
Local	Flowering Plants	Spiny Milkwort	Polygala heterorhyncha	No	No	G3				11
Assemblage	Flowering Plants	Cottam's Potentilla	Potentilla cottamii	No	No	G1		NV		11
Local	Flowering Plants	Morefield's Cinquefoil	Potentilla morefieldii	No	No	G1				24
Assemblage	Flowering Plants	Ruby Mountains Primrose	Primula capillaris	No	No	G1				16
Local	Flowering Plants	House Range Primrose	Primula domensis	No	No	G1				5
Assemblage	Flowering Plants	Nevada Primrose	Primula nevadensis	No	No	G2				42
Assemblage	Flowering Plants	King's Indigo-bush	Psorothamnus kingii	No	No	G3			MV	20
Local	Flowering Plants	Snow Willow	Salix nivalis	No	No	G5			EV	
Local	Flowering Plants	Blaine's Pincushion	Sclerocactus blainei	No	Yes	G1		NV		24
Local	Flowering Plants	Nye County Fish-hook Cactus	Sclerocactus nyensis	No	Yes	G1		NV		24
Local	Flowering Plants	Mohave Fishhook Cactus	Sclerocactus polyancistrus	No	Yes	G4				46
Local	Flowering Plants	Great Basin Fishhook Cactus	Sclerocactus pubispinus	No	Yes	G4		NV		53
Local	Flowering Plants	Schlesser's Pincushion	Sclerocactus schlesseri	No	Yes	G1		NV		38
Local	Flowering Plants	Desert Valley Fishhook Cactus	Sclerocactus spinosior	No	No	G2				25
Assemblage	Flowering Plants	Mono Ragwort	Senecio pattersonensis	No	No	G2				15
Coarse Filter	Flowering Plants	Owens Valley Checker-mallow	Sidalcea covillei	No	Yes	G3		CA		41
Local	Flowering Plants	Jan's Catchfly	Silene nachlingerae	No	No	G2		NV		52
Local	Flowering Plants	Peterson's Catchfly	Silene petersonii	No	No	G2				13
Local	Flowering Plants	Nye County Smelowskia	Smelowskia holmgrenii	No	No	G2		NV		43
Local	Flowering Plants	Jone's Globemallow	Sphaeralcea caespitosa	No	No	G2				12
Local	Flowering Plants	Jone's Globemallow	Sphaeralcea caespitosa var. williamsiae	No	No	T2		NV		47
Local	Flowering Plants		Stipa shoshoneana	No	No	G2				2
Local	Flowering Plants	Masonic Mountain Jewelflower	Streptanthus oliganthus	No	No	G2		CA		51
Local	Flowering Plants	Tiehm's Stroganowia	Stroganowia tiehmii	No	No	G2		NV		80
Local	Flowering Plants	Alpine Goldenweed	Tonestus alpinus	No	No	G2				26
Local	Flowering Plants	Granite Haplopappus	Tonestus graniticus	No	No	G1		NV		3
Local	Flowering Plants	Charleston Ground-daisy	Townsendia jonesii var. tumulosa	No	No	T3		NV		103

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Local	Flowering Plants	Currant Summit Clover	Trifolium andinum var. podocephalum	No	No	T1		NV		8
Local	Flowering Plants	Dedecker's Clover	Trifolium dedeckerae	No	No	G2		CA		11
Local	Flowering Plants	Frisco Clover	Trifolium friscanum	No	No	G1				6
Assemblage	Flowering Plants	Leiberg's Clover	Trifolium leibergii	No	No	G2				32
Local	Flowering Plants	Rollins Clover	Trifolium rollinsii	No	No	G2				39
Assemblage	Flowering Plants	Rock Violet	Viola lithion	No	No	G1		NV		12
Local	Mosses	Meesia Moss	Meesia triquetra	No	No	G5			EV	
Local	Mosses		Orthotrichum spjutii	No	No	G1				1
Species generally found in wetland habitats										
Coarse Filter	Amphibians	Inyo Mountains Salamander	Batrachoseps campi	No	No	G2	CA	CA		19
Coarse Filter	Amphibians	Western Toad	Bufo boreas	No	Yes	G4	UT	UT		90
Local	Amphibians	Yosemite Toad	Bufo canorus	Yes	No	G2	CA			97
Local	Amphibians	Black Toad	Bufo exsul	No	Yes	G1	CA	CA		6
Coarse Filter	Amphibians	Mount Lyell Salamander	Hydromantes platycephalus	No	No	G3	CA			17
Coarse Filter	Amphibians	Owens Valley Web-toed Salamander	Hydromantes sp. 1	No	No	G1	CA			2
Coarse Filter	Amphibians	Pacific Chorus Frog	Pseudacris regilla	No	No	G5	UT			
Coarse Filter	Amphibians	Columbia Spotted Frog	Rana luteiventris	Yes	Yes	G4	ID, NV, UT	UT	HV	27
Coarse Filter	Amphibians	Columbia Spotted Frog - Great Basin	Rana luteiventris pop. 3	Yes	Yes	T2				270
Coarse Filter	Amphibians	Northern Leopard Frog	Rana pipiens	No	Yes	G5	CA, ID, NV, UT	UT	PS	175
Local	Amphibians	Sierra Nevada Yellow-legged Frog	Rana sierrae	No	No	G1	NV		PS	
Coarse Filter	Amphibians	Great Basin Spadefoot	Spea intermontana	No	No	G5		CA	MV	
Coarse Filter	Birds	Clark's Grebe	Aechmophorus clarkii	No	Yes	G5	ID, NV		PS	
Coarse Filter	Birds	Western Grebe	Aechmophorus occidentalis	No	Yes	G5	ID, NV		PS	
Coarse Filter	Birds	Wood Duck	Aix sponsa	No	Yes	G5				
Assemblage	Birds	Northern Pintail	Anas acuta	No	Yes	G5	ID, NV		PS	
Assemblage	Birds	American Wigeon	Anas americana	No	Yes	G5				
Assemblage	Birds	Northern Shoveler	Anas clypeata	No	Yes	G5				
Assemblage	Birds	Cinnamon Teal	Anas cyanoptera	No	Yes	G5	NV		PS	
Assemblage	Birds	Blue-winged Teal	Anas discors	No	Yes	G5				
Local	Birds	Great Egret	Ardea alba	No	Yes	G5	CA, ID			14
Local	Birds	Great Blue Heron	Ardea herodias	No	Yes	G5	CA			
Assemblage	Birds	Lesser Scaup	Aythya affinis	No	Yes	G5	ID			
Assemblage	Birds	Redhead	Aythya americana	No	Yes	G5	NV		PS	
Assemblage	Birds	Canvasback	Aythya valisineria	No	Yes	G5	CA, NV		PS	
Local	Birds	American Bittern	Botaurus lentiginosus	No	Yes	G4	CA		MV	
Assemblage	Birds	Canada Goose	Branta canadensis	No	Yes	G5				

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Coarse Filter	Birds	Cattle Egret	Bubulcus ibis	No	Yes	G5	ID			1
Assemblage	Birds	Barrow's Goldeneye	Bucephala islandica	No	Yes	G5	CA			
Coarse Filter	Birds	Green Heron	Butorides virescens	No	Yes	G5				3
Assemblage	Birds	Least Sandpiper	Calidris minutilla	No	Yes	G5	NV		PS	
Coarse Filter	Birds	Western Snowy Plover	Charadrius alexandrinus nivosus	No	Yes	T3	CA, NV		MV	118
Coarse Filter	Birds	Mountain Plover	Charadrius montanus	Yes	Yes	G3	CA, UT	AZ, CA, UT		
Coarse Filter	Birds	Black Tern	Chlidonias niger	No	Yes	G4	CA, ID, NV		PS	16
Coarse Filter	Birds	American Dipper	Cinclus mexicanus	No	Yes	G5				
Coarse Filter	Birds	Marsh Wren	Cistothorus palustris	No	Yes	G5				
Coarse Filter	Birds	Western Yellow-billed Cuckoo	Coccyzus americanus occidentalis	Yes	Yes	T3	CA, NV	CA	MV	51
Local	Birds	Trumpeter Swan	Cygnus buccinator	No	Yes	G4	ID		MV	20
Coarse Filter	Birds	A Yellow Warbler	Dendroica petechia brewsteri	No	No	T3	CA		PS (for species	9
Coarse Filter	Birds	Snowy Egret	Egretta thula	No	Yes	G5	CA, ID, NV		PS	1
Coarse Filter	Birds	A Willow Flycatcher	Empidonax traillii adastus	No	No	T5	NV		PS	
Coarse Filter	Birds	Mountain willow flycatcher	Empidonax traillii brewsteri	No	Yes	T3	CA, NV		PS	
Coarse Filter	Birds	Wilson's Snipe	Gallinago delicata	No	Yes	G5				
Assemblage	Birds	Common Loon	Gavia immer	No	Yes	G5	CA, ID, NV		PS	7
Local	Birds	Common Yellowthroat	Geothlypis trichas	No	Yes	G5			PS	26
Coarse Filter	Birds	Greater Sandhill Crane	Grus canadensis tabida	No	Yes	T4	CA, NV	CA	PS	26
Assemblage	Birds	Black-necked Stilt	Himantopus mexicanus	No	Yes	G5	ID, NV, UT		PS	11
Coarse Filter	Birds	Caspian Tern	Hydroprogne caspia	No	Yes	G5	CA, ID, UT			9
Coarse Filter	Birds	Least Bittern	Ixobrychus exilis	No	Yes	G5	CA			4
Coarse Filter	Birds	Western Least Bittern	Ixobrychus exilis hesperis	No	Yes	T3	NV		PS	13
Coarse Filter	Birds	California Gull	Larus californicus	No	Yes	G5	CA, ID			3
Coarse Filter	Birds	Franklin's Gull	Leucophaeus pipixcan	No	Yes	G4	ID, NV			1
Assemblage	Birds	Long-billed Dowitcher	Limnodromus scolopaceus	No	Yes	G5	NV		PS	
Assemblage	Birds	Hooded Merganser	Lophodytes cucullatus	No	Yes	G5	ID			
Assemblage	Birds	Common Merganser	Mergus merganser	No	Yes	G5				3
Coarse Filter	Birds	Long-billed Curlew	Numenius americanus	No	Yes	G5	CA, ID, NV, UT	UT	PS	86
Coarse Filter	Birds	Black-crowned Night-Heron	Nycticorax nycticorax	No	Yes	G5	CA, ID			2
Coarse Filter	Birds	Osprey	Pandion haliaetus	No	Yes	G5	CA, UT		PS	29
Coarse Filter	Birds	American White Pelican	Pelecanus erythrorhynchos	No	Yes	G4	CA, ID, NV, UT		MV	86
Coarse Filter	Birds	Double-crested Cormorant	Phalacrocorax auritus	No	Yes	G5	CA			
Assemblage	Birds	red-necked phalarope	Phalaropus lobatus	No	Yes	G4	NV		MV	
Coarse Filter	Birds	Wilson's Phalarope	Phalaropus tricolor	No	Yes	G5	ID		MV	
Assemblage	Birds	White-faced Ibis	Plegadis chihi	No	Yes	G5	CA, ID, NV		PS	16
Local	Birds	Horned Grebe	Podiceps auritus	No	Yes	G5				

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Local	Birds	Eared Grebe	Podiceps nigricollis	No	Yes	G5	NV		PS	1
Assemblage	Birds	American Avocet	Recurvirostra americana	No	Yes	G5	ID, NV, UT		PS	30
Coarse Filter	Birds	Black Phoebe	Sayornis nigricans	No	Yes	G5	NV		IL	1
Coarse Filter	Birds	Forster's Tern	Sterna forsteri	No	Yes	G5	CA, ID, NV		PS	1
Assemblage	Birds	Willet	Tringa semipalmata	No	Yes	G5	NV		PS	
Coarse Filter	Birds	Yellow-headed Blackbird	Xanthocephalus xanthocephalus	No	Yes	G5	CA			2
Coarse Filter	Butterflies & Skippers	Carson Wandering Skipper	Pseudocopaeodes eunus obscurus	Yes	No	T1				31
Local	Butterflies & Skippers	Nokomis Fritillary	Speyeria nokomis	No	No	G3				2
Coarse Filter	Butterflies & Skippers	Carson Valley Silverspot	Speyeria nokomis carsonensis	No	No	T1		NV		29
Local	Caddisflies	Denning's Cryptic Caddisfly	Cryptochia denningi	No	No	G1				1
Coarse Filter	Fairy, Clam, & Tadpole Shrimps	Mono Lake Brine Shrimp	Artemia monica	No	No	G1				5
Coarse Filter	Freshwater & Anadromous Fishes	Desert Sucker	Catostomus clarkii	No	Yes	G3		AZ, UT		16
Coarse Filter	Freshwater & Anadromous Fishes	White River Desert Sucker	Catostomus clarkii intermedius	No	Yes	T1			HV	20
Coarse Filter	Freshwater & Anadromous Fishes	Meadow Valley Wash Desert Sucker	Catostomus clarkii ssp. 2	No	Yes	T2			PS	27
Coarse Filter	Freshwater & Anadromous Fishes	Bluehead Sucker	Catostomus discobolus	No	Yes	G4		UT		6
Coarse Filter	Freshwater & Anadromous Fishes	Owens Sucker	Catostomus fumeiventris	No	No	G3				22
Coarse Filter	Freshwater & Anadromous Fishes	Flannelmouth Sucker	Catostomus latipinnis	No	Yes	G3		AZ, UT	PS	7
Coarse Filter	Freshwater & Anadromous Fishes	Wall Canyon sucker	Catostomus sp. 1	No	No	G1			MV	
Coarse Filter	Freshwater & Anadromous Fishes	Cui-ui	Chasmistes cujus	Yes	Yes	G1			MV	2
Coarse Filter	Freshwater & Anadromous Fishes	White River Sculpin	Cottus sp. 3	No	No	G1				2
Coarse Filter	Freshwater & Anadromous Fishes	Preston White River Springfish	Crenichthys baileyi albivallis	No	Yes	T1			PS	12
Coarse Filter	Freshwater & Anadromous Fishes	White River Springfish	Crenichthys baileyi baileyi	Yes	Yes	T1			PS	4
Coarse Filter	Freshwater & Anadromous Fishes	Hiko White River Springfish	Crenichthys baileyi grandis	Yes	Yes	T1			PS	6
Coarse Filter	Freshwater & Anadromous Fishes	Moorman White River Springfish	Crenichthys baileyi thermophilus	No	Yes	T1			PS	7
Coarse Filter	Freshwater & Anadromous Fishes	Railroad Valley Springfish	Crenichthys nevadae	Yes	Yes	G2			PS	42
Coarse Filter	Freshwater &	Amargosa Pupfish	Cyprinodon nevadensis amargosae	No	No	T1		CA		1

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	Anadromous Fishes									
Coarse Filter	Freshwater & Anadromous Fishes	Owens River Pupfish	Cyprinodon radiosus	Yes	Yes	G1		CA		8
Coarse Filter	Freshwater & Anadromous Fishes	Pahrump Poolfish	Empetrichthys latos latos	Yes	Yes	T1			MV	2
Coarse Filter	Freshwater & Anadromous Fishes	Desert Dace	Eremichthys acros	Yes	Yes	G1			MV	22
Coarse Filter	Freshwater & Anadromous Fishes	Alvord Chub	Gila alvordensis	No	No	G2			HV	1
Coarse Filter	Freshwater & Anadromous Fishes	Fish Creek Springs Tui Chub	Gila bicolor euchila	No	Yes	T1				2
Coarse Filter	Freshwater & Anadromous Fishes	Independence Valley Tui Chub	Gila bicolor isolata	No	Yes	T1			PS	4
Coarse Filter	Freshwater & Anadromous Fishes	Newark Valley Tui Chub	Gila bicolor newarkensis	No	Yes	T1				42
Coarse Filter	Freshwater & Anadromous Fishes	Lahontan Creek Tui Chub	Gila bicolor obesa	No	Yes	T4				
Coarse Filter	Freshwater & Anadromous Fishes	Owens Tui Chub	Gila bicolor snyderi	Yes	Yes	T1		CA		9
Coarse Filter	Freshwater & Anadromous Fishes	Fish Lake Valley Tui Chub	Gila bicolor ssp. 4	No	Yes	T1			PS	2
Coarse Filter	Freshwater & Anadromous Fishes	Hot Creek Valley Tui Chub	Gila bicolor ssp. 5	No	Yes	T1				9
Coarse Filter	Freshwater & Anadromous Fishes	Little Fish Lake Valley Tui Chub	Gila bicolor ssp. 6	No	Yes	T1			HV	5
Coarse Filter	Freshwater & Anadromous Fishes	Railroad Valley Tui Chub	Gila bicolor ssp. 7	No	Yes	T1			MV	14
Coarse Filter	Freshwater & Anadromous Fishes	Big Smokey Valley Tui Chub	Gila bicolor ssp. 8	No	Yes	T1			HV	14
Coarse Filter	Freshwater & Anadromous Fishes	Roundtail Chub	Gila robusta	Yes	Yes	G3		UT		
Coarse Filter	Freshwater & Anadromous Fishes	A Roundtail Chub	Gila robusta jordani	Yes	Yes	T1			PS	10
Coarse Filter	Freshwater & Anadromous Fishes	Virgin River Chub	Gila seminuda	Yes	Yes	G1			PS	6
Coarse Filter	Freshwater & Anadromous Fishes	Least Chub	Iotichthys phlegethontis	Yes	Yes	G1		UT		23
Coarse Filter	Freshwater & Anadromous Fishes	White River Spinedace	Lepidomeda albivallis	Yes	Yes	G1			PS	17
Coarse Filter	Freshwater & Anadromous Fishes	Southern Leatherside Chub	Lepidomeda aliciae	No	Yes	G2		UT		22
Coarse Filter	Freshwater &	Northern Leatherside Chub	Lepidomeda copei	No	Yes	G1		UT		1

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	Anadromous Fishes									
Coarse Filter	Freshwater & Anadromous Fishes	Virgin Spinedace	Lepidomeda mollispinis	Yes	Yes	G1				14
Coarse Filter	Freshwater & Anadromous Fishes	Virgin River Spinedace	Lepidomeda mollispinis mollispinis	No	Yes	T1		UT	PS	5
Coarse Filter	Freshwater & Anadromous Fishes	Big Spring Spinedace	Lepidomeda mollispinis pratensis	Yes	Yes	T1			MV	9
Coarse Filter	Freshwater & Anadromous Fishes	Yellowstone Cutthroat Trout	Oncorhynchus clarkii bouvieri	No	No	T2	NV	NV	MV	
Coarse Filter	Freshwater & Anadromous Fishes	Lahontan Cutthroat Trout	Oncorhynchus clarkii henshawi	Yes	Yes	T3			MV	300
Coarse Filter	Freshwater & Anadromous Fishes	Paiute Cutthroat Trout	Oncorhynchus clarkii seleniris	Yes	No	T1				8
Coarse Filter	Freshwater & Anadromous Fishes	Bonneville Cutthroat Trout	Oncorhynchus clarkii utah	No	Yes	T4		UT		122
Coarse Filter	Freshwater & Anadromous Fishes	Inland Redband Trout and Redband Steelhead	Oncorhynchus mykiss gairdneri	No	Yes	T4				6
Coarse Filter	Freshwater & Anadromous Fishes	Woundfin	Plagopterus argentissimus	Yes	Yes	G1			PS	7
Coarse Filter	Freshwater & Anadromous Fishes	Relict Dace	Relictus solitarius	No	Yes	G2				93
Coarse Filter	Freshwater & Anadromous Fishes	Speckled Dace	Rhinichthys osculus	Yes	No	G5		AZ		41
Coarse Filter	Freshwater & Anadromous Fishes	Big Smokey Valley Speckled Dace	Rhinichthys osculus lariversi	No	Yes	T1			HV	8
Coarse Filter	Freshwater & Anadromous Fishes	Independence Valley Speckled Dace	Rhinichthys osculus lethoporus	Yes	Yes	T1			HV	2
Coarse Filter	Freshwater & Anadromous Fishes	Clover Valley Speckled Dace	Rhinichthys osculus oligoporus	Yes	Yes	T1			HV	8
Coarse Filter	Freshwater & Anadromous Fishes	Lahontan Speckled Dace	Rhinichthys osculus robustus	No	Yes	T5				
Coarse Filter	Freshwater & Anadromous Fishes	Diamond Valley Speckled Dace	Rhinichthys osculus ssp. 10	No	No	TH			HV	2
Coarse Filter	Freshwater & Anadromous Fishes	Owens Speckled Dace	Rhinichthys osculus ssp. 2	No	No	T1		CA		11
Coarse Filter	Freshwater & Anadromous Fishes	Monitor Valley Speckled Dace	Rhinichthys osculus ssp. 5	No	No	T1			HV	4
Coarse Filter	Freshwater & Anadromous Fishes	Oasis Valley Speckled Dace	Rhinichthys osculus ssp. 6	No	Yes	T1	NV	NV	PS	16
Coarse Filter	Freshwater & Anadromous Fishes	White River Speckled Dace	Rhinichthys osculus ssp. 7	No	No	T2			MV	44
Coarse Filter	Freshwater &	Pahranagat Speckled Dace	Rhinichthys osculus velifer	No	Yes	T1			PS	12

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	Anadromous Fishes									
Coarse Filter	Freshwater Mussels	California Floater	Anodonta californiensis	No	Yes	G3			MV	19
Coarse Filter	Freshwater Mussels	Western Pearlshell	Margaritifera falcata	No	Yes	G4				
Coarse Filter	Freshwater Snails	Badwater Snail	Assiminea infima	No	No	G1			PS	1
Coarse Filter	Freshwater Snails	Steptoe Hydrobe	Eremopyrgus eganensis	No	No	G1			PS	8
Local	Freshwater Snails	Green River Pebblesnail	Fluminicola coloradoensis	No	No	G2				6
Coarse Filter	Freshwater Snails	Pyramid Lake Pebblesnail	Fluminicola dalli	No	No	G1			HV	4
Coarse Filter	Freshwater Snails	Virginia Mountains Pebblesnail	Fluminicola virginius	No	No	G1			HV	2
Local	Freshwater Snails	Deep Springs Snail	Fontelicella sp. 6	No	No	G1				1
Local	Freshwater Snails	Great Basin Rams-horn	Helisoma newberryi	No	No	G1				
Coarse Filter	Freshwater Snails	smooth juga	Juga interioris	No	No	G1			EV	
Coarse Filter	Freshwater Snails	Utah Physa	Physa gyrina utahensis	No	Yes	T2				4
Coarse Filter	Freshwater Snails	Cloaked Physa	Physa megalochlamys	No	Yes	G3				2
Local	Freshwater Snails	Lamb Rams-horn	Planorbella oregonensis	No	No	G1				1
Coarse Filter	Freshwater Snails	Benton Valley Springsnail	Pyrgulopsis aardahli	No	No	G1				1
Coarse Filter	Freshwater Snails	Duckwater Pyrg	Pyrgulopsis aloba	No	No	G1			PS	4
Coarse Filter	Freshwater Snails	Southern Duckwater Pyrg	Pyrgulopsis anatina	No	No	G1			PS	2
Coarse Filter	Freshwater Snails	Longitudinal Gland Pyrg	Pyrgulopsis anguina	No	Yes	G1			EV	3
Coarse Filter	Freshwater Snails	Elongate Cain Spring Pyrg	Pyrgulopsis augustae	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Pleasant Valley Pyrg	Pyrgulopsis aurata	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Large Gland Carico Pyrg	Pyrgulopsis basiglans	No	No	G1			EV	4
Coarse Filter	Freshwater Snails	Small Gland Carico Pyrg	Pyrgulopsis bifurcata	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Flat Pyrg	Pyrgulopsis breviloba	No	No	G1			EV	6
Coarse Filter	Freshwater Snails	Fly Ranch Pyrg	Pyrgulopsis bruesi	No	No	G1			HV	2
Coarse Filter	Freshwater Snails	Cortez Hills Pebblesnail	Pyrgulopsis bryantwalkeri	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Carinate Duckwater Pyrg	Pyrgulopsis carinata	No	No	GX		NV	PS	
Coarse Filter	Freshwater Snails	Smooth Glenwood Pyrg	Pyrgulopsis chamberlini	No	Yes	G1				1
Coarse Filter	Freshwater Snails	Transverse Gland Pyrg	Pyrgulopsis cruciglans	No	No	G1			EV	8
Coarse Filter	Freshwater Snails	Desert Springsnail	Pyrgulopsis deserta	No	Yes	G2		AZ		3
Coarse Filter	Freshwater Snails	Dixie Valley Pyrg	Pyrgulopsis dixensis	No	No	G1			MV	2
Coarse Filter	Freshwater Snails	Smoke Creek Pyrg	Pyrgulopsis eremica	No	No	G2				5
Coarse Filter	Freshwater Snails	Otter Creek Pyrg	Pyrgulopsis fusca	No	Yes	G1				1
Coarse Filter	Freshwater Snails	Emigrant Pyrg	Pyrgulopsis gracilis	No	No	G1			EV	4
Coarse Filter	Freshwater Snails	Hamlin Valley Pyrg	Pyrgulopsis hamlinensis	No	Yes	G1				2
Coarse Filter	Freshwater Snails	Upper Thousand Spring Pyrg	Pyrgulopsis hovinghi	No	No	G1			EV	
Coarse Filter	Freshwater Snails	Hubbs Pyrg	Pyrgulopsis hubbsi	No	No	G1		AZ	PS	4
Coarse Filter	Freshwater Snails	Humboldt Pyrg	Pyrgulopsis humboldtensis	No	No	G1			EV	11

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Coarse Filter	Freshwater Snails	Kings River Pyrg	Pyrgulopsis imperialis	No	No	G1			EV	4
Coarse Filter	Freshwater Snails	Carinate Glenwood Pyrg	Pyrgulopsis inopinata	No	Yes	G1				2
Coarse Filter	Freshwater Snails	Toquerville Springsnail	Pyrgulopsis kolobensis	No	No	G5		AZ		94
Coarse Filter	Freshwater Snails	Landyes Pyrg	Pyrgulopsis landyei	No	No	G1			PS	2
Coarse Filter	Freshwater Snails	Butterfield Pyrg	Pyrgulopsis lata	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Crittenden springsnail	Pyrgulopsis lentiglans	No	No	G1			EV	
Coarse Filter	Freshwater Snails	Elko Pyrg	Pyrgulopsis leporina	No	No	G1			EV	4
Coarse Filter	Freshwater Snails	Squat Mud Meadows Pyrg	Pyrgulopsis limaria	No	No	G1			HV	13
Coarse Filter	Freshwater Snails	Lockes Pyrg	Pyrgulopsis lockensis	No	No	G1			PS	2
Coarse Filter	Freshwater Snails	Long Valley Pyrg	Pyrgulopsis longae	No	No	G1				1
Coarse Filter	Freshwater Snails	Western Lahontan Pyrg	Pyrgulopsis longiglans	No	No	G2				28
Coarse Filter	Freshwater Snails	Hardy Pyrg	Pyrgulopsis marcida	No	No	G1			EV	14
Coarse Filter	Freshwater Snails	Pahranagat Pebblesnail	Pyrgulopsis merriami	No	No	G1		AZ	PS	13
Coarse Filter	Freshwater Snails	Oasis Valley Springsnail	Pyrgulopsis micrococcus	No	No	G3		AZ	MV	8
Coarse Filter	Freshwater Snails	Northern Soldier Meadow Pyrg	Pyrgulopsis militaris	No	No	G1			HV	2
Coarse Filter	Freshwater Snails	Twentyone Mile Pyrg	Pyrgulopsis millenaria	No	No	G1			EV	
Coarse Filter	Freshwater Snails	Camp Valley Pyrg	Pyrgulopsis montana	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Neritiform Steptoe Ranch Pyrg	Pyrgulopsis neritella	No	No	G1			PS	2
Coarse Filter	Freshwater Snails	Ninemile Pyrg	Pyrgulopsis nonaria	No	Yes	G1				2
Coarse Filter	Freshwater Snails	Elongate Mud Meadows Pyrg	Pyrgulopsis notidicola	Yes	No	G1			HV	3
Coarse Filter	Freshwater Snails	Sub-globose Steptoe Ranch Pyrg	Pyrgulopsis orbiculata	No	No	G1			PS	4
Coarse Filter	Freshwater Snails	Owens Valley Springsnail	Pyrgulopsis owensensis	No	No	G1				10
Coarse Filter	Freshwater Snails	Big Warm Spring Pyrg	Pyrgulopsis papillata	No	No	G1			PS	8
Coarse Filter	Freshwater Snails	Bifid Duct Pyrg	Pyrgulopsis peculiaris	No	Yes	G2			EV	11
Coarse Filter	Freshwater Snails	Antelope Valley Pyrg	Pyrgulopsis pellita	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Fish Slough Springsnail	Pyrgulopsis perturbata	No	No	G1				3
Coarse Filter	Freshwater Snails	Ovate Cain Spring Pyrg	Pyrgulopsis pictilis	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Flat-topped Steptoe Pyrg	Pyrgulopsis planulata	No	No	G1			PS	2
Coarse Filter	Freshwater Snails	Fish Lake Pyrg	Pyrgulopsis ruinosa	No	No	GX			HV	
Coarse Filter	Freshwater Snails	Sada's Pyrg	Pyrgulopsis sadai	No	No	G1			EV	13
Coarse Filter	Freshwater Snails	White River Valley Pyrg	Pyrgulopsis sathos	No	No	G1			EV	14
Coarse Filter	Freshwater Snails	Sub-globose Snake Pyrg	Pyrgulopsis saxatilis	No	Yes	G1				2
Coarse Filter	Freshwater Snails	Northern Steptoe Pyrg	Pyrgulopsis serrata	No	No	G1			EV	6
Coarse Filter	Freshwater Snails	Sterile Basin Pyrg	Pyrgulopsis sterilis	No	No	G1			EV	6
Coarse Filter	Freshwater Snails	Lake Valley Pyrg	Pyrgulopsis sublata	No	No	G1			EV	2
Coarse Filter	Freshwater Snails	Southern Steptoe Pyrg	Pyrgulopsis sulcata	No	No	G1			PS	4
Coarse Filter	Freshwater Snails	Southern Bonneville Pyrg	Pyrgulopsis transversa	No	Yes	G2				4

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Coarse Filter	Freshwater Snails	Southern Soldier Meadow Pyrg	Pyrgulopsis umbilicata	No	No	G1			HV	10
Coarse Filter	Freshwater Snails	Northwest Bonneville Pyrg	Pyrgulopsis variegata	No	Yes	G2			EV	11
Coarse Filter	Freshwater Snails	Duckwater Warm Springs Pyrg	Pyrgulopsis villacampae	No	No	G1			PS	4
Coarse Filter	Freshwater Snails	Vineyards Pyrg	Pyrgulopsis vinyardi	No	No	G1			EV	4
Coarse Filter	Freshwater Snails	Wong's Springsnail	Pyrgulopsis wongi	No	No	G2		AZ	MV	63
Coarse Filter	Freshwater Snails	Fat-whorled Pondsnail	Stagnicola bonnevillensis	No	Yes	G1				5
Coarse Filter	Freshwater Snails	Mountain Marshsnail	Stagnicola montanensis	No	No	G3				1
Coarse Filter	Freshwater Snails	Widelip Pondsnail	Stagnicola traski	No	No	G3				4
Coarse Filter	Freshwater Snails	Grated Tryonia	Tryonia clathrata	No	No	G2			PS	10
Coarse Filter	Freshwater Snails	Grapevine Springs Elongate Tryonia	Tryonia margae	No	No	G1				2
Coarse Filter	Freshwater Snails	Monitor Tryonia	Tryonia monitorae	No	No	G1			PS	4
Coarse Filter	Freshwater Snails	Desert Tryonia	Tryonia porrecta	No	No	G3			MV	14
Coarse Filter	Freshwater Snails	Grapevine Springs Squat Tryonia	Tryonia rowlandsi	No	No	G1				1
Coarse Filter	Freshwater Snails	Desert Valvata	Valvata utahensis	No	Yes	G2				
Local	Mammals	Sierra Nevada Mountain Beaver	Aplodontia rufa californica	No	Yes	T3	CA, NV		HV	21
Local	Mammals	American Beaver	Castor canadensis	No	Yes	G5			PS	
Local	Mammals	North American River Otter	Lontra canadensis	No	Yes	G5	NV, UT		MV	36
Local	Mammals	Common Muskrat	Ondatra zibethicus	No	Yes	G5				
Coarse Filter	Mammals	water shrew	Sorex palustris	No	Yes	G5	NV		MV	16
Local	Mayflies	A Mayfly	Ameletus edmundsi	No	No	G1				3
Local	Mayflies	A Mayfly	Cinygmula gartrelli	No	No	G2				1
Local	Mayflies	A Mayfly	Paraleptophlebia packii	No	No	G2				1
Local	Mayflies	A Mayfly	Parameletus columbiae	No	No	G2				1
Local	Mayflies	A Mayfly	Susperatus tuberculatus	No	No	G1				1
Local	Other Beetles	Utah Chaetarthrian Water Scavenger Beetle	Chaetarthria utahensis	No	No	G1				
Coarse Filter	Other Beetles	Leech's Skyline Diving Beetle	Hydroporus leechi	No	No	G1				1
Coarse Filter	Other Beetles	Travertine Band-thigh Diving Beetle	Hygrotus fontinalis	No	No	G1				4
Coarse Filter	Other Beetles	Ash Springs riffle beetle	Stenelmis lariversi	No	No	G1				2
Coarse Filter	Other Insects	Pahranagat Naucorid Bug	Pelocoris shoshone shoshone	No	No	T1		NV		2
Coarse Filter	Stoneflies	A Stonefly	Capnia hornigi	No	No	G3				
Coarse Filter	Stoneflies	Tiny Forestfly	Malenka tina	No	No	G3				1
Coarse Filter	Stoneflies	Utah Needlefly	Perlomyia utahensis	No	No	G3				17
Coarse Filter	Stoneflies	Utah Sallfly	Sweltsa gaufini	No	No	G3				2
Coarse Filter	Tiger Beetles	Riparian Tiger Beetle	Cicindela praetextata	No	No	G2				1
Coarse Filter	Turtles	Western Pond Turtle	Actinemys marmorata	No	No	G3	CA	CA	PS	

Assessment Approach	Taxonomic Group	Common Name	Scientific Name	Federally Listed	State Protected	Rounded Global Rank	Relevant SWAPs	Relevant BLM Special Status	NatureServe Climate Change Vulnerability Index	# of Element Occurrences
Coarse Filter	Turtles	Northern Pacific Pond Turtle	Actinemys marmorata marmorata	No	No	T3	CA, NV		PS	15
Local	Ferns & relatives	Crenulate Moonwort	Botrychium crenulatum	No	No	G3				22
Coarse Filter	Flowering Plants	Meadow Pussytoes	Antennaria arcuata	No	No	G2		NV	MV	15
Coarse Filter	Flowering Plants	Mesic Milkvetch	Astragalus diversifolius	No	No	G2				4
Coarse Filter	Flowering Plants	Horn's Milkvetch	Astragalus hornii var. hornii	No	No	T2		CA		1
Coarse Filter	Flowering Plants	Lemmon's Milkvetch	Astragalus lemmonii	No	No	G2		CA		11
Coarse Filter	Flowering Plants	Sodaville Milkvetch	Astragalus lentiginosus var. sesquimetralis	No	Yes	T1		NV		8
Local	Flowering Plants	Monte Neva Paintbrush	Castilleja salsuginosa	No	Yes	G1		NV		4
Coarse Filter	Flowering Plants	Tecopa Bird's-beak	Cordylanthus tecopensis	No	No	G2		CA, NV		4
Coarse Filter	Flowering Plants	Wasatch Draba	Draba brachystylis	No	No	G1				7
Coarse Filter	Flowering Plants	Mono Buckwheat	Eriogonum ampullaceum	No	No	G3				8
Local	Flowering Plants	Steamboat Buckwheat	Eriogonum ovalifolium var. williamsiae	Yes	Yes	T1		NV		20
Coarse Filter	Flowering Plants	Poison Canyon Stickseed	Hackelia brevicula	No	No	G2				9
Coarse Filter	Flowering Plants	King's Ivesia	Ivesia kingii	Yes	No	G3				2
Local	Flowering Plants	Pine Nut Ivesia	Ivesia pityocharis	No	No	G2		NV		48
Local	Flowering Plants	Southwestern Pepper-grass	Lepidium nanum	No	No	G3				585
Local	Flowering Plants	Playa Phacelia	Phacelia inundata	No	No	G2		CA, NV		6
Coarse Filter	Flowering Plants	Tiny-flower Phacelia	Phacelia minutissima	No	No	G3		NV		71
Local	Flowering Plants	Parish's Phacelia	Phacelia parishii	No	No	G2		AZ, CA, NV		28
Coarse Filter	Flowering Plants	Desert Allocarya	Plagiobothrys salsus	No	No	G2				1
Local	Flowering Plants	Williams combleaf	Polyctenium williamsiae	No	Yes	G2		NV		64
Local	Flowering Plants	Soldier Meadows Cinquefoil	Potentilla basaltica	Yes	No	G1		CA, NV		71
Coarse Filter	Flowering Plants	Ute Ladies'-tresses	Spiranthes diluvialis	Yes	Yes	G2		NV		19
Coarse Filter	Flowering Plants	Hooded Ladies'-tresses	Spiranthes romanzoffiana	No	Yes	G5				1

B-1.1.2 Species CEs of Conservation Concern

Summaries of the at-risk status for species treated as CEs within the CBR ecoregion are included in Table B - 2 through Table B - 5. The tables summarize species according to the assessment approach, or how they were treated in the assessment, and by informal taxonomic category. While "species" are referred to throughout this report, there are actually a number of subspecies or varieties of full species included in the assessment. Table B - 1 provides this information for individual taxa. Landscape species (Table B - 2) for the REA were entirely associated with 'dry' or upland habitats. These included birds, mammals, and reptiles. Vulnerable species assemblages (Table B - 3) included a broader variety of species by informal taxonomy, and included species associated with both upland and wetland/aquatic habitats. Local species (Table B - 4), most extensive in number (318), with 284 in uplands and 34 known to be in wet habitats are summarized by watershed. A total of 267 species meeting criteria for inclusion in the REA were efficiently assessed indirectly through analysis of coarse filter CEs (Table B - 5), spanning a range of upland and aquatic environments.

All but one of the landscape species are relatively common (Table B - 2); the greater sage-grouse is the only species to have a high at-risk status rank under the NatureServe ranking methodology with a global rank of G3. Only two of the 28 landscape species, the kit fox and the greater sage-grouse, have Federal status in all or a portion of their range. Most of the landscape species are protected or recognized by some sort of state legislation (22 species), and many of them were also listed in one or more state wildlife action plans (23 species). The BLM has 11 species listed within their state special status lists.

Table B - 2. Summary of species treated individually as landscape species

Approach	Informal Taxonomy	Total Species	# with Federal Status	# with State Status	# with G1 - G3 Status Rank	# BLM Special Status	# listed in SWAPS
Landscape Species	Birds	15	1	15	1	5	13
Landscape Species	Mammals	7	1	6	0	5	4
Landscape Species	Reptiles	6	0	1	0	1	6
	Total	**28**	**2**	**22**	**1**	**11**	**23**

There were a total of 91 species treated within the species assemblages (Table B - 3); of these many were plants, and birds were also important assemblage components. More than half of the assemblage species have high at-risk status ranks (48 species). Many species are protected by state legislation (especially birds), are considered special status by BLM (most are plants), or were listed in a SWAP (birds and mammals in particular). Only two plants have Federal status, the Churchill Narrows Buckwheat (*Eriogonum diatomaceum*), and Webber Ivesia (*Ivesia webberi*).

Table B - 3. Summary of species treated within species assemblages.

Approach	Informal Taxonomy	Total Species	# with Federal Status	# with State Status	# with G1 - G3 Status Rank	# BLM Special Status	# listed SWAPS
Species Assemblage	Birds	29	0	29	0	0	22
Species Assemblage	Mammals	11	0	5	1	4	10

Approach	Informal Taxonomy	Total Species	# with Federal Status	# with State Status	# with G1 - G3 Status Rank	# BLM Special Status	# listed SWAPS
Species Assemblage	Ants, Wasps, & Bees	1	0	0	1	0	0
Species Assemblage	Other Beetles	6	0	0	6	0	0
Species Assemblage	Terrestrial Snails	3	0	0	3	0	0
Species Assemblage	Flowering Plants	41	2	3	37	28	0
	Total	**91**	**2**	**37**	**48**	**32**	**32**

Species treated in the assessment as "local" species totaled 318, of which over half (171) are plants, 87 are vertebrates, and the remainder (60) are invertebrates (Table B - 4). Fifty-six percent of these species are considered globally rare, including most of the plants. Most of the vertebrates are listed in a SWAP, and also have some state protection. Many of the invertebrates are also globally rare, and butterflies and skippers are of particular concern to the state BLM offices, being on special status lists (as are a number of plants). Only 8 species total have any Federal status- 4 mammals, 3 plants and 1 amphibian.

Table B - 4. Summary of species treated as local species.

Approach	Informal Taxonomy	Total Species	# with Federal Status	# with State Status	# with G1 - G3 Status Rank	# BLM Special Status	# listed in SWAPS
Local	Amphibians	3	1	1	3	1	3
Local	Birds	31	0	31	0	6	24
Local	Mammals	39	4	19	3	7	30
Local	Reptiles	14	0	6	0	2	14
Local	Ants, Wasps, & Bees	4	0	0	4	0	0
Local	Butterflies & Skippers	24	0	0	3	21	0
Local	Caddisflies	1	0	0	1	0	0
Local	Freshwater Snails	4	0	0	4	0	0
Local	Mayflies	5	0	0	5	0	0
Local	Millipedes & Centipedes	1	0	0	1	0	0
Local	Other Beetles	7	0	0	7	2	0
Local	Spiders & other Chelicerates	1	0	0	1	0	0
Local	Terrestrial Snails	11	0	6	9	2	0
Local	Tiger Beetles	2	0	0	1	1	0
Local	Ferns & relatives	2	0	0	1	0	0

Approach	Informal Taxonomy	Total Species	# with Federal Status	# with State Status	# with G1 - G3 Status Rank	# BLM Special Status	# listed in SWAPS
Local	Flowering Plants	167	3	19	134	77	0
Local	Mosses	2	0	0	1	0	0
	Total	**318**	**8**	**82**	**178**	**119**	**71**

A total of 267 species were assigned to one or more of the coarse filter CEs (Table B - 5). These species are considered to be adequately assessed and 'captured' by the coarse filter CEs, which were assessed separately. Many of the species captured through coarse filter CEs are aquatic species such as freshwater fish or snails, all closely associated with aquatic habitats; while others such as birds and amphibians utilize the riparian or wetland vegetation found adjacent to aquatic habitats for portions of their life cycle. Most of the species (231) are associated with the aquatic/wetland/riparian coarse filter CEs (Table B - 5), and a much smaller number were captured in one of the terrestrial coarse filter CEs. Many species are considered globally rare (45%), and over 50% of them have state protective status. Of the 122 vertebrates captured in the aquatic coarse filter CEs, 24 of them have Federal status- more species than in any of the other 3 assessment approaches; of these all but 2 are fish species. Of the invertebrates, only 2 have Federal status yet almost all of them are considered globally rare; many of the 86 G1-G3 species in the aquatic category are freshwater snails. Of the species captured in the terrestrial coarse filter CEs, most are vertebrates followed by plants.

Table B - 5. Summary of species captured and treated within a coarse filter CE.

Approach	Informal Taxonomy	Total Species	# with Federal Status	# with State Status	# with G1 - G3 Status Rank	# BLM Special Status	# listed in SWAPS
Captured in aquatic coarse filter	Vertebrates	122	24	95	23	28	51
Captured in aquatic coarse filter	Invertebrates	93	1	17	86	9	0
Captured in aquatic coarse filter	Plants	16	2	4	11	8	0
Captured in terrestrial coarse filter	Vertebrates	43	1	35	1	9	31
Captured in terrestrial coarse filter	Invertebrates	2	1	0	1	0	0
Captured in terrestrial coarse filter	Plants	14	1	2	10	7	0
	Total	**290**	**30**	**153**	**132**	**61**	**82**

*Note: Out of the 267 species captured in the coarse filter CEs, 23 species are associated with both an aquatic coarse filter and a terrestrial coarse filter; hence the total species in the above table is higher than 267.

B-1.1.3 Terrestrial Coarse-filter

Conceptual models developed for this REA combine text, concept diagrams, and tabular summaries in order to clearly state assumptions made about the ecological composition, structure, dynamic processes, and interactions with major CAs within the ecoregion. These conceptual models lead then to spatial models to enable us to gauge the relative ecological status of each CE within 5th level watersheds. Content included for each CE is described below. Some text is repeated for each CE within the conceptual model, such as the VDDT modeling information, to allow the reader to view or print the entire material for an individual CE.

All of the terrestrial coarse filter conceptual models are included in this document: CBR_ConceptualModels_TerrestrialCoarseFilterCEsSept_2012_final.pdf

The descriptive material builds upon the descriptions for terrestrial ecological systems that NatureServe has and serves on its website(http://www.natureserve.org/explorer/index.htm to search and download existing descriptions). For this REA, additional material was added for each coarse filter CE, especially focusing on content describing natural and altered vegetation dynamics, as well as threats and stressors to the system. The information developed is intended to cover the full range of distribution of the CEs, which can extend beyond the ecoregion, and does not specifically focus on it's characteristics or dynamics as they occur within this ecoregion.

The descriptions include many names of plant species that are characteristic of the coarse filter ecological system type. In the text sections these names are provided as scientific names. Vascular plant species nomenclature follows the nationally standardized list of Kartesz (1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990) and Anderson et al. (1990) for mosses, Egan (1987, 1989, 1990, 1991) and Esslinger and Egan (1995) for lichens, and Stotler and Crandall-Stotler (1977) for liverworts/hornworts. Within Appendix E a table is included with common names for each species.

For some coarse filter types, animal or plant species of conservation or management concern were identified that are known to be strongly associated. Assessment of these species is presumed to be well-addressed through assessment of these coarse filter CEs. These species are listed by informal taxonomic groups, with common names followed by scientific names.

Each model begins by characterizing what the CE is and how it nests within the broader conceptual model already established for the ecoregion. Each CE is placed within one of the 4 major model components and within one of the Model Groups within those (Table B - 6).

The next component of the conceptual model clarifies relevant taxonomic relationships, with "(CES304.773)" referring to the standard NatureServe element code for this ecological system type. We also list the LANDFIRE Biophysical Settings code.

Table B - 6. Terrestrial Coarse filter CEs for Central Basin and Range Ecoregion

Ecoregion Conceptual Model		**Coarse filter Element Name**
Level 1	**Level 2**	
Montane Dry Land System	Alpine Uplands	Rocky Mountain Alpine Turf
	Montane Canyons	Inter-Mountain Basins Cliff and Canyon
	Montane Shrublands	Great Basin Semi-Desert Chaparral
		Inter-Mountain Basins Montane Sagebrush Steppe
		Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland
	Subalpine/Montane Forests & Woodlands	Great Basin Pinyon-Juniper Woodland
		Inter-Mountain Basins Aspen-Mixed Conifer Forest and

Ecoregion Conceptual Model		Coarse filter Element Name
Level 1	Level 2	
		Woodland
		Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
		Rocky Mountain Aspen Forest and Woodland
Basin Dry Land System	Desert Scrub	Inter-Mountain Basins Mixed Salt Desert Scrub
		Mojave Mid-Elevation Mixed Desert Scrub
	Dunes	Inter-Mountain Basins Active and Stabilized Dune
	Semi-desert Shrub & Steppe	Colorado Plateau Mixed Low Sagebrush Shrubland
		Great Basin Xeric Mixed Sagebrush Shrubland
		Inter-Mountain Basins Big Sagebrush Shrubland
		Inter-Mountain Basins Big Sagebrush Steppe
		Inter-Mountain Basins Semi-Desert Grassland
		Inter-Mountain Basins Semi-Desert Shrub-Steppe

Conservation Element Characterization

This section of the conceptual model includes a narrative of the CE distribution, biophysical setting, and floristic composition. For terrestrial coarse filter CEs, a direct linkage is provided between the CE concept and Ecological Site Descriptions (ESDs) applicable to the ecoregion. Crosswalks are provided only to approved ESDs by NRCS Multiple Resource Land Area (MLRA) that overlap the ecoregion. The NRCS Site ID in the crosswalk table identifies each type as determined by NRCS. This list is not a complete cross-walk as some MLRAs do not have approved ESDs. Additionally, the user should consider that ESDs are based on landform/soil concepts, so the match between these concepts and ecological system concepts - defined as an integration between biophysical and natural floristic composition - will be imperfect and may vary from type to type.

Vegetation dynamics, both natural and altered, are described in narrative text, with supporting literature cited. Again, this information is developed across the range-wide distribution of the ecological system type.

Change Agent Effects on the CE

In this section the primary change agents are characterized and as possible, current knowledge of their effects on this CE. Some CAs have specific effects on each CE such as the alteration of expected fire regimes and the interacting effects of introduced weed infestations. Narrative is provided on the effects of CAs on the individual CE, in an “altered dynamics” section. Wildfire and invasive plant CAs are described and modeled within the context of their effects on coarse filter CEs.

The impacts of wildfire and invasive plants are modeled through the use of the Vegetation Dynamics Development Tool (VDDT) and simulations were run in the Path Landscape Model (ESSA Technologies). Models were developed by the Nevada chapter of The Nature Conservancy, and modified for use in this REA. VDDT is a state-and-transition modeling platform that simulates vegetation dynamics based on user-defined states and transitions. States (boxes) represent a vegetation community defined by a cover type and structural stage. Transitions link states through processes such as succession, disturbance, and management, and can be either deterministic or probabilistic. Deterministic transitions usually simulate successional changes by defining the number of years until a transition occurs from one successional stage to the next, in the absence of disturbance. Probabilistic transitions specify an annual transition probability of moving from one state to another. Probabilistic transitions represent disturbances (e.g., fire and drought), ecological processes (e.g. tree encroachment and natural recovery), and land management activities (e.g., seeding and prescribed fire).

For each simulation, the landscape is partitioned into a number of cells or simulation units and allocated among state classes in the model. At each time step, deterministic transitions occur based on the age of the cell and probabilistic transitions may occur based on the specified transition probability. VDDT is a nonspatial model, and all cells are simulated independently of other cells. The Path model uses VDDT as a simulation engine but allows users to organize model runs, run many models simultaneously, and view output across all model runs simultaneously. Each coarse filter CE was described using two VDDT models – one describing the natural range of variation (NRV) under historic conditions, and one describing contemporary dynamics and including uncharacteristic states such as annual grass or depleted shrub. The contemporary model includes all states and transitions from the NRV model in addition to a set of uncharacteristic states and transitions.

Ecological Status Criteria and Indicators

To assess ecological status for each CE within the ecoregion, NatureServe's ecological integrity framework sets up practical criteria and indicators for this purpose (Faber-Langendoen et al. 2006, Unnasch et al. 2008). This framework provides a scorecard for reporting on the ecological status of a given CE within a given location, and facilitates the aggregation and synthesis of the component results for broader measures of ecological integrity at landscape and ecoregional scales. Using this framework, indicators were chosen to provide a measurement for a limited set of key ecological attributes, or ecological drivers for each CE. Ecological attributes may include natural characteristics, such as native species composition, or stressors such as effects of relevant change agents, that are well known to affect the natural function and integrity of the CE.

In part because of project constraints, indicators that were identified *emphasize ecosystem stressors* that can be more readily measured using available remotely sensed data. Spatial models that reflect these indicators serve as the link between the conceptual models and the spatial representation of ecological status. For each CE, the definitions and justifications for each of the indicators assessed for that CE are provided, organized in an Ecological Status Scorecard table. Each indicator is scored according to criteria described in the table and is calculated between 0 and 1, with 1 indicating highest ecological status and 0 indicating lowest status (and presumably transitional to a wholly different ecological state).

References for the CE

Literature is listed that is relevant to the classification, distribution, floristic composition, ecological processes, threats, stressors, or management of the CE, in some cases form portions of it's range outside of the ecoregion. These are not exhaustive literature surveys, rather are an accumulation of known references. Some documents may be listed that are not cited in the narrative text.

B-1.1.4 Aquatic Coarse-filter

Our conceptual models combine text, concept diagrams, and tabular summaries in order to clearly state our assumptions about the ecological composition, structure, dynamic processes, and interactions with major CAs within the ecoregion. These conceptual models lead then to spatial models to enable us to gauge the relative ecological status of each CE within 5th level watersheds. Below we describe what content to be included for each CE. Some text is repeated for each CE, such as the indicator justification information, to allow the reader to view or print the entire material for an individual CE.

All of the aquatic coarse filter conceptual models are included in this document: CBR_ConceptualModels_AquaticCoarseFilterCEsSept_2012_final.pdf

The descriptive material builds upon the descriptions for terrestrial ecological systems that NatureServe has been developing since 2003 when the ecological systems classification was first developed (see http://www.natureserve.org/explorer/index.htm). For this REA, we added additional material for each coarse filter CE, especially focusing on adding aquatic components, aquatic dynamics and describing natural and altered dynamics, as well as threats and stressors to the system. The information we have developed is intended to cover the full range of distribution of the CEs, which may extend beyond the ecoregion, and does not specifically focus on the characteristics or dynamics as they occur within this ecoregion.

Some descriptions include many names of plant species that are characteristic of riparian, wetland, spring and lacustrine fringe coarse filter ecological system types. In most text sections these names are provided as scientific names; we recognize that common names are better known and we will provide at a later date a listng of scientific names with their common names. Vascular plant species nomenclature follows the nationally standardized list of Kartesz (1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990) and Anderson et al. (1990) for mosses, Egan (1987, 1989, 1990, 1991) and Esslinger and Egan (1995) for lichens, and Stotler and Crandall-Stotler (1977) for liverworts/hornworts. Within Reference Appendices not yet developed we will include a table with common names for each species.

All Tables and Figures are numbered within each CEs conceptual model, not sequentially through the entire document.

For all coarse filter types, we have identified both aquatic and terrestrial animal or plant species of conservation or management concern that are known to be strongly associated with these ecosystems. Assessment of these species is presumed to be well-addressed through the assessment of the coarse filter CE. Species are listed by informal taxonomic groups, with common names followed by scientific names.

Each model begins by characterizing what the CE is and how it nests within the broader conceptual model already established for the ecoregion. Each CE is placed within one of the 2 major model components (Level 1, see Table B - 7 below for the list), and then into one of the sub-model groups (Level 2).

Table B - 7. Aquatic Coarse filter CEs in the CBR and placement in Ecoregional Conceptual Model

Aquatic Coarse filter CEs in the CBR and placement in Ecoregional Conceptual Model		
Level 1	**Level 2**	**Coarse filter Element Name**
Montane Wet System	Montane Streams & Riparian	Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream
		Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream
Basin Wet System	Playa, Greasewood Flats, Washes	Inter-Mountain Basins Greasewood Flat
		Inter-Mountain Basins Wash
		Inter-Mountain Basins Playa
	Basin and Foothill Streams & Riparian	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream
	Basin Lake/Reservoir	Great Basin Lake / Reservoir*
	Desert Springs, Seeps	Great Basin Springs and Seeps*

* Lakes/Reservoirs and Springs and Seeps CEs can and do occur in the montane regions of the Great Basin Ecoregion.

Conservation Element Characterization

This section of the conceptual model includes a narrative of the CE distribution, biophysical and hydrologic setting, and floristic composition. For the Inter-Mountain Basins Greasewood Flat coarse filter CEs, we also provide a direct linkage between the CE concept and Ecological Site Descriptions (ESDs) applicable to the ecoregion. Crosswalks are provided only to approved ESDs by NRCS Multiple Resource Land Area (MLRA) that overlap the ecoregion. Vegetation, species and hydrologic dynamics, both natural and altered, are described in narrative text, with supporting literature cited. Again, this information is developed across the range-wide distribution of the ecological system type.

One section of the conceptual model is devoted to the aquatic habitat component of the CE.

Change Agent Effects on the CE

In this section we characterize the primary change agents and current knowledge of their effects on this CE. Some CAs have specific effects on each CE such as the alteration of hydrologic regimes and the interacting effects of introduced weed infestations. We provide narrative on the effects of CAs on the individual CE, in an “altered dynamics” section. Invasive aquatic and terrestrial plant species CAs are described and modeled within the context of their effects on coarse filter CEs.

The Inter-Mountain Basins Greasewood Flat coarse filter CE is unique in our conceptual models for the aquatic CEs, in that we have also modeled the impacts of wildfire and invasive plants are through the use of the Vegetation Dynamics Development Tool (VDDT) and simulations were run in the Path Landscape Model (ESSA Technologies). Models were developed by the Nevada chapter of The Nature Conservancy, and modified by our team for use in this REA. Further details about the VDDT modeling is provided in that CEs conceptual model.

Conceptual Model Diagram

We provide a diagram (composed of three sub-figures) conceptualizing the relationships between Change Agents, the stresses they induce in the CE, the response of the CE to those stressors, and how we plan to measure either the stress or the CE response with indicators. It is intended to be illustrative of the effect of each Change Agent on Aquatic CE's ecological integrity. Change Agents are a source of different types of stressors. Different types of stressors invoke different responses, and Indicators are metrics by which we can directly measure the amount of stress or response within each type of CE.

We have not attempted to list all change agents, stresses, or responses, and the indicators are generally those we are applying in the assessment, rather than a complete suite of possible indicators.

Ecological Status Criteria and Indicators

To assess ecological status for each CE within the ecoregion, NatureServe’s ecological integrity framework sets up practical criteria and indicators for this purpose (Faber-Langendoen et al. 2006, Unnasch et al. 2008). This framework provides a scorecard for reporting on the ecological status of a given CE within a given location, and facilitates the aggregation and synthesis of the component results for broader measures of ecological integrity at landscape and ecoregional scales. Using this framework, indicators are chosen to provide a measurement for a limited set of key ecological attributes, or ecological drivers for each CE. Ecological attributes may include natural characteristics, such as native species composition, or stressors such as effects of relevant change agents, that are well known to affect the natural function and integrity of the CE.

In part because of project constraints, indicators that we have identified emphasize ecosystem stressors that can be more readily measured using available remotely sensed data. Spatial models that reflect these indicators serve as the link between the conceptual models and the spatial representation of ecological status. For each CE, we provide the definitions and justifications for each of the indicators we will be assessing for that CE, organized in an Ecological Status Scorecard table. Each indicator is scored according to criteria described in the table and is calculated between 0 and 1, with 1 indicating highest ecological status and 0 indicating lowest status (and presumably transitional to a wholly different ecological state).

References for the CE

Literature is listed that is relevant to the classification, distribution, floristic composition, ecological processes, threats, stressors, or management of the CE, in some cases from portions of it's range outside of the ecoregion. These are not exhaustive literature surveys, rather are an accumulation of known references. Some documents may be listed that are not cited in the narrative text.

B-1.1.5 Vulnerable Species Assemblages

The species assemblages were identified by botany and zoology staff of the Nevada Natural Heritage Program. They were limited to selecting species to include in an assemblage to those which met criteria established early on in the REA process; NatureServe provided them a list of species meeting these criteria. These criteria were:

- All taxa listed under Federal or State protective legislation (including species, subspecies, or designated subpopulations)
- Full species with NatureServe Global Conservation Status rank of G1-G3[3]
- Full species or subspecies listed as BLM Special Status and those listed by applicable SWAPs with habitat included within the ecoregion
- Full species and subspecies scored as *Vulnerable* within the ecoregion according to the NatureServe Climate Change Vulnerability Index (CCVI).

A number of assemblages were identified, and proposed to the AMT. The ones included in this appendix are those for which we were able to develop a spatial model of habitat distribution for the assemblage; several others were dropped due to a lack of data from which to build a model, or because the model itself yielded a poor result. These assemblages range from having only two species (one assemblage), to being composed of a couple of dozen species; some are entirely flowering plants, others a mix of plants and animals including birds, mammals, invertebrates, and reptiles.

All of the vulnerable species assemblage conceptual models are included in this document: CBR_ConceptualModels_SpeciesAssemblagesSept_2012_final.pdf

Each model begins by characterizing what the CE is and how it nests within the broader conceptual model already established for the ecoregion. Each CE is placed within one of the 2 major model components (Level 1, see table below for the list), and then into one of the sub-model groups (Level 2).

Table B - 8. Vulnerable Species Assemblage CEs in the CBR and placement in Ecoregional Conceptual Model

Species Assemblage CEs in the MBR and placement in Ecoregional Conceptual Model		
Level 1	**Level 2**	**Species Assemblage Name**

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[3] See http://www.natureserve.org/explorer/ranking.htm for NatureServe Conservation Status Rank definitions

Basin Wet System	Basin River & Riparian	Migratory waterfowl & shorebirds
Montane Dry Land System	Alpine Uplands	Carbonate (Limestone/Dolomite) alpine
		Non-carbonate alpine
	Subalpine/Montane Forests & Woodlands	Montane conifer
Basin Dry Land System	Cliff & Outcrop	Azonal carbonate rock crevices
		Azonal non-carbonate rock crevices
	Desert Scrub	Gypsum soils
	Semi-desert Shrub & Steppe	Clay soil patches
		Sand dunes/sandy soils (when deep and loose)

Conservation Element Characterization

Because these are concepts developed specifically for the REA assessment, our descriptive information for these assemblages has been kept to relatively simple summarizing of information we had available for the species within the assemblage, and some information about the environmental setting in which the assemblage is found. A couple of the assemblages were particularly difficult to describe (montane conifer, for example) because the species in the assemblage are diverse in their habitat requirements, many of them are highly mobile, and the “montane conifer zone” itself is a complex mosaic of vegetation types.

The descriptions include a short summary of the concept of the assemblage, it’s general range within the ecoregion, the environmental setting for it, and the “habitat” or the ecosystem setting for it. We generally use scientific names for the plants when they are mentioned in the text, although in places the common name for a genus might be used, such as “cottonwood”, or “willow”. We provide a complete listing of the species in the assemblage organized by informal taxonomy and with both common and scientific names. All Tables and Figures are numbered within each CEs conceptual model, not sequentially through the entire document.

Vascular plant species nomenclature follows the nationally standardized list of Kartesz (1999), with very few exceptions. Nomenclature for nonvascular plants follows Anderson (1990) and Anderson et al. (1990) for mosses, Egan (1987, 1989, 1990, 1991) and Esslinger and Egan (1995) for lichens, and Stotler and Crandall-Stotler (1977) for liverworts/hornworts. Within Reference Appendices not yet developed we will include a table with common names for each species.

Change Agent Effects on the CE

In this section we characterize the primary change agents and current knowledge of their effects on the assemblage. In most cases, this information was derived by reviewing information for the species within the assemblage, but also by expert knowledge of some of the impacts of change agents on particular habitats (e.g. rock climbing is a probable change agent for assemblages found in rock crevices). Some CAs have specific effects on each CE such as the alteration of hydrologic regimes and the interacting effects of introduced weed infestations. We provide narrative on the effects of CAs on the individual CE, in an “altered dynamics” section.

Conceptual Model Diagram

We provide a diagram (composed of three sub-figures) conceptualizing the relationships between Change Agents, the stresses they induce in the CE, the response of the CE to those stressors, and how we plan to measure either the stress or the CE response with indicators. It is intended to be illustrative of the effect of each Change Agent on the CE's ecological condition. Change Agents are a source of different types of stressors. Different types of stressors invoke different responses, and Indicators are metrics by which we can directly measure the amount of stress or response within each CE.

We have not attempted to list all change agents, stresses, or responses, and the indicators are those we are applying in the assessment, rather than a complete suite of possible indicators.

Ecological Status Criteria and Indicators

To assess ecological status for each CE within the ecoregion, NatureServe's ecological integrity framework sets up practical criteria and indicators for this purpose (Faber-Langendoen et al. 2006, Unnasch et al. 2008). This framework provides a scorecard for reporting on the ecological status of a given CE within a given location, and facilitates the aggregation and synthesis of the component results for broader measures of ecological integrity at landscape and ecoregional scales. Using this framework, indicators are chosen to provide a measurement for a limited set of key ecological attributes, or ecological drivers for each CE. Ecological attributes may include natural characteristics, such as native species composition, or stressors such as effects of relevant change agents, that are well known to affect the natural function and integrity of the CE.

In part because of project constraints, indicators that we have identified emphasize ecosystem stressors that can be more readily measured using available remotely sensed data. Spatial models that reflect these indicators serve as the link between the conceptual models and the spatial representation of ecological status. For each CE, we provide the definitions and justifications for each of the indicators we will be assessing for that CE, organized in an Ecological Status Scorecard table. Each indicator is scored according to criteria described in the table and is calculated between 0 and 1, with 1 indicating highest ecological status and 0 indicating lowest status (and presumably transitional to a wholly different ecological state).

References for the CE

Each species within each assemblage has an extensive list of literature references associated with it. However, we do not provide all of those for each assemblage, as in some cases it would be many dozens of citations. Hence, for each assemblage we have provided a selection of references; a full listing of references for each assemblage will be provided separately to BLM if requested. These are not exhaustive literature surveys, rather are an accumulation of known references. Documents may be listed that are not cited in the narrative text.

B-1.1.6 Landscape Species

In the section that follows, the content included for each species CE is described. Characterization data that has been developed for these species is intended to represent the taxon across the entire range of its distribution (i.e., global-level data). Species CE data has been obtained from a biodiversity database developed centrally at NatureServe over the past thirty-five years. This database is dynamic, maintained and refined through updates made to reflect current changes to taxonomy, and by the periodic import of new records that are developed according to standard methodology by natural heritage member program scientists and other collaborators, including government agencies, universities, natural history museums and botanical gardens, and additional conservation organizations. This ongoing process of information being added and existing records revised helps to maintain currentness and enhance completeness of the data. All of the landscape species conceptual models are included in this document: CBR_ConceptualModels_LandscapeSpeciesSept_2012_final.pdf

NatureServe's database contains an array of information about elements of biodiversity, with particular emphasis on those that are more threatened across their range. Tracked data includes taxonomy, conservation status, ecological and life history, habitat requirements, and distribution, with primary sources of this information consisting of scientific literature, museum specimen records, reliably documented observation records, species lists, range maps, external databases, and experts, including scientists from natural heritage member programs. While centrally NatureServe maintains range maps and/or data representing all native full species vertebrates and vascular plants, at the local member program level, resources generally limit tracking specific locations where elements occur within their jurisdictions to those having the highest conservation concern.

NatureServe scientists use a set of references generally accepted by researchers working on a given taxonomic group, supplemented by recent scientific literature and expert opinion, to establish a standard "global" scientific name and taxon circumscription for every element of biodiversity contained in the central database. Arranged by taxonomic level and species type, the major references NatureServe used (December 2011) for the species CE names and taxonomy follows.

HIGHER TAXONOMY

Phyla and Subphyla

- Integrated Taxonomic Information System. Integrated Taxonomic Information System: Biological Names. Available online at: http://www.itis.gov/.
- Margulis, L., and K. V. Schwartz. 1998. Five kingdoms: An Illustrated Guide to the Phyla of Life on Earth. Third edition. W. H. Freeman and Company, New York. 520 pp.

PHYLUM CRANIATA (VERTEBRATES)

Class Mammalia (Mammals)

- American Society of Mammalogists. Mammalian species. Cumulative index available online: http://www.science.smith.edu/departments/Biology/VHAYSSEN/msi/default.html [ASM publishes 20-30 species accounts each year; each summarizes the current understanding of a species' biology.]
- Baker, R. J., L. C. Bradley, R. D. Bradley, J. W. Dragoo, M. D. Engstrom, R. S. Hoffman, C. A. Jones, F. Reid, D. W. Rice, and C. Jones. 2003. Revised checklist of North American mammals north of Mexico, 2003. Museum of Texas Tech University Occasional Papers 229:1-23.
- Da Fonseca, G., G. Herrmann, Y. Leite, R. Mittermeier, A. Rylands, and J. L. Patton. 1996. Lista anotada dos mamíferos do Brasil. Conservation International, Washington, D.C.
- Hall, E. R. 1981. The Mammals of North America. Second edition. John Wiley & Sons, New York. [Used for North American mammal subspecies names, within the framework of the species classification of the major sources cited here.]
- Reid, F. A. 1997. A field guide to the mammals of Central America and southern Mexico. Oxford University Press, New York.
- Wilson, D. E., and F. R. Cole. 2000. Common names of mammals of the world. Smithsonian Institution Press, Washington, D.C.
- Wilson, D. E., and D. M. Reeder (editors). 2005. Mammal species of the world: a taxonomic and geographic reference. Third edition. The Johns Hopkins University Press, Baltimore. Two volumes. 2,142 pp. Available online at: http://www.bucknell.edu/msw3/.

Class Aves (Birds)

- American Ornithologists' Union. 1957. Checklist of North American birds. Fifth edition. Port City Press, Inc., Baltimore, Maryland. [Used for North American bird subspecies names, within the framework of the species classification in AOU checklist.]
- American Ornithologists' Union (AOU). 1998. Check-list of North American birds. Seventh edition. American Ornithologists' Union, Washington, D.C. [as modified by subsequent supplements and corrections published in *The Auk*]. Also available online: http://www.aou.org/.

- The Birds of North American Online. Available at: http://bna.birds.cornell.edu/BNA/. [subscription required]
- Howard, R. and A. Moore. 2003. A complete checklist of the birds of the world. Third edition. Princeton University Press, Princeton, New Jersey. 1039 pp.
- Remsen, J. V., Jr., A. Jaramillo, M. Nores, M. B. Robbins, T. S. Schulenberg, F. G. Stiles, J. M. C. da Silva, D. F. Stotz, and K. J. Zimmer. Version [11 November 2011]. A classification of the bird species of South America. American Ornithologists' Union. http://www.museum.lsu.edu/~Remsen/SACCBaseline.html.

Classes Chelonia, Crocodylia, and Reptilia (Turtles, Crocodilians, and Reptiles)

- Collins, J. T., S. L. Collins, and T. W. Taggart. 2010. Amphibians, reptiles, and turtles in Kansas. Eagle Mountain Publishing, Eagle Mountain, Utah. xvi + 312 pp.
- Crother, B. I. (editor). 2008. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Sixth edition. Society for the Study of Amphibians and Reptiles Herpetological Circular 37:1-84.
- Ernst, C. H., and R. W. Barbour. 1989. Turtles of the world. Smithsonian Institution Press, Washington, D.C.
- Ernst, C. H., R. W. Barbour, and J. E. Lovich. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, D.C.
- Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C.
- Iverson, J. B. 1992. A revised checklist with distribution maps of the turtles of the world. Privately printed, Earlham, Indiana.
- King, F. W., and R. L. Burke, editors. 1989. Crocodilian, tuatara, and turtle species of the world: a taxonomic and geographic reference. Association of Systematics Collections, Washington, D.C. 216 pp.
- McDiarmid, R. W., J. A. Campbell, and T. A. Touré. 1999. Snake species of the world: a taxonomic and geographic reference. Volume 1. The Herpetologists' League, Washington, D.C.
- Schwartz, A., and R.W. Henderson. 1988. West Indian amphibians and reptiles: a check-list. Milwaukee Public Museum, Contributions in Biology and Geology. No. 74:1-264. [Major source for West Indian reptiles]
- Society for the Study of Amphibians and Reptiles. 1971 et seq. Catalogue of American Amphibians and Reptiles. (Published by the American Society of Ichthyologists and Herpetologists, 1963-1970.)
- Stebbins, R. C. 2003. A field guide to western reptiles and amphibians. Third edition. Houghton Mifflin Company, Boston.

The primary purpose of the species CE characterization is to provide sufficient information on classification, range, ecology and life history, and habitat requirements to permit assumptions about effects on the species that would likely result from change agents such as development, invasive plant species, or changes in fire regime, that are components of the assessment process. Thus, the CE characterization provides narrative detailing individual attributes of the element, and information on Change Agents (CAs) that may threaten its survival.

Each model begins by characterizing what the CE is and how it nests within the broader conceptual model already established for the ecoregion. Each CE is placed within one of the 2 major model components (Level 1, see Table B - 9 below for the list), and then into one of the sub-model groups (Level 2).

Table B - 9. Landscape Species CEs in the CBR and placement in Ecoregional Conceptual Model

Species CEs in the CBR and placement in Ecoregional Conceptual Model		
Level 1	**Level 2**	**Taxon Name**
Montane Dry Land System	Montane Canyons	Desert Bighorn Sheep *Ovis canadensis nelsoni*
		Golden Eagle *Aquila chrysaetos*
	Montane Shrublands	Loggerhead Shrike *Lanius ludovicianus*
		Mule Deer *Odocoileus hemionus*
		White-tailed Jackrabbit *Lepus townsendii*
	Subalpine/Montane Forests & Woodlands	Big Brown Bat *Eptesicus fuscus*
		Clark's Nutcracker *Nucifraga columbiana*
		Cooper's Hawk *Accipiter cooperii*
		Northern Rubber Boa *Charina bottae*
		Swainson's Hawk *Buteo swainsoni*
Basin Dry Land System	Cliff & Outcrop	Brazilian Free-tailed Bat *Tadarida brasiliensis*
		Great Basin Collared Lizard *Crotaphytus bicinctores*
	Desert Scrub	Coachwhip *Masticophis flagellum*
		Western Patch-nosed Snake *Salvadora hexalepis*
	Semi-desert Shrub & Steppe	Brewer's Sparrow *Spizella breweri*
		Columbian Sharp-tailed Grouse *Tympanuchus phasianellus columbianus*
		Ferruginous Hawk *Buteo regalis*
		Greater Sage-Grouse *Centrocercus urophasianus*
		Kit Fox *Vulpes macrotis*
		Northern Sagebrush Lizard *Sceloporus graciosus graciosus*
		Prairie Falcon *Falco mexicanus*
		Pygmy Rabbit

Species CEs in the CBR and placement in Ecoregional Conceptual Model		
Level 1	**Level 2**	**Taxon Name**
		Brachylagus idahoensis
		Sage Sparrow *Amphispiza belli*
		Sage Thrasher *Oreoscoptes montanus*
		Savannah Sparrow *Passerculus sandwichensis*
Montane Wet System	Montane Lakes & Wetlands	Northern Harrier *Circus cyaneus*
Basin Wet System	Basin River & Riparian	Bald Eagle *Haliaeetus leucocephalus*
		Common Kingsnake *Lampropeltis getula*

Conservation Element Characterization

Below, the individual components included in each species CE are described. Characterization data that has been developed for species CEs is intended to represent the taxon across the entire range of its distribution (i.e., global-level data); therefore, the information may be more relevant to subpopulations or specific areas within that range, which might extend beyond the ecoregion. Note that for some species, particular components of information may be lacking.

The narrative provided includes information on classification, range, ecology and life history, and habitat requirements, as well as major threats. Each field of information is described below with a brief description of the field's contents.

CLASSIFICATION COMMENTS

Brief clarification of any anomalies or changes in the element taxonomy concerning the validity or taxonomic distinctness of the species.

RANGE

Current total geographic range-wide extent of the species, with breeding/nonbreeding or seasonal ranges specified, if different.

OCCURRENCES

Estimate of total number of precise locations where the species is known to occur across its range, including information on how the estimate was derived. Occurrence data is developed and maintained by natural heritage member programs, which document and delimit the presence and extent of individual species on the landscape. Species occurrences commonly reflect populations or subpopulations.

POPULATION

Estimate of total population size for the species across its range, including information on how the estimate was derived, variations, and data for specific portions of the range.

HABITAT

Summary of the habitats and microhabitats commonly used by the species throughout its range, including any daily, seasonal, and geographic variation in habitat use.

PHENOLOGY

Summary of the seasonal variations of the species across its range, including differences in seasons of activity and periods of daily activity.

ECOLOGY

Summary of the ecology of the species across its range, including any additional information resulting from studies that have been conducted, and citations where appropriate. Information on population density, dispersal distances, home range size, annual and seasonal fluctuations in population size, nonbreeding coloniality/sociality, major predators, competitors, parasites, age-specific survival rates, and other significant ecological factors could be included.

MOBILITY

Discussion of the seasonality, direction, distances, major routes, sociality/dispersion, daily timing, and variability (e.g., between populations) in movement/migration patterns of the species across its range.

FOOD

Information on food types, food location (e.g., microhabitat), foraging methods/strategy, seasonal and geographic variation in diet, and major differences in diet among age classes (e.g., young vs. adults) for the species across its range. Additional information resulting from studies that have been conducted should be included, along with citations where appropriate. If the species is classically considered to be an omnivore, this fact should be included, along with appropriate references.

REPRODUCTION

Description of the reproduction of the species across its range, including information on clutch/litter size and frequency, gestation/incubation period, seasonal timing of reproductive activities, nature and period of any parental care, age of sexual maturity, and size and general nature of breeding aggregations. Additional information resulting from studies that have been conducted is included, along with citations where appropriate.

Change Agent (CA) Characterization

Altered Dynamics

Description of the primary change agents, including information on the scope, severity, and immediacy (timing) of threats, and current knowledge of their effects on the species across its range. Comments should include whether the scope and severity of the threats to species are observed, inferred, or suspected, or result from qualitative observation of its impact on the CE. The extent, including geographic variation, and effects of current or projected extrinsic influences on the species should be described, along with any additional threats or interactions among different threats, including high-magnitude threats considered insignificant in immediacy.

Conceptual Model Diagram

We provide a diagram (composed of three sub-figures) conceptualizing the relationships between Change Agents, the stresses they induce in the CE, the response of the CE to those stressors, and how we plan to measure either the stress or the CE response with indicators. It is intended to be illustrative of the effect of each Change Agent on the CE's ecological condition. Change Agents are a source of different types of stressors. Different types of stressors invoke different responses, and Indicators are metrics by which we can directly measure the amount of stress or response within each CE.

We have not attempted to list all change agents, stresses, or responses, and the indicators are those we are applying in the assessment, rather than a complete suite of possible indicators.

Ecological [Habitat] Status Criteria and Indicators

To assess ecological status for each CE within the ecoregion, NatureServe's ecological integrity framework sets up practical criteria and indicators for this purpose (Faber-Langendoen et al. 2006, Unnasch et al. 2008). This framework provides a scorecard for reporting on the ecological status of a given CE within a given location, and facilitates the aggregation and synthesis of the component results for broader measures of ecological integrity at landscape and ecoregional scales. Using this framework, indicators are chosen to provide a measurement for a limited set of key ecological attributes, or ecological drivers for each CE. Ecological attributes may include natural characteristics, such as native species composition, or stressors such as effects of relevant change agents, that are well known to affect the natural function and integrity of the CE.

In part because of project constraints, indicators that we have identified emphasize ecosystem stressors that can be more readily measured using available remotely sensed data. Spatial models that reflect these indicators serve as the link between the conceptual models and the spatial representation of ecological status. For each CE, we provide the definitions and justifications for each of the indicators we will be assessing for that CE, organized in an Ecological Status Scorecard table. Each indicator is scored according to criteria described in the table and is calculated between 0 and 1, with 1 indicating highest ecological status and 0 indicating lowest status (and presumably transitional to a wholly different ecological state).

For most of the landscape species conservation elements, we have developed spatial models predicting distribution of habitat for the species; only a few species have current occupied habitat mapped. Hence for the ecological status assessment, the unit of assessment for most species is its predicted habitat, rather than current occupied habitat. Only greater sage-grouse, mule deer and desert bighorn sheep have occupied habitat models; for bald and golden eagles habitat is represented by point localities for actual occurrences and those will be the assessment units. For all other species predicted habitat is the habitat unit of assessment.

References for the CE

Literature is listed that is relevant to the classification, distribution, ecology and life history, threats, and habitat requirements of the individual CE, in some cases from portions of its range outside of the ecoregion. These are not exhaustive literature surveys, but rather an accumulation of known references. Some documents may be listed that are not cited in the narrative text.

B-1.2 Spatial Modeling of Distribution

Spatial models were documented in the form of 'box and arrow' diagrams for each analyses (or category of analyses) that illustrated data inputs, analytical processes, and outputs. Data generation models explained how distribution maps for certain CEs and CAs could be created for those features that lacked complete or acceptable distribution data from existing sources. Spatial models for assessments are described in subsequent sections below.

Spatial modeling for CEs first takes the form of distribution modeling, indicating the location of the CE. Most often, this simply refers to the current known location, such as the mapped distribution of, e.g., the Great Basin Lower Montane Riparian Woodland and Shrubland/Stream. However, distributions for CEs take several forms. For some landscape species CEs, spatial distributions are developed for three distinct habitat components. For example, as specified in its conceptual model, mule deer is spatially represented using three distinct map units; summer range, winter range, and year-around range. Terrestrial coarse filter units have been mapped in two forms; there current distribution and their biophysical setting. The biophysically setting, as developed for LANDFIRE aims to depict the potential distribution of the unit, given natural landscape disturbance regimes like wildfire.

One additional form of CE distribution modeling comes in the form of climate envelope models, where the climate variables that characterize the current distribution of the CE are developed; and then forecasted to future decades using the predicted climate distributions. These models should not be construed to predict the future distribution of a given CE, *but rather simply to indicate the degree and magnitude of potential change in climate regime relative to a particular CE*. See Section B-1.3 below for methods of bioclimate envelope modeling. Below we summarize the primary methods used in distribution modeling for CEs.

Deductive and Inductive Models

Deductive models utilize existing mapped information, and then recombine them according to a set of rules determined by the modeler. This contrasts with ***inductive models,*** where most commonly, geo-referenced observations (e.g., known observations of a given species) are combined with maps of potential explanatory variables (climate, elevation, landform, soil variables, etc.). Statistical relationships between dependent variables (observations) and independent explanatory variables are used to derive a new spatial model.

In many instances for this REA, existing data were previously derived through inductive modeling. Review of these models led to suggestions for their refinement, which were implemented through deductive methods. In other instances, only deductive, or only inductive methods were used. Here we briefly summarize and illustrate each category of spatial models.

B-1.2.1 Terrestrial Coarse-filter: Deductive Models

Building from the framework of the ecoregional conceptual model, the major ecological systems were identified for the ecoregion. The “coarse filter” includes terrestrial ecological system types that express the predominant ecological pattern and dynamics of uplands of the ecoregion (Table B - 10). These classified units a) characterize each component of the ecoregion’s conceptual model, b) define the vast majority of this ecoregion’s lands, and c) reflect described ecological types with distributions concentrated within this ecoregion.

Ecological models (both conceptual and spatial) for these coarse filter elements formed a major focus for this ecoregional assessment. NatureServe ecological classifications provided the basis for several existing national or regional map products (e.g., NatureServe national map, ReGAP in CA and SW region, LANDFIRE EVT & BpS, etc.) and/or may be readily reconciled with locally-desired classification systems for plant communities (see the Terrestrial Coarse filter Conceptual Models appendix for more detailed descriptions of ecosystem types listed in this appendix). NatureServe databases, existing map products and the list of ecosystems of interest identified in REA statement of work were used to establish the list of these core CEs.

Terrestrial coarse filter CEs were defined and described using the the NatureServe ecological systems classification (Comer et al. 2003) and depicted initially with data derived from SW ReGAP, CAGAP, and LANDFIRE EVT (for California portions), all of whom used inductive modeling methods. As depicted in Figure B - 1, each of these current and potential distributions was reviewed to determine, from an expert point of view, where error occurred that could be addressed using deductive modeling with ancillary spatial data (e.g., landforms, soils, hydrography, elevation, etc.).

Table B - 10. Terrestrial Coarse filter CEs for Central Basin and Range Ecoregion

Ecoregion Conceptual Model		**Coarse filter Element Name**
Level 1	**Level 2**	
Montane Dry Land System	Alpine Uplands	Rocky Mountain Alpine Turf
	Montane Canyons	Inter-Mountain Basins Cliff and Canyon

Ecoregion Conceptual Model		Coarse filter Element Name
Level 1	**Level 2**	
	Montane Shrublands	Great Basin Semi-Desert Chaparral
		Inter-Mountain Basins Montane Sagebrush Steppe
		Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland
	Subalpine/Montane Forests & Woodlands	Great Basin Pinyon-Juniper Woodland
		Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
		Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
		Rocky Mountain Aspen Forest and Woodland
Basin Dry Land System	Desert Scrub	Inter-Mountain Basins Mixed Salt Desert Scrub
		Mojave Mid-Elevation Mixed Desert Scrub
	Dunes	Inter-Mountain Basins Active and Stabilized Dune
	Semi-desert Shrub & Steppe	Colorado Plateau Mixed Low Sagebrush Shrubland
		Great Basin Xeric Mixed Sagebrush Shrubland
		Inter-Mountain Basins Big Sagebrush Shrubland
		Inter-Mountain Basins Big Sagebrush Steppe
		Inter-Mountain Basins Semi-Desert Grassland
		Inter-Mountain Basins Semi-Desert Shrub-Steppe

NatureServe Terrestrial Ecological Systems Map for the Continental United States

NatureServe’s terrestrial ecological systems map for the coterminous U.S. was the first, and the major, source dataset used to develop the coarse filter distributions.

The NatureServe dataset represents compilation of the work of multiple state and Federal agencies as part of the US Gap Analysis and LandFire programs, all of whom used inductive models. Multi-season satellite imagery (Landsat ETM+) from 1999-2001 were used in conjunction with digital elevation model (DEM) derived datasets (e.g. elevation, landform) to model natural and semi-natural vegetation. The minimum mapping unit for this dataset is approximately 1 acre. Landcover classes were drawn from NatureServe's Ecological System concept. Five-hundred and fourty-four land cover classes composed of 12 cultural and 532 Natural/Semi-natural types were mapped across the coterminous U.S. Land cover classes were mapped with a variety of techniques including decision tree classifiers, terrain modeling, inductive modeling, and unsupervised classification. The 67 USGS mapping zones were modeled independently of one another by multiple spatial analysis laboratories.

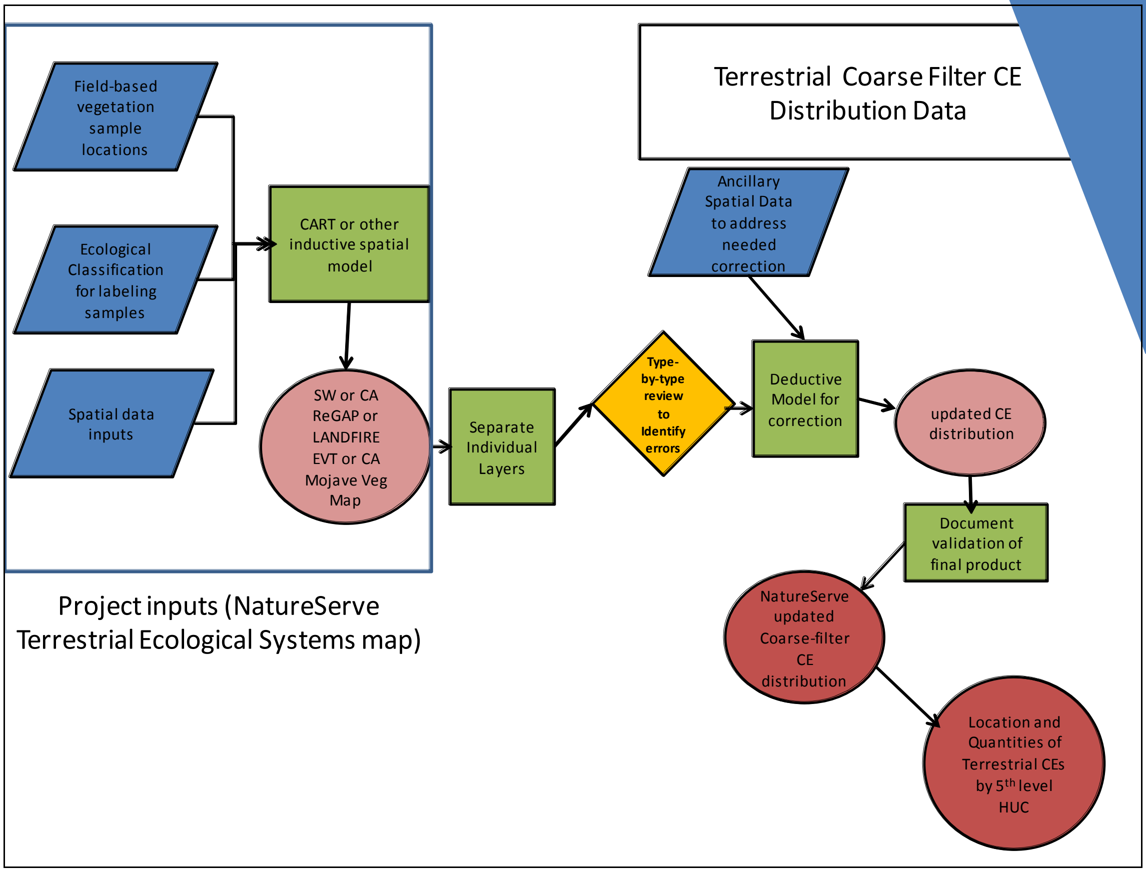

Figure B - 1. Process steps for mapping terrestrial coarse filter CEs.

Prior to the initiation of the BLM REAs, NatureServe stitched together the resultant spatial data from the Gap and LANDFIRE efforts, into one comprehensive map for the coterminous US. In the western US, SW ReGap data were used for the 5 southwestern states (AZ, CO, NM, NV, UT), and LANDFIRE data were used for California. PNW ReGap was the source for data from ID, MT, OR, WA and WY. Following completion of this national dataset, each individual land cover type was evaluated by NatureServe (again, prior to the initiation of the BLM REAs) through individual working groups and two regional workshops attended by State, Federal, and Natural Heritage Program ecologists. Where individual systems were identified with likely errors a description was recorded of the issue and a fix where available was described and initiated by NatureServe. All changes are available in supporting documentation (see National Ecological Systems Modification.pdf for documentation of all changes made) and represent the opinion of multiple experts. Updates to specific system types were performed to update known errors in the data layer.

Additional Processing to Represent Current Coarse filter Distributions for the REA

The current distribution of the eighteen terrestrial coarse filters CEs within the CBR ecoregion (Table B - 10) were reviewed and, if necessary, revised (Table B - 12). The main focus of this review was on the boundary between Arizona or Nevada and California, since the source data for California was LANDFIRE, and there were major unresolved discrepancies along the state borders. In addition, the sparsely vegetated coarse filters, such as badlands, pavement, cliff & outcrop, or dunes, were systematically reviewed because of *a priori* knowledge they'd been poorly mapped on the California side of the ecoregion.

Six source datasets were used in this review (Table B - 11): NatureServe Ecological System types v2.7 (ES, described above), LANDFIRE Existing Vegetation Types Refresh 2008 (EV), LANDFIRE Existing Vegetation Cover Refresh 2008 (EC), LANDFIRE Biophysical Settings Refresh 2001 (BP), California ReGAP Land Cover 2003 (CG), and USGS Mojave Vegetation Map 2000 (MV, overlapped a small portion of the CBR).

Three ancillary datasets were used to subset the distributions of these ecosystem/vegetation maps including: National Resource Conservation Service (NRCS) Multiple Resource Land Area (MRLA), US Forest Service (USFS) EcoMap 2005 (EcoMap), and US Geological Survey (USGS) 30 meter National Elevation Dataset (NED). All source and ancillary datasets are 30 meter pixel resolution and masked/snapped to the CBR boundary.

Table B - 11. Source and ancillary datasets used for current coarse filter distributions.

Source Dataset Name	Delivered File Name(s)	Methods Abbreviation
California ReGAP Land Cover 2003	CBR_TES_C_GAP_CALIFORNIA_2008_CA_ESLF.img	CG
LANDFIRE Biophysical Settings Refresh 2001	TES_H_Landfire_BPS.img	BP
LANDFIRE Existing Vegetation Cover Refresh 2008	TES_C_Landfire_EVC.img	EC
LANDFIRE Existing Vegetation Types Refresh 2008	TES_C_Landfire_EVTR.img	EV
National Elevation Dataset (NED) - 30 m	CBR_ELV_USGS_NED_30m MBR_ELV_USGS_NED_30m	NED
National Resource Conservation Service (NRCS) Multiple Resource Land Area (MRLA)	CBR_MRLA_Subregions_poly MBR_MRLA_Subregions_poly	MRLA
NatureServe Terrestrial Ecosystems and Landcover	C_NATURESERVE_L48_ESLF_V2_7.img	ES
US Forest Service (USFS) EcoMap 2005 (EcoMap)	CBR_EcoMap_Subregions_poly MBR_Ecomap_Subregions_poly	EcoMap
USGS Mojave Vegetation Map 2000	MBR_TES_C_CA_Mojave_vegcda_poly	MV

For each terrestrial coarse filter CE, its distribution was extracted from the NatureServe ecological systems v2.7 map (the ES), and clipped to the combined CBR and MBR area. Each was then reviewed across its distribution within the CBR boundary, by NatureServe ecology staff familiar with the type's concept and distribution. Draping the individual CE distribution onto a shaded relief map helped to identify areas where the CE was correctly or incorrectly mapped. During the review, the expert also had on-hand the California ReGAP land cover map (CG), the refreshed LANDFIRE existing vegetation types (EV), and the Mojave vegetation map (MV) to cross-check how the type was mapped in a particular area by those efforts. Locations where the mapping of the type needed correction were identified. Each area would then be corrected by selecting the type's pixels within that area and applying a conversion to a different type.

The revised distributions of these ecological systems were then combined into a current terrestrial coarse filter CEs dataset for the combined CBR and MBR ecoregions and all other cells were coded as null. This dataset was then clipped for each REA boundary.

Table B - 12. Revisions made to terrestrial coarse filter CE current distributions during expert review.

Terrestrial Coarse filter	Changes Made
Colorado Plateau Mixed Low Sagebrush Shrubland	No change from ES
Great Basin Pinyon-Juniper Woodland	The complete distributions of this class within ES, EV and CG were combined;
Great Basin Semi-Desert Chaparral	No change from ES

Terrestrial Coarse filter	Changes Made
Great Basin Xeric Mixed Sagebrush Shrubland	The complete distributions of this class within EV and CG were combined.
Inter-Mountain Basins Active and Stabilized Dune	No change from ES
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	No change from ES
Inter-Mountain Basins Big Sagebrush Shrubland	The complete distributions of this class within EV and CG were combined.
Inter-Mountain Basins Big Sagebrush Steppe	The complete distributions of this class within ES and EV were combined, excluding occurrences within the Carson Basin and Mountains and Southern Nevada Basin and Range MRLA subregions.
Inter-Mountain Basins Cliff and Canyon	Updated with a change in elevation moving window model based upon the 10m DEM; adjacent sparse land cover types with greater than 50m elevation change in 100m^2 moving window were updated to Inter-Mountain Basins Cliff and Canyon.
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	No change from ES
Inter-Mountain Basins Mixed Salt Desert Scrub	The complete distributions of this class within ES, EV and CG were combined, excluding occurrences of this class within the Owens Valley, Saline Valley-Cottonwood Mountains and High Desert Plains subsections of the USFS ECOMAP.
Inter-Mountain Basins Montane Sagebrush Steppe	the complete distributions of this class within ES, EV and CG were combined, plus the complete distribution of Artemesia tridentata ssp. vaseyana Shrubland Alliance within EV.
Inter-Mountain Basins Semi-Desert Grassland	No change from ES
Inter-Mountain Basins Semi-Desert Shrub-Steppe	No change from ES
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	No change from ES
Mojave Mid-Elevation Mixed Desert Scrub (Joshua Tree)	The complete distributions of this class within CG and MV were combined, plus occurrences of this class within EV within all of the MBR, as well as the extent 50 to 100 kilometers north of the MBR boundary, based on expert knowledge of the on the ground distribution, plus the distribution of this class within BP below 1575 meters in elevation (using USGS NED) within the Grand Canyon.
Rocky Mountain Alpine Turf	The complete distributions of this class within ES and EV were combined.
Rocky Mountain Aspen Forest and Woodland	The complete distributions of this class within ES and EV were combined.

B-1.2.1.1 Potential (Biophysical Settings) Distributions

LANDFIRE Biophysical Settings Data

The biophysical settings (BpS) data layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. It is an attempt to incorporate current scientific knowledge regarding the functioning of ecological processes - such as fire - in the centuries preceding non-indigenous human influence. LANDFIRE mapped biophysical settings across the United States, using NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer et al. 2003). The BpS data layer is used in LANDFIRE to depict reference conditions of vegetation, and the actual time period for this data set is a composite of both the historical context provided by the fire regime and vegetation dynamics models, and the more recent field and geospatial data used to create it.

Prior to initiation of the BLM REAs, NatureServe compiled the LANDFIRE BpS data into one comprehensive BpS map for the coterminous U.S., and this was the primary source dataset for the potential distributions of the coarse filter CEs.

Additional Processing to Represent Potential Coarse filter Distributions

The potential (BpS) distributions of the terrestrial coarse filter CEs were used in conjunction with the current distributions described above to assess “change in extent”, one of the indicators of ecological status for the terrestrial coarse filter CEs.

Two source datasets were used in the review (Table B - 13): LANDFIRE Biophysical Settings Refresh 2001 (BP) and USGS Great Basin Integrated Landscape Monitoring Ecological System BpS 2005 (GB, Hak and Comer 2009). Three ancillary datasets were used to subset the distributions of these ecosystem/vegetation maps including: National Resource Conservation Service (NRCS) Multiple Resource Land Area (MRLA), US Forest Service (USFS) EcoMap, 2005 (EcoMap), and US Geological Survey (USGS) 30 meter National Elevation Dataset (NED). All source and ancillary datasets are 30 meter pixel resolution and masked/snapped to the CBR boundary.

Table B - 13. Source and ancillary datasets used for potential coarse filter distributions.

Source Dataset Name	Delivered File Name(s)	Methods Abbreviation
LANDFIRE Biophysical Settings Refresh 2001	TES_H_Landfire_BPS.img	BP
National Elevation Dataset (NED) - 30 m	CBR_ELV_USGS_NED_30m	NED
National Resource Conservation Service (NRCS) Multiple Resource Land Area (MRLA)	CBR_MRLA_Subregions_poly	MRLA
US Forest Service (USFS) EcoMap 2005 (EcoMap)	CBR_EcoMap_Subregions_poly	EcoMap
USGS Great Basin Integrated Landscape Monitoring BpS	CBR_TES_H_NATURESERVE_GBLIM.img	GB

Seventeen terrestrial ecological systems within the CBR ecoregion were reviewed and, if necessary, revised (Table B - 14). For the review, each CE distribution was extracted from the compiled BpS map (the BP), and clipped to the CBR area. Each was then reviewed across its distribution within the CBR boundary, by NatureServe ecology staff familiar with the type’s concept and distribution. Draping the individual CE distribution onto a shaded relief map helped to identify areas where the CE was correctly or incorrectly mapped. One coarse filter CE was not reviewed for potential distribution as its potential and current distributions were assumed to be completely congruent (Inter-Mountain Basins Active and Stabilized Dune).

The revised or unchanged distributions of these ecological systems were then combined into a potential biophysical settings dataset for the combined CBR ecoregion, and all other cells were coded as null. This dataset was then clipped to the REA boundary.

Table B - 14. Revisions made to terrestrial coarse filter CE potential distributions during expert review.

Terrestrial Coarse filter	Changes Made
Colorado Plateau Mixed Low Sagebrush Shrubland	No change
Great Basin Pinyon-Juniper Woodland	The complete distribution within BP.
Great Basin Semi-Desert Chaparral	No change
Great Basin Xeric Mixed Sagebrush Shrubland	The complete distribution within GB, plus occurrences within BP within the Carson Basin and Mountains and Southern Nevada Basin and Range MRLA subregions.
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	No change
Inter-Mountain Basins Big Sagebrush Shrubland	The complete distribution of this class within BP.
Inter-Mountain Basins Big Sagebrush Steppe	The complete distribution of this class within BP.
Inter-Mountain Basins Cliff and Canyon	No change
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	No change
Inter-Mountain Basins Mixed Salt Desert Scrub	The complete distribution of this class within BP, excluding occurrences within the Owens Valley, Saline Valley-Cottonwood Mountains and High Desert Plains subsections of the USFS ECOMAP.
Inter-Mountain Basins Montane Sagebrush Steppe	The complete distribution of this class within GB, plus all occurrences within BP that occur outside of the GB study area.
Inter-Mountain Basins Semi-Desert Grassland	No change
Inter-Mountain Basins Semi-Desert Shrub-Steppe	No change
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	No change
Mojave Mid-Elevation Mixed Desert Scrub (Joshua Tree)	The complete distribution of this class within BP, excluding occurrences above 1575 meters in elevation (using USGS NED) within the Grand Canyon.
Rocky Mountain Alpine Turf	The complete distribution of this class within BP.
Rocky Mountain Aspen Forest and Woodland	The complete distribution of this class within BP.

B-1.2.2 Sensitive Soils

MQ28 - WHERE ARE SENSITIVE SOIL TYPES WITHIN THE ECOREGION?

As a desired CE, sensitive soils were defined by BLM. Sensitive soils are those which are extremely susceptible to impact and difficult to restore and reclaim, including those with high erosion potential (water and wind), high salinity (excess salt and excess sodium), high gypsum content, low water-holding capacity (droughty), restricted rooting depth, or hydric qualities (Bryant, L. BLM internal communication). The approach for this REA was designed to identify soils with these characteristics given the best available data at any given location. BLM provided a list of vulnerable soil properties, to which 2 additional categories were added: gypsum soils, and hydric soils. Shallow soils (restricted rooting depth) could not be reliably modeled form the available data and were dropped form further analysis; soils with excessive sodium and salts were combined into one model for “sodium adsorption ratio”.

Where available, the SSURGO 1:24,000 dataset provided by NRCS provided one of the best means for identifying these soils (Table B - 15). In portions of the study area for which SSURGO was unavailable, 1:250,000 scale STATSGO data were utilized when finer-scale draft soil survey data could not be obtained. A 10-meter resolution digital elevation model (DEM), processed for landform characteristics (slope, aspect, concavity, surface flow character, etc), was used in conjunction with SSURGO/STATSGO to identify soils vulnerable to water erosion. Additional datasets used in the modeling of these distributions included surficial geology, NWI wetland classes, and NatureServe's terrestrial ecological systems land cover map to exclude upland areas, or select land cover types likely to have excess sodium or salts in the soils. Below in Figure B - 2 through Figure B - 6 are provided the spatial modeling diagrams for each soil type, with criteria used from each input dataset.

Table B - 15. Sensitive soils groups and criteria for definition.

Properties	Low	Moderate	High	Restrictive Feature / Vulnerability Category[1]
Slope (Pct) Kw < 0.20[1,2] Kw 0.20 – 0.36[2,3] Kw >0.36[2,3]	<20 <15 <10	20 - 40 15 - 35 10 - 25	>40 >35 >25	Steep Slopes – Water Erosion
Wind Erodibility Group (Surface Layer)	5, 6, 7, 8	3,4, 4l	1, 2	Wind Erosion Hazard
Available Water Capacity[3] (Average To 40 Inches Or Limiting Layer) (In/In)	>0.10	0.05 - 0.10	<0.05	Droughty Soils
Salinity[3] (Mmhos/Cm) (Surface Layer)	<8	8 – 15.9	≥16	Excess Salt [note: this was combined with Sodium Adsorption Ratio]
Sodium Adsorption Ratio[3] (Surface Layer)	<8	8 - 12.9	≥13	Excess Sodium
Gypsum > 10%[5] (% by weight of hydrated calcium sulfates in the fraction of soil less than 20mm in size)	< 10%		>10%	Gypsum Soils
Soils with Hydric Properties	Field: hydclprs value = "All Hydric"	Field: Hydric Rating Value = Yes Land Cover Type = not upland	[Many Factors; see below spatial Model]	Hydric Soils

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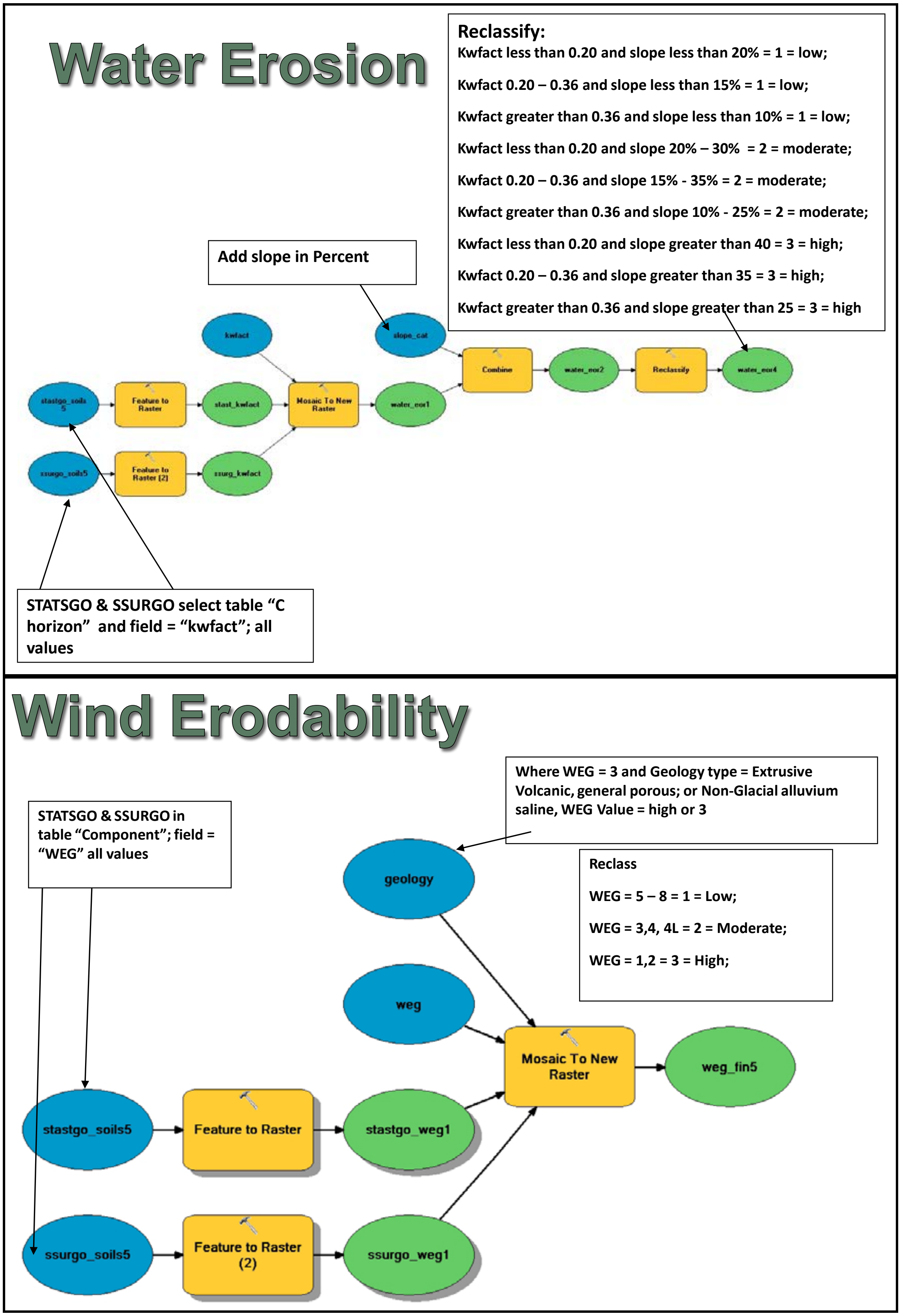
[1] Table content, with the exception of gypsum and hydric soils, is based on values developed by BLM Soil Specialist Bill Ypsilantis (Bryant, L. BLM internal communication).

[2] K Factor of surface layer adjusted for the effect of rock fragments (Kw).

[3] The representative value for the range in soil properties

[4] For Central Great Basin, include soils in WEG 3 that have formed from volcanic parent materials or Bonneville Lake Sediments in the "high" category, based on experience in NV and UT in which soils from these parent materials have high potential to blow following wildfire or other vegetation loss, even with the finer surface textures characteristic of WEG.

[5] Food and Agriculture Organization of the United Nations (FAO) 1990.



Water Erosion

Reclassify:

Kwfact less than 0.20 and slope less than 20% = 1 = low;

Kwfact 0.20 – 0.36 and slope less than 15% = 1 = low;

Kwfact greater than 0.36 and slope less than 10% = 1 = low;

Kwfact less than 0.20 and slope 20% – 30% = 2 = moderate;

Kwfact 0.20 – 0.36 and slope 15% - 35% = 2 = moderate;

Kwfact greater than 0.36 and slope 10% - 25% = 2 = moderate;

Kwfact less than 0.20 and slope greater than 40 = 3 = high;

Kwfact 0.20 – 0.36 and slope greater than 35 = 3 = high;

Kwfact greater than 0.36 and slope greater than 25 = 3 = high

Add slope in Percent

STATSGO & SSURGO select table "C horizon" and field = "kwfact"; all values

Wind Erodability

Where WEG = 3 and Geology type = Extrusive Volcanic, general porous; or Non-Glacial alluvium saline, WEG Value = high or 3

STATSGO & SSURGO in table "Component"; field = "WEG" all values

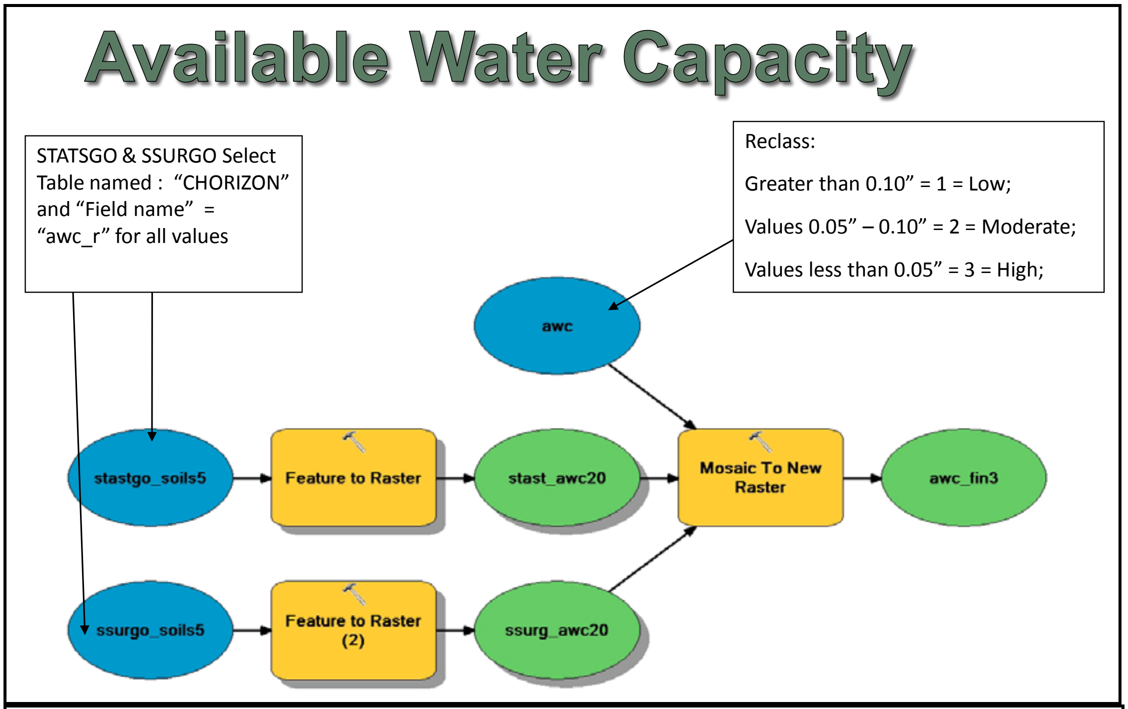
Reclass

WEG = 5 – 8 = 1 = Low;

WEG = 3,4, 4L = 2 = Moderate;

WEG = 1,2 = 3 = High;

Figure B - 2. Conceptual and spatial models for modeling distribution of sensitive soils: criteria used for Water Erosion and Wind Erodability


Available Water Capacity

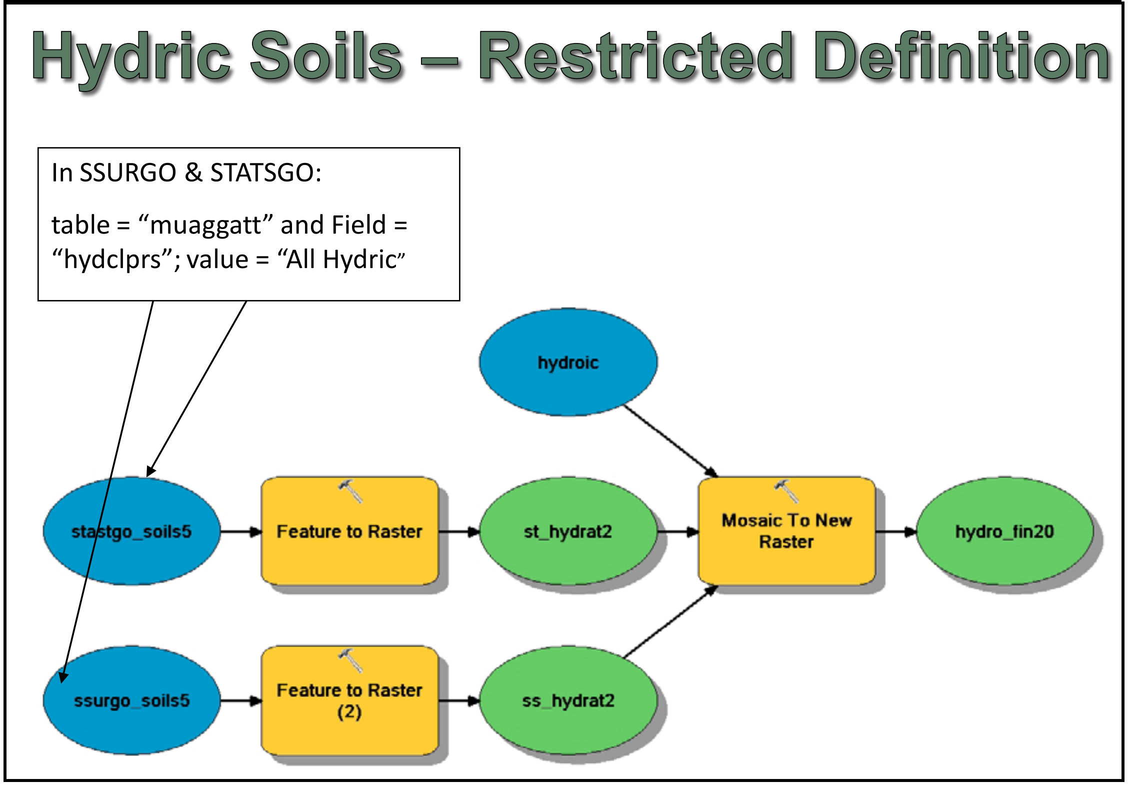
STATSGO & SSURGO Select Table named : “CHORIZON” and “Field name” = “awc_r” for all values

Reclass:

Greater than 0.10” = 1 = Low;

Values 0.05” – 0.10” = 2 = Moderate;

Values less than 0.05” = 3 = High;

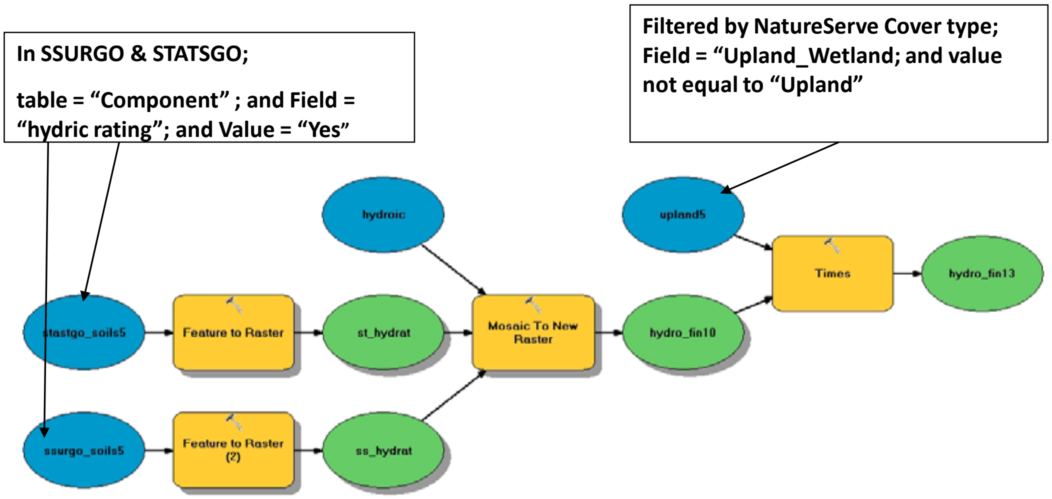

Hydric Soils – Restricted Definition

In SSURGO & STATSGO:

table = “muaggatt” and Field = “hydclprs”; value = “All Hydric”

Figure B - 3. Conceptual and spatial models for modeling distribution of sensitive soils: criteria used for Available Water Capacity and Hydric Soils - Restricted Definition

Hydric Soils – Moderate Definition

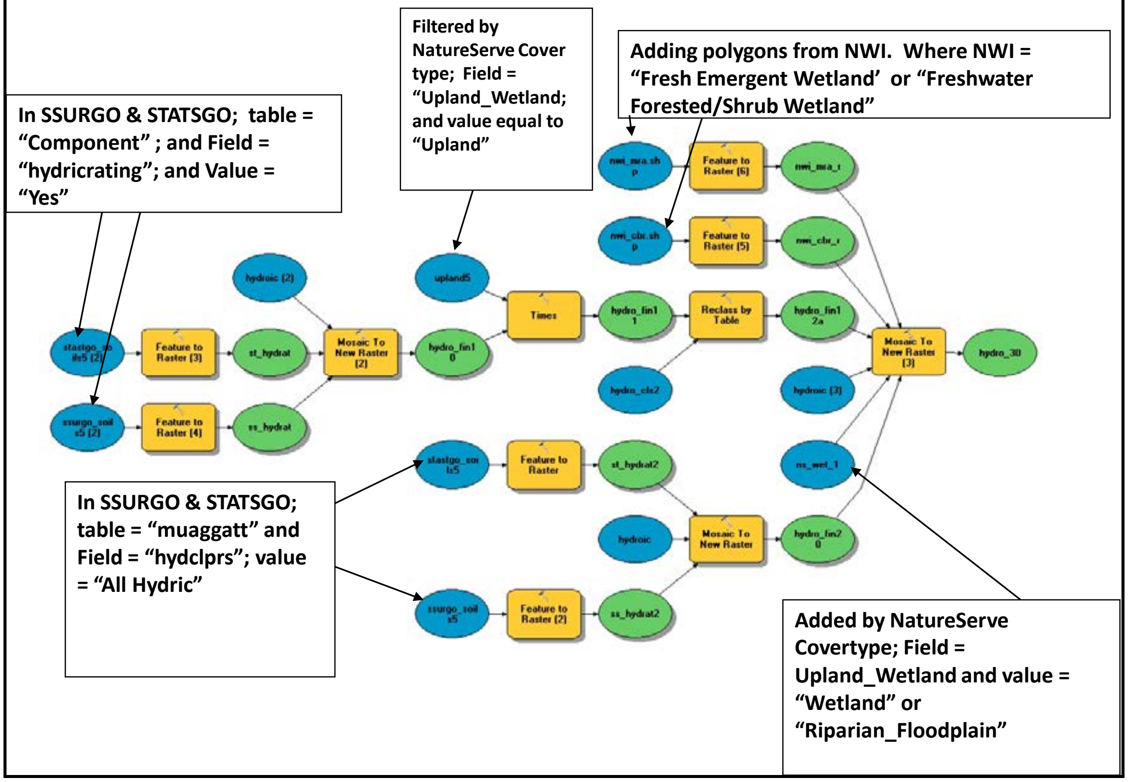


In SSURGO & STATSGO;

table = “Component” ; and Field = “hydric rating”; and Value = “Yes”

Filtered by NatureServe Cover type; Field = “Upland_Wetland; and value not equal to “Upland”

Hydric Soils – Inclusive Definition



Filtered by NatureServe Cover type; Field = “Upland_Wetland; and value equal to “Upland”

Adding polygons from NWI. Where NWI = “Fresh Emergent Wetland’ or “Freshwater Forested/Shrub Wetland”

In SSURGO & STATSGO; table = “Component” ; and Field = “hydricrating”; and Value = “Yes”

In SSURGO & STATSGO; table = “muaggatt” and Field = “hydclprs”; value = “All Hydric”

Added by NatureServe Covertype; Field = Upland_Wetland and value = “Wetland” or “Riparian_Floodplain”

Figure B - 4. Conceptual and spatial models for modeling distribution of sensitive soils: criteria used for Hydric Soils – Moderate and Inclusive Definitions

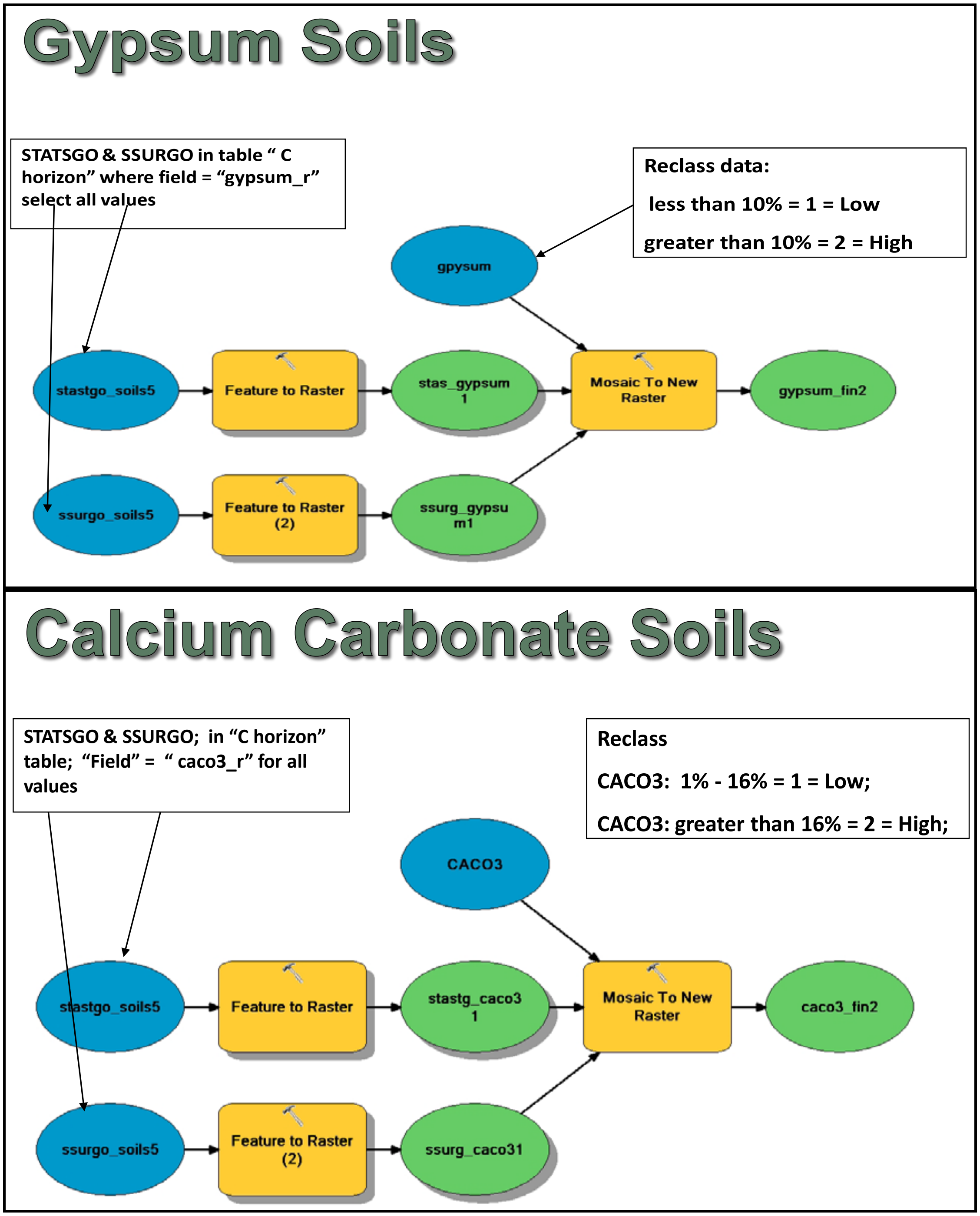
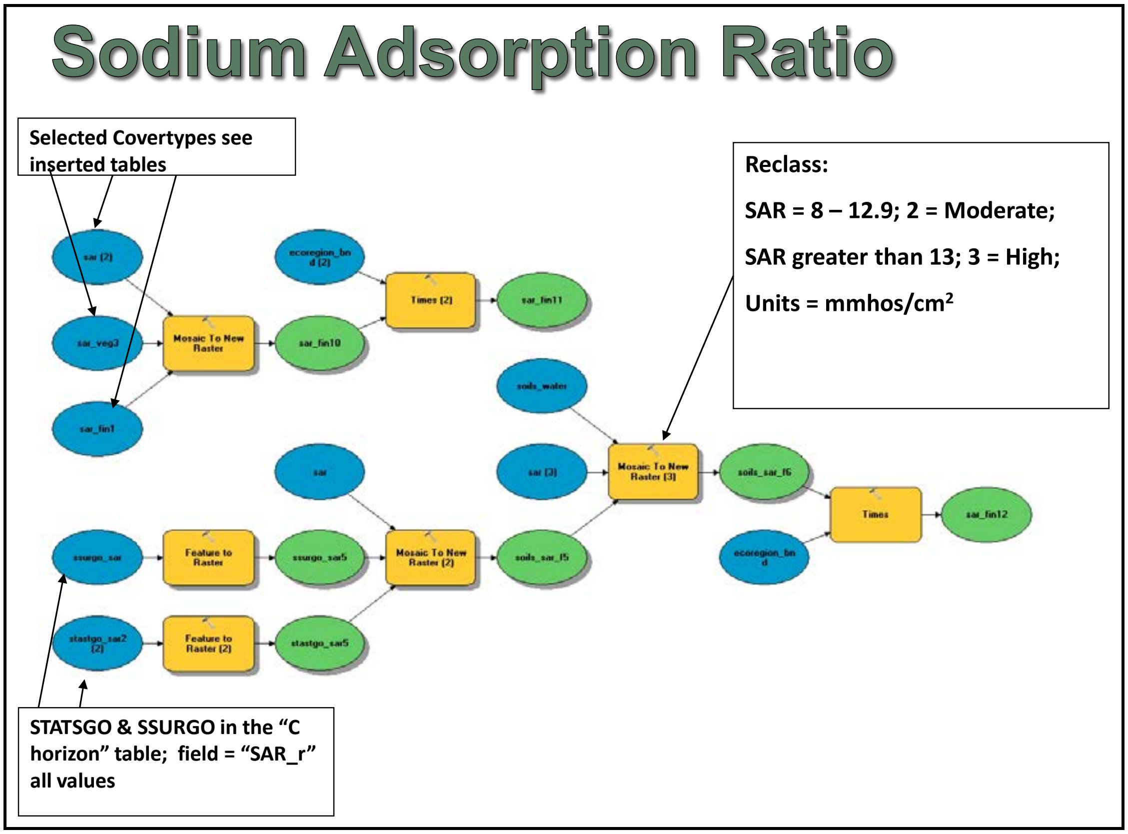


Figure B - 5. Conceptual and spatial models for modeling distribution of sensitive soils: criteria used for Gypsum Soils and Calcium Carbonate Soils



Sodium Adsorption Ratio

Selected Covertypes see inserted tables

Reclass:

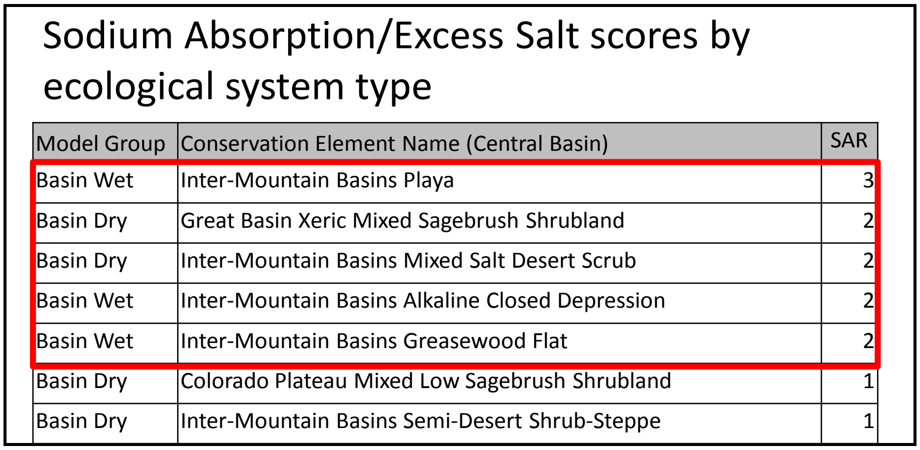
SAR = 8 – 12.9; 2 = Moderate;

SAR greater than 13; 3 = High;

Units = mmhos/cm^2

STATSGO & SSURGO in the “C horizon” table; field = “SAR_r” all values

a)



Sodium Absorption/Excess Salt scores by ecological system type

Model Group	Conservation Element Name (Central Basin)	SAR
Basin Wet	Inter-Mountain Basins Playa	3
Basin Dry	Great Basin Xeric Mixed Sagebrush Shrubland	2
Basin Dry	Inter-Mountain Basins Mixed Salt Desert Scrub	2
Basin Wet	Inter-Mountain Basins Alkaline Closed Depression	2
Basin Wet	Inter-Mountain Basins Greasewood Flat	2
Basin Dry	Colorado Plateau Mixed Low Sagebrush Shrubland	1
Basin Dry	Inter-Mountain Basins Semi-Desert Shrub-Steppe	1

b)

Figure B - 6. Conceptual and spatial models for modeling distribution of sensitive soils: criteria used for Sodium Adsorption Ratio (soils with excess salts or sodium) (figure a); figure b shows the ecological systems used for deductive modeling of these soil properties.

Data Limitations and Uncertainty

SSURGO provides a moderately good means for identifying sensitive soils in those locations where it is available. Where SSURGO is not available, our ability to accurately map sensitive soil areas was somewhat compromised. Where SSURGO is not available, STATSGO was used. In conjunction with those data sources, DEM-derived landform data was utilized, along with land cover datasets. While soil attributes analogous to those available from SSURGO can be used to define sensitive soils based on STATSGO map units, the coarse resolution of that data increases the potential for errors of omission regarding occurrences of sensitive soils in these areas. It was beyond the scope of this REA to incorporate landscape context (e.g., wind pattern) into the calculation of wind erosion potential. There is undoubtedly some error introduced by the use of these spatial inputs of distinct spatial and thematic resolutions. While these are issues, for the purposes of the REA the results provide moderately certain predictions of where these vulnerable soils types occur.

B-1.2.2.1 Change Agent Overlap with Sensitive Soils

Given their widespread distribution, sensitive soils might have a higher degree of development CA overlap than other CEs. Table B - 16 indicates the percent of each soil type overlapped by current change agents. Given the limitations of available spatial data, hydric soils were mapped in three ways, spanning a range of confidence in the data. The inclusive definition for mapped hydric soils included the largest area, relative to the more restrictive definition. The overlap of development CAs with these three map depictions of hydric soils ranged from 14.49% up to 19.58%. Other classes of sensitive soils coincide with development change agents in lesser percentages of their current extent. Lowest overlap appeared with Gypsum soils, with 7.84% of current extent within the ecoregion. Modeled distributions of three of the vulnerable soils are shown in Figure B - 7, Figure B - 8, and Figure B - 9.

Table B - 16. Change Agents overlap with sensitive soils (percent)

Sensitive Soil Type	Percent Overlapped by Anthropogenic Land Use*
Hydric Soil (Inclusive Definition)	19.58
Hydric Soil (Moderate Definition)	14.58
Hydric Soil (Restrictive Definition)	14.49
High Sodium Adsorption Ratio	11.71
High Available Water Capacity (most droughty soils)	9.08
High sensitivity to wind erosion	8.83
High sensitivity to water erosion	8.80
Calcium Carbonate Soils	8.00
Gypsum Soils	7.84

*Includes urban development; all classes of roads; solar, wind and geothermal renewable energies; mines; landfills; oil or gas wells; military urbanized areas; railroads; canals; electric utility lines; pipelines; crops or irrigated pasture.

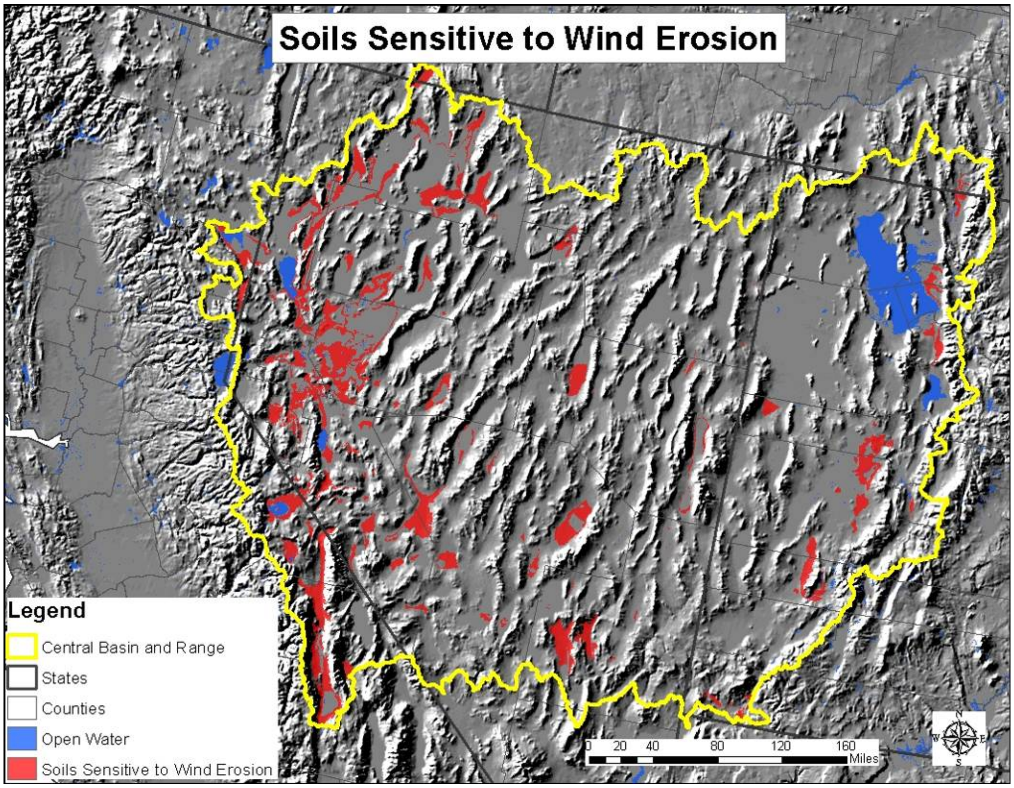


Figure B - 7. Distribution of soils vulnerable to wind erosion.

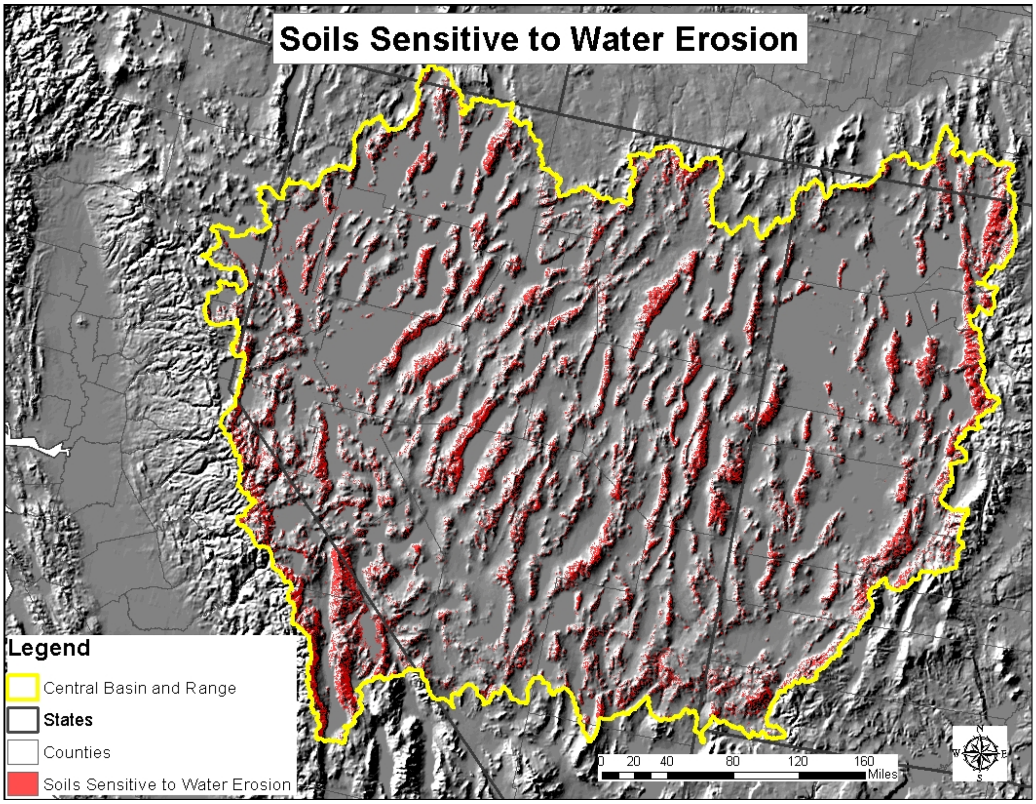


Figure B - 8. Distribution of soils vulnerable to water erosion.

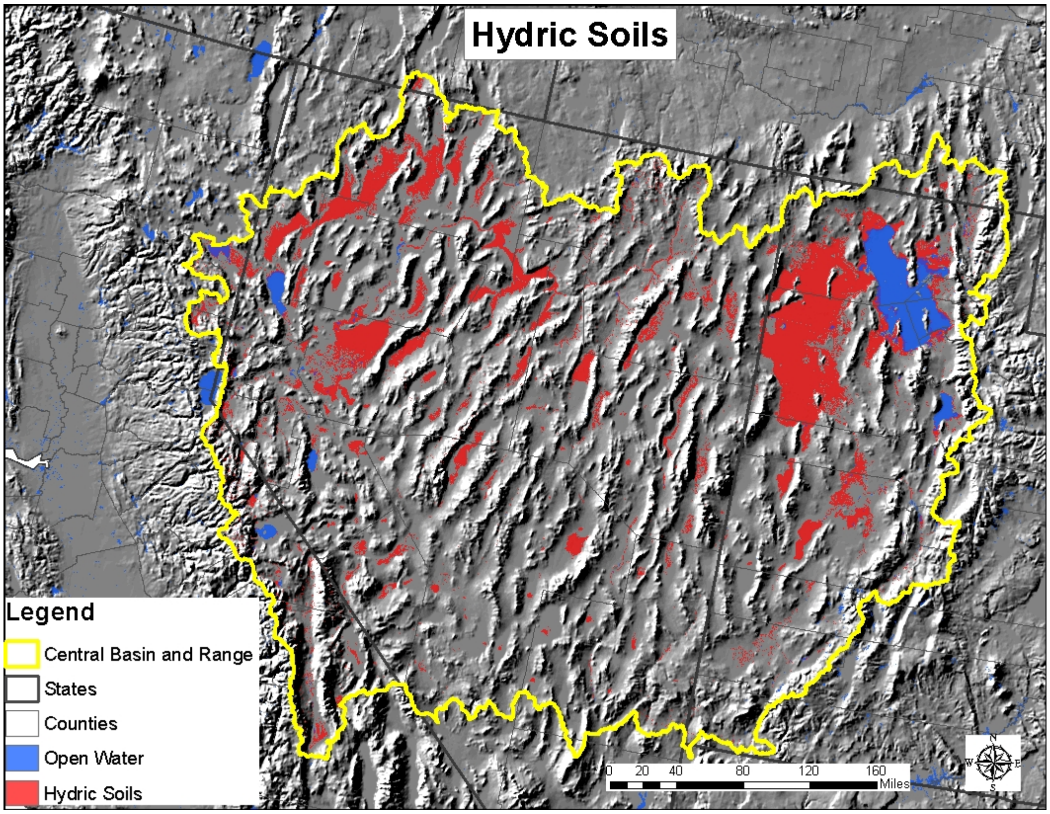


Figure B - 9. Distribution of hydric soils of the most inclusive definition.

B-1.2.3 Aquatic Coarse-filter: Deductive Models

Building from the framework of the ecoregional conceptual model, the major wetland and aquatic ecological systems were identified for the ecoregion. The "coarse filter" includes aquatic ecological system types that express the predominant ecological pattern and dynamics of wetlands and aquatic habitats of the ecoregion (Table B - 17). These classified units a) characterize each component of the ecoregion's conceptual model, b) define the variety of wetland and aquatic resources of this ecoregion, and c) reflect described ecological types with distributions concentrated within this ecoregion.

Ecological models (both conceptual and spatial) for these coarse filter elements form a major focus for this ecoregional assessment. NatureServe ecological classifications provided the basis for several existing national or regional map products (e.g., NatureServe national map, ReGAP in CA and SW region, LANDFIRE EVT & BpS, etc.) and/or may be readily reconciled with locally-desired classification systems for plant communities (see the Aquatic Coarse filter Conceptual Models document for more detailed descriptions of ecosystem types listed in this appendix). NatureServe databases, existing map products and the list of ecosystems of interest identified in REA statement of work were used to establish the list of these core CEs.

Table B - 17. Aquatic Coarse filter CEs for Central Basin and Range Ecoregion

CE Name	Input Data Layers and specific values	Elevation Rule	Notes
Great Basin Lake / Reservoir	C_NATURESERVE_L48_ESLF_V2_7.img, value = openwater		any water body within CBR
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	C_NATURESERVE_L48_ESLF_V2_7.img, value = 9168, + CBR_AQ_USGS_NHD_nhdflowline_ln, value = perennial streams	up to 2500 m	
Great Basin Springs and Seeps	CBR_AQ_USGS_NHD_NHDWaterbody_poly AQ_C_NVHP_Spring_locations_Veg_poly	None	any seep/spring with CBR
Inter-Mountain Basins Greasewood Flat	C_NATURESERVE_L48_ESLF_V2_7.img, value = 9103, (no NHD streams added)	None	low gradient flat broad valley bottoms mapped as Greasewood
Inter-Mountain Basins Playa	C_NATURESERVE_L48_ESLF_V2_7.img , value = 3179, (no NHD streams added)	None	internal drainage flats, mapped as flat barren internal drainage basin bottom
Inter-Mountain Basins Wash	C_NATURESERVE_L48_ESLF_V2_7.img, value= 3152, + CBR_AQ_USGS_NHD_nhdflowline_ln, value = ephemeral streams	None	narrow and flat to steep intermittent or ephemeral streams
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	C_NATURESERVE_L48_ESLF_V2_7.img value = 9156 + CBR_AQ_USGS_NHD_nhdflowline_ln, value =perennial streams	up to 2800 m	only east of the Great Salt Lake
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	C_NATURESERVE_L48_ESLF_V2_7.img values 9187 & 9171, + CBR_AQ_USGS_NHD_nhdflowline_ln, value = perennial streams	2500 - 3500 m elevation	combined two systems (woodland and shrubland)

Aquatic/wetland/riparian coarse filter units are defined using the NatureServe ecological systems classification (Comer et al. 2003) and their distributions were depicted initially with data derived from SW ReGAP, CA GAP, and LANDFIRE EVT (for CA portions). These map sources applied inductive modeling methods to derive their maps. As depicted in Figure B - 11, each of these current distributions was reviewed to determine, from an expert point of view, where error occurred that could be addressed using other ancillary spatial data (e.g., landforms, soils, hydrography, elevation, etc.). In addition our intent was to include in the distributions, as possible with available spatial data, the aquatic components of these CEs, so distributions of streams, rivers, open water bodies, and other aquatic habitat were added to the initial mapped distributions of riparian or wetland vegetation.

In addition to modeling the distribution of aquatic course filter conservation elements, all water bodies mapped by the NHD were reviewed in GIS to determine if they were a naturally occurring waterbody or a construct. All lakes behind dams were labeled man-made, except for known natural lakes that have dams that augment their water levels. Water treatment ponds, mine tailing ponds and evaporation ponds were labled as man-made. Tell-tale signs of human construct are square-sided ponds, cluster of angular-shaped ponds, lakes and ponds with straight edges on one or more sides. Linear features that are constructed such as aquaeucts, were also labeled as man-made. The location of these waterbodies and their “natural vs man-made label” are available for review in the GIS file CBR_MQ30_Lakes_NHD_v27_NaturalManmade_poly, and are shown in Figure B - 10.

Surface Water Resources Including Natural and Man-made Water Bodies

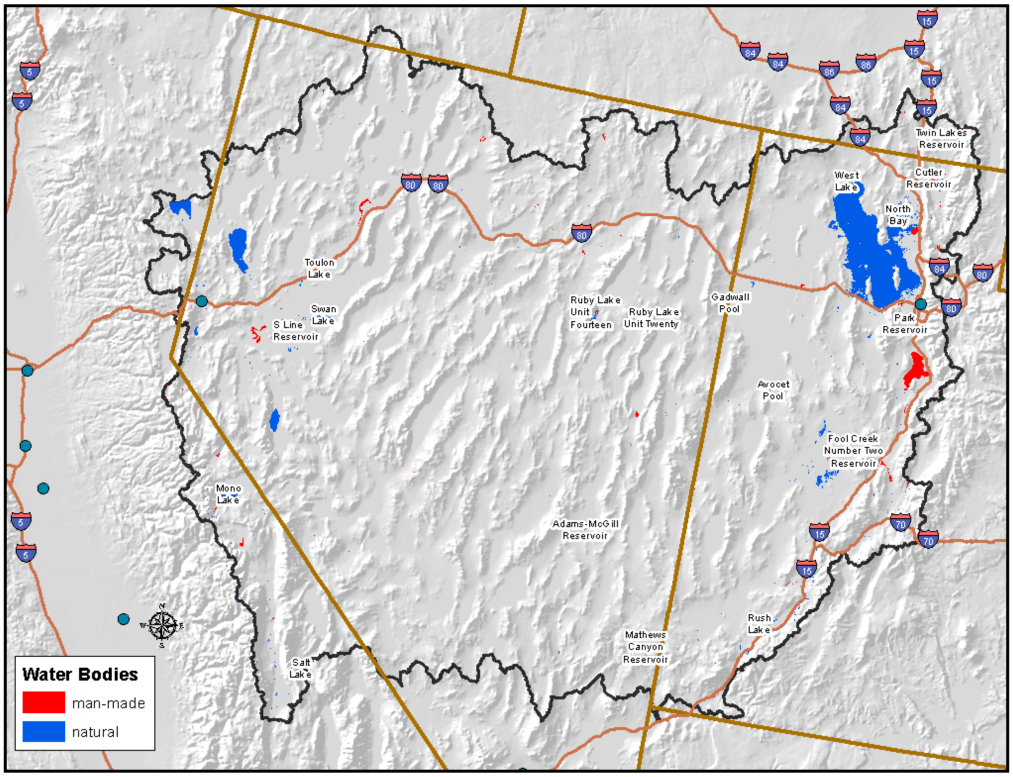


Figure B - 10. Map of current surface water bodies in CBR, including natural and man-made bodies.

NatureServe Ecological Systems Map for the Continental United States

NatureServe’s ecological systems map for the coterminous U.S. was the first, and the major, source dataset used to develop the coarse filter distributions. This effort includes both upland, riparian and wetland ecosystems, and mapped locations of open bodies of water.

The NatureServe dataset represents compilation of the work of multiple state and Federal agencies as part of the US Gap Analysis and LandFire programs. Multi-season satellite imagery (Landsat ETM+) from 1999-2001 were used in conjunction with digital elevation model (DEM) derived datasets (e.g. elevation, landform) to model natural and semi-natural vegetation. The minimum mapping unit for this dataset is approximately 1 acre. Landcover classes were drawn from NatureServe's Ecological System concept. Five-hundred and forty-four land cover classes composed of 12 cultural and 532 Natural/Semi-natural types were mapped across the coterminous U.S. Land cover classes were mapped with a variety of techniques including decision tree classifiers, terrain modeling, inductive modeling, and unsupervised classification. The 67 USGS mapping zones were modeled independently of one another by multiple spatial analysis laboratories.

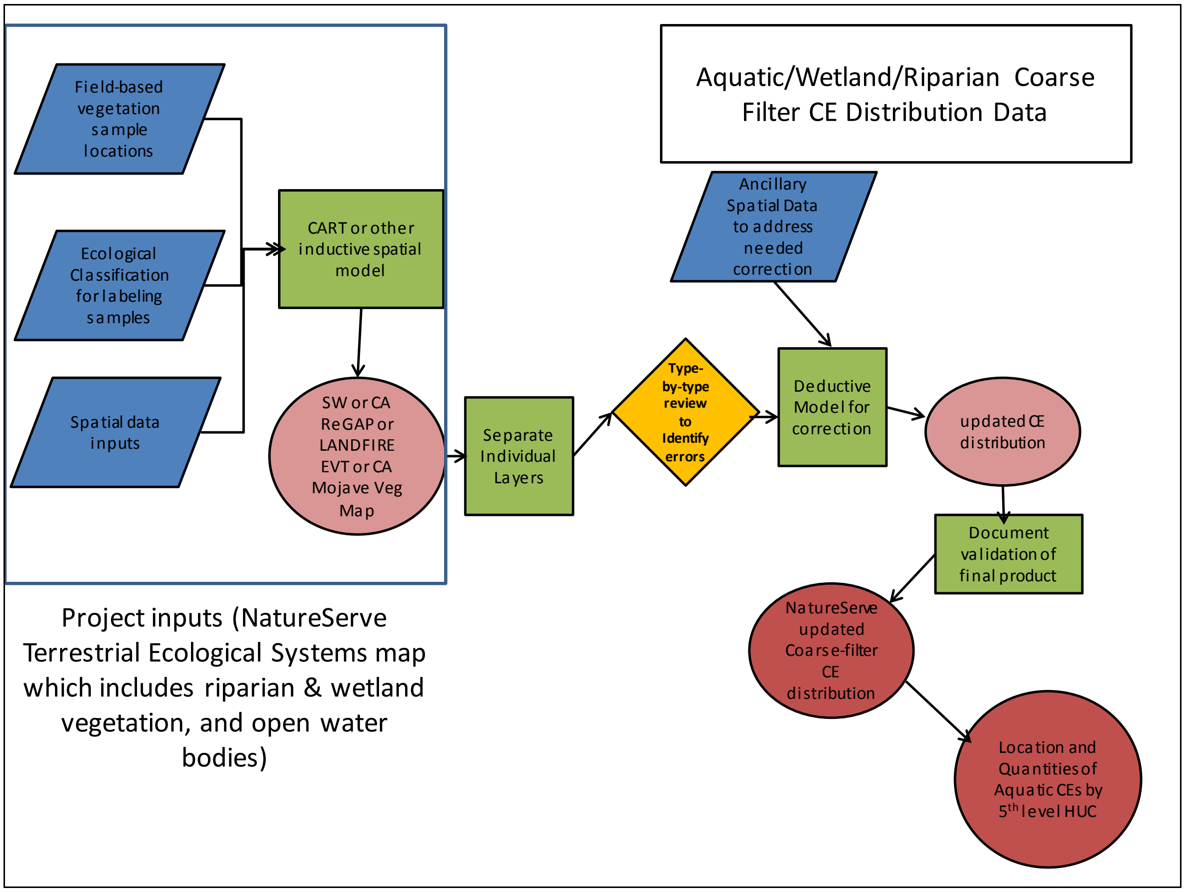


Figure B - 11. Process steps for mapping aquatic / wetland ecological system coarse filter CEs.

Prior to initiation of the BLM REAs NatureServe stitched together the resultant spatial data from the Gap and LANDFIRE efforts, into one comprehensive map for the coterminous US. In the western US, SW ReGap data were used for the 5 southwestern states (AZ, CO, NM, NV, UT), and LANDFIRE data were used for California. PNW ReGap was the source for data from ID, MT, OR, WA and WY. Following completion of the national dataset, each individual land cover type was evaluated by NatureServe (prior to the initiation of the BLM REAs) through individual working groups and two regional workshops attended by State, Federal, and Natural Heritage Program ecologists. Where individual systems were identified with likely errors a description was recorded of the issue and a fix where available was described and initiated by NatureServe. All changes are available in supporting documentation (see National Ecological Systems Modification.pdf for documentation of all changes made) and represent the opinion of multiple experts. Updates to specific system types were performed to update known errors in the data layer.

Additional Processing to Represent Aquatic/Wetland Coarse filter Distributions for the REA

The current distribution of the eight aquatic/wetland/riparian coarse filters CEs within the CBR ecoregion (Table B - 17) were reviewed and, if necessary, revised by adding USGS National Hydrography Dataset (NHD) stream miles and correcting the elevational distributions. Two source datasets were used in this review (Table B - 18): NatureServe Ecological System types v2.7 (ES, described above) and the USGS NHD. Two ancillary datasets were used to subset the distributions of these ecosystem/vegetation maps including: National Wetland Inventory maps (USFWS NWI), and USGS 30 m Digital Elevation Model and US Geological Survey (USGS) 30 meter National Elevation Dataset (NED). All source and ancillary datasets are 30 meter pixel resolution and masked/snapped to the CBR boundary.

First the distribution of the riparian, wash, playa and greasewood ecosystems were examined and updates or corrections were made where they did not match the elevational rules (see Table B - 17). For all riparian aquatic CEs perennial stream segments from NHD Streams were added to the mapped distribution. Each 30 m pixel of perennial stream within the elevational rule (Table B - 17) was labeled as part of the riparian ecosystem CE. Lakes and Reservoirs distribution came from NatureServe Ecosystem map pixels labeled “open water”. This source was found to be more complete and accurate than the lakes/reservoirs found in the NHD.

Springs and Seeps distribution came from the USGS NHD Springs. The USGS spring data was compared to the Nevada Natural Heritage Program (NVHP) spring inventory data; if a USGS point was located within 200m (100m on either side) of an existing Heritage Program occurrence, the NVHP point was considered a duplicate and was deleted. The NV Heritage Program data were in polygon format and converted to points (“feature to points”). The USGS data were already in point format. The two resultant point shapefiles were merged and stored as the final springs and seeps point layer. All NVHP spring locations were already included in the NHD spring layer, however information from the NVHP springs data was retained in the final data layer. NVHP information included the spring name and an element occurrence rank (a condition assessment) for the vegetative community surrounding the spring.

The main focus of this review was to increase the riparian and wash distributions by adding NHD Streams that were not previously included in the ES map, and to correct errors in the elevational distribution of montane vs. basin riparian ecosystems.

Table B - 18. Source and ancillary datasets used for aquatic/wetland coarse filter distributions.

Source Dataset Name	Delivered File Name(s)	Methods Abbreviation
NatureServe Terrestrial Ecosystems and Landcover	C_NATURESERVE_L48_ESLF_V2_7.img	ES
National Fish & Wildlife Service Wetland Inventory Map	AQ_FWS_L1_NWI_wrkng_poly;	NWI
National USGS Hydrography Dataset	CBR_AQ_USGS_NHD_nhdflowline_ln	NHD Streams
National USGS Hydrography Dataset	CBR_AQ_USGS_NHD_NHDWaterbody_poly	NHD Springs
Nevada Heritage Program Spring Inventory Dataset	AQ_C_NVHP_Spring_locations_Veg_poly	NVHP Springs
National Elevation Dataset (NED) - 30m	CBR_ELV_USGS_NED_30m	NED

For each aquatic coarse filter CE, its distribution was extracted from the NatureServe ecological systems v2.7 map (the ES), and clipped to the CBR area. Each was then reviewed across its distribution within the CBR boundary, by NatureServe ecology staff familiar with the type’s concept and distribution. Draping the individual CE distribution onto a shaded relief map helped to identify areas where the CE was correctly or incorrectly mapped. During the review, the expert also had on-hand the USFWS NWI map to cross-check how the type was mapped in a particular area by those efforts. Locations where the mapping of the type needed correction were identified. Each area would then be corrected by selecting the type's pixels within that area and applying a conversion to a different type or by applying the elevation rules (Table B - 17).

The revised distributions of these ecological systems were then combined with perennial or ephemeral NHD stream segments (where appropriate, see Table B - 17) for a complete mapping of the aquatic resources within the ecoregion. This combination of NHD streams, and NatureServe ES map was turned into the current aquatic (including wetland & riparian) coarse filter CEs dataset for the combined CBR ecoregion and all other cells were coded as null. This dataset was then clipped for the REA boundary. After comparing to the Nevada Natural Heritage Program's springs and seeps dataset, the NHD Springs and Seeps were retained as the CBR Springs and Seeps CE.

B-1.2.4 Vulnerable Species Assemblages: Maxent Models

MaxEnt (Maximum Entropy Species Distribution Modeling, Version 3.3.3e, November 2010) was used to model nine species assemblages (Table B - 19). The resultant models represent the probability of occurrence for a particular species or a particular suite of species within the CBR Ecoregion. The models are the composites of multiple cross-validated inductive MaxEnt models of species distributions using non-spectral landscape variables.

Input Variables

Model Inputs:

1) Known Occurrences or Presence Localities (point file format)
2) Environmental Variables (grid file format)

The Maxent principle is to estimate the probability distribution of species by finding the largest spread (maximum entropy) on a geographic dataset of species presences in relation to a set of "background" environmental variables. Model parameters differed by species but included a suite of non-spectral landscape variables. Variables were all re-sampled to a standard 100m resolution because of the variability in the resolution of the source data and inputs. Also required by the model are known presence locations of a particular species or suite of species. In the case of species assemblages, the known element occurrences of species within the assemblage were used. Point representations of the element occurrences were created by using several selection criteria. First, the element occurrences needed to be relatively small (low level of uncertainty associated with the occurrence, less than 1260ha). Polygon features were then converted to points using the "feature to point" tool. Point localities were then used as inputs for modeling.

Each model was run specifying parameters unique to the species assemblages or species being modeled. Maxent used these parameters to build models of species occurrence starting with a uniform distribution of probability values over the entire grid and then conducts an optimization routine that iteratively improves model fit, recorded as gain.

Models were validated using the k- fold cross-validation technique, which withholds random subsets of the presence localities to test the model as it is built. The k-fold cross validation technique randomly divides the presence localities into k subsets and replicate models are run testing the model on those k subsets. The replicate runs of the model are then averaged into a final composite model. The number of subsets should vary based on the number of presence localities. For the models of species and assemblages described below, a standard rule was applied that if the species or assemblage had less than 150 presence localities, a 5-fold cross validation was run, and greater than 150 localities, a 10-fold cross validation was run. If an assemblage or species had more than 1500 presence localities, a 15-fold cross validation was run.

Model Outputs

Model outputs include an ASCII file which was converted to a continuous raster grid for import into ArcGIS (Figure B - 12). Each cell in the raster grid contains a probability value that represents the probability of occurrence for that particular species or assemblage at that location. There are many methods for generating a model of habitat from this probability raster. For these models, a threshold was applied, a probability of occurrence value below which areas were considered non-habitat (NoData) and above which areas were considered to have high habitat potential (values recorded in the raster as 1). The threshold values were obtained by using the known presence localities and extracting the probability values from the resultant MaxEnt model raster to those presence localities. The probability values were summarized and one of two types of thresholds was applied (Liu et al. 2005):

1) The average probability value at known occurrences for the particular species or assemblage (more conservative and less inclusive) or

2) The average probability value at known occurrences minus one standard deviation for the particular species or assemblage (less conservative and more inclusive).

Decisions regarding the threshold application were based on expert opinion after visual inspection of the two types of thresholds. The distributions after threshold application were compared and the threshold was chosen that captured the known occurrences but didn't overestimate the amount of potential habitat. The threshold application does affect the model output in that option 1 above provides a more conservative output and generally produces a distribution that is smaller in extent than option 2, which is more inclusive. The decision to apply either option 1 or option 2 was made by experts who thoroughly analyzed and compared both distribution outputs from both methods.

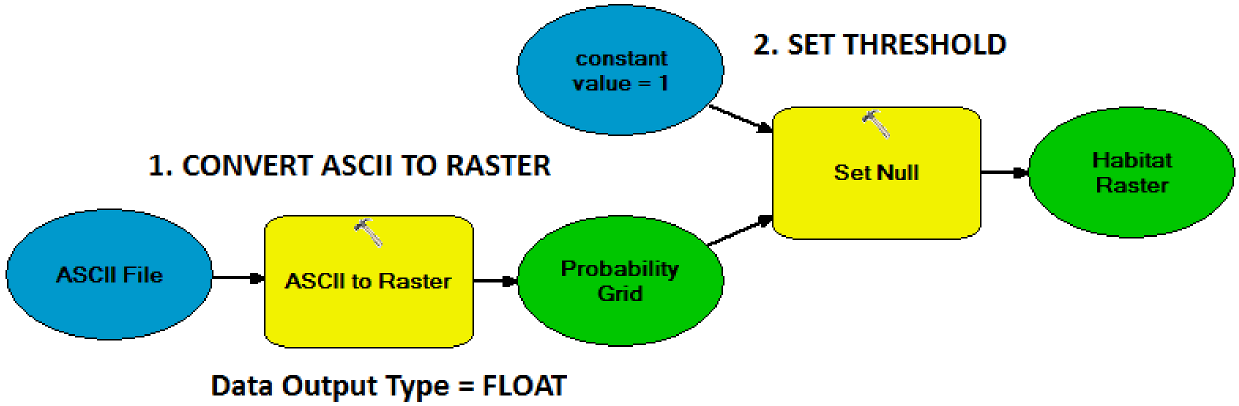


Figure B - 12. Schematic of habitat map derivation from MaxEnt outputs

Data Interpretation

Additional outputs include summarizes of model performance, the importance of each predictor variable and the shape of its influence, documentation of the options chosen, and information regarding the raw data. For more specifics on the individual models, see the supplemental materials provided with each of the modeled outputs. Also provided is an analysis of variable contributions (Table B - 20 below) which ranks the importance of the predictor variables. Maxent tracks the overall gain in the model when small changes are made to each coefficient value associated with a particular feature. The gains associated with each feature are then summed and taken as a proportion of all contributions.

References

Liu, C., P.M. Berry, T.P. Dawson, and R.G. Pearson. 2005. Selecting thresholds of occurrence in the prediction of species distributions. Ecography 28: 385 – 393.

Carbonate Alpine Species Assemblage

The carbonate alpine species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 167 point localities consisting of 8 different species within the "Flowering Plants" and "Terrestrial Snails" Info Taxa. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) digital elevation model, (2) geology, (3) distance to calcium carbonate soils, (4) NatureServe's Ecological Systems Map, (5) soil ph, (6) available water holding capacity, (7) slope, and (8) aspect. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.997). A probability threshold of 0.69 was applied to distinguish between habitat (greater than 0.69) and non-habitat (less than 0.69). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.86) minus one standard deviation (0.17). The values for the final model are "1" for high potential habitat and "NoData" for non-habitat.

Noncarbonate Alpine Species Assemblage

The noncarbonate alpine species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 29 point localities consisting of 2 different species within the "Flowering Plants" Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) digital elevation model, (2) geology, (3) NatureServe's Ecological Systems Map, (4) distance to calcium carbonate soils, (5) soil ph, (6) slope, and (7) aspect. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.996). A probability threshold of 0.66 was applied to distinguish between habitat (greater than 0.66) and non-habitat (less than 0.66). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.78) minus one standard deviation (0.12). The values for the final model are "1" for high potential habitat and "NoData" for non-habitat.

Azonal Carbonate Rock Crevices

The azonal carbonate rock crevices species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 1015 point localities consisting of 23 different species within the "Flowering Plants" Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) NatureServe's Ecological Systems Map, (2) soil ph, (3) distance to calcium carbonate soils, (4) digital elevation model, (5) slope, (6) geology, (7) distance to hydric soils, (8) distance to perennial streams, (9) distance to intermittent streams, (10) average percentage of large rock fragments within soil, (11) aspect, and (12) available water holding capacity. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.955). A probability threshold of 0.73 was applied to distinguish between habitat (greater than

0.73) and non-habitat (less than 0.73). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.73). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Azonal noncarbonate Rock Crevices Species Assemblage

The azonal noncarbonate rock crevices species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 137 point localities consisting of 5 different species within the “Flowering Plants” Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) NatureServe’s Ecological Systems Map, (2) average percent large rock fragments within soil, (3) geology, (4) soil ph, and (5) digital elevation model. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.945). A probability threshold of 0.63 was applied to distinguish between habitat (greater than 0.63) and non-habitat (less than 0.63). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.63). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Clay Soil Patches Species Assemblage

The clay soil patches species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 779 point localities consisting of 13 different species within the “Flowering Plants” Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) average percent clay in soil, (2) digital elevation model, (3) soil ph, (4) geology, (5) NatureServe’s Ecological Systems Map, (6) average percent large rock fragments within soil, (7) slope, and (8) aspect. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.955). A probability threshold of 0.74 was applied to distinguish between habitat (greater than 0.74) and non-habitat (less than 0.74). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.74). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Gypsum Soils Species Assemblage

The gypsum soils species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 697 point localities consisting of 6 different species within the ”Ants, Bees, Wasps”, “Flowering Plants”, and “Mosses” Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) digital elevation model, (2) distance to gypsum soils, (3) soil ph, (4) geology, (5) NatureServe’s Ecological Systems Map, (5) available water holding capacity, (6) aspect, and (7) slope. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.955). A probability threshold of 0.74 was applied to distinguish between habitat (greater than 0.74) and non-habitat (less than 0.74). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.74). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Montane Conifer Species Assemblage

The montane conifer species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 723 point localities consisting of 13 different species within the “Flowering Plants”, “Birds”, and “Mammals” Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) digital elevation model, (2) NatureServe’s Ecological Systems Map, (3) thermotype, (4) soil ph, (5) geology, (6) ombrotype, (7) aspect, and (8) slope. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.859). A probability threshold of 0.66 was applied to distinguish between habitat (greater than 0.66) and non-habitat (less than 0.66). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.66). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Sand Dunes and Sandy Soils Species Assemblage

The sand dunes and sandy soils species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 1586 point localities consisting of 30 different species within the “Ants, Wasps, Bees”, “Flowering Plants”, “Mammals”, “Other Beetles”, and “Reptiles” Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) digital elevation model, (2) NatureServe’s Ecological Systems Map, (3) soil ph, (4) percentage of coarse sands within soil, (5)average sand totals, (6) distance to hydric soils, (7) total sand, (8) slope, (9) geology, (10) aspect, (11) available water holding capacity. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.992). A probability threshold of 0.74 was applied to distinguish between habitat (greater than 0.74) and non-habitat (less than 0.74). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.74). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Migratory Waterfowl and Shorebirds Species Assemblage

The migratory shorebirds and waterfowl species assemblage was modeled using MaxEnt (Maximum Entropy for Species Distribution Modeling). Inputs for the model included known occurrences or presence localities of species within the assemblage and non-spectral environmental variables (grid file format, all standardized to 100m resolution to reflect the variability in resolution of the source data. Element occurrence inputs included 41 point localities consisting of 4 different species within the “Birds” Info Tax. The specific environmental variables used (and ordered according to their contribution toward overall model development) include: (1) Distance to waterbodies, (2) distance to hydric soils, (3) NatureServe’s Ecological Systems Map, (4) distance to perennial streams, (5) slope, (6) distance to riparian conservation elements, (7) distance to wetland conservation elements, (8) distance to intermittent streams, (9) distance to springs and seeps, (10) available water holding capacity, and (11) digital elevation model. Overall performance of the model (as recorded by AUC or Area Under the Curve) was relatively high (0.926). A probability threshold of 0.43 was applied to distinguish between habitat (greater than 0.43) and non-habitat (less than 0.43). The value was obtained by determining the average probability value of the modeled output at the known occurrences or point localities (0.66) minus one standard deviation (0.23). The values for the final model are “1” for high potential habitat and “NoData” for non-habitat.

Table B - 19. Description of model inputs and model performance. *For explanation of input environmental variables, their derivation, and their source datasets, see Table B - 20.

Model	**Input Occurrence Locations**	**Input Environmental Variables (Ordered by Contribution to Model Output)***	**Model Performance (as determined by AUC)**	**Threshold**
Carbonate Alpine	167 point localities with: • 8 different species • "Flowering Plants" and "Terrestrial Snails" Informal Taxonomy	(1) digital elevation model, (2) geology, (3) distance to calcium carbonate soils, (4) NatureServe's Ecological Systems Map, (5)soil ph, (6) available water holding capacity, (7) slope, and (8) aspect	0.997	0.69 mean (0.86) – std (0.17)
Noncarbonate Alpine	29 point localities with: • 2 species • "Flowering Plants" Informal Taxonomy	(1) digital elevation model, (2) geology, (3) NatureServe's Ecological Systems Map, (4) distance to calcium carbonate soils, (5) soil ph, (6) slope, and (7) aspect	0.996	0.66 mean (0.78) – std (0.12)
Azonal Carbonate Rock Crevices	1015 point localities with: • 23 species • "Flowering Plants" Informal Taxonomy	(1) NatureServe's Ecological Systems Map, (2) soil ph, (3) distance to calcium carbonate soils, (4) digital elevation model, (5) slope, (6) geology, (7) distance to hydric soils, (8) distance to perennial streams, (9) distance to intermittent streams, (9) average percentage of large rock fragments within soil, (10) aspect, and (11) available water holding capacity	0.955	0.73 mean (0.73)
Azonal Noncarbonate Rock Crevices	137 point localities with: • 5 species • "Flowering Plants" Informal Taxonomy	(1) NatureServe's Ecological Systems Map, (2) average percent large rock fragments within soil, (3) geology, (4) soil ph, and (5) digital elevation model	0.945	0.63 mean (0.63)
Clay Soil Patches	779 point localities with: • 13 species • "Flowering Plant" Informal Taxonomy	(1) average percent clay in soil, (2) digital elevation model, (3) soil ph, (4) geology, (5) NatureServe's Ecological Systems Map, (6) average percent large rock fragments within soil, (7) slope, and (8) aspect	0.955	0.74 mean (0.74)
Gypsum Soils	697 point localities with: • 6 species • "Ants, Bees, Wasps", "Flowering Plants", and "Mosses" Informal Taxonomy	(1) digital elevation model, (2) distance to gypsum soils, (3) soil ph, (4) geology, (5) NatureServe's Ecological Systems Map, (5) available water holding capacity, (6) aspect, and (7) slope	0.994	0.77 mean (0.77)
Montane Conifer	723 point localities with: • 13 species • "Flowering Plants", "Birds", and "Mammals: Informal Taxonomy	(1) digital elevation model, (2) NatureServe's Ecological Systems Map, (3) thermotype, (4) soil ph, (5) geology, (6) ombrotype, (7) aspect, and (8) slope	0.859	0.66 mean (0.66)
Sand Dunes and Sandy Soils	1586 point localities with: • 30 species • "Ants, Wasps, Bees", "Flowering Plants", "Mammals", "Other Beetles", and "Reptiles" Informal Taxonomy	(1) digital elevation model, (2) NatureServe's Ecological Systems Map, (3) soil ph, (4) percentage of coarse sands within soil, (5)average sand totals, (6) distance to hydric soils, (7) total sand, (8) slope, (9) geology, (10) aspect, (11) available water holding capacity	0.992	0.74 mean (0.74)
Migratory Waterfowl and Shorebirds	41 point localities with: • 4 species • "Birds" Informal Taxonomy	(1) Distance to waterbodies, (2) distance to hydric soils, (3) NatureServe's Ecological Systems Map, (4) distance to perennial streams, (5) slope, (6) distance to riparian conservation elements, (7) distance to wetland conservation elements, (8) distance to intermittent streams, (9) distance to springs and seeps, (10) available water holding capacity, and (11) digital elevation model	0.926	0.43 mean (0.66) – std (0.23)

Table B - 20. Detailed description of input environmental variables.

DESCRIPTIVE DATASET NAME	ABBREVIATION	DATA SOURCE FILENAME	Intermediate?	Explanation
aspect	Aspect	OT1_USGS_US_NED_ALB83	Yes	Aspect was calculated from the digital elevation model.
available water holding capacity	Awc	CEIII_NATURESERVE_SOILS_CBR_AWC_FIN CEIII_NATURESERVE_SOILS_MBR_AWC_FIN	No	
average percent large rock fragments in soil	Rock_frags	NA	Yes	Maximum percentage value of frag10 (RV) from STATSGO for main component within each soil map unit (the % by weight of the horizon occupied by rock fragments greater than 10 inches in size)
Clay percentage within soil	Clay	NA	Yes	Average percentage value of claytotal (RV) from STATSGO for main component within each soil map unit (mineral particles less than 0.002mm in equivalent diameter as a weighted % within the less than 2.0mm fraction of soil)
digital elevation model	Dem	OT1_USGS_US_NED_ALB83	No	
distance to calcium carbonate soils	Cacao3	CEIII_NATURESERVE_SOILS_CBR_CACO3_FIN CEIII_NATURESERVE_SOILS_MBR_CACO3_FIN	Yes	Euclidean distance function applied to calcium carbonate soils.
distance to gypsum soils	Gypsum	CEIII_NATURESERVE_SOILS_CBR_GYP_FIN CEIII_NATURESERVE_SOILS_MBR_GYP_FIN	Yes	Euclidean distance function applied to gypsum soils.
distance to hydric soils	Hydric_dist	CEIII_NATURESERVE_SOILS_CBR_HYDRO20 CEIII_NATURESERVE_SOILS_MBR_HYDRO20	Yes	Euclidean distance function applied to hydric soils.
distance to intermittent streams	Intermit_d	NA	Yes	
distance to perennial streams	Perenn_d	NA	Yes	
distance to riparian conservation elements	Ripce_dist	CEI_NATURESERVE_L48_ESLF_V2_7	Yes	Derived from the “Upland_Wetland” attribute field. Euclidean distance function applied to selections from the attribute field.
distance to springs	Springs_dist	CEV_final_USGS_NVHP_LCI_spring_locations	Yes	Euclidean distance function applied to springs locations.
Distance to waterbodies	Waterbdy_dist	CEIII_USGS_NHD_NHDWaterbody	Yes	Euclidean distance function applied to lakes and reservoirs.
distance to wetlands	Wetland_dist	CEI_NATURESERVE_L48_ESLF_V2_7	Yes	Derived from the “Upland_Wetland” attribute field. Euclidean distance function applied to selections from the attribute field.
geology	Geology	CEIII_USGS_GEOSS_GEOLOGY_1KM	No	
NatureServe's ecological systems map	Eslf_v27	CEI_NATURESERVE_L48_ESLF_V2_7	No	
ombrotype	Ombrotype	CEIII_USGS_GEOSS_OMBROTYPES	No	
percentage of coarse sands within soils	Coarse_sands	CEIII_NATURESERVE_SOILS_CBR_SAND_CRS CEIII_NATURESERVE_SOILS_MBR_SAND_CRS	No	Average percentage value of coarse sands (representative value) from STATSGO for main component within each soil map unit (mineral particles 0.5 – 1.0mm as a weighted % of the less than 2mm fraction of soil)
percentage of total sands within soil	Total_sand	CEIII_NATURESERVE_SOILS_CBR_SAND_TOT CEIII_NATURESERVE_SOILS_MBR_SAND_TOT	No	Maximum percentage value of sand total (representative value) from STATSGO for main component within each soil map unit (mineral particles 0.05 – 2.0mm as a weighted % of the less than 2mm fraction of soil)
Average percentage of total sand within largest component of soil	Avg_tot_sand	NA	Yes	Average percentage value of sand total(representative value) from STATSGO for main component within each soil map unit (mineral particles 0.05 – 2.0mm as a weighted % of the less than 2mm fraction of soil)
slope	Slope	OT1_USGS_US_NED_ALB83	Yes	Slope calculated from the digital elevation model.
soil pH	Ph1to1	CEIII_NATURESERVE_SOILS_CBR_PH1TO1 CEIII_NATURESERVE_SOILS_MBR_PH1TO1	No	
thermotype	Thermotype	CEIII_USGS_GEOSS_THERMOTYPES	No	

B-1.2.5 Landscape Species

Landscape Species CE distributions were either directly from BLM and REA partners (e.g., Greater sage-grouse, mule deer, desert bighorn sheep, etc.; or derived through deductive and inductive modeling steps. Some landscape species were represented spatially using multiple habitat components (e.g., winter range vs. summer range); as established in conceptual models and then articulated as distinct spatial models. Southwest ReGAP maps provided the starting point for most landscape species; with existing habitat location/ suitability models available for all but the California portion of their distribution. The same rules were applied (e.g., vegetation type, elevation thresholds, etc.) to extend these models into California as appropriate. See species-specific summaries for detailed explanation.

Spatial data for landscape species distributions came from three general sources: (1) BLM-provided or recommended existing data sets, (2) expansions/updates to species models originally created by the USGS Southwest Regional Gap Analysis Project (SWReGAP), and (3) element occurrences records representing the distributions of bald and golden eagles. This document provides an overview of these data sets.

B-1.2.5.1 Species with BLM Provided/Recommended Data

Bighorn Sheep Occupied Habitat

Data used to represent desert bighorn sheep occupied habitat were assembled (merged) from spatial data provided by BLM and several state agencies. For desert bighorn sheep, the distribution was derived from habitat use areas compiled by the BLM from state Fish and Wildlife agencies that are partners in the Western Associations of Fish and Wildlife Agencies (WAFWA), then provided to the REA contractor. These use areas were determined by state wildlife biologists. Data is recommended for analysis and display at 1:100,000 scale. The original data, which was provided as polygon shapefiles, was converted to a 30-meter resolution raster and clipped to the REA boundaries.

Mule Deer Winter, Summer, and Year-Round Range

Data used to represent summer, winter, and year-round mule deer habitat was provided by BLM and clipped to the REA boundaries. This data originates from the RemoteSensing/GIS Laboratory at Utah State University. The distribution was derived from habitat use areas compiled from state Fish and Wildlife agencies that are partners in WAFWA, then provided to the REA contractor by BLM. Habitat delineations were identified through a Delphi process on a state-by-state basis and were subsequently tablet-digitized from 1:250,000 scale maps. The original data, which was provided as polygon shapefiles, was converted to a 30-meter resolution raster and clipped to the REA boundaries.

Greater Sage-grouse, Leks

The source data for greater sage-grouse lek density (Doherty et al. 2010) delineated high abundance population centers containing 25, 50, 75, and 100% of known breeding populations. This data is intended to provide a large-scale view of the distribution and abundance of sage-grouse.

We merged these data to create a single layer depicting areas of (a) high, (b) medium-high, (c) medium-low, and (d) low lek density corresponding to the 25, 50, 75, and 100% distribution extents, converted this to a 30-meter resolution raster, and clipped the results to the REA boundary.

Greater Sage-grouse, Occupied Habitat

Data used to represent greater sage-grouse habitat were provided by BLM in the form of a vectorized version of a 30-meter resolution model representing occupied greater sage-grouse habitat in the western United States (BLM 2009). This model is for the baseline year of 2006, but has been modified by removal of habitat within fire perimeters for 2007 and 2008. It is recommended for use at a maximum scale of 1:100,000.

B-1.2.6 Species Models based on SWReGap Parameters

This section details the creation of species distributions based upon models previously developed by the U.S. Geological Survey's Southwest Regional Gap Analysis Project (SWReGAP). Models were created for the twenty-three species listed on Table B - 21. The habitat parameters identified by SWReGAP were used to map habitat for the entire study area using updated data sets and for areas not covered by the original models (i.e. portions of California, Idaho , and Oregon).

Where SWReGAP mapped multiple habitat components for a single species (e.g. breeding AND year-round habitat) we retained only the most restrictive habitat component (e.g. breeding); the modeled component for each species is listed on Table B - 21. For Brewer's sparrow, we provide separate distributions for both breeding and migratory habitat. For the big brown bat, both breeding and year-round habitat were modeled together.

Model parameters differed by species, but included elevation, landform, and ecological systems. For two of the modeled species (Great Basin collared lizard and kit fox) SWReGAP also specified soil type as a model parameter. These soil parameters were not incorporated in the models due to the relatively unspecific nature of the specified soil types and coarse resolution of readily-available soils data. Excluding these soil parameters had relatively little impact on the final habitat distributions, as verified by comparing the new results to the original distribution as modeled by SWReGap.

Elevation and landform were derived from USGS GEOSS data. Ecological systems were defined using Version 2.8 of NatureServe's terrestrial ecological systems map. Where ecological systems are listed for individual species, the list includes the entire set of ecological systems SWReGap used in their models, but not all of these systems occur within the REA boundary (e.g. Madrean Encinal system is found in southeastern Arizona, was used in the SWReGap model but not in the CBR). File names for these source data sets are listed below.

- Terrestrial ecological systems: CEI_TERRESTRIAL_ECOLOGICAL_SYSTEMS_CBRMBR
- Elevation: OT1_USGS_US_NED_ALB83
- Landform: CEIII_USGS_GEOSS_LANDFORM_30M

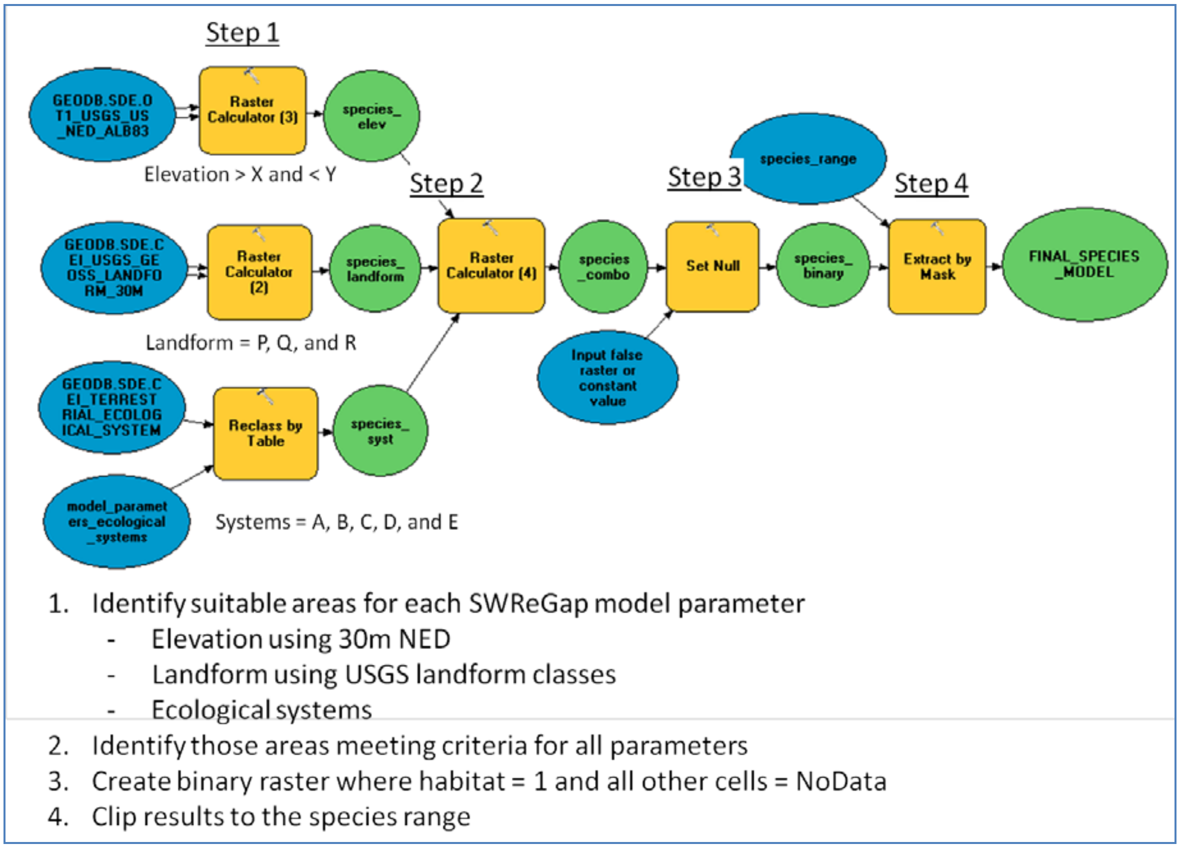
Table B - 21. Habitat components and model parameters for 23 species modeled from SWReGap parameters.

Common Name	**Included Component**	**Model Parameters**
Big Brown Bat	Known or probable occurrence, breeding, summering & Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Brazilian Free-tailed Bat	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Brewer's Sparrow	Known or probable occurrence, breeding, summering	Ecological systems
	Known or probable occurrence, non-breeding, migratory	Ecological systems
Clark's Nutcracker	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Coachwhip	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Columbian Sharp-tailed Grouse	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Common Kingsnake	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Cooper's Hawk	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Ferruginous Hawk	Known or probable occurrence, breeding, summering	Ecological systems, Elevation
Great Basin Collared Lizard	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation, Landform
Kit Fox	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Loggerhead Shrike	Known or probable occurrence, breeding, summering	Ecological systems, Elevation
Northern Harrier	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems
Northern Rubber Boa	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Northern Sagebrush Lizard	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
Prairie Falcon	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems
Pygmy Rabbit	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation, Landform
Sage Sparrow	Known or probable occurrence, breeding, summering	Ecological systems, Elevation
Sage Thrasher	Known or probable occurrence, breeding, summering	Ecological systems, Elevation
Savannah Sparrow	Known or probable occurrence, breeding, summering	Ecological systems
Swainson's Hawk	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems
Western Patch-nosed Snake	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation
White-tailed Jackrabbit	Known or probable occurrence, breeding and non-breeding, winter and summer	Ecological systems, Elevation

Within the area originally covered by SWReGAP models, we clipped our results to the species range, defined by 8-digit hydrologic units (4th level watersheds or HUCs) by SWReGAP. Where it was necessary to extend these ranges into California, Idaho, and/or Oregon, we did so by consulting range maps provided in the California Wildlife Habitat Relationships database (http://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx), NatureServe species distribution shapefiles, and expert opinion. These ranges are stored together in a GIS shapefile, with an attribute field for each species indicating whether or not each 4th level watershed is included in the range for that species.

The expanded models were generated via the following geoprocessing steps, as shown in the schematic model (Figure B - 13):

1a. Reclassification of the ecological systems raster into suitable (1) and non-suitable(0) values based on the parameters for each species as listed later in this appendix;
1b. Use of the raster calculator (conditional statement) to create rasters of suitable(1) and non-suitable (0) values from the elevation and landform rasters as required for each species, based on the parameters for each species as listed later in this appendix ;
2. Use of the raster calculator to combine the raster values from steps 1 & 2;
3. Use of the set null command to set null all cells where the systems, elevation, and landform do not ALL indicate suitable habitat (note that for some species, only 1 or 2 of these three variables is used) and return “1” for all cells where suitable habitat is indicated;
4. Clipping of the results of step 4 to the species range, as defined by 4th level watersheds. Note that prior to performing this clip, a definition query was in the range map feature class properties to select only those Hucs considered range for the species in question.
5. The final model is displayed with a value of “1” for high potential habitat and “NoData” for non-habitat.



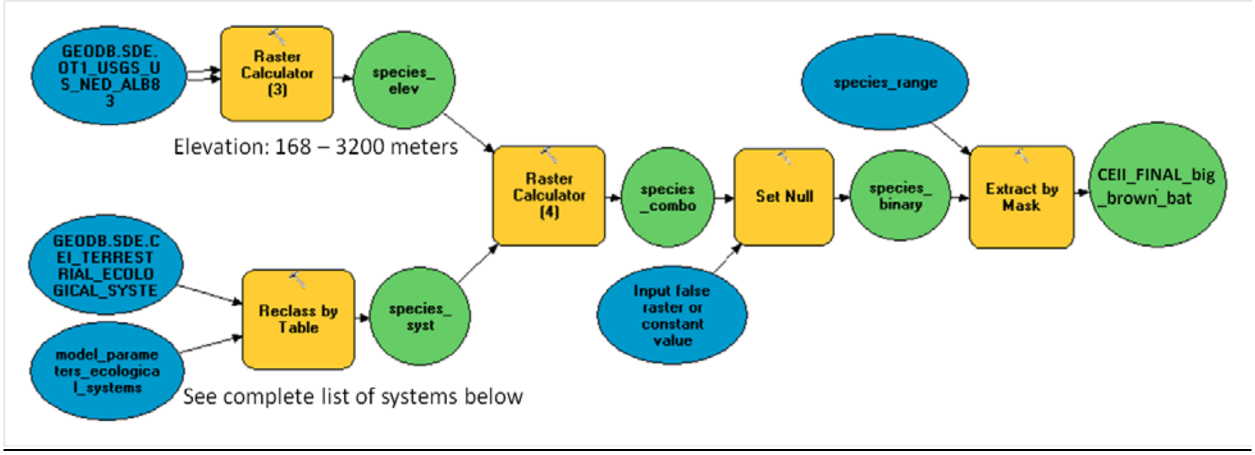
1. Identify suitable areas for each SWReGap model parameter
    - Elevation using 30m NED
    - Landform using USGS landform classes
    - Ecological systems
2. Identify those areas meeting criteria for all parameters
3. Create binary raster where habitat = 1 and all other cells = NoData
4. Clip results to the species range

Figure B - 13. General process model for creating species distribution data based on SWReGap models.

The remainder of this section provides the species-specific model parameters, a schematic model tailored for each species, and the list of ecological systems used by SW ReGap for the model.

BIG BROWN BAT

The distribution of the big brown bat (*Eptesicus fuscus*) was mapped using ecological systems and elevation (168 to 3220 meters) to define habitat as shown in the schematic model below. For this species, the provided model includes habitat for both breeding and year-round habitat as shown in the schematic model
below.

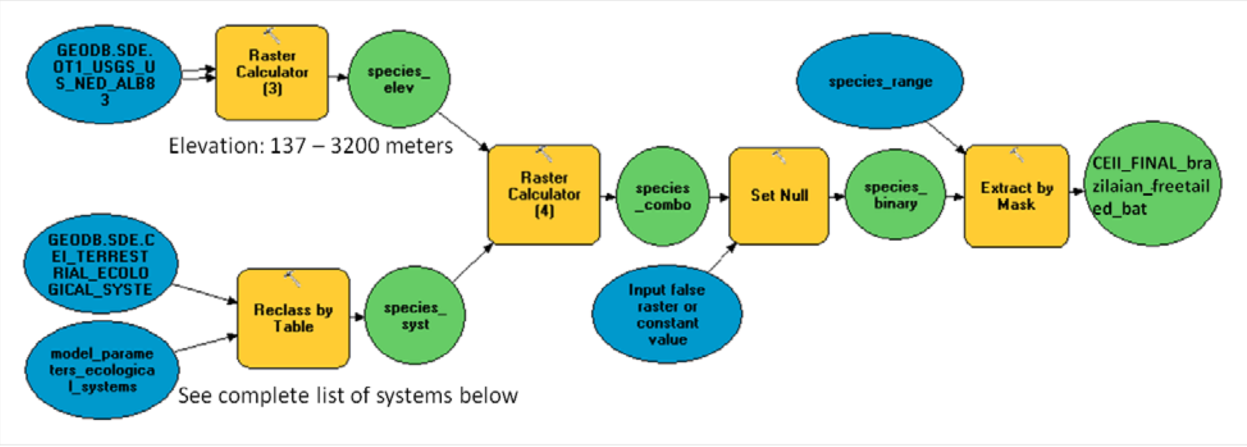


ESLF Code	System Name
11	Open Water
21	Developed-Open Space
22	Developed-Low Intensity
23	Developed-Medium Intensity
24	Developed-High Intensity
80	Agriculture – General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3120	North American Warm Desert Bedrock Cliff and Outcrop
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3160	Inter-Mountain Basins Active and Stabilized Dune
3173	Inter-Mountain Basins Cliff and Canyon
3179	Inter-Mountain Basins Playa
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4104	Rocky Mountain Aspen Forest and Woodland
4105	Rocky Mountain Bigtooth Maple Ravine Woodland
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4207	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
4210	Madrean Encinal
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4213	Madrean Upper Montane Conifer-Oak Forest and Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4237	Rocky Mountain Lodgepole Pine Forest
4238	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland
4239	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4242	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4243	Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4260	Southern Coastal Plain Mesic Slope Forest
5252	Chihuahuan Mixed Salt Desert Scrub
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub

5308	Colorado Plateau Pinyon-Juniper Shrubland
5310	Mogollon Chaparral
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7107	Inter-Mountain Basins Semi-Desert Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9103	Inter-Mountain Basins Greasewood Flat
9153	Western Great Plains Floodplain
9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9171	Rocky Mountain Subalpine-Montane Riparian Woodland
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

BRAZILIAN FREE-TAILED BAT

The distribution of the Brazilian free-tailed bat (*Tadarida brasiliensis*) was mapped using ecological systems and elevation (137 to 3220 meters) to define habitat as shown in the schematic model below.



Elevation: 137 – 3200 meters

See complete list of systems below

ESLF Code	System Name
21	Developed-Open Space
22	Developed-Low Intensity
23	Developed-Medium Intensity
24	Developed-High Intensity
80	Agriculture - General
81	Agriculture - Pasture/Hay

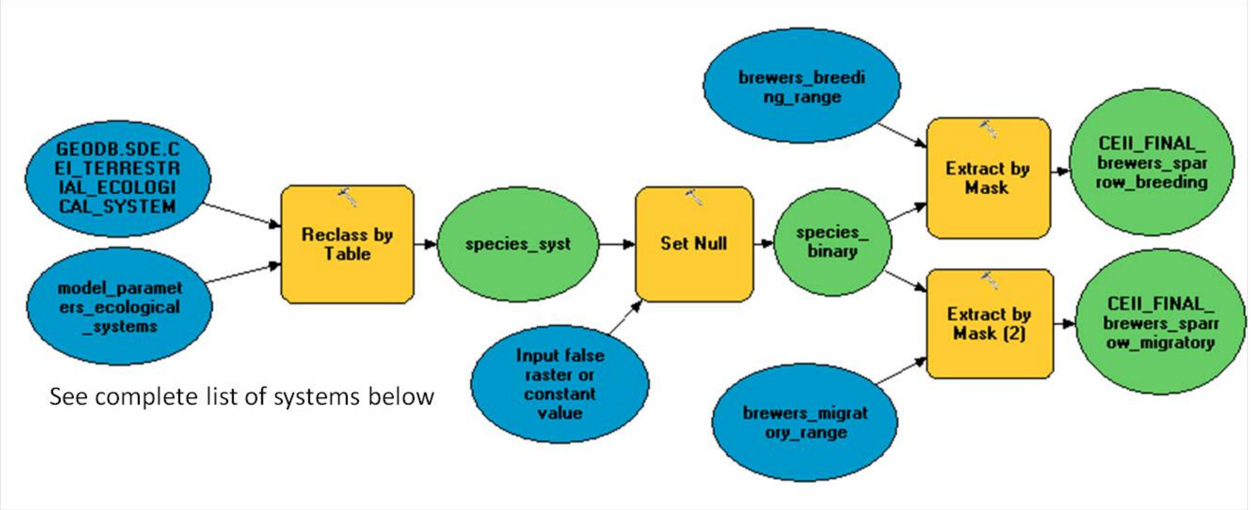
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3120	North American Warm Desert Bedrock Cliff and Outcrop
3121	North American Warm Desert Active and Stabilized Dune
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3160	Inter-Mountain Basins Active and Stabilized Dune
3179	Inter-Mountain Basins Playa
4105	Rocky Mountain Bigtooth Maple Ravine Woodland
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4207	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
4210	Madrean Encinal
4212	Madrean Pinyon-Juniper Woodland
4213	Madrean Upper Montane Conifer-Oak Forest and Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4238	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland
4239	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4260	Southern Coastal Plain Mesic Slope Forest
4303	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland
5252	Chihuahuan Mixed Salt Desert Scrub
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5310	Mogollon Chaparral
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie
7107	Inter-Mountain Basins Semi-Desert Grassland
7119	Southern Rocky Mountain Montane-Subalpine Grassland

7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9103	Inter-Mountain Basins Greasewood Flat
9151	North American Warm Desert Wash
9153	Western Great Plains Floodplain
9171	Rocky Mountain Subalpine-Montane Riparian Woodland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9182	North American Warm Desert Riparian Woodland and Shrubland
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

BREWER'S SPARROW

The distribution of Brewer's sparrow (*Spizella breweri*) was mapped using only ecological systems to define habitat.

Two habitat distributions were created for this species: (1) breeding habitat, and (2) migratory habitat. The same parameters were used for both, but the model extent was clipped to separate defined ranges for each as shown in the schematic model below.

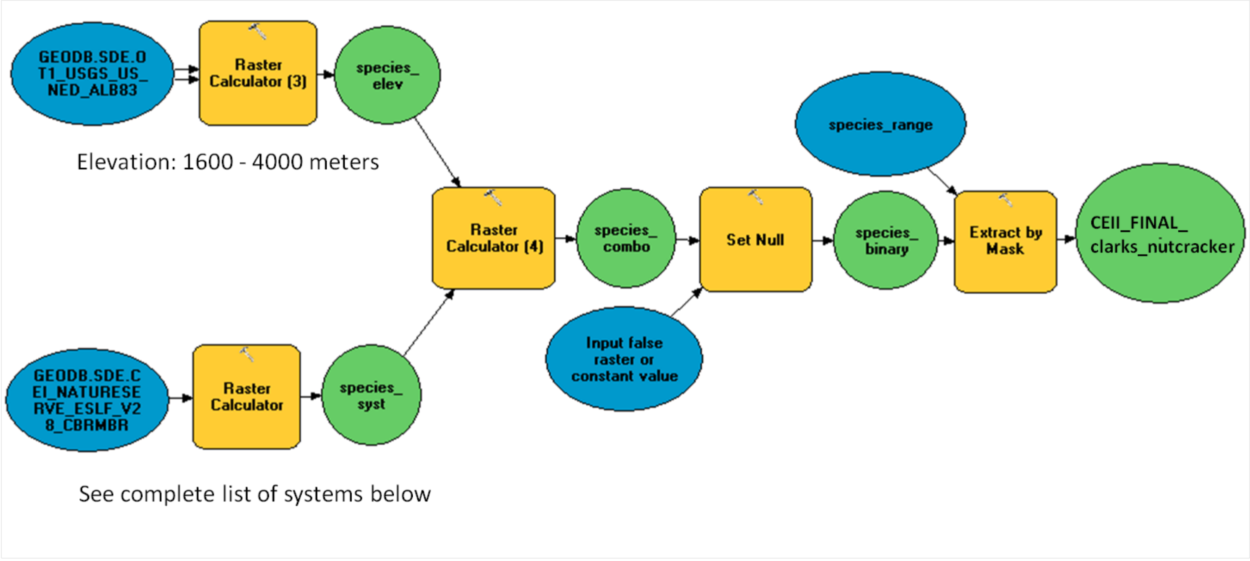


ESLF Code	System Name
3139	Inter-Mountain Basins Shale Badland
3143	North American Warm Desert Pavement
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5259	Mojave Mid-Elevation Mixed Desert Scrub
5263	Rocky Mountain Lower Montane-Foothill Shrubland
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5301	Apacherian-Chihuahuan Mesquite Upland Scrub

5308	Colorado Plateau Pinyon-Juniper Shrubland
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5454	Inter-Mountain Basins Big Sagebrush Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
7104	Central Mixedgrass Prairie
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9182	North American Warm Desert Riparian Woodland and Shrubland
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

CLARK'S NUTCRACKER

The distribution of Clark's nutcracker (*Nucifraga Columbiana*) was mapped using ecological systems and elevation (1600 to 4000 meters) to define habitat as shown in the schematic model below.

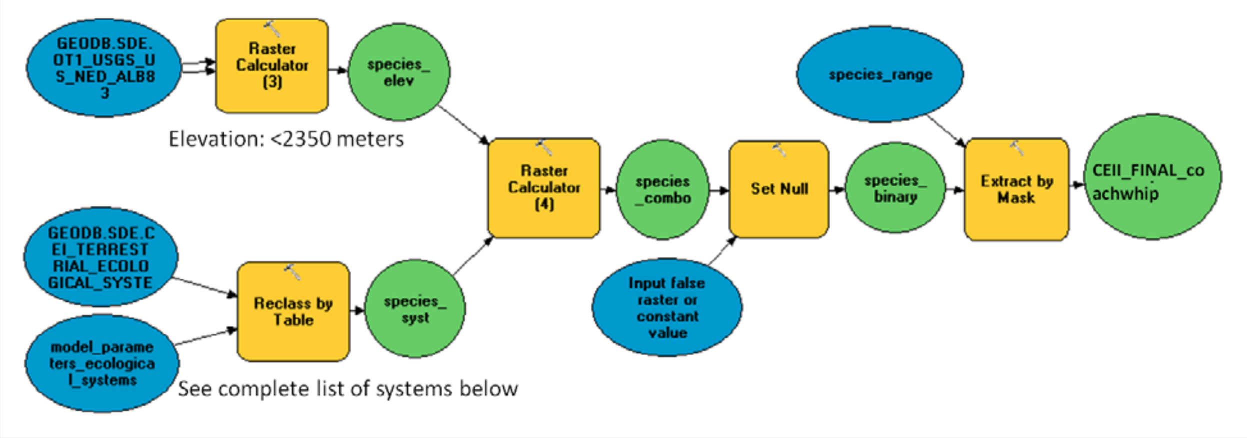


ESLF Code	System Name
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4207	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4213	Madrean Upper Montane Conifer-Oak Forest and Woodland

4218	California Montane Jeffrey Pine-(Ponderosa Pine) Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4237	Rocky Mountain Lodgepole Pine Forest
4238	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland
4239	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4242	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4243	Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4245	Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4302	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
5308	Colorado Plateau Pinyon-Juniper Shrubland

COACHWHIP

The distribution of the coachwhip (*Masticophis flagellum*)was mapped using ecological systems and elevation (less than 2350 meters) to define habitat as shown in the schematic model below.

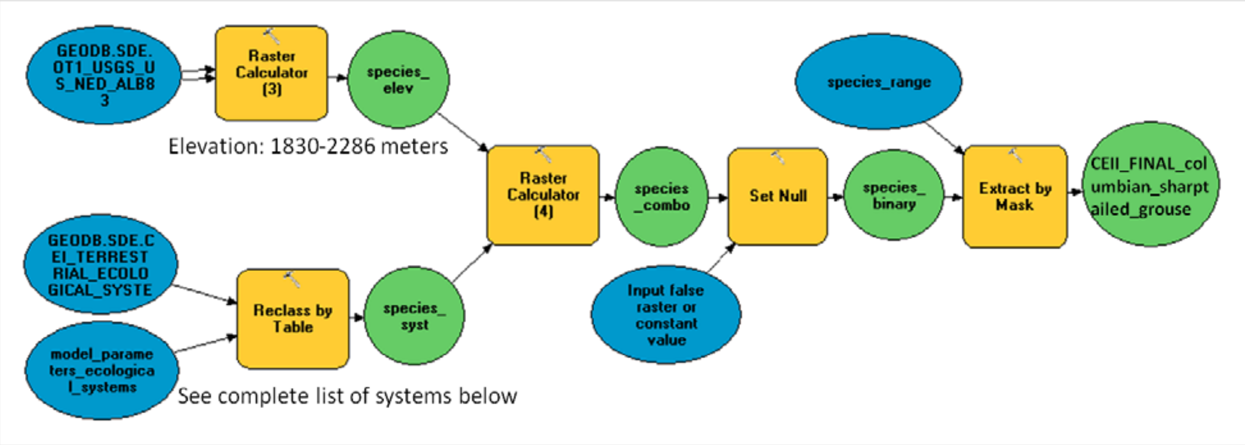


ESLF Code	System Name
3120	North American Warm Desert Bedrock Cliff and Outcrop
3121	North American Warm Desert Active and Stabilized Dune
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3160	Inter-Mountain Basins Active and Stabilized Dune
3173	Inter-Mountain Basins Cliff and Canyon
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4210	Madrean Encinal
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland

4260	Southern Coastal Plain Mesic Slope Forest
5252	Chihuahuan Mixed Salt Desert Scrub
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5308	Colorado Plateau Pinyon-Juniper Shrubland
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7107	Inter-Mountain Basins Semi-Desert Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9103	Inter-Mountain Basins Greasewood Flat
9153	Western Great Plains Floodplain
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

COLUMBIAN SHARP-TAILED GROUSE

The distribution of the Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*) was mapped using ecological systems and elevation (1830 to 2286 meters) to define habitat as shown in the schematic model below.

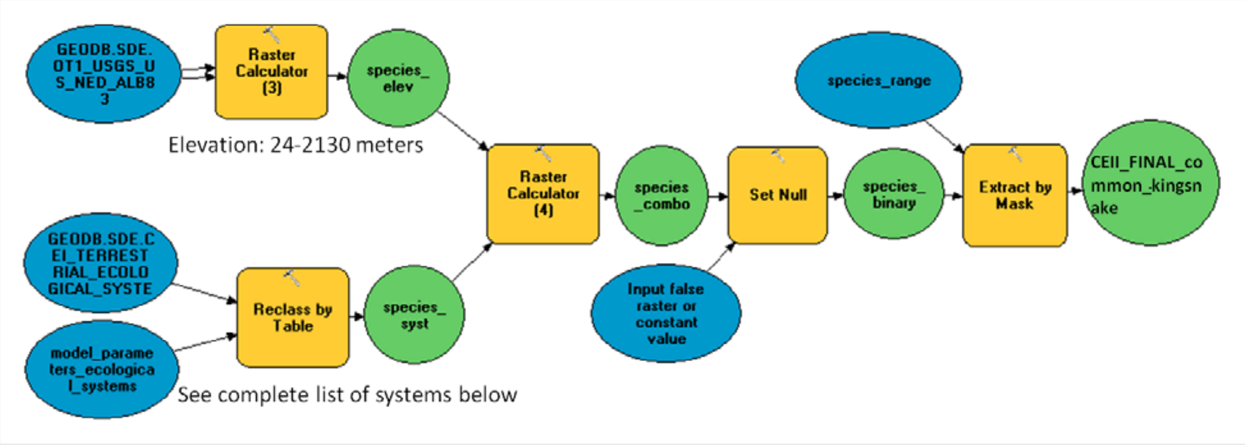


ESLF	System Name

Code	
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5454	Inter-Mountain Basins Big Sagebrush Steppe
9329	Western Great Plains Riparian
5209	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5271	Western Great Plains Sandhill Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie
7107	Inter-Mountain Basins Semi-Desert Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9182	North American Warm Desert Riparian Woodland and Shrubland

COMMON KINGSNAKE

The distribution of the common kingsnake (*Lampropeltis getula)* was mapped using ecological systems and elevation (24 - 2130 meters) to define habitat as shown in the schematic model below.



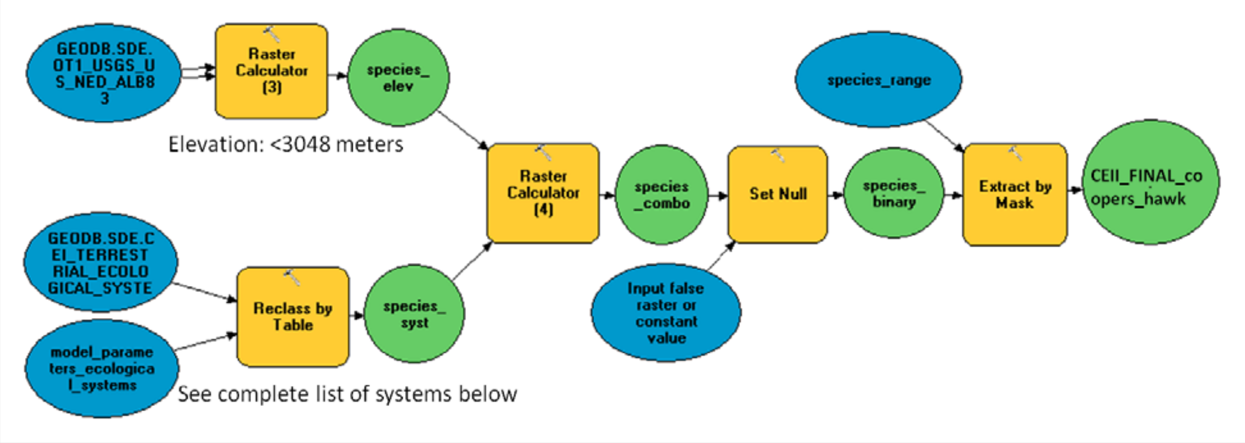
ESLF Code	System Name
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3120	North American Warm Desert Bedrock Cliff and Outcrop
3121	North American Warm Desert Active and Stabilized Dune

3123	North American Warm Desert Badland
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3139	Inter-Mountain Basins Shale Badland
3143	North American Warm Desert Pavement
3160	Inter-Mountain Basins Active and Stabilized Dune
3161	North American Warm Desert Playa
3171	Sierra Nevada Cliff and Canyon
3173	Inter-Mountain Basins Cliff and Canyon
3179	Inter-Mountain Basins Playa
3180	North American Warm Desert Volcanic Rockland
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4210	Madrean Encinal
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4260	Southern Coastal Plain Mesic Slope Forest
5252	Chihuahuan Mixed Salt Desert Scrub
5253	Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5259	Mojave Mid-Elevation Mixed Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5265	Sonora-Mojave Mixed Salt Desert Scrub
5268	Sonoran Mid-Elevation Desert Scrub
5270	Southern Colorado Plateau Sand Shrubland
5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5307	Madrean Oriental Chaparral
5310	Mogollon Chaparral
5314	Sonora-Mojave Semi-Desert Chaparral
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe

7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
9103	Inter-Mountain Basins Greasewood Flat
9151	North American Warm Desert Wash
9153	Western Great Plains Floodplain
9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9178	North American Warm Desert Riparian Mesquite Bosque
9182	North American Warm Desert Riparian Woodland and Shrubland
9187	Rocky Mountain Subalpine-Montane Riparian Shrubland
9222	North American Arid West Emergent Marsh
9256	Western Great Plains Saline Depression Wetland
9329	Western Great Plains Riparian

COOPER'S HAWK

The distribution of Cooper's hawk (*Accipiter cooperii)* was mapped using ecological systems and elevation (less than 3048 meters) to define habitat as shown in the schematic model below.

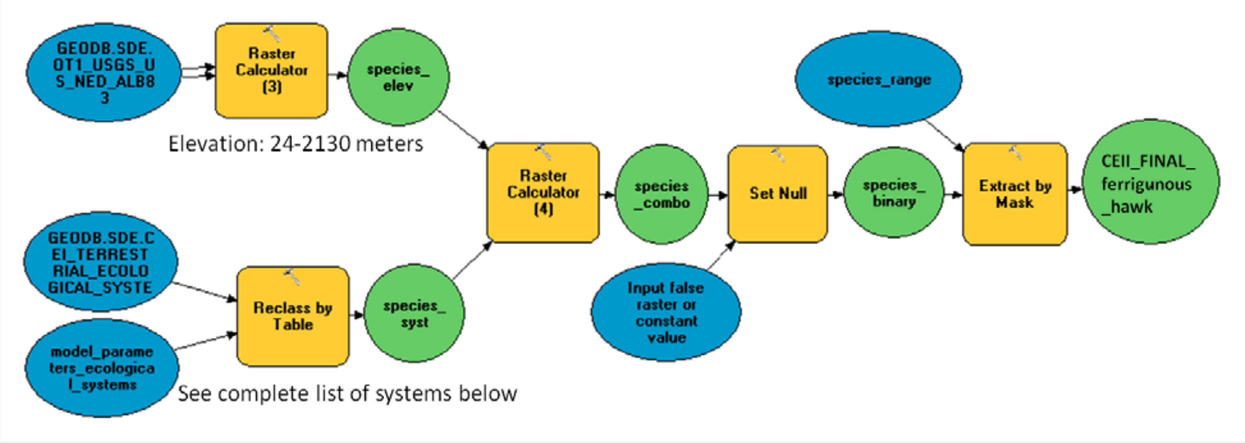


ESLF Code	System Name
21	Developed-Open Space
22	Developed-Low Intensity
23	Developed-Medium Intensity
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3173	Inter-Mountain Basins Cliff and Canyon
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4104	Rocky Mountain Aspen Forest and Woodland
4203	Colorado Plateau Pinyon-Juniper Woodland

4206	Great Basin Pinyon-Juniper Woodland
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4213	Madrean Upper Montane Conifer-Oak Forest and Woodland
4237	Rocky Mountain Lodgepole Pine Forest
4238	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland
4239	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4242	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4243	Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4302	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
5308	Colorado Plateau Pinyon-Juniper Shrubland
7104	Central Mixedgrass Prairie
7122	Western Great Plains Shortgrass Prairie
9153	Western Great Plains Floodplain
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9171	Rocky Mountain Subalpine-Montane Riparian Woodland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9178	North American Warm Desert Riparian Mesquite Bosque
9182	North American Warm Desert Riparian Woodland and Shrubland
9329	Western Great Plains Riparian

FERRIGUNOUS HAWK

The distribution of the Ferrigunous hawk (*Buteo regalis*) was mapped using ecological systems and elevation (24 to 2130 meters) to define habitat as shown in the schematic model below.



Elevation: 24-2130 meters

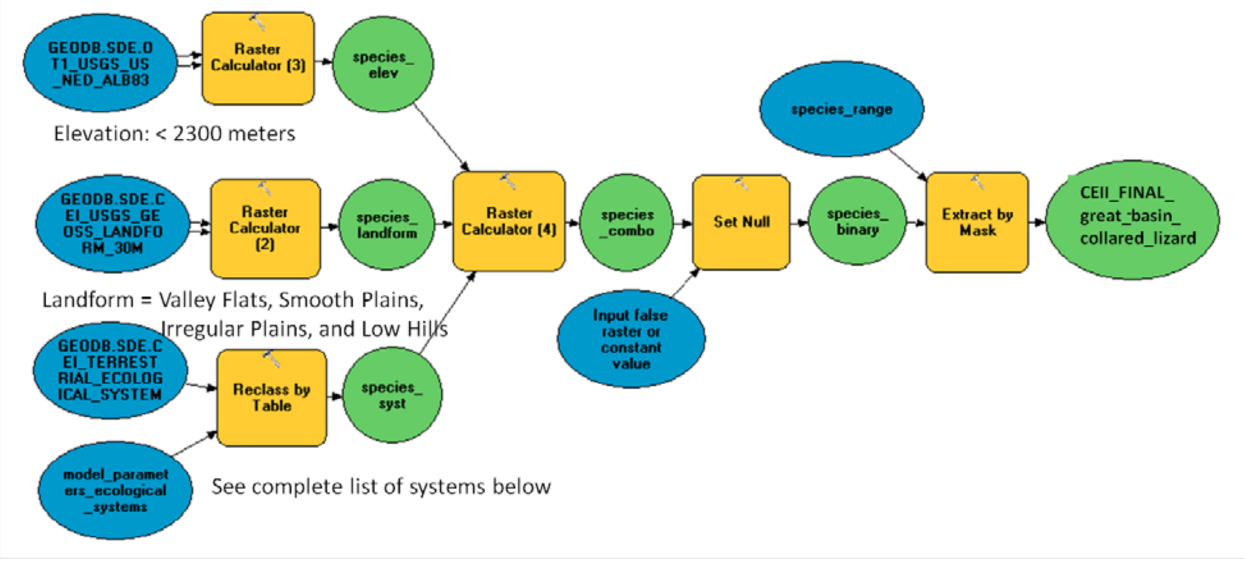
See complete list of systems below

ESLF Code	System Name
80	Agriculture - General

81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3120	North American Warm Desert Bedrock Cliff and Outcrop
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3142	Western Great Plains Cliff and Outcrop
3160	Inter-Mountain Basins Active and Stabilized Dune
3171	Sierra Nevada Cliff and Canyon
3173	Inter-Mountain Basins Cliff and Canyon
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5203	Inter-Mountain Basins Mat Saltbush Shrubland
5209	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5454	Inter-Mountain Basins Big Sagebrush Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
9103	Inter-Mountain Basins Greasewood Flat
9151	North American Warm Desert Wash

GREAT BASIN COLLARED LIZARD

The distribution of the Great Basin collared lizard (*Crotaphytus bicinctores*) was mapped using ecological systems, elevation (less than 2300 meters), and landform (valley flats, smooth plains, irregular plains, and low hills) to define habitat as shown in the schematic model below.

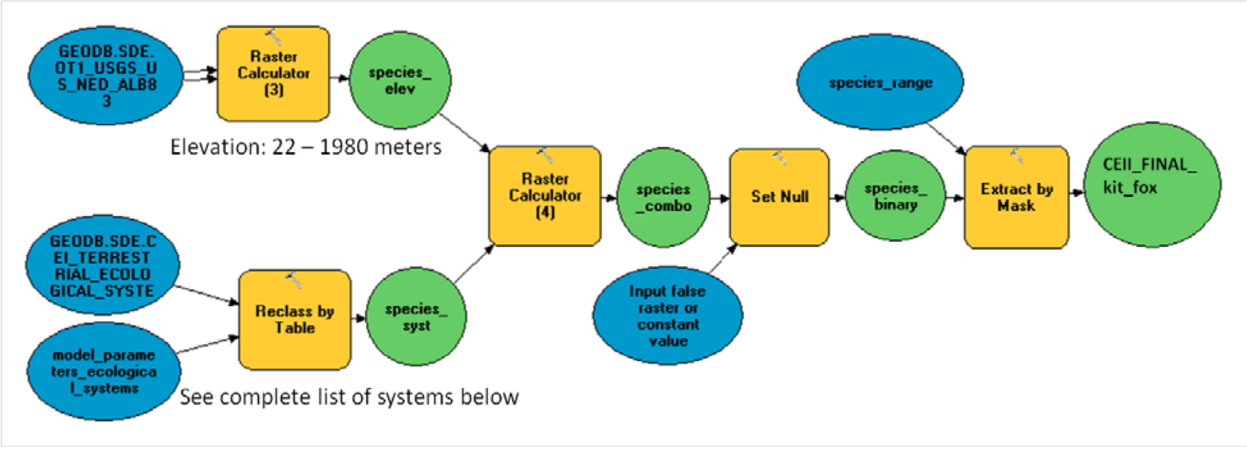


ESLF Code	System Name
3120	North American Warm Desert Bedrock Cliff and Outcrop
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3171	Sierra Nevada Cliff and Canyon

3173	Inter-Mountain Basins Cliff and Canyon
3180	North American Warm Desert Volcanic Rockland
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5259	Mojave Mid-Elevation Mixed Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5265	Sonora-Mojave Mixed Salt Desert Scrub
5268	Sonoran Mid-Elevation Desert Scrub
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
9151	North American Warm Desert Wash

KIT FOX

The distribution of the kit fox (*Vulpes macrotis*) was mapped using ecological systems and elevation (22 to 1980 meters) to define habitat as shown in the schematic model below.

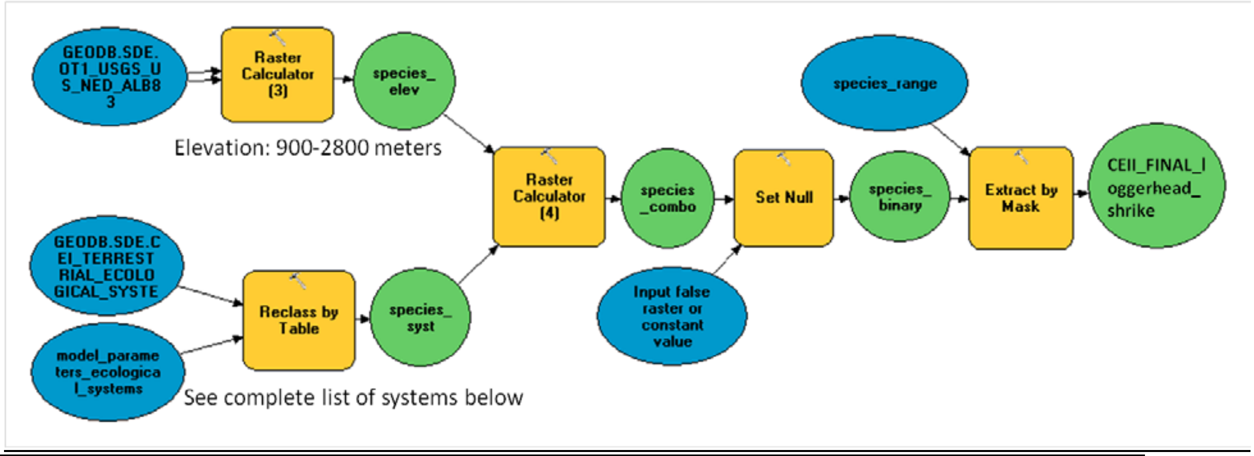


ESLF Code	System Name
3121	North American Warm Desert Active and Stabilized Dune
3123	North American Warm Desert Badland
3139	Inter-Mountain Basins Shale Badland
3152	Inter-Mountain Basins Wash
3161	North American Warm Desert Playa
3179	Inter-Mountain Basins Playa
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5203	Inter-Mountain Basins Mat Saltbush Shrubland
5209	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe
5252	Chihuahuan Mixed Salt Desert Scrub

5253	Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5259	Mojave Mid-Elevation Mixed Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5265	Sonora-Mojave Mixed Salt Desert Scrub
5268	Sonoran Mid-Elevation Desert Scrub
5270	Southern Colorado Plateau Sand Shrubland
5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5307	Madrean Oriental Chaparral
5308	Colorado Plateau Pinyon-Juniper Shrubland
5309	Great Basin Semi-Desert Chaparral
5310	Mogollon Chaparral
5314	Sonora-Mojave Semi-Desert Chaparral
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5454	Inter-Mountain Basins Big Sagebrush Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7122	Western Great Plains Shortgrass Prairie
9151	North American Warm Desert Wash

LOGGERHEAD SHRIKE

The distribution of the loggerhead shrike (*Lanius ludovicianus*) was mapped using ecological systems and elevation (900 to 2800 meters) to define habitat as shown in the schematic model below.

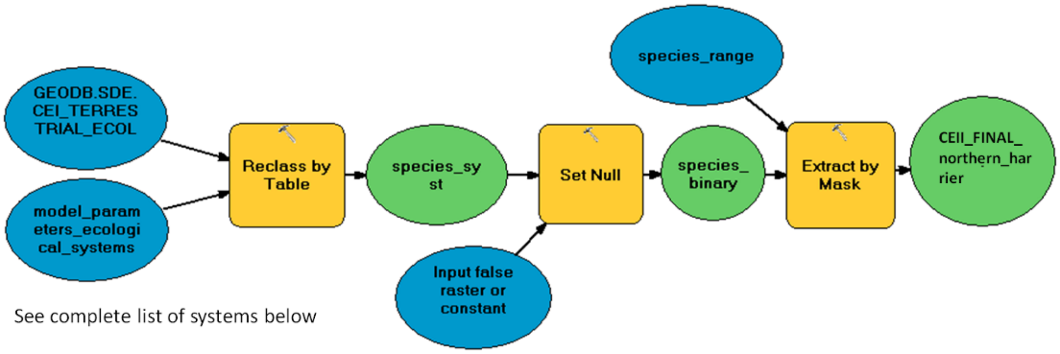


ESLF Code	System Name
21	Developed-Open Space
22	Developed-Low Intensity
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3152	Inter-Mountain Basins Wash
3173	Inter-Mountain Basins Cliff and Canyon
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4203	Colorado Plateau Pinyon-Juniper Woodland
4210	Madrean Encinal
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4260	Southern Coastal Plain Mesic Slope Forest
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5252	Chihuahuan Mixed Salt Desert Scrub
5253	Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5259	Mojave Mid-Elevation Mixed Desert Scrub
5263	Rocky Mountain Lower Montane-Foothill Shrubland
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5265	Sonora-Mojave Mixed Salt Desert Scrub
5268	Sonoran Mid-Elevation Desert Scrub
5270	Southern Colorado Plateau Sand Shrubland

5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5308	Colorado Plateau Pinyon-Juniper Shrubland
5309	Great Basin Semi-Desert Chaparral
5310	Mogollon Chaparral
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5317	Western Great Plains Mesquite Woodland and Shrubland
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7119	Southern Rocky Mountain Montane-Subalpine Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9103	Inter-Mountain Basins Greasewood Flat
9151	North American Warm Desert Wash
9153	Western Great Plains Floodplain
9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9178	North American Warm Desert Riparian Mesquite Bosque
9182	North American Warm Desert Riparian Woodland and Shrubland
9329	Western Great Plains Riparian
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

NORTHERN HARRIER

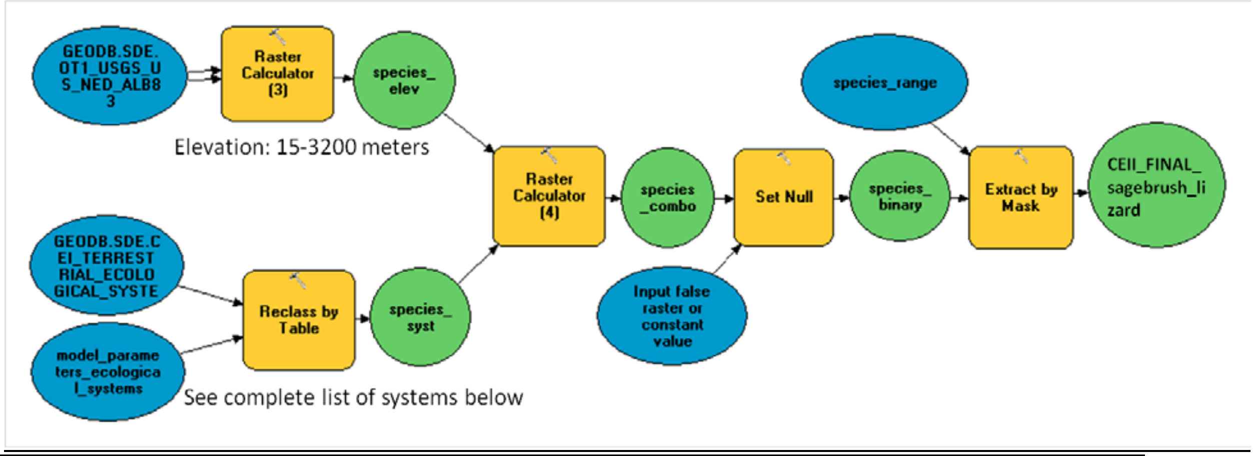
The distribution of the northern harrier (*Circus cyaneus*) was mapped based solely on the distribution of ecological systems as shown in the schematic model below.



ESLF Code	System Name
2	Recently Burned
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
5252	Chihuahuan Mixed Salt Desert Scrub
5254	Chihuahuan Succulent Desert Scrub
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
7104	Central Mixedgrass Prairie
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9103	Inter-Mountain Basins Greasewood Flat
9153	Western Great Plains Floodplain
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9178	North American Warm Desert Riparian Mesquite Bosque
9182	North American Warm Desert Riparian Woodland and Shrubland
9222	North American Arid West Emergent Marsh
9256	Western Great Plains Saline Depression Wetland
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

NORTHERN SAGEBRUSH LIZARD

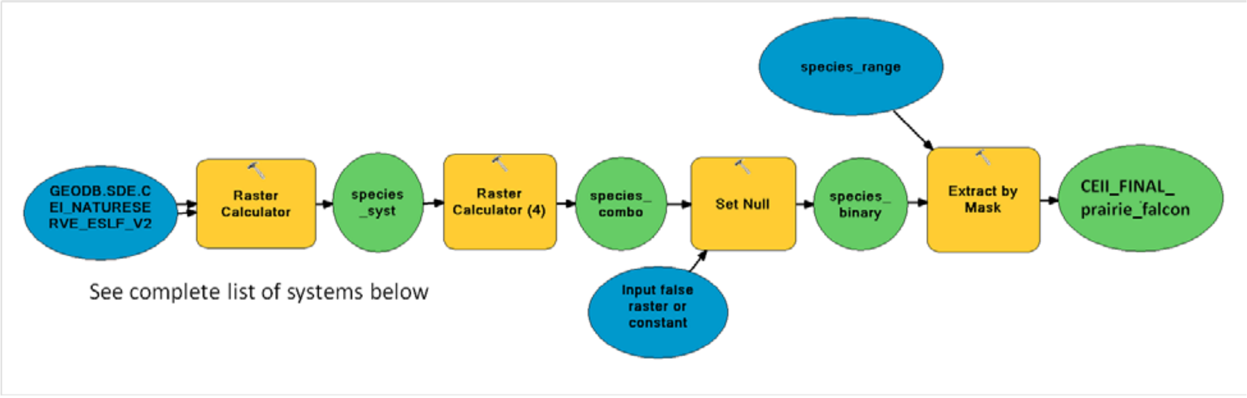
The distribution of the northern sagebrush lizard (*Sceloporus graciosus grasiosus*) was mapped using ecological systems and elevation (15 to 3200 meters) to define habitat as shown in the schematic model below.



ESLF Code	System Name
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3173	Inter-Mountain Basins Cliff and Canyon
3179	Inter-Mountain Basins Playa
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5259	Mojave Mid-Elevation Mixed Desert Scrub
5263	Rocky Mountain Lower Montane-Foothill Shrubland
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5308	Colorado Plateau Pinyon-Juniper Shrubland
5310	Mogollon Chaparral
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

PRAIRIE FALCON

The distribution of the prairie falcon (*Falco mexicanus*) was mapped based solely on the distribution of ecological systems as shown in the schematic model below.

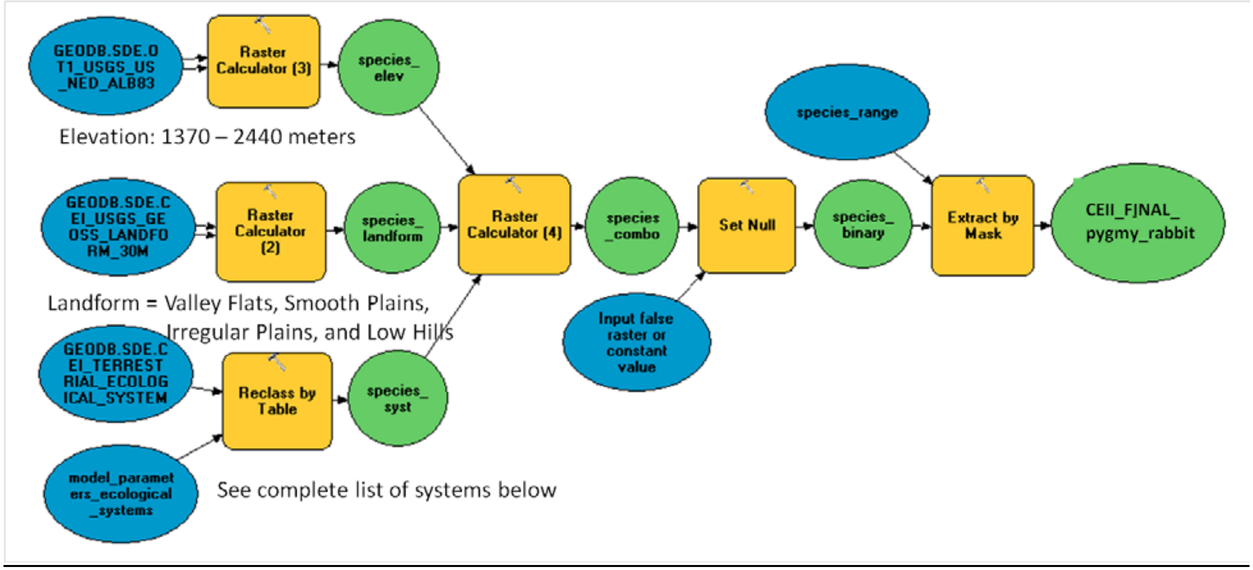


ESLF Code	System Name
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3120	North American Warm Desert Bedrock Cliff and Outcrop
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
3142	Western Great Plains Cliff and Outcrop
3171	Sierra Nevada Cliff and Canyon
3173	Inter-Mountain Basins Cliff and Canyon
4210	Madrean Encinal
4241	Southern Rocky Mountain Ponderosa Pine Woodland
5203	Inter-Mountain Basins Mat Saltbush Shrubland
5252	Chihuahuan Mixed Salt Desert Scrub
5254	Chihuahuan Succulent Desert Scrub
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5307	Madrean Oriental Chaparral
5310	Mogollon Chaparral
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5314	Sonora-Mojave Semi-Desert Chaparral
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie
7105	Chihuahuan Sandy Plains Semi-Desert Grassland

7107	Inter-Mountain Basins Semi-Desert Grassland
7117	Rocky Mountain Alpine Turf
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9151	North American Warm Desert Wash
9153	Western Great Plains Floodplain
9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9182	North American Warm Desert Riparian Woodland and Shrubland
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

PYGMY RABBIT

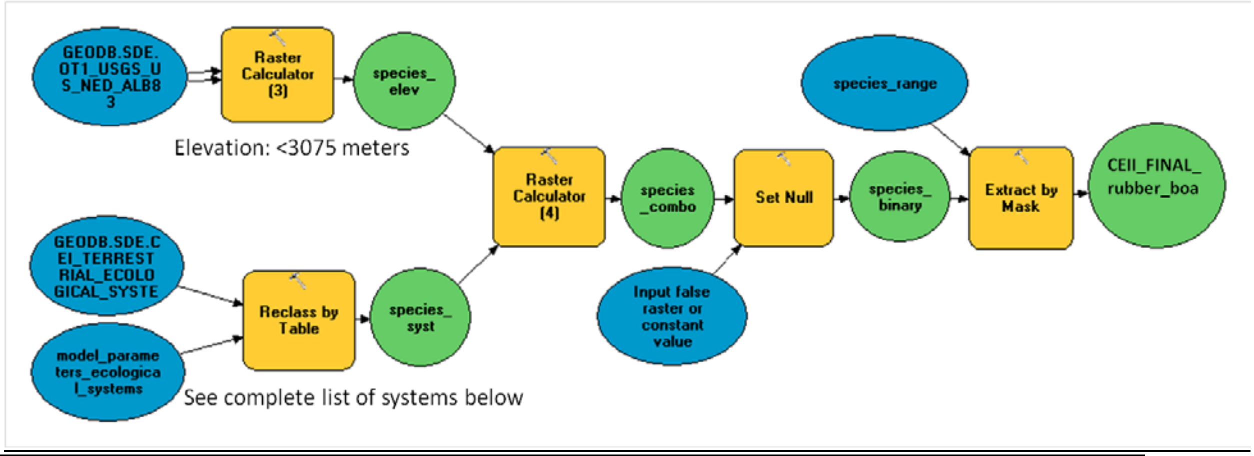
The distribution of the pygmy rabbit (*Brachylagus idahoensis*) was mapped using ecological systems, elevation (less than 1370 to 2440 meters), and landform (valley flats, smooth plains, irregular plains, and low hills) to define habitat as shown in the schematic model below.



ESLF Code	System Name
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5454	Inter-Mountain Basins Big Sagebrush Steppe

NORTHERN RUBBER BOA

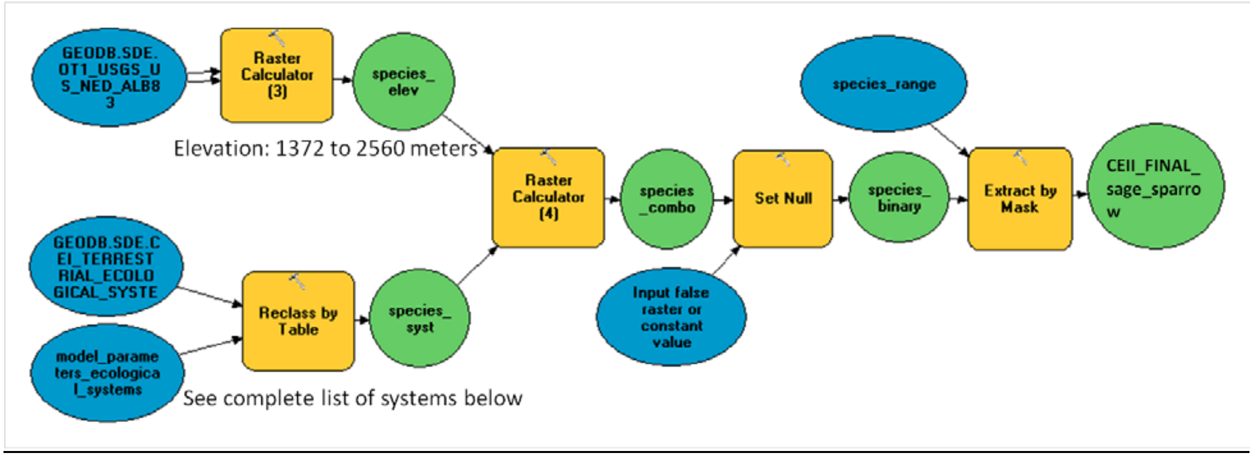
The distribution of the rubber boa (*Charina bottae*) *was* mapped using ecological systems and elevation (less than 3075 meters) to define habitat as shown in the schematic model below.



ESLF Code	System Name
4239	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4302	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
5309	Great Basin Semi-Desert Chaparral
7118	Rocky Mountain Subalpine-Montane Mesic Meadow
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9171	Rocky Mountain Subalpine-Montane Riparian Woodland
9182	North American Warm Desert Riparian Woodland and Shrubland

SAGE SPARROW

The distribution of the sage sparrow (*Amphispiza belli*) was mapped using ecological systems and elevation (1372 to 2560 meters) to define habitat as shown in the schematic model below.

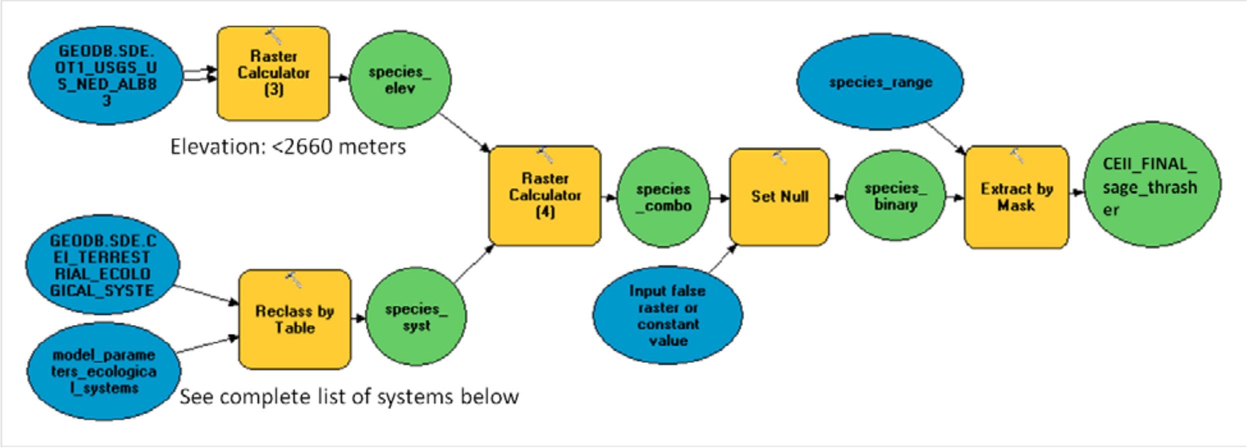


ESLF Code	System Name
3121	North American Warm Desert Active and Stabilized Dune
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3139	Inter-Mountain Basins Shale Badland
3143	North American Warm Desert Pavement

3160	Inter-Mountain Basins Active and Stabilized Dune
3161	North American Warm Desert Playa
3173	Inter-Mountain Basins Cliff and Canyon
3183	Colorado Plateau Mixed Bedrock Canyon and Tableland
4203	Colorado Plateau Pinyon-Juniper Woodland
4212	Madrean Pinyon-Juniper Woodland
4236	Rocky Mountain Foothill Limber Pine-Juniper Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
4260	Southern Coastal Plain Mesic Slope Forest
4303	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5203	Inter-Mountain Basins Mat Saltbush Shrubland
5252	Chihuahuan Mixed Salt Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5263	Rocky Mountain Lower Montane-Foothill Shrubland
5265	Sonora-Mojave Mixed Salt Desert Scrub
5270	Southern Colorado Plateau Sand Shrubland
5271	Western Great Plains Sandhill Steppe
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5307	Madrean Oriental Chaparral
5308	Colorado Plateau Pinyon-Juniper Shrubland
5309	Great Basin Semi-Desert Chaparral
5310	Mogollon Chaparral
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5314	Sonora-Mojave Semi-Desert Chaparral
5317	Western Great Plains Mesquite Woodland and Shrubland
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5451	Chihuahuan Gypsophilous Grassland and Steppe
5454	Inter-Mountain Basins Big Sagebrush Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
9103	Inter-Mountain Basins Greasewood Flat
9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

SAGE THRASHER

The distribution of the sage thrasher (*Oreoscoptes montanus) was* mapped using ecological systems and elevation (less than 2660 meters) to define habitat as shown in the schematic model below.

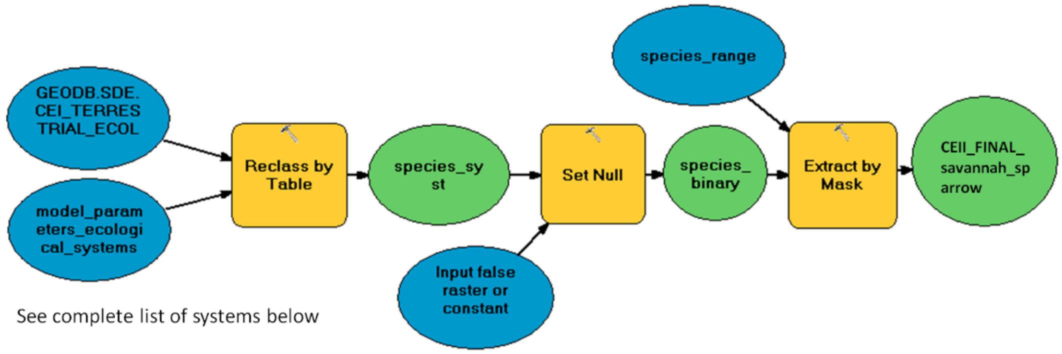


ESLF Code	System Name
3121	North American Warm Desert Active and Stabilized Dune
3128	Inter-Mountain Basins Volcanic Rock and Cinder Land
3152	Inter-Mountain Basins Wash
4203	Colorado Plateau Pinyon-Juniper Woodland
4212	Madrean Pinyon-Juniper Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
5201	Colorado Plateau Mixed Low Sagebrush Shrubland
5252	Chihuahuan Mixed Salt Desert Scrub
5253	Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5258	Inter-Mountain Basins Mixed Salt Desert Scrub
5265	Sonora-Mojave Mixed Salt Desert Scrub
5270	Southern Colorado Plateau Sand Shrubland
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5313	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5317	Western Great Plains Mesquite Woodland and Shrubland
5404	Inter-Mountain Basins Juniper Savanna
5405	Madrean Juniper Savanna
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe

5451	Chihuahuan Gypsophilous Grassland and Steppe
5454	Inter-Mountain Basins Big Sagebrush Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
9103	Inter-Mountain Basins Greasewood Flat
9151	North American Warm Desert Wash
9153	Western Great Plains Floodplain
9155	Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
9156	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9178	North American Warm Desert Riparian Mesquite Bosque
9182	North American Warm Desert Riparian Woodland and Shrubland
9329	Western Great Plains Riparian
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

SAVANNAH SPARROW

The distribution of the savannah sparrow (*Passerculus sandwichensis*) was mapped based solely on the distribution of ecological systems as shown in the schematic model below.

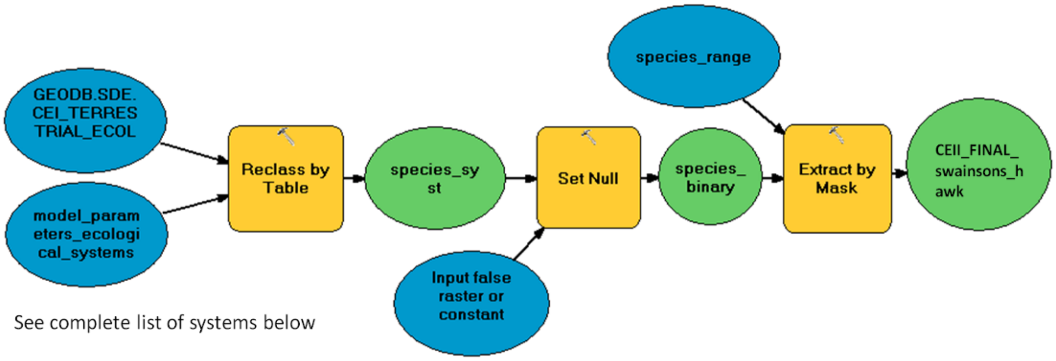


ESLF Code	System Name
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5454	Inter-Mountain Basins Big Sagebrush Steppe
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie

7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7110	North Pacific Montane Grassland
7118	Rocky Mountain Subalpine-Montane Mesic Meadow
7119	Southern Rocky Mountain Montane-Subalpine Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
9153	Western Great Plains Floodplain
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9182	North American Warm Desert Riparian Woodland and Shrubland
9217	Rocky Mountain Alpine-Montane Wet Meadow
9222	North American Arid West Emergent Marsh
9256	Western Great Plains Saline Depression Wetland
9265	Temperate Pacific Subalpine-Montane Wet Meadow
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

SWAINSON'S HAWK

The distribution of Swainson's hawk *Buteo swainsoni*) was mapped based solely on the distribution of ecological systems as shown in the schematic model below.

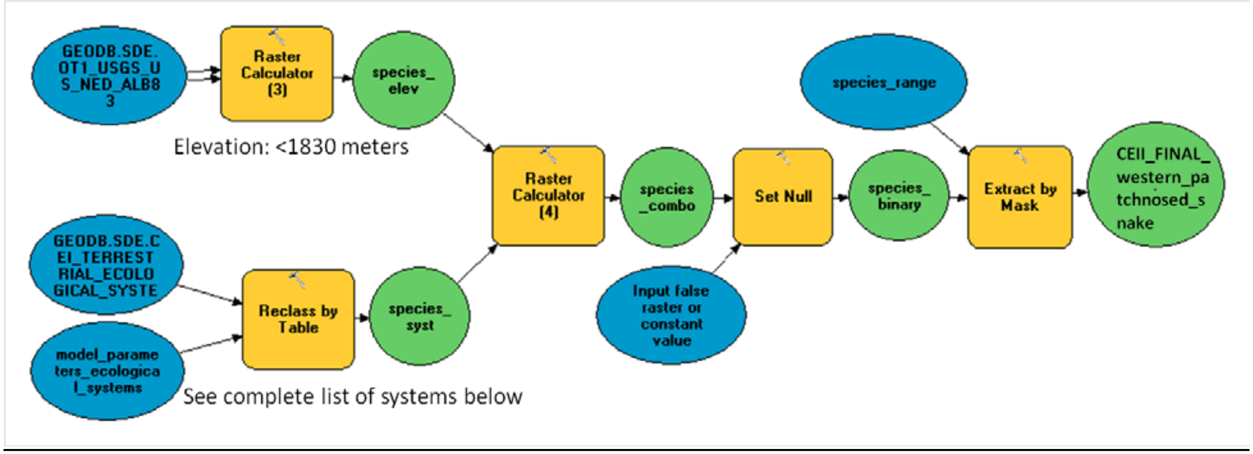


ESLF Code	System Name
80	Agriculture - General
81	Agriculture - Pasture/Hay
82	Agriculture - Cultivated Crops and Irrigated Agriculture
3129	Rocky Mountain Cliff, Canyon and Massive Bedrock
4203	Colorado Plateau Pinyon-Juniper Woodland
4206	Great Basin Pinyon-Juniper Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
5254	Chihuahuan Succulent Desert Scrub
5255	Colorado Plateau Blackbrush-Mormon-tea Shrubland
5259	Mojave Mid-Elevation Mixed Desert Scrub

5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5306	Chihuahuan Mixed Desert and Thorn Scrub
5309	Great Basin Semi-Desert Chaparral
5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5408	Southern Rocky Mountain Juniper Woodland and Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5451	Chihuahuan Gypsophilous Grassland and Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7105	Chihuahuan Sandy Plains Semi-Desert Grassland
7107	Inter-Mountain Basins Semi-Desert Grassland
7110	North Pacific Montane Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie
7123	Western Great Plains Tallgrass Prairie
9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9171	Rocky Mountain Subalpine-Montane Riparian Woodland

WESTERN PATCH-NOSED SNAKE

The distribution of the western patch-nosed snake (*Salvadora hexalepis*) was mapped using ecological systems and elevation (less than 1830 meters) to define habitat as shown in the schematic model below.

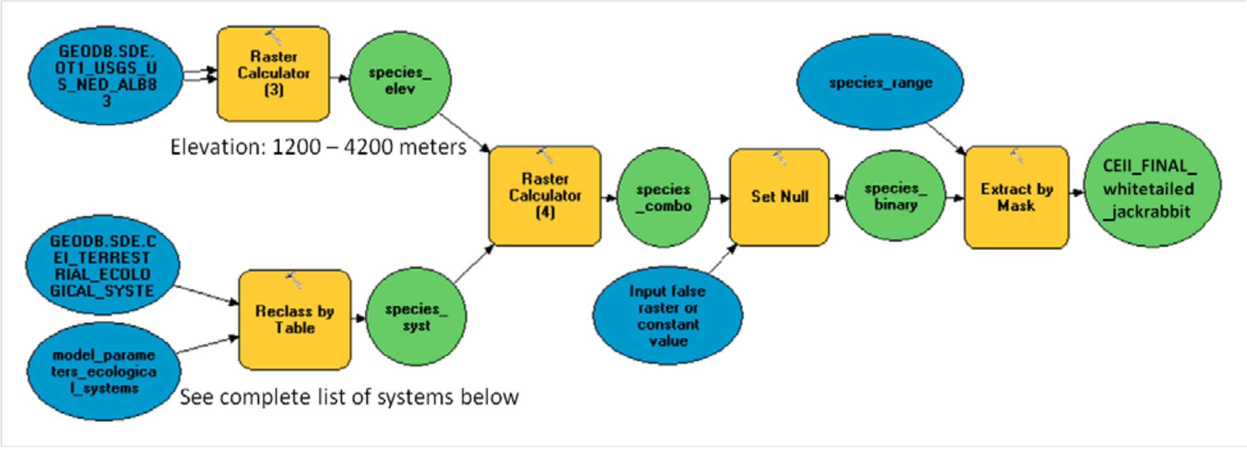


ESLF Code	System Name
4210	Madrean Encinal
4211	Madrean Lower Montane Pine-Oak Forest and Woodland
4212	Madrean Pinyon-Juniper Woodland
5259	Mojave Mid-Elevation Mixed Desert Scrub
5264	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5268	Sonoran Mid-Elevation Desert Scrub
5301	Apacherian-Chihuahuan Mesquite Upland Scrub
5314	Sonora-Mojave Semi-Desert Chaparral

5315	Sonoran Paloverde-Mixed Cacti Desert Scrub
5405	Madrean Juniper Savanna
5450	Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
9172	North American Warm Desert Lower Montane Riparian Woodland and Shrubland
9178	North American Warm Desert Riparian Mesquite Bosque
9182	North American Warm Desert Riparian Woodland and Shrubland
9411	Chihuahuan-Sonoran Desert Bottomland and Swale Grassland

WHITE-TAILED JACKRABBIT

The distribution of the white-tailed jackrabbit (*Lepus townsendii*) was mapped using ecological systems and elevation (1200 – 4200 meters) to define habitat as shown in the schematic model below.



ESLF Code	System Name
4206	Great Basin Pinyon-Juniper Woodland
4207	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
4241	Southern Rocky Mountain Ponderosa Pine Woodland
4244	Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4246	Southern Rocky Mountain Pinyon-Juniper Woodland
5209	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe
5256	Great Basin Xeric Mixed Sagebrush Shrubland
5257	Inter-Mountain Basins Big Sagebrush Shrubland
5455	Inter-Mountain Basins Montane Sagebrush Steppe
5456	Inter-Mountain Basins Semi-Desert Shrub-Steppe
7104	Central Mixedgrass Prairie
7107	Inter-Mountain Basins Semi-Desert Grassland
7116	Rocky Mountain Alpine Fell-Field
7118	Rocky Mountain Subalpine-Montane Mesic Meadow
7119	Southern Rocky Mountain Montane-Subalpine Grassland
7120	Western Great Plains Foothill and Piedmont Grassland
7122	Western Great Plains Shortgrass Prairie

9168	Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
9217	Rocky Mountain Alpine-Montane Wet Meadow

B-1.2.7 Species Represented by Element Occurrence Records

Element occurrence (EOs) records from NatureServe's multi-jurisdictional database were used to map the distribution of two species: the bald eagle and the golden eagle. These records were derived from species occurrence observations tracked by individual state natural heritage programs and downloaded data for these two birds from the Global Biodiversity Information Facility (http://data.gbif.org/welcome.htm). The GBIF data were merged with data from NatureServe member programs and standard attributes were applied. Both EOs and GBIF data are spatially represented by point locations. Due to the sensitive nature of these data records, their distribution is restricted. Thus, the data were incorporated into analyses of landscape species CEs for the REA, but not provided in raw form to the BLM.

The element occurrence / GBIF data set for the bald eagle contains 771 point occurrence records within the CBR boundaries, collected between 2000 and 2011. The element occurrence / GBIF data set for the golden eagle contains 1864 point occurrence records within the CBR boundaries, collected between 2000 and 2011.

B-1.2.8 Local species: Handling of Element Occurrences

Local species data were derived primarily from field observations and/or Element Occurrence records from Natural Heritage programs. Species presumed to be addressed in the REA through assessment of coarse filter CEs, and those local-scale species treated within summaries by watershed, required no additional modeling steps, although data for use in by watersehd summaries were aggregated as described below.

Element Occurrence (EO) / Observation data were provided by NatureServe member programs in Arizona, California, Idaho, Nevada, Oregon, and Utah for use in the CBR REA project. NatureServe aggregated these data into a single dataset with standardized taxonomy and conservation status attributes. The initial dataset was created by selecting all EO / Observation data within or overlapping the final CBR boundary. Since the focus of this analysis is on taxa that are believed to be current and extant, several exclusions were applied to remove extirpated or historical populations from the dataset:

- Excluded EO / Observation records for extirpated populations (Eorank = "X" or "X?"),
- Using median Landscape Condition Model (LCM) calculated values for each EO / Obs record, excluded EO / Observation records that are only known from historical records (Eorank = "H" or "H?"; or last observed date older than 1980) with a low median LCM value (<=30) and the area of the EO / Observation is less than 1260 ha, and
- For large EO / Obs records (>1260 ha), excluded all records with a last observed date older than 1980.

As needed, subspecies and varieties were "rolled up" to the relevant "full species". The "assessment type" was assigned to all records according to the final CBR species list. The final EO / Observation dataset for CBR contains 14,114 records.

For the Landscape Species, the EOs for these species were combined with the 5th level watersheds (5th level watershed) raster layer, and the resulting raster tables were converted to geodatabase tables.

These data were summarized by pixels, and converted to acres for each landscape species distribution per 5th level watershed. All records where the landscape species has less than 248 acres (100 ha) in a 5th level watershed watershed were excluded as not likely to occur in the watershed.

The final summary lists for 5th level watershed watersheds was created by performing a spatial join between the EO/Observation, Bald Eagle, Golden Eagle, and Landscape Species Distribution Model datasets and the CBR 5th level watershed watershed layer. The tabular results of the spatial join were exported from GIS to text (CSV) files, that were then imported to an Access database. In Access, the results of the various analyses were merged, and updates were conducted as needed with attributes from the final CBR species list (such as conservation statuses). A series of queries were conducted to create a list of the unique species per watershed, and from that summarized the unique species list to get the number of rare plant species and EOs per watershed.

Figure B - 14 summarizes the number of local species occurring in each 5th level watershed, based on natural heritage element occurrence records. These species localities are generally concentrated along the western, eastern, and southeastern portions of the ecoregion.

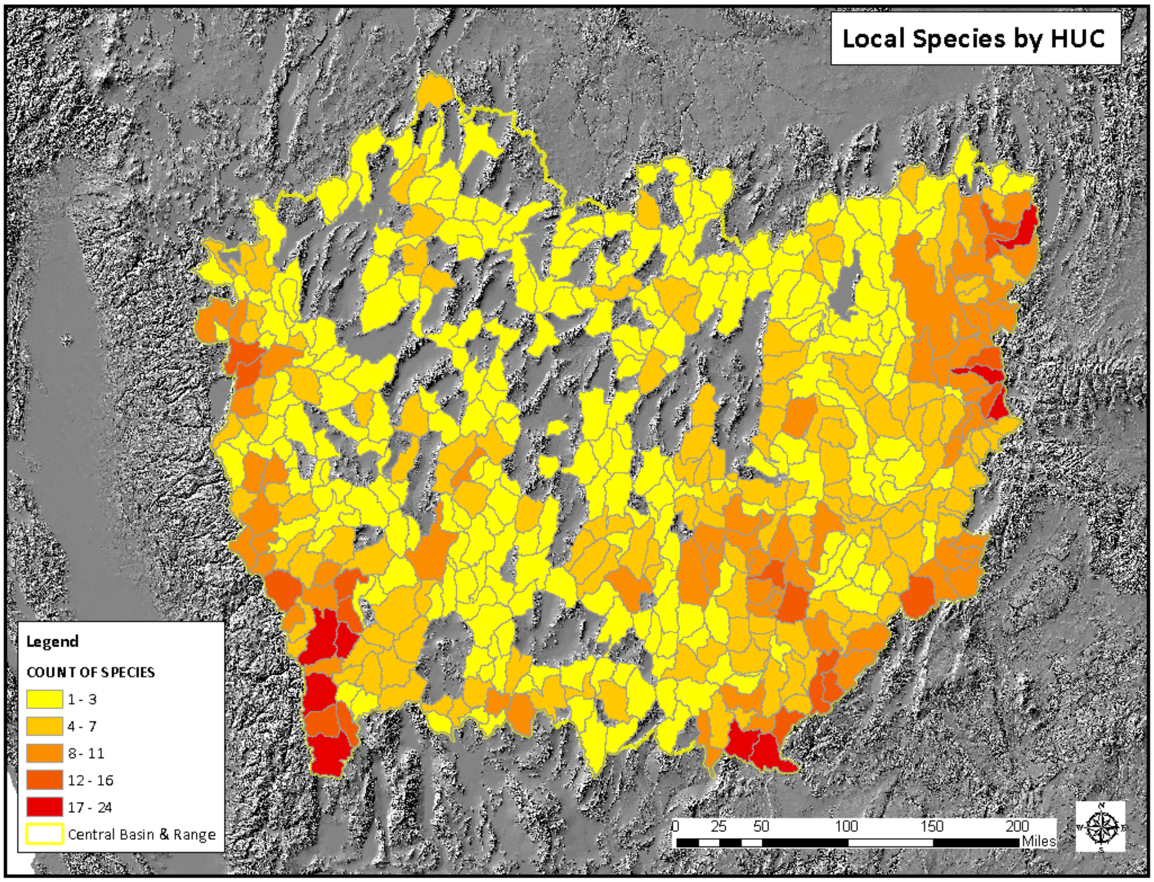


Figure B - 14. Local species summarized by number known to occur within each 5th level watershed of the CBR.

Bioclimate Envelope Modeling

B-1.2.9 Introduction

In order to forecast how climate change may result in geographic shifts of the suitable climatic conditions for a species, we must first define its ‘bioclimactic envelope’. Species distribution models, also called ecological niche models, perform this task by correlating known localities of a species’ current range with current climatic conditions. Of course, climactic conditions such as air temperature and precipitation levels are not the sole defining characteristics of species occupied range. Some species, for example, may be limited or facilitated by the presence of particular vegetation communities, or by other habitat characteristics such as topography or soil type, etc. Nonetheless, climatic conditions play a broad role in determining the suitability of habitat for most species, and they have indirect influence on those other factors, such as the extent of certain vegetation communities or the characteristics of local hydrology, that in turn influence habitat selection for species. Thus, there is value for management in anticipating the geographic changes in bioclimatic suitability that climate change may bring. This information can serve as one of many inputs in developing an understanding of how climate change might affect a given species of management interest.

More informative and quantifiable estimates of potential range shifts can be obtained by projecting current bioclimates defined by species distributions into future climatic conditions based on the most recent climate model data (e.g. Gonzales et al. 2010; Jiguet et al. 2011). This approach integrates observations of occurrence data for a target species with digital grids of spatial climate observations to generate a species’ multidimensional bioclimatic ‘envelope’ or ‘niche’. The species’ identified n-dimensional bioclimatic envelope can then be projected into 21st century climate scenarios developed by the Intergovernmental Panel on Climate Change (IPCC), resulting in a map of the future distribution of the species current bioclimatic niche. This information offers one basic building block for a myriad of studies that include prediction of extinction risk, analysis of future conservation priorities and species range shifts.

However, IPCC GCMs present two challenges: 1) the coarse spatial resolution at which they are produced (with grid cells ranging from 1^{o} to 5^{o}, with an average of over 2.0^{o}) and 2) the difficulty comparing across the many different GCMs that exist, each of which are run under alternative emissions scenarios, and each of which archive different climate variable outputs. Both challenges limit our ability to compare and contrast results based on different model simulations, quantify the associated uncertainties inherent to multiple simulations, or understand the impacts of climate change on the spatial scales relevant to biodiversity (Dettinger 2006; Beaumont et al. 2007). To address the first issue, GCMs are downscaled to finer spatial resolutions using one of several approaches. To quantify uncertainties confronting conservationists, an ensemble approach was used to increase the statistical confidence on the likelihood of various future climate outcomes (Salathé Jr. et al. 2007, Kremen et al. 2008).

B-1.2.9.1 Limitations and Uncertainties

Results from climate space trend and bioclimatic envelope analyses should be carefully considered in light of the limitations and uncertainties that constrain virtually all scientific efforts to understand the potential impacts of changes in climate. This is particularly true when the analysis objective requires an understanding of current and future climate conditions at fine spatial and temporal scales relevant to plants and animal populations of management concern.

Every dataset and modeling approach that is used in forecasting climate change impacts contains an inherent degree of uncertainty. Here, we discuss each source of uncertainty in modeling climate change impacts to the distributions of CEs and vegetation assemblages or in analyzing trends in climate space over time.

Climate observations

Historical and recent climate data from observations is restricted to scattered weather stations, whose density patterns generally reflect patterns of human settlement. Weather station locations are inherently biased towards easily accessible, low elevation sites (Figure B - 15). For analysis of current climate space trends, we use the PRISM spatial climate dataset for the years 1900-2010 (Daly et al. 2002). PRISM uses a sophisticated, proprietary interpolation algorithm to create gridded climate data for the conterminous U.S., which is freely available at 4km2 resolution (http://www.prism.oregonstate.edu/products/matrix.phtml?view=data). PRISM is widely accepted as the highest quality spatial climate dataset available for the U.S., and it has been adopted as the official climate data for the U.S. Dept of Agriculture. Nonetheless, all efforts to interpolate sparse weather station observations face challenges. While temperature interacts with topography in a relatively predictable manner, the interpolation of precipitation, particularly over topographically complex regions, is a known weakness of all gridded climate datasets. *Therefore results of spatial and temporal precipitation analyses from gridded climate data are less certain than those for temperature, particularly over mountainous terrain.*

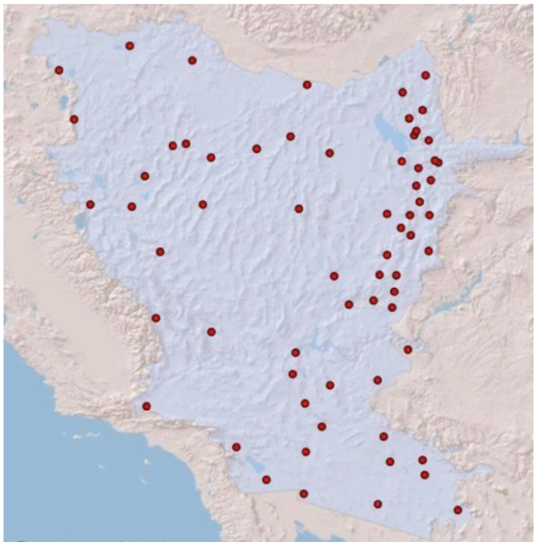


Figure B - 15.Verified weather stations measuring temperature and precipitation in the Central and Mojave basin and range ecoregions. Source: Global Historical Climatology Network v.2

A second, higher resolution gridded climate dataset is available from the PRISM group for purchase, and this 800m^2 resolution is recognized as a superior product. The for-sale product offers a more sophisticated and validated algorithm that better accounts for interactions of climate and topography, such as cold air drainages, temperature inversions, and microclimates generated by slope and aspect. Also, the much finer spatial scale of the purchased product more closely reflects the scale at which plants and animals interact with climate. If the observed climate space trend analysis of the CBR at 4km^2 proves to be a useful product, we strongly recommend that a finer spatial scale analysis with a more sophisticated gridded climate dataset would be a worthy investment in support of management planning.

Future climate projections

Any effort to understand the impacts of future climate change on biodiversity requires outputs from global or regional climate models. There are a wide range of models to choose from – almost two dozen global circulation models (GCM – also called global climate models) were vetted by the Intergovernmental Panel on Climate Change (IPCC) in their last assessment report (IPCC 2007). Global climate models attempt to capture the patterns, forcings and feedbacks of the entire global climate system over time, and are therefore relatively limited in their direct applications to regional scale questions. The process of climate model *downscaling* uses alternative approaches to create gridded climate data based on GCM outputs at much finer spatial resolution for regional to local scale impacts analyses.

To assess model performance, climate models are initialized with known atmospheric conditions from the recent past (such as 1950-2000), and their outputs compared to observed conditions. No single climate model outperforms all others in reproducing patterns of climate across the globe. The climate modeling community supports the concept that multimodel ensembles, that is, the average of a suite of climate models, generally outperform any single climate model in reproducing observed patterns of global climate (Tebaldi & Knutti 2007). Comparing results across a range of models also supports an evaluation of model agreement, which is one approach to decreasing uncertainty in future climate impacts assessments (Tebaldi et al. 2011).

For this REA, we use a range of global and regional climate model results to analyze climate change impacts on the biodiversity and landscapes of the CBR. As dictated by the scope of the REA, all climate model results reflect only the A2 greenhouse gas emissions scenario, which forecasts steadily increasing amounts of heat trapping gases emitted into the atmosphere for the remainder of this century (IPCC 2000). Therefore, *uncertainty due to the rate and magnitude of greenhouse gas emissions is not explored in this REA*. However, within the scenario described by the A2 future, the bioclimatic envelope modeling and climate space trend analysis are conducted with multiple climate model outputs. Our intention is to capture a reasonable range of model variation and to provide measures of degree of climate model agreement, both of which reduce the uncertainty inherent in impacts assessments relying on one or a very few models.

Biogeographic distributions

The distribution of any given species or vegetation assemblage can rarely be assessed with complete confidence. Even painstaking fieldwork, museum collection records, or computer algorithms classifying satellite data, cannot fully characterize the dynamic distribution of biodiversity in time and space. Point observations of species distributions are always an underestimate of actual distributions. Range maps drawn by creating convex hulls around the outermost point observations are usually overestimates, as species are not continuously distributed in space.

Samples were selected from the mapped distributions of either landscape speices or terrestrial coarse filter, to be used as input to the bioclimate modleing. For specific methods on input landscape species distribution data see section B-1.2.5 in this appendix for the Landscape Species. For specific methods on terrestrial coarse filter input distribution data see B-1.2.1.

The samples used to develop the climate envelope models were based upon two datasets. The individual animal species models were developed using the intersection of SW-ReGap species range maps and a 16Km2 derived hexagon map encompassing the combined CBR and MBR boundaries extended to the Sonoran and the Northern Basin and Range Ecoregions (Figure B - 16 shows this analysis boundary). Each species was statistically summarized to define the quartile distribution of percent area included in all the intersecting hexagons. Those hexagons meeting the 75% quartile or higher were defined as a sample point.

The ecological systems samples utilized the same sample design as used for the species, but used additional field based sample points (geo-referenced vegation samples form the LANDIFRE reference database, keyed to ecological system) to define a confirmed hexagon of occurrence. Each hexagon was coded to enable the identification of the source of the hexagon selection as to mapped distribution, field based sample, or both.

Ecological niche models

Ecological niche models, also called species distribution models, correlate observations of species known distributions with spatial data on climate and/or environment from those same locations. Their use has dramatically increased over the last decade as researchers seek to understand the relationship between species distributions and global change in areas as diverse as food security, public health, ecology and conservation.

There are a range of alternative algorithms that build correlative models of species distributions, and different modeling approaches can produce different results (Pearson et al. 2006). For biogeographic data that is presence-only, that is, when locality information confirms where a species has been observed, but cannot confirm where a species does not occur, the modeling algorithm called Maxent has demonstrated superior performance (Elith & Graham 2006). There are many additional factors that can affect the performance of niche models, including the quality of the species locality data inputs, the quality and choice of inputs for climate and/or environmental variables, and the degree to which the chosen variables actually influence the distribution of the target species. Niche models make several simplifying assumptions. They do not account for the varying dispersal ability of different taxa; they do not consider genetic or evolutionary adaptive potential across individuals or populations, and they do not account for the influence of biotic interactions.

For a rapid assessment focused on climate change impacts to species and vegetation assemblages of management concern, there exists neither the time nor the resources to produce in-depth, species-specific niche modeling efforts. Our assessment analyzes the current and future distribution of bioclimatic envelopes defined by monthly variables of temperature and precipitation. For future distributions, we independently model six different bioclimatic envelopes per species, based on the six downscaled GCMs in the EcoClim 4km^2 dataset. With this approach, we can describe the relatively stability or vulnerability to change of each species bioclimatic envelope, and assess degree of model agreement across the six models as a measure of the confidence in these projections. Where multiple climate models agree that the existing bioclimate for a given species remains relatively geographically stable, this is an indication of lower vulnerability. Alternatively, where multiple climate models agree that existing bioclimate will shift significantly from its current location, this indicates high vulnerability to climate change. The analysis produced here should not emphasize the question “Where will a given species live in the future?” – this question requires much further in-depth analysis of species-specific ecology to be incorporated into the modeling effort. But the multimodel ensemble approach used in this rapid assessment can produce a hypothesis of the relative stability or vulnerability of species bioclimatic envelopes to the climate changes forecast by midcentury under an A2 scenario. By combining the results for multiple species, patterns of stability and turnover in species richness across the CBR can be estimated.

B-1.2.10 Methods

B-1.2.10.1 Regional Analysis Boundary

For purposes of the bioclimate envelope modeling a regional analysis boundary (Figure B - 16) was delineated for summarizing and analyzing the bioclimatic envelope model results because it is consistent with the species and coarse filter range data that was input into the model. The regional boundary was chosen to sample the species and coarse filters, and other input data and these samples were used to model species’ or coarse filter niches within this boundary. Because bioclimatic envelope modeling only represents the part of a species niche that is defined by the occurrence data provided, it is more accurate to include a larger sample so the model has a correct representation of a species niche and its associated bioclimatic variables. There are many species and coarse filters whose distribution crosses boundaries, such as the bald eagle and golden eagle whose ranges are extensive in both CBR and MBR. Results for species bioclimatic shift in the future also cross boundaries, and these results might be misunderstood if summarized separately for MBR and CBR.

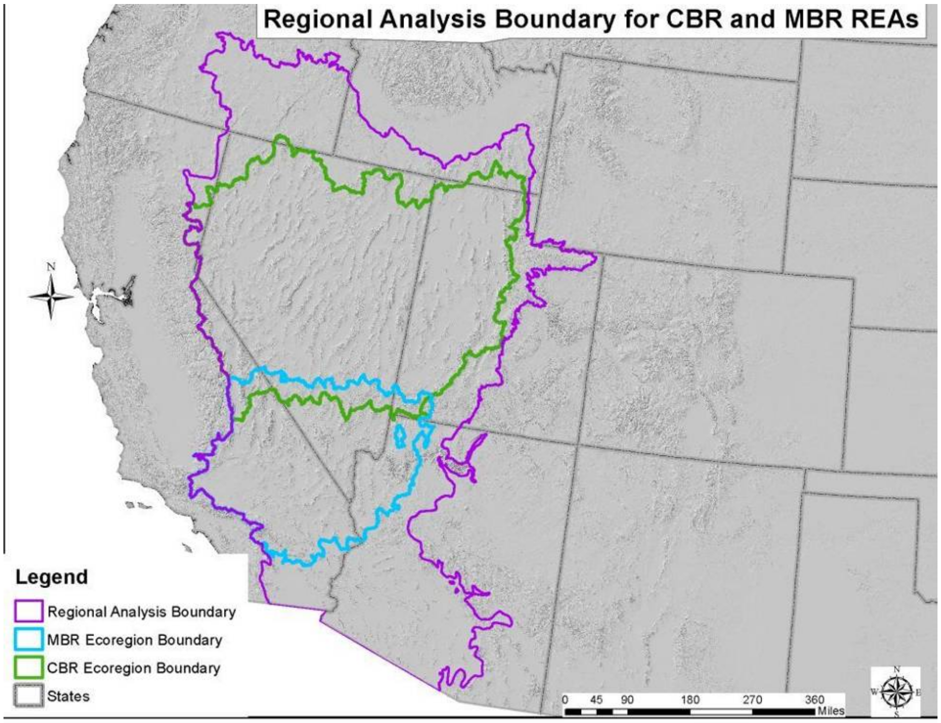


Figure B - 16. Regional analysis boundary used for the bioclimate envelope modeling of coarse filter and landscape species CEs.

B-1.2.10.2 Bioclimate Envelope Modeling

In order to predict how climate change may shift the suitable climatic conditions for a species or vegetation class, we first define its bioclimactic niche by correlating its current range with current climatic conditions. The species' identified niche can then be projected into the future using downscaled Global Circulation Models (GCMs) to predict where a niche will occur at different timeslices in 21st century climate scenarios. This information offers one basic building block for a myriad of biogeographic studies that include prediction of extirpation risk, analysis of future conservation priorities and species range shifts. A total of 41terrestrial coarse filter or landscape species CEs received bioclimate envelope modeling, across both the CBR and MBR REAs (Table B - 22). For Brewer's sparrow and mule deer one or 2 additional habitat components were modeled.

The species distribution modeling algorithm MaxEnt (Phillips et al. 2006, Phillips and Dudik 2008) was used in conjunction with spatial climate data from PRISM and EcoClim 4x 4 km to model current and future bioclimate of conservation elements in the CBR and MBR regions. Maxent is a correlative niche model that uses the principle of maximum entropy to estimate a set of functions that relate environmental variables and species known occurrences in order to approximate species' niche and potential geographic distribution (Figure B - 17). Maxent was chosen because of its established performance with presence-only data relative to alternative niche modeling techniques, and its built-in capacity to deal with multi-colinearity in the environmental variables (Elith et al. 2006, Elith and Leathwick 2009). Maxent is a machine learning algorithm related to Bayesian theory that considers redundant information without penalizing models by over-fitting, eliminating the need to apply any type of variable reduction technique before running the models. Maxent calculates a surface of probability across geographic space, where each cell has a value of the probability that a species niche will occur there at a given time. Maxent focuses on how the environment where the species is known to occur relates to the environment across the rest of the study area (the “background”). The model does not identify either the species occupied niche or fundamental niche; rather the model identifies only that part of the niche defined by the observed records (for further explanation on the algorithm refer to: Phillips et al. 2006, Elith et al. 2011).

Table B - 22. List of coarse filter and landscape species with bioclimate envelope models.

REA	Conservation Element Name
Terrestrial Coarse Filter CEs	
Both	Great Basin Pinyon-Juniper Woodland
Both	Great Basin Xeric Mixed Sagebrush Shrubland
CBR	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
CBR	Inter-Mountain Basins Big Sagebrush Shrubland
CBR	Inter-Mountain Basins Big Sagebrush Steppe
CBR	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland
Both	Inter-Mountain Basins Mixed Salt Desert Scrub
CBR	Inter-Mountain Basins Montane Sagebrush Steppe
CBR	Inter-Mountain Basins Semi-Desert Shrub-Steppe
CBR	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland
Both	Mojave Mid-Elevation Mixed Desert Scrub
CBR	Rocky Mountain Aspen Forest and Woodland
MBR	Sonora-Mojave Creosotebush-White Bursage Desert Scrub
MBR	Sonora-Mojave Mixed Salt Desert Scrub
MBR	Sonora-Mojave Semi-Desert Chaparral
Landscape Species CEs	
Both	Bald Eagle
Both	Brewer's Sparrow - Breeding
Both	Brewer's Sparrow - Migratory
CBR	Clark's Nutcracker
Both	Coachwhip
CBR	Columbian Sharp-tailed Grouse
Both	Common Kingsnake
Both	Cooper's Hawk
Both	Desert Bighorn Sheep
MBR	Desert Tortoise - Mohave Population
MBR	Desert Tortoise - Sonoran Population
CBR	Ferruginous Hawk
MBR	Gila Monster
MBR	Glossy Snake
Both	Golden Eagle
CBR	Greater Sage-Grouse (just occupied habitat)

REA	Conservation Element Name
MBR	Mohave Ground Squirrel
MBR	Mohave Rattlesnake
Both	Mule Deer - summer range
Both	Mule Deer - winter range
Both	Mule Deer - yr round range
Both	Northern Harrier
Both	Northern Rubber Boa
Both	Northern Sagebrush Lizard
CBR	Pygmy Rabbit
Both	Sage Sparrow
CBR	Swainson's Hawk
Both	Western Patch-nosed Snake
CBR	White-tailed Jackrabbit

Threshold selection

In order to translate the raw Maxent probability distribution into estimates of species presence or absence a specific threshold needs to be selected, a necessary post-processing step when using an ensemble approach. The threshold used in this analysis is the "equal training sensitivity plus specificity" threshold. This threshold maximizes the agreement between observed and predicted distributions, a choice that has proven to produce the most accurate predictions (Jimenes-Valverde and Lobo 2007; Lobo et al. 2007; Liu et al. 2005).

Model evaluation

Model evaluation was performed using the area under the curve (AUC) of the receiver operating characteristic (ROC) plot analysis (Fielding and Bell 1997). Twenty percent of occurrence points for a given conservation element were withheld from the model to be used as independent test data in calculating the AUC. The AUC is a widely accepted, threshold-independent metric of species distribution model performance (Marmion et al., 2009; Warren et al., 2010) that provides an overall picture of how well the data fits the model and has previously been used in comprehensive SDM evaluations (Elith et al. 2006).

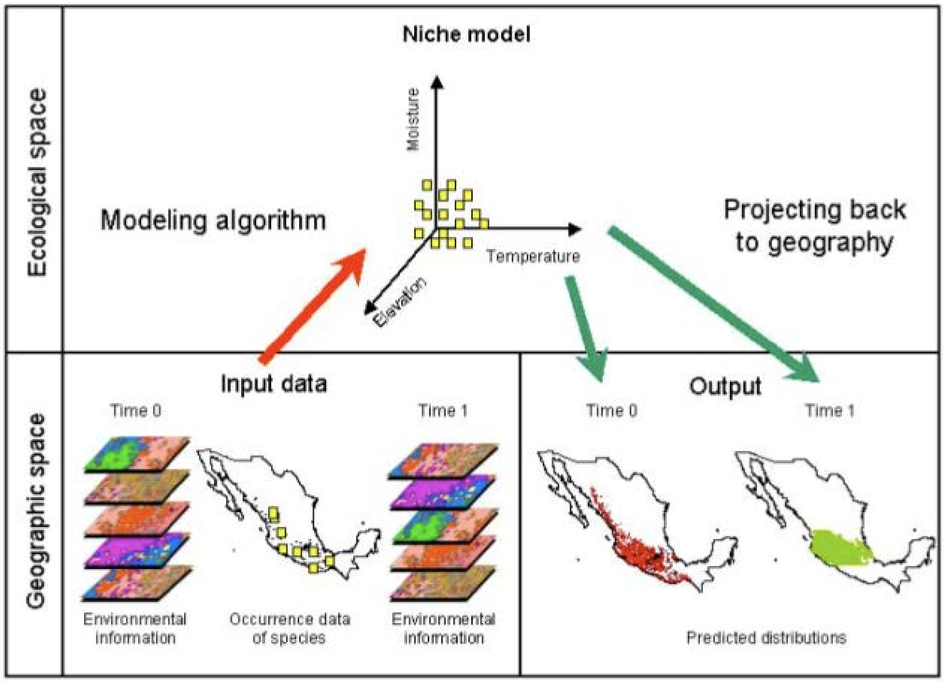


Figure B - 17**.** The process used in this study defines certain aspects of a species' niche in environmental space by relating observed species occurrence to environmental variables. The process does not identify a species' realized or fundamental niche, but rather only the part of the niche defined by the occurrence data provided. In this case, the process defines a potential suitable bioclimate, which can then be projected into the future under various climate change scenarios. (adapted from Martinez-Meyer, 2005)

Ensemble Approach

The ensemble approach focuses on the degree of agreement among multiple GCMs. Various GCMs predict different outcomes for future climatic conditions, even when provided the same input data, because each model accounts for the interactions of various elements of the oceanic-atmospheric system differently. Therefore, an ensemble approach, wherein multiple GCMs are run using the same input data and emissions scenarios and their results compared, averaged, or otherwise aggregated, is increasingly accepted as the preferred method for applying climate projections for a variety of purposes (Tebaldi et al. 2011).

Bioclimatic envelope modeling is conducted with a range of GCMs that have been downscaled to 4km^2 using a 50-year 20th century baseline derived from PRISM, following the statistical downscaling methods of Tabor & Williams (2010). Each timeslice (2020s and 2050s) was run independently with each of the 6 different GCMs. The six downscaled GCMs are part of a larger spatial future climate dataset called EcoClim (Hamilton *et al.* in prep), and were selected on the basis of climate variable availability. The six GCMs used here were the only models vetted for the IPCC's 4th Assessment Report that archived monthly maximum and minimum temperatures, and were all run under the A2 emissions scenario (as required by scope of REA). Below are the names of the 6 GCMs downscaled to 4km2 and used for bioclimatic envelope modeling and climate space trend analysis.

- BCCR_BCM2_0
- CSIRO_MK3_0
- CSIRO_MK3_5
- INMCM3_0
- MIROC3_2_MEDRES

- NCAR_CCSM3_0

The probability outputs were then converted to presence absence and then combined using an additive function. Therefore, each timeslice for a given species has 6 values, with 6 being the highest level of agreement (all 6 GCMs agree on a species predicted suitable bioclimate) and 1 being the lowest, (only1 GCM predicts suitable bioclimate). This approach supports an assessment of multimodel agreement in projections of bioclimatic shifts.

B-1.2.10.3 Model Post Processing: Change Summary Layer

In order summarize change in bioclimate for a species, a change surface was created which is the difference between current and 2050s. A2 2050 outputs were reclassified to a presence/absence layer (absence = 1, presence = 5). A desired GCM agreement of at least 2 GCMs was chosen. Current layers were already presence/absence but were reclassified to coded values (0 = 1 and 1= 4). The last step was subtracting the current from the future which created a surface with the coded values: -3 = lost bioclimate, 0 = absence, 1 = maintained bioclimate, 4 = gained bioclimate (Figure B - 18). 4x4 km grid cells with lost bioclimate are areas where there was suitable bioclimate but in 2050 climate models predict this climate envelope will no longer exist for that grid cell. Maintained bioclimate are areas that are predicted to be suitable under both current and future climate regimes. "Gained" bioclimate are grid cells that were predicted to be suitable for current conditions, but may be suitable in the future. Gained bioclimate is essentially showing a potential geographic shift in future suitable climate conditions for a species.

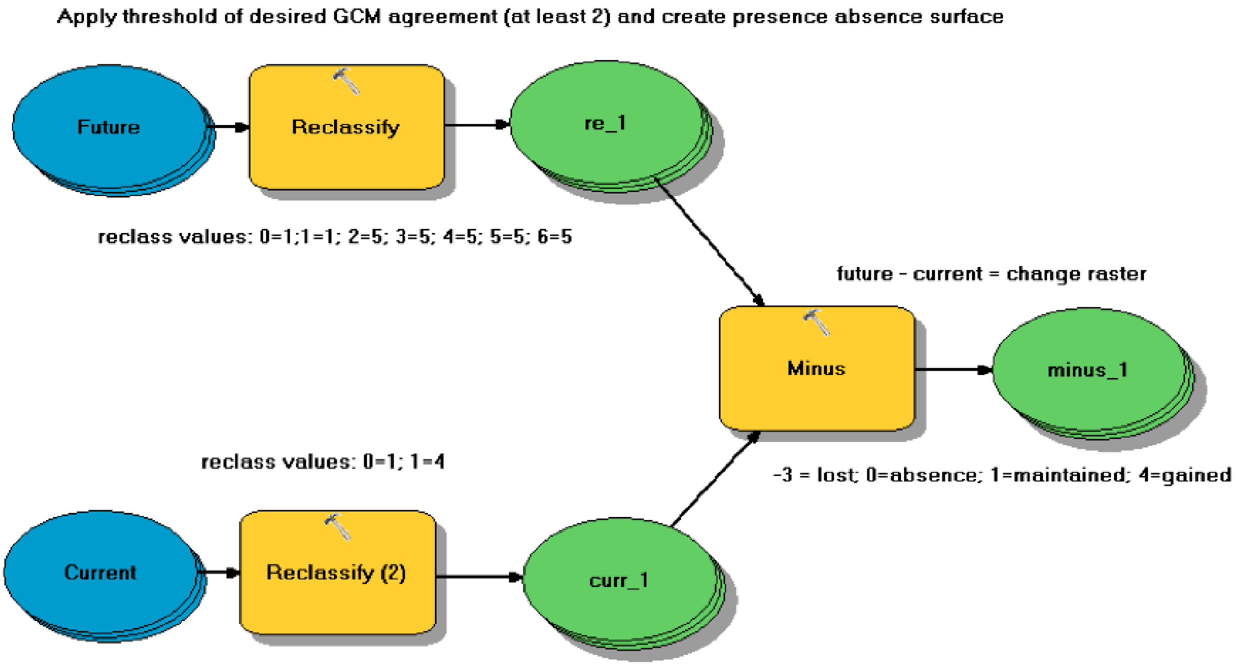


Figure B - 18. Change in Climate Suitability Future vs. Current

B-1.3 Ecological Status Modeling

B-1.3.1 Indicators of Ecological Status – Spatial Models

Relative effects of co-occurrences of CAs and CEs are primarily addressed by gauging ecological status of CEs within a given assessment scenario (i.e., current conditions vs. forecasted conditions at 2025). The approach taken was based upon existing methods aiming to gauge relative ecological integrity. Ecological integrity is variously defined to express the ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion. Therefore, methods for assessment first aim to characterize reference conditions for each CE, including natural composition, structure, and dynamic processes. Additionally, they characterize common stressors and their observed ecological effects. With these observations and assumptions described, indicators of integrity are identified and measured to compare current or forecasted conditions to reference conditions; resulting in a series of ecological status scores for each CE. The primary reporting unit for ecological status of CEs is the 5th level watershed; however, for landscape species and the species assemblages, a 4 km^2 grid was used.

Conceptual models for each CE were used to characterize natural attributes, primary change agents, and current knowledge of their effects on each CE. Current knowledge of CA effects on CEs was documented to reliably differentiate where CAs are likely to cause ecological stress to a given CE. Where CAs can be viewed as ‘stressors’ to CEs, the potential responses to each stressor are identified. Measurable indicators are then identified to gauge that effect.

Using NatureServe’s ecological integrity framework (Faber-Langendoen et al. 2006, Unnasch et al. 2008, Rocchio and Crawford 2011), indicators are chosen to provide a measurement for a limited set of **key ecological attributes**, or ecological drivers, for each CE. Key ecological attributes (KEAs) may include natural characteristics, such as native species composition, or *stressors* such as effects of relevant change agents that are well known to affect the natural function and integrity of the CE. The KEAs are organized by the “rank factors” of **Landscape Context**, **Condition,** and **Relative Extent**. Given the rapid and regional nature of an REA, stressor-based indicators were relied upon for this assessment. Indicators were selected that practically enabled reporting at 5th level watershed and 4 km^2 grid cells as reporting units.

Figure B - 19 and Figure B - 20 illustrate conceptual linkages between CAs and Stressors (A), Stressors and expected Responses (B) and the Indicators used to gauge Stressors and their Responses (C), for a given CE.

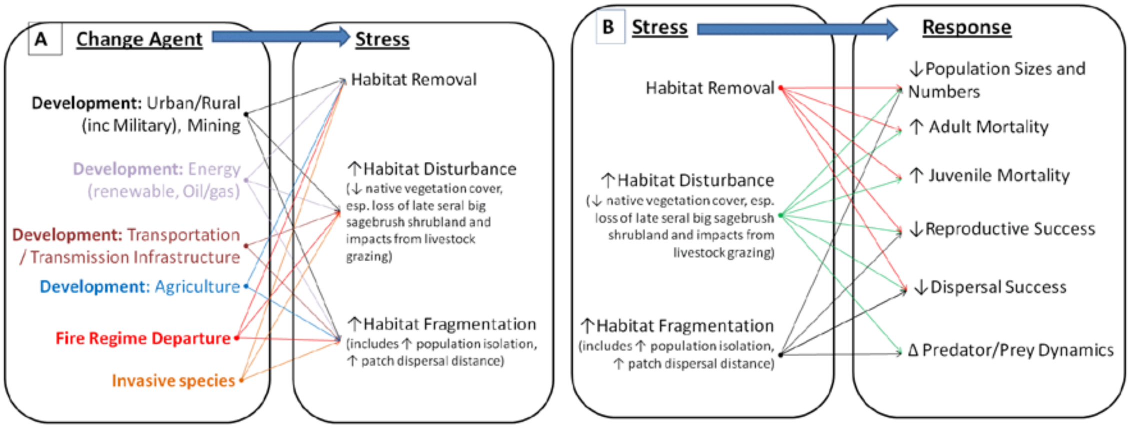


Figure B - 19. Example of conceptual model linking change agents, ecological stressors and their anticipated effects for a landscape species CE

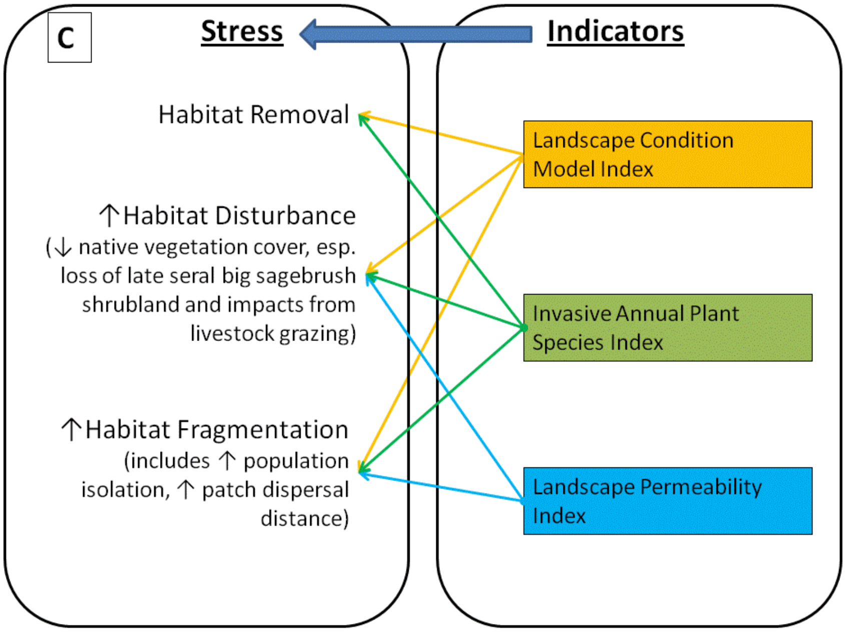


Figure B - 20. Example of conceptual model linking ecological stressors and their anticipated responses to their measurable indicators for a landscape species CE

Spatial models that reflect these indicators serve as the link between the conceptual models and the spatial representation of ecological status. These indicators were applied in varying combinations with each CE. Table B - 23 and Table B - 24 include a listing of indicators used for each CE, and detailed explanations of each indicator where spatial models were developed. In this section we provide more detail for each indicator used for the terrestrial CEs and how they were spatially scored; similarly detailed methods are provided for indicators and metrics for the aquatic coarse filter CEs in B-2.1.4.

Table B - 23. Ecological status indicators for CBR terrestrial coarse filter and vulnerable species assemblage CEs. “Y” denotes when the indicator was assessed for the CE.

	Key Ecological Attribute -->	**I. Extent/Size**	**II. Landscape Condition**		**III. Landscape Connectivity**	**IV. Stressors on Biotic Condition**
Ecoregional Conceptual Model Group	**Metric-->** **Conservation Element Name**	**1. Change in extent**	**2. Landscape Condition Index**	**3. Fire Regime Departure Index**	**4. Landscape Connectivity Index**	**5. Invasive Annual Grass Index**
Terrestrial Coarse Filter CEs						
Alpine Uplands	Rocky Mountain Alpine Turf	N	Y	Y	N	Y
Subalpine/Montane Forests & Woodlands	Great Basin Pinyon-Juniper Woodland	Y	Y	Y	N	Y
Subalpine/Montane Forests & Woodlands	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Y	Y	Y	N	Y
Subalpine/Montane Forests & Woodlands	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	Y	Y	Y	N	Y
Subalpine/Montane Forests & Woodlands	Rocky Mountain Aspen Forest and Woodland	Y	Y	Y	N	Y
Montane Canyons	Inter-Mountain Basins Cliff and Canyon	N	Y	N	N	Y
Montane Shrublands	Great Basin Semi-Desert Chaparral	Y	Y	Y	N	Y
Montane Shrublands	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	Y	Y	Y	N	Y
Montane Shrublands	Inter-Mountain Basins Montane Sagebrush Steppe	Y	Y	Y	N	Y
Semi-desert Shrub & Steppe	Colorado Plateau Mixed Low Sagebrush Shrubland	N	Y	Y	N	Y
Semi-desert Shrub & Steppe	Great Basin Xeric Mixed Sagebrush Shrubland	Y	Y	Y	N	Y
Semi-desert Shrub & Steppe	Inter-Mountain Basins Big Sagebrush Shrubland	Y	Y	Y	N	Y
Semi-desert Shrub & Steppe	Inter-Mountain Basins Big Sagebrush Steppe	Y	Y	Y	N	Y
Semi-desert Shrub & Steppe	Inter-Mountain Basins Semi-Desert Grassland	Y	Y	Y	N	Y
Semi-desert Shrub & Steppe	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Y	Y	Y	N	Y
Desert Scrub	Inter-Mountain Basins Mixed Salt Desert Scrub	Y	Y	Y	N	Y
Desert Scrub	Mojave Mid-Elevation Mixed Desert Scrub	Y	Y	Y	N	Y
Dunes	Inter-Mountain Basins Active and Stabilized Dune	N	Y	N	N	Y

	Key Ecological Attribute -->	I. Extent/Size	II. Landscape Condition		III. Landscape Connectivity	IV. Stressors on Biotic Condition
Ecoregional Conceptual Model Group	**Metric--> Conservation Element Name**	**1. Change in extent**	**2. Landscape Condition Index**	**3. Fire Regime Departure Index**	**4. Landscape Connectivity Index**	**5. Invasive Annual Grass Index**
Vulnerable Species Assemblage CEs						
Alpine uplands	Carbonate (Limestone/Dolomite) alpine	N	Y	N	N	N
Alpine uplands	Non-carbonate alpine	N	Y	N	N	N
Subalpine/Montane Forests & Woodlands	Montane conifer	N	Y	N	N	Y
Semi-desert Shrub & Steppe	Clay soil patches	N	Y	N	N	Y
Semi-desert Shrub & Steppe	Sand dunes/sandy soils (when deep and loose)	N	Y	N	N	Y
Cliff & Outcrop	Azonal carbonate rock crevices	N	Y	N	N	N
Cliff & Outcrop	Azonal non-carbonate rock crevices	N	Y	N	N	N
Desert Scrub	Gypsum soils	N	Y	N	N	Y
Basin River & Riparian	Migratory waterfowl & shorebirds	N	Y	N	N	N

Table B - 24. Ecological status indicators for CBR Landscape Species CEs. “Y” denotes when the indicator was assessed for the CE. Two indicators measured for coarse filter, change in extent and fire regime departure, were not assessed for any species CEs.

			Key Ecological Attribute -->	II. Landscape Condition	III. Landscape Connectivity	IV. Stressors on Biotic Condition
Taxonomic Group	**Ecoregional Conceptual Model Group**	**Scientific Name**	**Metric--> Species CE**	**2. Landscape Condition Index**	**4. Landscape Connectivity Index**	**5. Invasive Annual Grass Index**
birds	Basin River & Riparian	Haliaeetus leucocephalus	Bald Eagle	Y	N	N
birds	Montane Canyons	Aquila chrysaetos	Golden Eagle	Y	N	N

			Key Ecological Attribute -->	**II. Landscape Condition**	**III. Landscape Connectivity**	**IV. Stressors on Biotic Condition**
Taxonomic Group	**Ecoregional Conceptual Model Group**	**Scientific Name**	**Metric-->** **Species CE**	**2. Landscape Condition Index**	**4. Landscape Connectivity Index**	**5. Invasive Annual Grass Index**
birds	Montane Lakes & Wetlands	Circus cyaneus	Northern Harrier	Y	N	N
birds	Montane Shrublands	Lanius ludovicianus	Loggerhead Shrike	Y	N	N
birds	Semi-desert Shrub & Steppe	Spizella breweri	Brewer's Sparrow	Y	N	Y
birds	Semi-desert Shrub & Steppe	Tympanuchus phasianellus columbianus	Columbian Sharp-tailed Grouse	Y	N	N
birds	Semi-desert Shrub & Steppe	Buteo regalis	Ferruginous Hawk	Y	N	N
birds	Semi-desert Shrub & Steppe	Centrocercus urophasianus	Greater Sage-Grouse	Y	Y	Y
birds	Semi-desert Shrub & Steppe	Falco mexicanus	Prairie Falcon	Y	N	N
birds	Semi-desert Shrub & Steppe	Amphispiza belli	Sage Sparrow	Y	N	Y
birds	Semi-desert Shrub & Steppe	Oreoscoptes montanus	Sage Thrasher	Y	N	Y
birds	Semi-desert Shrub & Steppe	Passerculus sandwichensis	Savannah Sparrow	Y	N	N
birds	Subalpine/Montane Forests & Woodlands	Nucifraga columbiana	Clark's Nutcracker	Y	N	N
birds	Subalpine/Montane Forests & Woodlands	Accipiter cooperii	Cooper's Hawk	Y	N	N
birds	Subalpine/Montane Forests & Woodlands	Buteo swainsoni	Swainson's Hawk	Y	N	N
mammals	Cliff & Outcrop	Tadarida brasiliensis	Brazilian Free-tailed Bat	Y	N	N
Mammals	Montane Canyons	Ovis canadensis nelsoni	Desert Bighorn Sheep	Y	N	N
mammals	Montane Shrublands	Odocoileus hemionus	mule deer	Y	N	N

			Key Ecological Attribute -->	**II. Landscape Condition**	**III. Landscape Connectivity**	**IV. Stressors on Biotic Condition**
Taxonomic Group	**Ecoregional Conceptual Model Group**	**Scientific Name**	**Metric-->** **Species CE**	**2. Landscape Condition Index**	**4. Landscape Connectivity Index**	**5. Invasive Annual Grass Index**
mammals	Montane Shrublands	Lepus townsendii	White-tailed Jackrabbit	Y	N	N
mammals	Semi-desert Shrub & Steppe	Vulpes macrotis	Kit Fox	Y	N	N
mammals	Semi-desert Shrub & Steppe	Brachylagus idahoensis	Pygmy Rabbit	Y	N	Y
mammals	Subalpine/Montane Forests & Woodlands	Eptesicus fuscus	Big Brown Bat	Y	N	N
reptiles	Basin River & Riparian	Lampropeltis getula	Common Kingsnake	Y	N	N
reptiles	Cliff & Outcrop	Crotaphytus bicinctores	Great Basin Collared Lizard	Y	N	N
reptiles	Desert Scrub	Masticophis flagellum	Coachwhip	Y	N	N
reptiles	Desert Scrub	Salvadora hexalepis	Western Patch-nosed Snake	Y	N	N
reptiles	Semi-desert Shrub & Steppe	Sceloporus graciosus graciosus	Northern Sagebrush Lizard	Y	N	N
reptiles	Subalpine/Montane Forests & Woodlands	Charina bottae	Northern Rubber Boa	Y	N	N

B-1.3.1.1 Key Ecological Attribute: Landscape Context

Landscape Condition Indicator

Ecological condition commonly refers to the state of the physical, chemical, and biological characteristics of natural ecosystems, and their interacting processes. Many human land uses affect ecological condition, (e.g., through vegetation removal or alteration, stream diversion or altered natural hydrology, introduction of non-native and invasive species, etc.). Landscape condition assessments commonly apply principles of landscape ecology with mapped information to characterize ecological condition for a given area (e.g., USEPA 2001, Sanderson et al. 2002). Since human land uses - such as built infrastructure for transportation or urban/industry, and land cover such as for agriculture or other vegetation alteration – are increasingly available in mapped form, they can be used to spatially model inferences about ecological condition.

Maps of this nature can be particularly helpful for identifying relatively unaltered landscape blocks, or for making inferences about the relative ecological integrity of natural habitats on the ground. They can also be used for screening ecological reference sites; i.e., a set of sites where anthropogenic stressors range from low to high. Ecological condition within reference sites is often further characterized in the field to determine how ecological processes respond to specific stressors, but spatial models can provide a very powerful starting point to build upon (Faber-Langendoen et al. 2006, 2012). Knowledge from reference sites may then apply to surroundings for many types of environmental decisions.

Nearly all studies documenting ecological effects of land use features on ecosystems are quite context-specific (e.g., Knight, et al. 1993, Gelbard and Belnap 2003); limiting their applicability to more generalized modeling. However, some researchers have developed more generalized models with less context-specific inputs and applications in mind. That is, they use generalizations about the relative ecological effects of human land uses to transparently construct the spatial model, and then use field-based observations to calibrate and validate the model relative to their intended use. For example, Brown and Vivas (2005) scored 25 common land use classes along a continuum of estimated “energy intensity values” (i.e., energy input for their development and maintenance); from lowest-intensity “pine plantations” to highest-intensity “central business district (average 4 stories).” This initial scoring enabled development of a “Landscape Development Index” varying from 1.00 to 10.00. These indices were applied to land use map classes to generate an inference of land use intensity in Florida. The result was validated using selected field-based observations.

The **Landscape Condition Model** builds on this and the growing body of published methods and software tools for ecological effects assessment and spatial modeling; all aiming to characterize relative ecological condition of landscapes (e.g., Knick and Rottenberry 1995, Forman and Alexander 1998, Trombulak and Frissel 1999, Theobald 2001, Seiler 2001, Sanderson et al. 2002, Riitters and Wickham 2003, Brown and Vivas 2005, Hansen et al. 2005, Leu et al. 2008, Comer and Hak 2009, Theobald 2010, Rocchio and Crawford, 2011). The intent of this model is to use regionally available spatial data to transparently express user knowledge regarding the relative effects of land uses on natural ecosystems and habitats. The authors’ expert knowledge forms the basis of stressor selection, and relative weightings, but numerous examples from published literature have been drawn upon to parameterize the model for application across the western United States, and this ecoregion. Independent data sets from across the western United States were drawn upon for subsequent model evaluation.

Technical Description: Table B - 25 summarizes the data sets and parameters for this model. Mapped information available for across the western conterminous United States was compiled into 20 categories, organized by a) *Transportation,* b) *Urban and Industrial Development,* and c) *Managed and*

Modified Land Cover. No attempt was made to depict ecological stressors that act at spatially broad scales, such as air pollutants or climate change. In most cases, original data exist as a 30m grid. Line and polygon features were summarized to 90m grids. Transportation features, derived from ESRI StreetMap data *circa* 2010, depict roads of five distinct sizes. These data provide a practical measure of human population centers and primary transportation networks that link those centers. While these road size classes do not coincide directly with traffic volume along a given stretch of road, their engineering and construction aimed to support distinct levels of traffic volume. Therefore, inferences of expected traffic volume can be derived from these mapped classes, especially when applied on this sub-continental scale.

As a compliment to Transportation features, Urban and Industrial Development includes industrial (e.g., mines, energy development) and built infrastructure across a range of densities, from high density urban and industrial zones, to suburban residential development and urban open spaces (golf courses, for outdoor recreation. These data were derived from national land cover data through combined efforts of the inter-agency LANDFIRE, USGS ReGAP (*circa 2001*), and National Land Cover Data (*the latter updated to 2006*). Other data sets in this category included oil/gas well, surface mining activity, and transmission line right-of-ways.

The third category, Managed and Modified Land Cover, includes the gradient of land cover types that reflect vegetation-based land use stressors at varying intensities. Again, national data from USGS ReGAP and LANDFIRE provide a consistent depiction of these varying land cover classes, from intensive (cultivated and/or irrigated) agriculture, vineyards and industrial tree plantations, areas dominated by introduced non-native vegetation in upland and wetland environments, and finally, areas where native vegetation predominates, but modifications have clearly taken place. These modifications include recently logged areas, or areas that have seen historic conversion, but have recovered some combination of mainly native vegetation (e.g., 'ruderal' old fields, etc.). For these latter classes, model users should presume varying degrees of accuracy and completeness in their original mapping, and map classes of 'introduced' vegetation should likely only include areas where substantial and obvious infestation has occurred. One can safely presume that the presence of introduced plant species, especially when at low densities, is not reliably represented by this regional model.

Model Parameters: Each input data layer is summarized to a 90m grid and, *where the land use occurs*, given a **site impact score** from 0.05 to 0.9 (Table B - 25) reflecting presumed ecological stress or impact. Values close to 1.0 imply relatively little ecological impact from the land use. For example, a given patch of 'ruderal' vegetation – historically cleared for farming, but recovering towards natural vegetation over recent decades, is given a Very Low (0.9) score for site impact as compared with irrigated agriculture (High Impact 0.3) or high-density urban/industrial development (Very High Impact 0.05). Certainly, there are some ecological values supported in these intensively used lands, but their relative condition is quite limited when compared with areas dominated by natural vegetation.

In this first step, 20 distinct data layers are produced, each with the impact score applied to pixels where a given land use occurs, and a value of 1 for all other pixels. Euclidian distance for each input layer is then populated for each 90m grid cell with a distance (in 90m increments) extending way from each pixel with and impact score <1 (Table B - 25).

A second model parameter – again, for each data layer - represents a **distance decay** function, expressing a decreasing ecological impact with distance away from the mapped location of each feature as applied to the Euclidian Distance value described above. Mathematically, this applies a formula that characteristically describes a "bell curve" shape that falls towards plus/minus infinity. This base formula is:

$$f(d) = \left(1-\frac{d^2}{h^2}\right)^2, d < r$$

where *d* = Euclidian distance (in meters, as measured in 90m increments), and *h* equals the distance decay score (from 0.05 – 1.0). In this formula, *r* = the maximum distance across the model analysis area, so the value for *d* must be less than *r*. Applying this formula, grid cells will have scores approaching r – 1.

Those features given a high decay score (*h* values approaching 1.0) result in a surface where the impact value dissipates within a relatively short distance. Those features given a low decay score (*h* values approaching 0.0) create a surface where the per-pixel impact value dissipates more gradually with distance away from the impacting feature. Note that given this formula, per-pixel values will actually never reach *r*, but will only approach *r*. Each layer is then normalized by dividing 1 by the per pixel value, this results in a grid with values >0 to 1.0.

Combining Input Layers: Figure B - 21 summarizes all processing steps, beginning with the selection of individual input layers for land use features. Querying a Table of Weights, per-pixel values for **site impact** apply to all pixels overlapping the land use layer. Where more than one land-use feature occurs in a given 90m grid cell, the **minimum site impact score** of all applicable features is applied to each grid cell (**site impact minimum** between 0.05 and 0.9).

Then, the distance decay formula utilizes per pixel Euclidian Distance and the Distance Decay formula to create a per-pixel value for each land use feature layer. As noted above, the result is a grid of >0 to 1.0 values. All 90m grids are then combined additively resulting in a grid of values between >0 to *m* (*m* up to 18 for this model). Because the resulting grid has the potential to include grid cell values greater than 1.0 the overall model is normalized against the maximum value *m.* The final grid represents a layer of > 0 to 1.0.

Finally, the site impact and distance decay minimum values for each 90m grid cells are compared and the lowest number is carried forward to the final landscape condition surface. The combined result is a wall-to-wall grid surface of Landscape Condition values falling between >0 and 1.0.

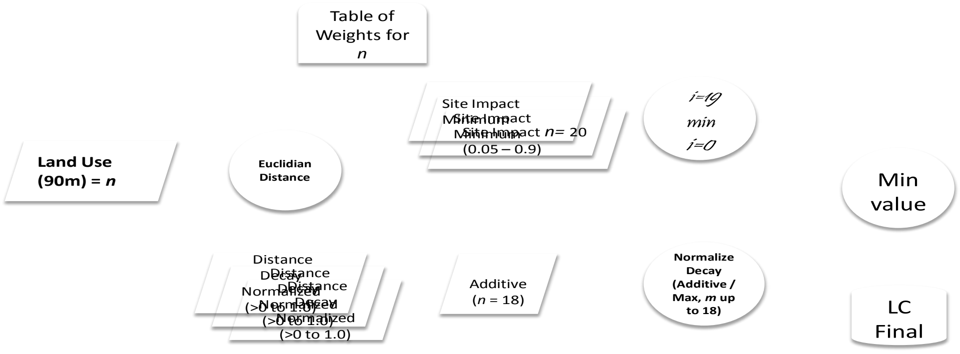


Figure B - 21. Landscape Condition model process

Table B - 25. Landscape Condition model weighting values

Land Use	**Site Impact**	**Distance Decay**
Transportation		
dirt roads & 4wd	0.7	Moderate
Local, neighborhood and connecting roads	0.5	Moderate
Secondary and connecting roads	0.2	Gradual
Primary Highways with limited access	0.05	very gradual
Primary Highways without limited access	0.05	very gradual
Landuse		
Pasture & Hay	0.9	Abrupt
Wind*	0.8	Gradual
Pipelines	0.7	Moderate
Utility	0.7	Gradual
Low Intensity Development*	0.6	Moderate
Geothermal	0.5	Moderate
Medium Intensity Development*	0.5	Moderate
Solar*	0.5	Moderate
mines/landfills	0.05	Abrupt
Developed High Intensity*	0.05	very gradual
Land Cover		
Open Space*	0.9	Abrupt
Recently Logged	0.9	Moderate
Introduced Wetland	0.3	Abrupt
Agriculture	0.3	Moderate
Introduced Uplands mapped	0.3	Moderate

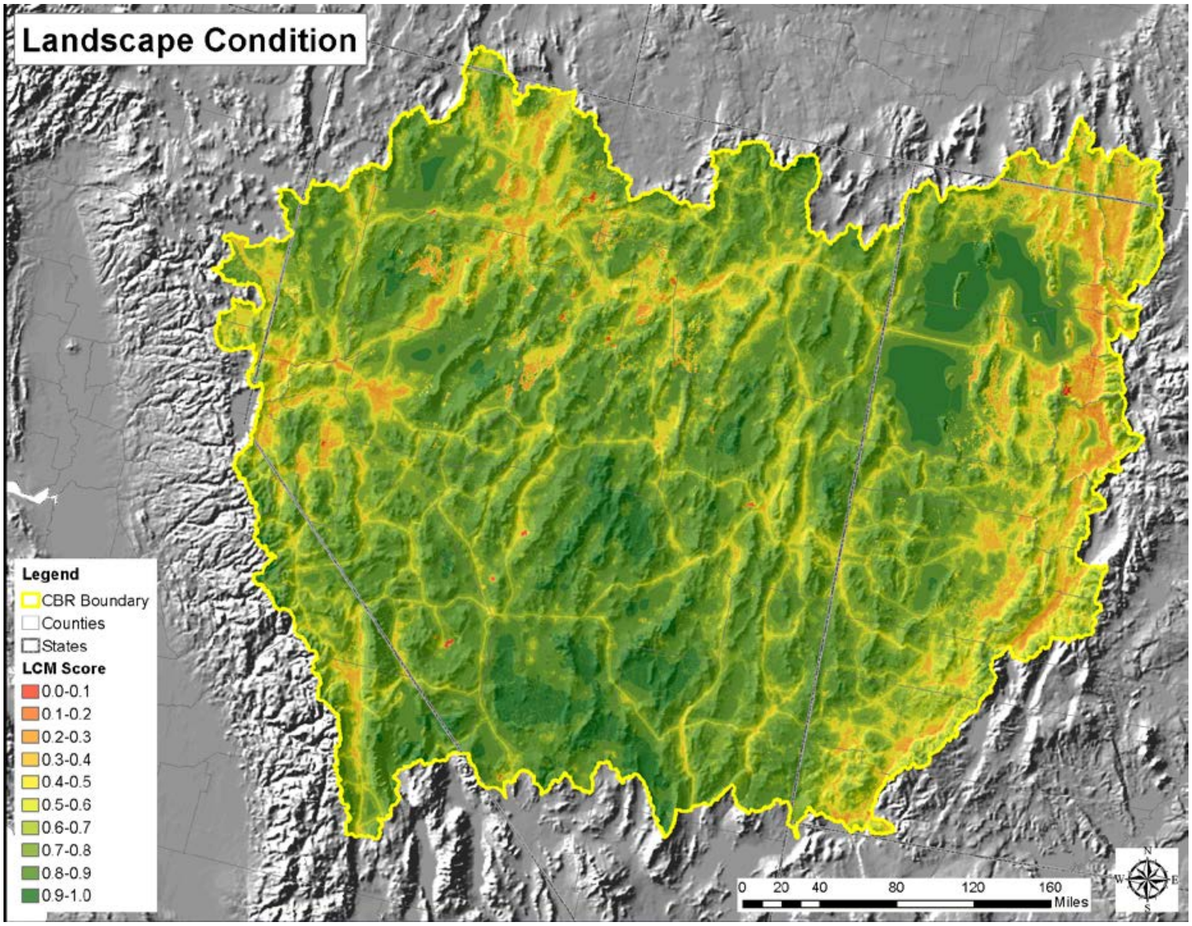


Figure B - 22. Current Landscape condition

Model Evaluation: *The Landscape Condition Model developed in this REA follows directly from a western United States model being developed for the Western Governors Association-sponsored Crucial Wildlife Habitats and Corridors mapping effort. Through that effort, west wide information was gathered for use in evaluating the west-wide landscape condition model. This information is applicable to understanding the relative performance of the model applied to this ecoregion. The following discussion applies to this west-wide model.*

In order to evaluate this model, field based measurements of ecological condition were gathered from several sources. By intersecting these geo-referenced observation data with the landscape condition model, the relative predictive power of the model was better understood. Field observations documenting the relative quality of biodiversity (e.g., at-risk species), field samples of vegetation plots (including abundance of invasive plant species), and local expert review of samples of aerial imagery, have been utilized to evaluate, calibrate, and validate this model. Each is briefly discussed below.

Natural Heritage Element Occurrences: Natural Heritage programs conduct biodiversity inventories within each state, documenting the location and relative ecological condition for at-risk species and rare and representative community types. While by no means complete, occurrence data provide one independent source of field-based observations of relative ecological condition suitable for use on landscape model evaluation. Natural Heritage methods involve development of criteria for evaluation of occurrence size, condition, and landscape context. The Element Occurrence Rank rates each occurrence along a scale from A-D. Occurrences with “A” and “B” ratings are considered of very high or high ecological condition, respectively. The “C” rated occurrences are considered of fair condition, and “D” rated occurrences are considered to be in poor ecological condition. “X” occurrences were documented historically, but with subsequent survey effort, were verified as extirpated from the location (typically through habitat loss). Care should be taken in evaluations of this nature utilizing these data, as criteria for ratings may vary, some at-risk species may have been rated relatively high due to large sub-population size while landscape context has been compromised (i.e., population size as a potential lagging indicator of condition), or their rating reflects viability requirements not addressed in the landscape condition model.

A total of 73,575 occurrences of at-risk species, each having been rated for condition (as well as extirpated), was intersected with the landscape condition model. ‘Box-and-whisker’ plots were developed to visualize the relative correspondence between these two data sets (Figure B - 23). The ‘box’ portions captures 50% of samples, the middle line of each box described the median of sample values, while the “whisker” or dotted lines capture the 95% of all samples. The ‘notch’ in each box provides an indication of significant difference among median values. So when boxes are paired together, if the ‘notch’ areas do not overlap, there is likely a statistically significant difference between pairs of samples.

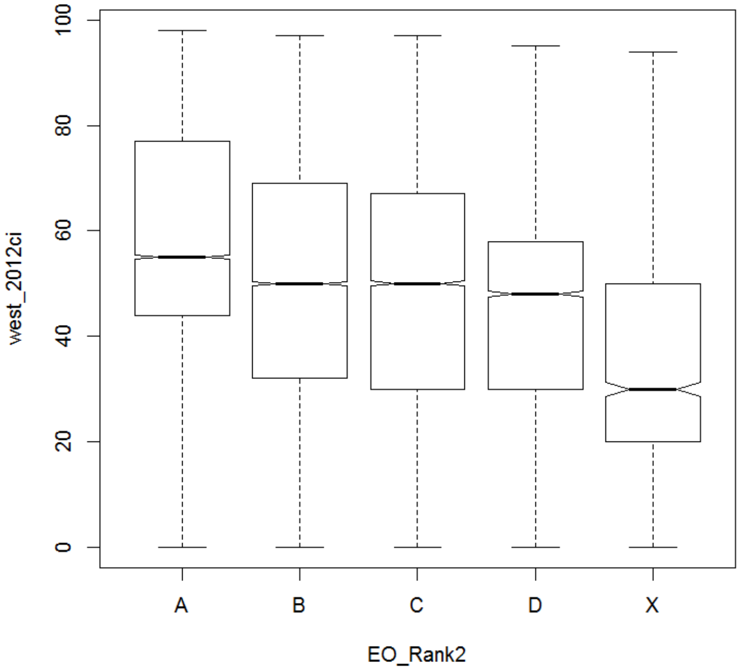


Figure B - 23. Summary correspondence between Natural Heritage Element Occurrences rated for condition as compared with predicted values from the NatureServe Landscape Condition model.

Note here that landscape condition is represented on the Y axis with scores between 1 and 100. Integer transformation was used prior to overlays with evaluation data sets. Again, the original landscape condition values were 0.0-1.0. While considerable variability is reflected in these results, significant differences are likely between A-rated occurrences vs. B and C occurrences. Likewise, significant differences (albeit less so) are apparent between BC and D rated occurrence. And finally, X occurrences are clearly distinguished from others along the continuum described by the landscape condition model.

LANDFIRE vegetation plot samples: Vegetation plots samples were compiled nationwide to provide reference locations for vegetation mapping by the inter-agency LANDFIRE effort. Gathered sample data were evaluated by LANDFIRE to ensure that they a) were located with adequate precision for mapping with a 30m grid resolution, b) reflected conditions from the past decade, and c) had sufficient floristic information to support their labeling to the LANDFIRE map legend. Therefore, sample plots tended to have information on plant species composition and relative abundance. For our purposes, the presence and relative abundance of invasive plants species, especially invasive annual grasses, were adequate for use in model evaluation. We would expect to see increasing abundance of invasive annual grasses throughout the middle ranges of scores (on Y axis: 40-70) from the landscape condition model (Figure B - 24). Sample plots with relative abundance values of invasive annual grasses were categorized into five classes, from Category 1 (<5% cover), Category 2 (5-10%), Category 3 (11-25%), category 4 (26-45%), and Category 5 (>45% cover). A total of 21,195 sample plots from across the West were intersected with the integer-transformed landscape condition model, and box plots were developed to visualize the relative correspondence between these two data sets. Again, a clear trend in correspondence may be observed from these results. Statistically significant differences in median values are likely between Category 1 vs. Category 2&3 vs. Category 4 vs. Category 5 along the continuum of values from the landscape condition model.

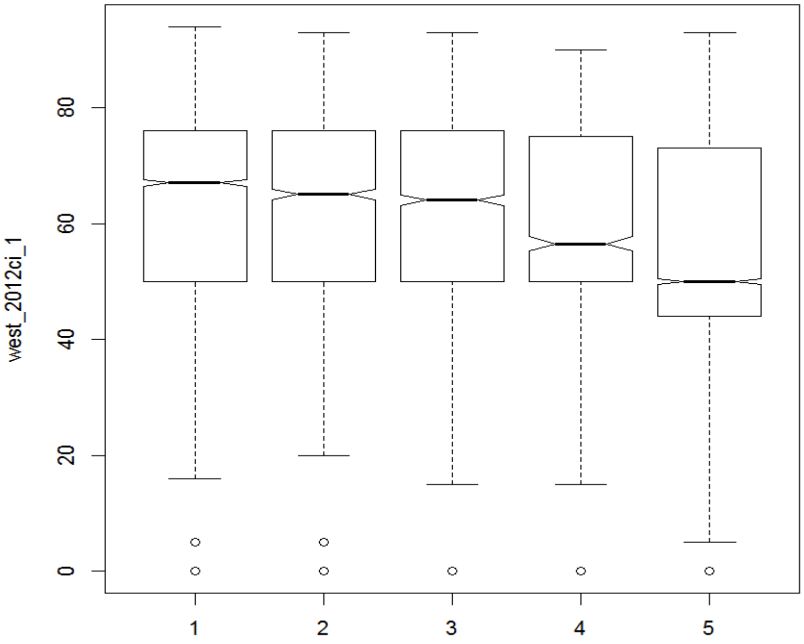


Figure B - 24. Summary correspondence between LANDFIRE vegetation samples categorized for invasive annual grass abundance as compared with predicted values from the NatureServe Landscape Condition model.

State review of high-resolution imagery: Experts from across all western states were asked to review sample areas with high-resolution aerial imagery to document their perspective on the relative ecological condition or intactness. A total of 1,560 stratified random points were established and buffered with 18 acre circles. An online survey included 21 questions about the ecological condition of each location. These included aspects of on-the-ground knowledge of the site (by the surveyor), predominant land use and land cover, and generalized summary of ecological condition (high, moderate, low, very low). Surveyors were also allowed to create their own survey locations and report on those. All states except UT and TX included respondents. Some 1,129 pre-selected samples were reviewed. Another 264 user-defined samples were created, concentrated in WA, OR, ID, WY, AZ, NE and KS. Results of the survey were overlain on the landscape condition to explore their relative correspondence.

Table B - 26 summarized overall results of this comparison. When generalized to two primary categories above and below 0.5 landscape condition scores, there is general agreement between predicted values of the model and expert interpretations. An agreement of 89.7% was documented for the high-moderate condition predictions with a somewhat lower 53.6% correspondence for the low-very low condition category. From these data, and overall model accuracy of 78.8% was calculated.

Table B - 26. Summary comparison of expert-reviewed aerial imagery and landscape condition model.

NatureServe Landscape Condition	High-Moderate 1.0 – 0.51	Low-Very Low 0.50 – 0.0	Total Samples	% of Samples
High – to - Moderate	874	196	1,070	81.7%
Low – to – Very Low	100	226	326	69.3%
Total Samples	974	422	1,396	
% of Samples	89.7%	53.6%		

Applying Landscape Condition to CE Distributions

The ecological assessment of all CEs was evaluated using the landscape condition model score for both current and the 2025 time frames. Landscape condition modeling is used as an indicator of ecological status of the element's distribution at a particular location (pixel or occurrence).

In addition to current landscape condition, the 2025 time period was addressed by an additional model. All layers types and disturbance weights were identical to the current condition layers, but updated with either future planning attributes or land use projections. Sites where renewable energy is in the process of planning were included. Future land use development was described using the 2030 SERGOM land use predictions. No information was available to estimate where future infrastructure such as roads may take place. The resultant map layer (Figure B - 25) shows little change between current and 2025 conditions; as described in Chapter 5, 2025 development is projected to only increase from less than 7.1% currently, to 7.6% by 2025. While this represents over 500,000 acres, it is not apparent in the below map.

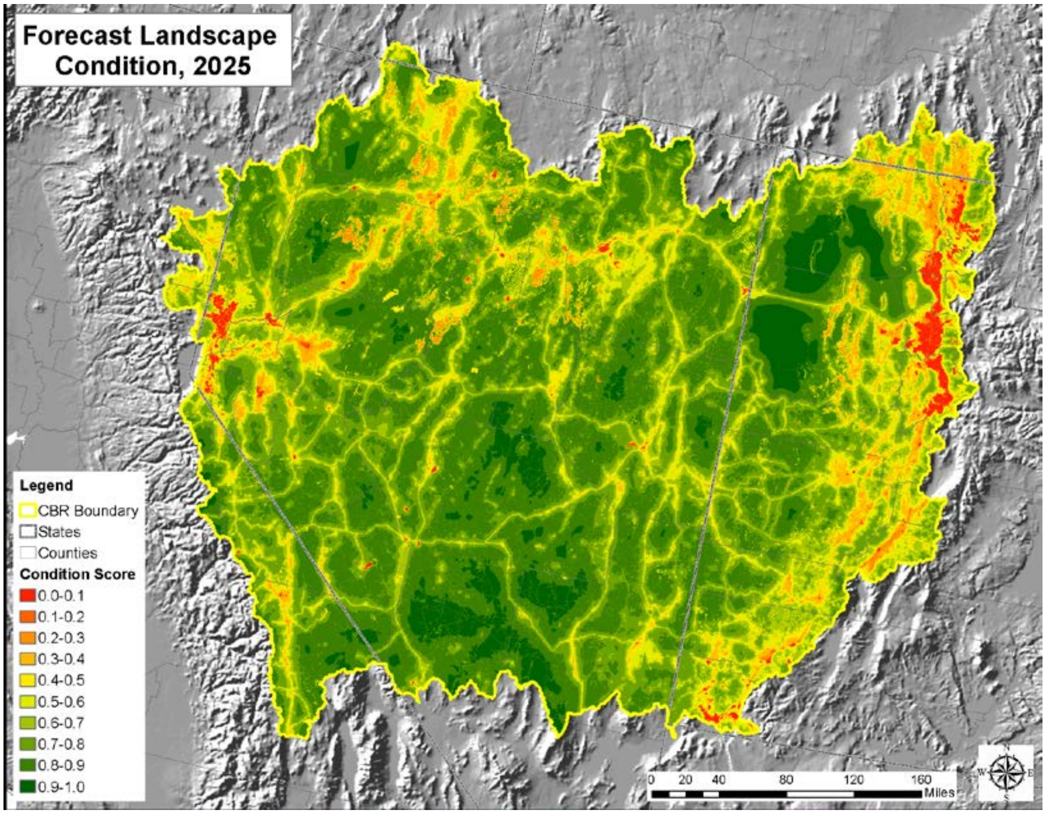


Figure B - 25. Forecasted landscape condition as of 2025; red indicates highly developed areas, while dark green indicates unimpacted areas.

Both the current (2010) and future (2025) landscape condition models are utilized in scoring CEs at multiple scales, the 4x4km grid cells (Figure B - 26a) and the 5th level watersheds (Figure B - 26b). For analysis each landscape condition model is converted to a 0-100 integer based raster. Following the conversion, each 4x4Km grid cell is summarized as an area weighted value based upon the following formula: *condition_wt = sum(cell count * landscape condition) / sum(cell count)*.

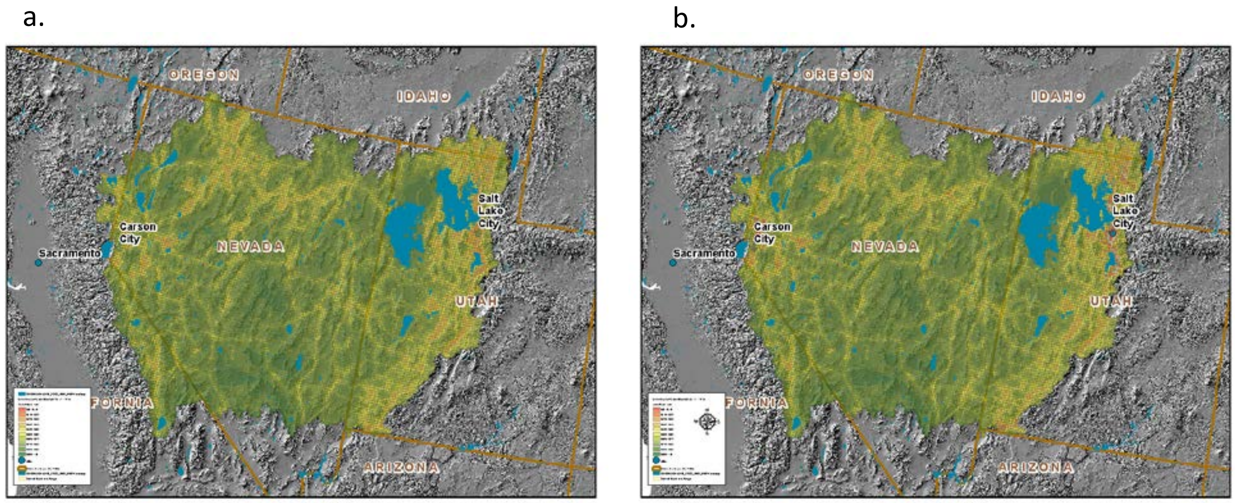


Figure B - 26. Rollup of landscape condition to the 4x4km grid cell for current landscape condition (left) and 2025 (right).

Landscape Connectivity Indicator

CircuitScape was used to address the function of connectivity in the ecological assessment. The advantage of using circuit theory for predicting landscape connectivity is the ability to define the connections via multiple channels of passage that better simulate the naturally occurring connections in landscape. Circuitscape is a modeling tool based on circuit theory that can be used to model habitat or landscape connectivity (www.circuitscape.org/, Shah and McRae 2008). Two inputs are required: 1) a layer representing the habitat areas to be assessed for connectivity, and 2) a layer indicating habitat quality, barriers to movement, or other features affecting a species' ability to disperse across the landscape. The model is designed to treat the habitat areas being assessed as electrical nodes and the second input as an electrical conductance layer. It applies "current" to the nodes, and the current flows according to the relative conductance (see Shah and McRae 2008). Circuitscape uses the pair of inputs to identify the network of pathways or areas having the highest connectivity (least resistance to species movement) between specified habitat patches or point locations. Version 3.5.7 was used for this assessment.

One CE in the CBR was selected to address the influence of landscape connectivity in the ecological status assessment (Figure B - 27). The greater sage-grouse was evaluated using the application of circuit theory using CircuitScape. The 100 percent lek distribution for each 270m^2 grid cell that defines its distribution was used as the input to be assessed for connectivity (input 1). The model parameters for CircuitScape were set to regional sources and the all-to-one option for connection was applied. The maximum connection result was selected as the representative surface.

The landscape condition model (also a 90m^2 grid rescaled to 270m) was applied as the underlying cost surface representing conductance of the landscape (Input 2). The base landscape condition model was converted to a 0-1000 integer layer for input to CircuitScape. No additional modifications were applied to the landscape condition model. It is used as a 'resistance surface' for *CircuitScape* to characterize relative landscape permeability among point locations established across the CEs current distribution. Relative connectivity is measured as 'current flow' values per 270m^2 grid cell. Highest current flow areas depict connectivity zones where high-levels of species movement might expect to be concentrated. Low current flow indicates barriers to movement in ecologically fragmented circumstances. The 270m^2 permeability surface is overlaid on the distributions of each CE and average square unit values are calculated per 4km^2 grid cell. The resulting index values range from 0 to 1, with 0 having no landscape connectivity (all barrier) and 1 having very high connectivity.

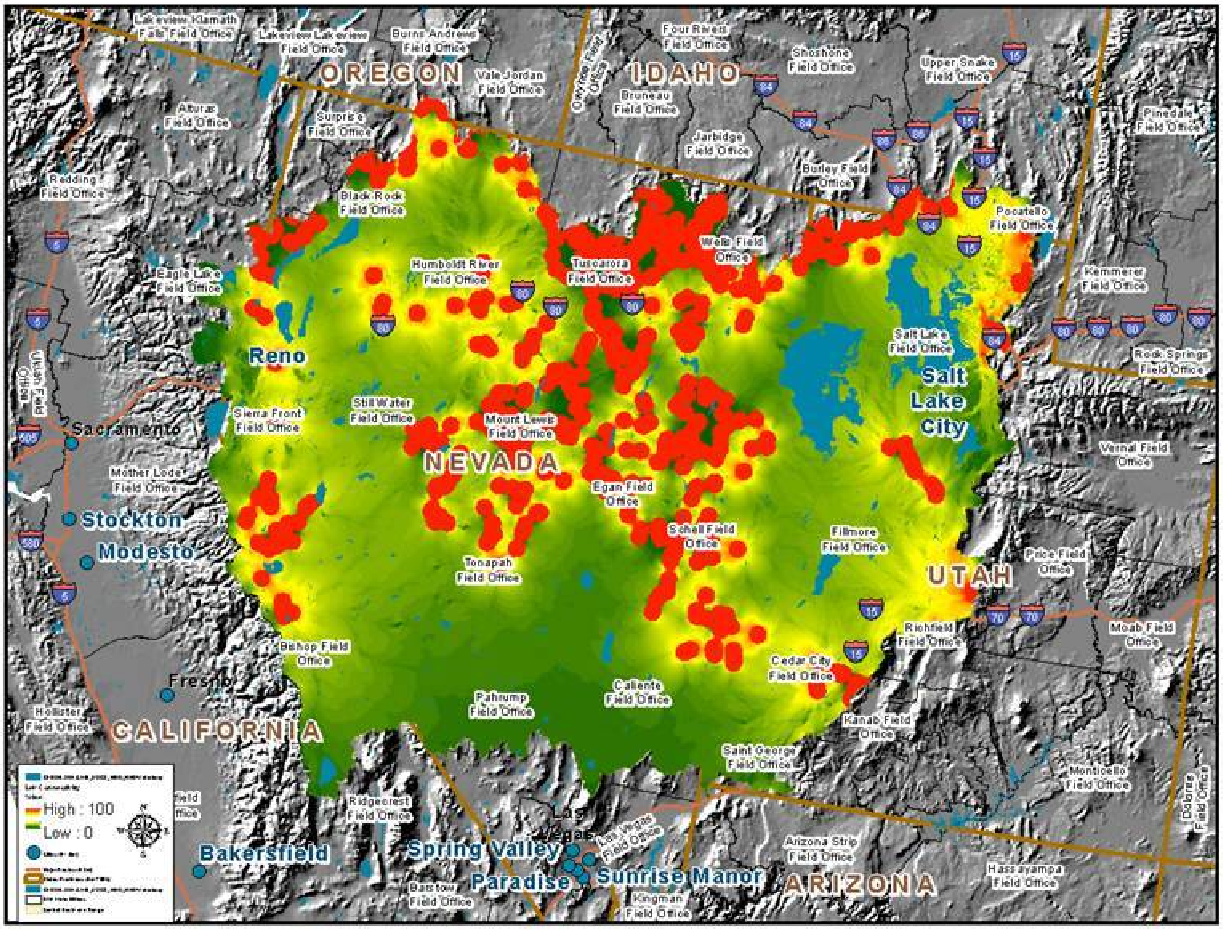


Figure B - 27. Current Greater Sage-Grouse lek connectivity

The purpose of the CircuitScape model was to identify the overall landscape permeability. As such, the Maximum value result was used from CircuitScape rather than the cumulative value which is better suited to defining areas of centrality.

B-1.3.1.2 Key Ecological Attribute: Ecological Condition

Invasive Annual Grasses Indicator

In order to apply the annual grasses model to analysis units (4x4Km or 5th level watershed) a summation was required that utilized both the extent of the annual grass category and the severity of the type. The following formula was utilized at all analysis units scales:

$$Index = \frac{\frac{C0 * 0.5 + C1 * 0.15 + C2 * 0.15 + C3 * 0.1 + C4 * 0.1 + C5 * 0.05}{Total\ in\ Unit}}{0.5}$$

C0=pixels with no annual grass in unit
C1=pixels with <= 5% annual grass cover
C2=pixels with > 5% and <= 15% annual grass cover
C3=pixels with > 15% and <= 25% annual grass cover
C4=pixels with > 25% and <= 45% annual grass cover
C5=pixels with > 45% annual grass cover

The weighting values as applied score areas with no annual grass extent the greatest proportional weight and the calculated value will be equal to 1. As annual grasses encroach into the analysis unit the maximum value of 1.0 is degraded progressively with pixels representing the >45% cover value having the greatest ability to drive down the maximum value. Figure B - 28 represents the application of the annual grasses to all 4x4 Km analysis units. In individual CE's the intersection of the CE with the annual grasses composite and summarized using the above formula.

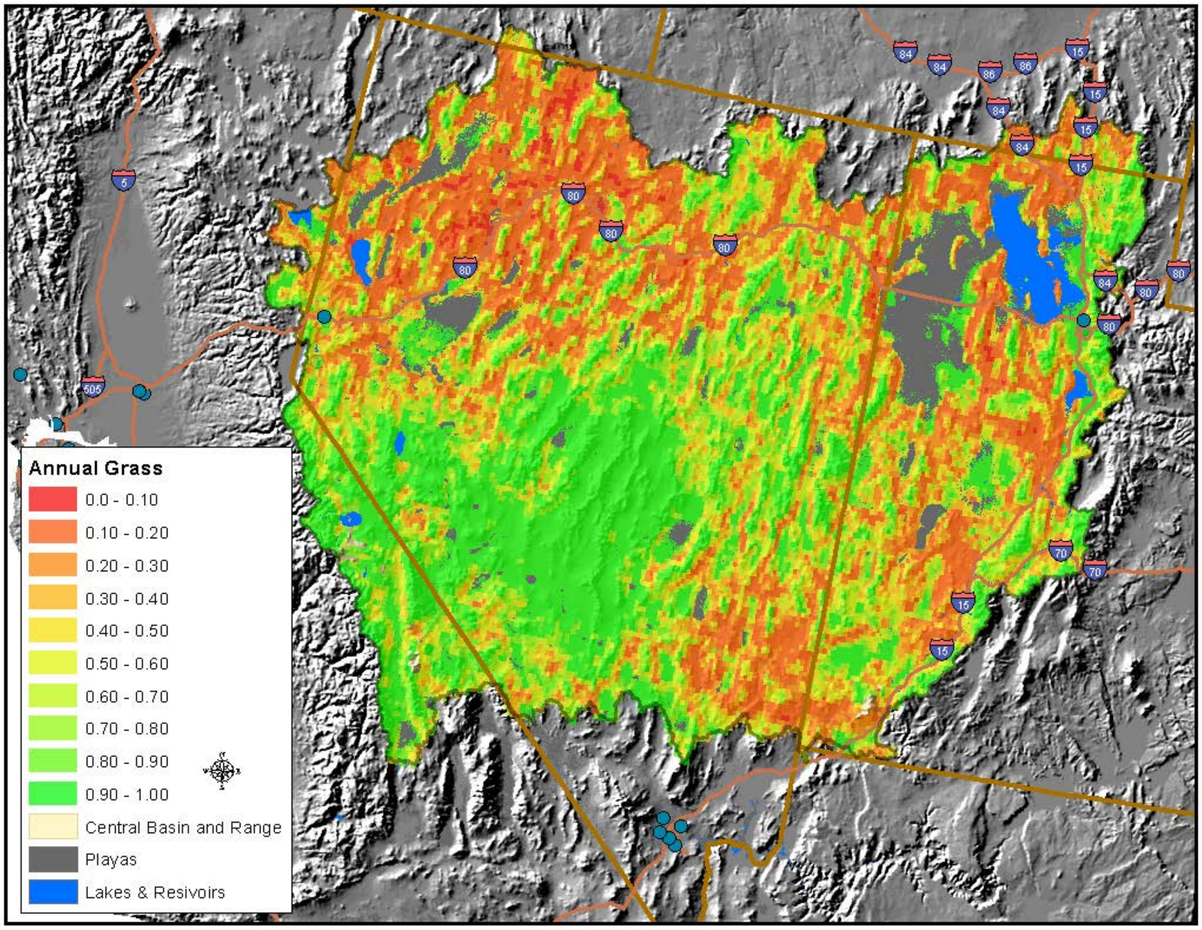


Figure B - 28.Total extent of annual grasses composite summarized by 4x4Km analysis unit.

Fire Regime Departure Indicator

By first constructing a conceptual model of successional dynamics, one can develop a powerful simulation tool to better understand the current conditions and forecast future trends. As noted in the methods section, state-and-transition models were developed using the Vegetation Dynamics Development Tool (VDDT) and simulations were run in the Path Landscape Model (ESSA Technologies). Models were run initially using historic conditions and fire regimes in order to characterize the Natural Range of Variation (NRV) which is used as a reference to compare to current and future conditions.

Given expected fire frequencies, one can anticipate a mix of successional stages for a given vegetation type across a defined landscape (in this case, a 5th level watershed). Changes to those fire frequencies, (e.g., through introduction of fine fuels or fire suppression over decades), results in a different distribution of vegetation succession class. For example, historical fire suppression might result in a proportional increase in late successional stages. Introduction of new fine fuels could result in increased fire frequency and a proportional increase in early successional stages. This change from NRV can be measured as an index of Ecological Departure (ED). Ecological Departure describes the dissimilarity between NRV and current, or predicted future, combinations of successional stages. ED is driven by two interacting factors, including a) the distribution of natural seral classes change, and b) the proportion of natural seral stages are displaced by uncharacteristic states. Uncharacteristic states could include areas where invasive non-native vegetation dominates, or in some cases, 'invasion' by native species; as occurs with juniper invasion from pinyon-juniper woodlands into nearby shrublands.

Current vegetation was then modeled by appending current, uncharacteristic states and transitions to the historic model. For example, the Great Basin Pinyon-Juniper Woodland model adds two uncharacteristic states to the reference model. These uncharacteristic states are the result of the introduction of annual grasses into the region, either as the pre-dominant state after a fire, or as an invasive under-growth below pinyon-juniper woodlands.

A map of succession classes describes the current mixture of vegetation stages. An updated view of the succession classes for the entire ecoregion (Figure B - 29) includes early (A-B), intermediate (C-D), and late (E) successional stages. It also includes uncharacteristic vegetation stages, relative to expected natural patterns, including areas where invasive annual grasses dominate the landscape. It can also include uncharacteristic native vegetation, such as where pinyon pine and junipers have extended into adjacent desert scrub or sagebrush due to historic land uses and changes in fire regimes.

The spatial extent of each CE within each HUC was calculated from the LANDFIRE biophysical settings (potential distribution) data. Each observation was then inspected and those occurrences in the smallest 5% were deleted from the data set. By and large, this excluded those occurrences that appeared in such small spatial extents as to be most likely classification errors, and those whose extent was less than the minimum dynamic area for that CE. This step was necessary in order to ensure that the initial starting conditions, based on these observed data, were not unduly biased by these relatively small occurrences.

This indicator was assessed by calculating and summarizing the updated LANDFIRE Succession classes (SClass) layer which characterizes current vegetation succession classes for the distribution of each CE within each 5th-level watershed. The resulting proportional calculation for current conditions is compared to the expected proportions, as derived from the VDDT or Path-Tools model characterizing the expected natural range of variation (NRV). This comparison defines the degree of departure (%). The Fire Regime Departure Index is calculated by subtracting the Departure percent from 1 to produce a normalized scale from 0 to 1 with 1 being no departure from NRV in distribution of succession classes and 0 being complete departure from NRV. The fire regime departure by system score is solely associated within each 5th level watershed, and cannot be summarized to individual CE extent as described in other measures of ecological integrity.

Since small spatial extent within a watershed was a criterion to remove a CE from a watershed in the dataset, not all watersheds with a CE have reported scores for departure. Minimum area thresholds were applied to each vegetation type (Table B - 27) to ensure that calculations were completed where there was sufficient aerial extent present to support the characteristic proportions of successional stages. This calculation of departure provides a 0.0 – 1.0 score for each CE within each watershed; with numbers closer to 0.0 showing increasingly severe departure.

Table B - 27. Minimum area thresholds applied to coarse-filter CEs to ensure adequate areal extent for calculations of proportions of successional stages, for fire regime departures.

Terrestrial Coarse-filter Name	Minimum # of hectares required for a departure score
Colorado Plateau Mixed Low Sagebrush Shrubland	400
Great Basin Pinyon-Juniper Woodland	1000
Great Basin Semi-Desert Chaparral	150
Great Basin Xeric Mixed Sagebrush Shrubland	1000
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	300
Inter-Mountain Basins Big Sagebrush Shrubland	1000
Inter-Mountain Basins Big Sagebrush Steppe	400
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	250
Inter-Mountain Basins Mixed Salt Desert Scrub	1500
Inter-Mountain Basins Montane Sagebrush Steppe	1000
Inter-Mountain Basins Semi-Desert Grassland	200
Inter-Mountain Basins Semi-Desert Shrub-Steppe	200
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	200
Mojave Mid-Elevation Mixed Desert Scrub- mesic	200
Mojave Mid-Elevation Mixed Desert Scrub- thermic	500
Rocky Mountain Alpine Turf	45
Rocky Mountain Aspen Forest and Woodland	100

Confidence in the modifications made to the SClass map are moderately high, but are limited to the overall model performance as completed by LandFire. The modifications of SClass made by NatureServe are applied based upon the overlap of the invasive annual grasses model representing the 15-25% cover model, which has high model performance (AUC=0.811), and the base SClass data layer as received from LandFire. Due to the modeling protocol followed by LANDFIRE it is difficult to define an overall model performance of the complete SClass data layer.

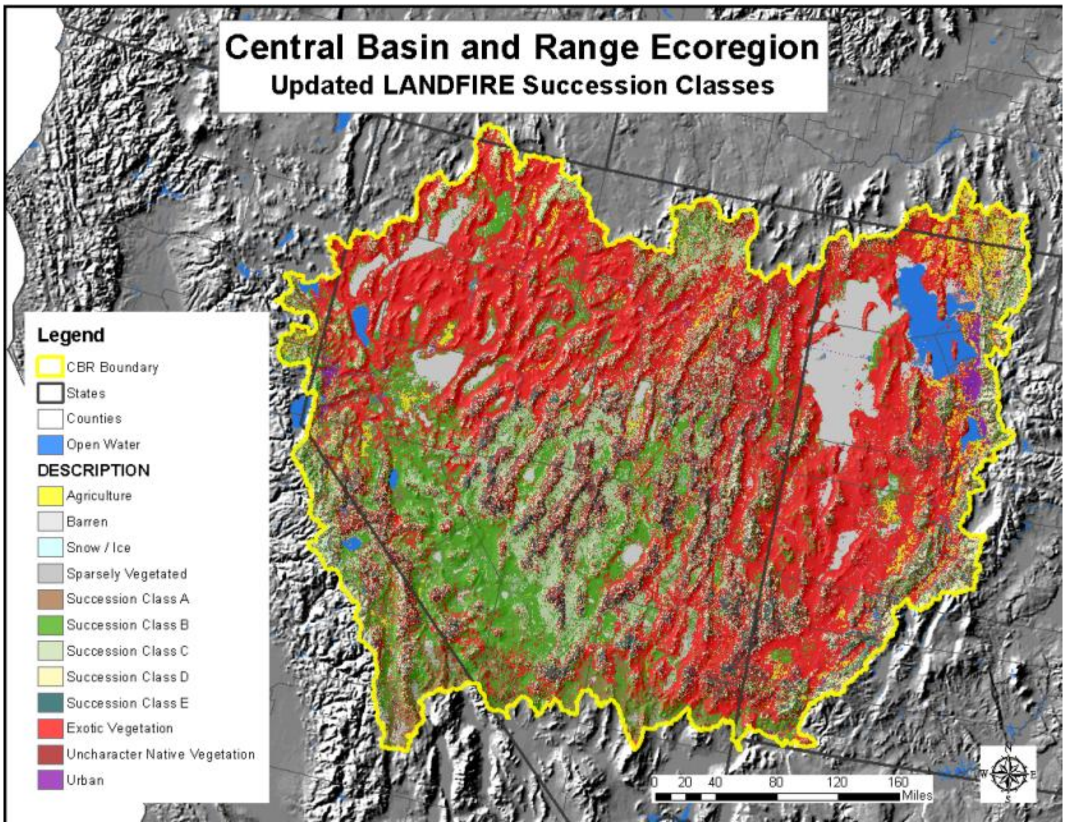


Figure B - 29. Updated succession class map for the ecoregion. These succession classes (SCLass) describe the stages within a systems ecological cere. SClasses are defined by relative age and canopy closure, so for example Succession Class A captures all early seral stages whereas Class E captures late seral - closed canopy systems. Not all systems are divided into all 5 classes; Two, Three, and Four class systems are common.

B-1.3.1.3 Key Ecological Attribute: Size

Change in Extent Indicator

Where a substantial change in extent for a given CE has occurred, it provides an indication of past/current land use practices and/or changing environmental conditions that could limit the provision of ecological services. It therefore serves as an appropriate indicator, among others, for gauging ecological integrity for each CE within each watershed. This indicator is assessed by intersecting the mapped current extent (*circa* early 2000s) of individual terrestrial coarse filter CEs with the biophysical setting (BpS) layer for this same CE (Figure B - 30). The BpS layer is an approximation of the potential (or historic) distribution of the CE, under a natural disturbance regime. The indexing of change in extent for ecological systems was performed at the watershed level by intersecting both the BpS and current ecological systems layers with the 5th level watersheds. The BpS represents an estimate of extent and does not comprise the actual historic extent of the system. With the requirement that the change index represents a 0 - 1.0 range with 1 being no change, the following was applied:

$$\lim_{100\%}\left(1 - abs\left(Change = \frac{BPS - Current}{BPS}\right)\right)$$

Multiple watersheds by ecological systems experienced more than 100% (+/-) change. To address the extreme events with greater than 100% change which occurs predominately in watersheds intersected with very low amounts of either BpS, or current systems, the change was limited in two ways. First, all watersheds that do not meet the requirement for the area threshold applied in the VDDT Fire Departure models (Table B - 27) were excluded from the change calculation. Secondly, all watersheds by systems that continue to exceed the 100% change ceiling were limited to a 100% change value. In the final change index these extreme change values are represented by zero (Figure B - 31). As a result of the first requirement, not all watersheds with a CE will have a reported score for change in extent.

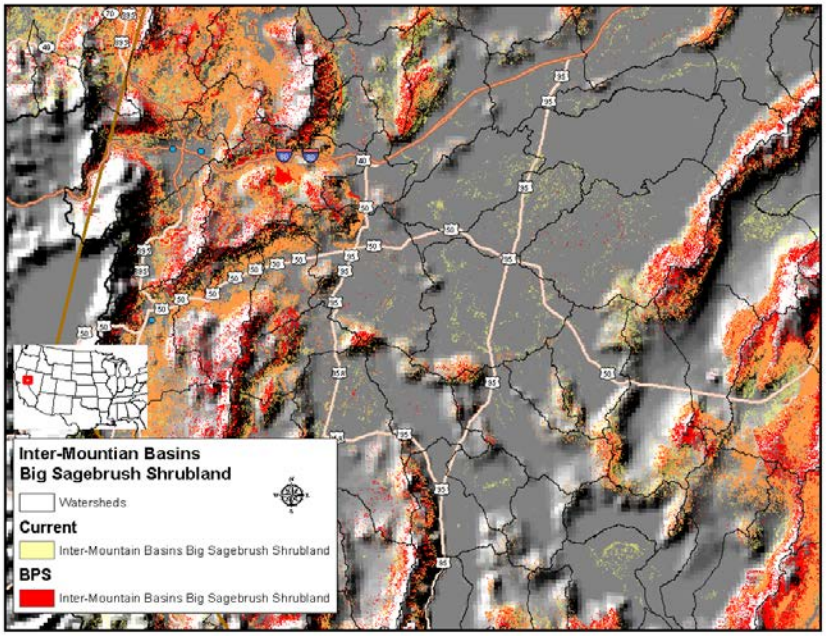


Figure B - 30. Current and potential (“historic”, as represented by BpS) distribution of the Inter-mountain Basins Big Sagebrush Shrubland.

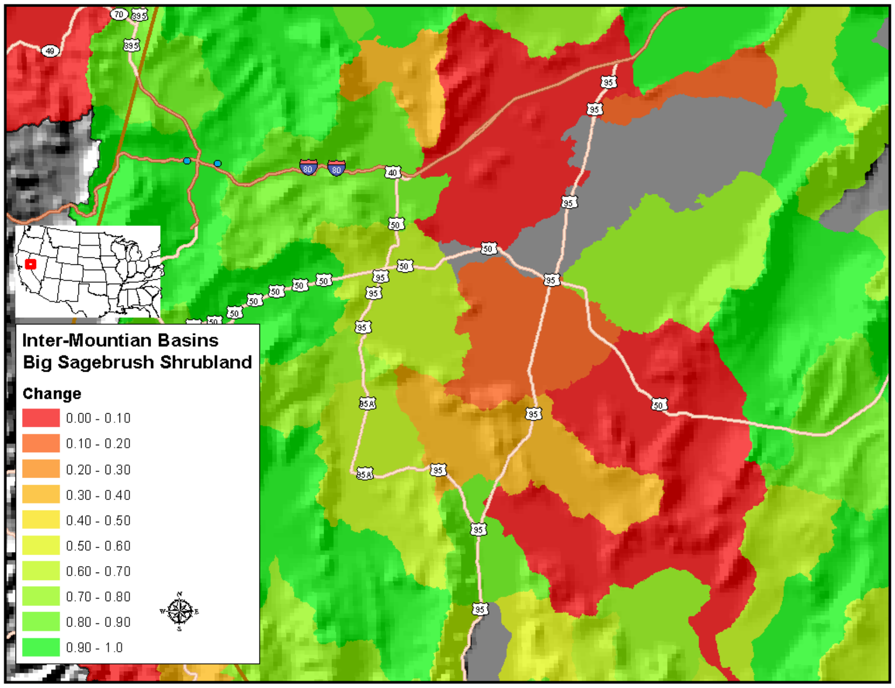


Figure B - 31. Change in extent scoring for Inter-mountain Basins Big Sagebrush Shrubland, by 5th level watershed.

B-1.4 Summary Indices of Ecological Integrity

Given practical limitations of an REA, a simple, overall index of ecological integrity was desired. However, upon review of the various options for building such an index, several factors contributed to the conclusion that several distinct, but complimentary, indices would provide the best summary information on ecological integrity. The first factor was the distinct nature of many groups of CEs and their chosen indicators of ecological integrity or status. Combining results for terrestrial coarse filter, landscape species, and aquatic CEs implies the combination of scores for indicators that are decidedly non-complimentary (e.g., scores for water quality having no known effect on terrestrial ecological integrity). A second factor was that two primary spatial reporting units were selected for using the REA. As previously mentioned, the 5th level watershed unit was selected as one primary reporting unit. This reporting unit was appropriate for addressing aquatic integrity, and was relied upon to encompass sufficient area of upland vegetation to address indicators of fire regime departure for individual vegetation CEs. However in the latter case, an overall score for fire regime departure, if summarized by watershed, would necessarily combined scores for high and low elevation vegetation types. Therefore, four summary indices of integrity, reported by watershed, were developed. The first summarized fire regime departure scores for types falling with Montane Upland and Basin Upland categories of the ecoregion-wide conceptual model (Table B - 6).

A 4 km^2 grid was used to report on overall indicators of Landscape Condition Index and Invasive Annual Grass index, providing two additional ecoregion-scale summary indices of ecological integrity. This approach resulted in six complimentary, summary indices of ecological integrity (Table B - 28).

Table B - 28. Summary indices of ecological integrity with associated reporting units.

Summary Indicator	Montane Upland	Basin Upland	Aquatic/Wetland, and Riparian
Landscape Condition	4km^2 grid		
Invasive Annual Grass	4km^2 grid		
Fire Regime Departure	Watershed	Watershed	
Hydrologic Condition			Watershed
Water Quality			Watershed

B-2 Findings in terms of Management Questions

B-2.1 Current Distribution and Ecological Status

Many management questions are addressed in this section of the appendix. Tabular summaries are provided of the results for the ecological status assessment of all CE groups (terrestrial and aquatic coarse filter CEs, vulnerable species assemblages, and landscape species). For maps, only a cross-section of CE results are provided, since distribution and status maps for all CEs and all indicators of status would result in several hundred maps. The spatial data have all been provided to BLM and are avaialble through the BLM data management portal.

MQ1 -What is the current distribution of potential habitat for each species CE?

MQ3 - What is the current distribution of suitable habitat, including seasonal habitat and movement corridors, for each landscape species and species assemblage CE?

MQ4 - Where are existing change agents potentially affecting this current habitat and/or movement corridors, for landscape species and species assemblage CEs?

MQ10 - Where are intact CE vegetative communities located?

MQ11 - Where are the likeliest current locations for high-integrity examples of each major terrestrial ecological system?

MQ30 - Where are current natural and man-made surface water resources?

MQ34 - Where are the likely recharge areas within a HUC?

MQ36 - What is the condition (ecological integrity) of aquatic conservation elements?

MQ39 - Where are the aquatic CE occurrences with the most degraded condition (ecological integrity)?

MQ42 - What areas now have unprecedented fuels composition (invasive plants), and are therefore at high potential for fire?

MQ45 - What areas are significantly ecologically affected by invasive species?

MQ50 - Where do development CAs cause significant loss of ecological integrity?

MQ57 - Where are the aquatic CEs showing degraded ecological integrity from existing groundwater extraction?

MQ58 - Where are artificial water bodies including evaporation ponds, etc.?

MQ80 - Where are areas affected by atmospheric deposition of pollutants, as represented specifically by nitrogen deposition, acid deposition, and mercury deposition?

B-2.1.1 Ecological Status: Terrestrial Coarse-filter Conservation Elements

Table B - 29 provides a concise summary of ecological status for each terrestrial coarse filter CE, totaling numbers of watersheds with status scores for each indicator. Ecological status indicators are scored from high to low values for the distribution of each CE within each 5th level watershed. The tables provide a count of 5th level watersheds for that CE x indicator, broken into 10 intervals from 0 to 1. Higher scores (1 is the highest) indicate relatively higher ecological status. Therefore, if a given indicator for a CE has most watersheds with scores in the higher intervals throughout the CBR ecoregion, that indicates high ecological status as related to that indicator. If all indicators are similarly scored, one can be more confident in the overall ecological status of the CE. However, one may also encounter relatively high scores for some indicators, while lower scores are common for others. This indicates some potential management concerns relative to ecological status for that CE. If all indicators skew towards lower scores, significant cause for management concern is warranted.

For example, the landscape condition indicator was summarized for watersheds supporting Inter-Mountain Basins Semi-Desert Grassland (bolded in below table). The table indicates that 421 (out of 563 total, or nearly 75%) of these watersheds had scores between 0.5 and 1; this indicates that most patches of these grasslands occur away from impacting development change agents, as measured in the spatial model of landscape condition. Inversely large numbers of watersheds with semi-desert grasslands indicate the poorest scores (0 to 0.1) for the fire regime departure indicator and the change in extent indicator. This suggests that long-term shifts in extent (typically due to land conversion, or in some cases, expansion from wildfire suppression) have taken place in some watersheds where this type occurs, and that fire regime departure is marked in some locations. The fire regime departure may well have an interacting relationship with invasive annual grasses, as indicated by the large number of watersheds (50%) scoring between 0.2 and 0.5 for this indicator, suggesting that semi-desert grassland patches in many watersheds may have substantial effects from invasive plants, which have lead to changes in fire regime.

In Table B - 29 relatively high counts of watersheds are bolded, to facilitate rapid review of ecological status across the full set of terrestrial coarse filter CEs. The total number of watersheds for each CE x indicator is provided; the number is not the same across all the indicators for each CE because the way the status calculations were done required the CE to actually co-occur with pixels of the indicator; and for fire regime departure, a minimum area of the CE's biophysical setting (BpS) was required to calculate departure within any watershed. NOTE: One indicator previously intended for use in the REA, landscape permeability, was dropped for application to ecological status scoring.

The fire regime departure indicator may correspond in certain types with the change in extent indicator. For example, the change in extent indicator for Inter-Mountain Basins Montane Sagebrush Steppe (*Artemisia tridentata* ssp. *vaseyana* plant communities), with 72.5% of watersheds where it occurs scoring between 0 and 0.1, suggests the effects of juniper and pinyon expansion from neighboring woodlands. While Great Basin Pinyon-Juniper Woodland scored in the upper intervals for landscape condition and change in extent, the effects of altered fire regime and woody expansion is manifested by the spread of change in extent scores across many of the intervals; and a large number of wathersheds scoring between 0.2 and 0.5 (generally poor scores) for fire regime departure. Finally, the expected pattern among the annual grass indicator is clear in Table B - 29, with types occurring at lower elevations throughout the basins of the ecoregion frequently scoring in lower intervals. This is sometimes not-yet coupled with fire regime departure, where fire frequency remains very low in some desert scrub types while they appear to be accumulating invasive plant abundances.

Overall, Table B - 29 indicates expected trends in ecological status among terrestrial coarse filter CEs (see e.g., Chambers et al. 2011, Brooks and Chambers 2011). One could expect that the highest elevation ecological systems throughout the CBR tend to occur in the most remote and un-impacted landscapes, and the landscape condition indicator scores substantiate this (Table B - 29). However, fire regime departure scores are low beginning at upper montane (even subalpine) elevations, such as among Aspen Forests and Aspen-Mixed Conifer Forest and Woodland. The expected pattern among the annual grass indicator is clear, with types occurring at lower elevations throughout the basins of the ecoregion also frequently scoring poorly, indicating high risk of invasive annual grasses. This is sometimes not-yet coupled with fire regime departure, where fire frequency remains very low in some desert scrub types while they appear to be accumulating invasive plant abundances.

Table B - 29. Indicator results by watershed for terrestrial coarse filter CEs (Current). For each indicator the count of 5th level watersheds is shown for each CE, broken out by indicator score interval.

KEA: Change in Extent/Size											
Change in extent											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	616	49	22	16	27	40	51	**66**	**72**	**105**	**168**
Great Basin Xeric Mixed Sagebrush Shrubland	597	**285**	26	32	22	26	31	31	41	53	50
Inter-Mountain Basins Mixed Salt Desert Scrub	572	**398**	61	35	23	16	11	16	8	2	2
Inter-Mountain Basins Montane Sagebrush Steppe	561	**407**	17	22	16	17	15	19	13	23	12
Great Basin Pinyon-Juniper Woodland	548	19	17	27	11	16	19	16	14	12	**397**
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	358	**93**	**54**	28	42	**49**	23	27	19	13	10
Rocky Mountain Aspen Forest and Woodland	339	**47**	25	22	29	**47**	28	33	**47**	34	27
Inter-Mountain Basins Semi-Desert Shrub-Steppe	246	**118**	21	24	18	15	11	7	5	11	16
Inter-Mountain Basins Semi-Desert Grassland	176	**98**	14	13	10	6	8	5	10	7	5
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	114	**32**	**27**	16	13	3	5	3	7	4	4
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	112	**81**	4	1	2	3	8	3	5	3	2
Mojave Mid-Elevation Mixed Desert Scrub	95	**21**	4	6	8	5	8	7	4	13	**19**
Inter-Mountain Basins Big Sagebrush Steppe	76	**32**	7	7	4	3	6	6	5	6	
Great Basin Semi-Desert Chaparral	51	**28**	4	5	3	2	2	5	1		1
Colorado Plateau Mixed Low Sagebrush Shrubland	27	**16**	3	2	1	1			4		
Rocky Mountain Alpine Turf	8	**3**	1	2		1					1

KEA: Landscape Condition

Landscape Condition Index

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	629	2			11	34	**76**	**114**	**225**	**144**	23
Inter-Mountain Basins Montane Sagebrush Steppe	623			1	3	8	36	**76**	**218**	**251**	30
Inter-Mountain Basins Mixed Salt Desert Scrub	622	1	1	7	19	66	72	**130**	**186**	**123**	17
Great Basin Pinyon-Juniper Woodland	618	4		9	10	13	29	**82**	**195**	**248**	28
Great Basin Xeric Mixed Sagebrush Shrubland	611	3		1	11	26	35	**92**	**235**	**187**	21
Inter-Mountain Basins Cliff and Canyon	567	**18**	4		10	15	32	**89**	**164**	**205**	30
Inter-Mountain Basins Semi-Desert Grassland	563	**32**	1	1	30	**70**	**103**	**107**	**139**	**72**	8
Inter-Mountain Basins Semi-Desert Shrub-Steppe	551	**28**		1	13	**47**	**74**	**115**	**160**	**95**	18
Rocky Mountain Aspen Forest and Woodland	528	**34**		1	2	2	8	**75**	**170**	**209**	27
Inter-Mountain Basins Big Sagebrush Steppe	526	**28**			8	**40**	**55**	**72**	**179**	**138**	6
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	428	22					6	**61**	**115**	**198**	26
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	212	**38**						3	28	**121**	22
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	210	**25**						25	**61**	**82**	17
Mojave Mid-Elevation Mixed Desert Scrub	192	**24**			2	13	15	**24**	**44**	**54**	16
Great Basin Semi-Desert Chaparral	137	**26**			1	4	3	**20**	**33**	**47**	3
Inter-Mountain Basins Active and Stabilized Dune	100	8			3	7	14	**26**	**24**	15	3
Rocky Mountain Alpine Turf	66	**12**				2	1	4	**17**	**30**	
Colorado Plateau Mixed Low Sagebrush Shrubland	33				1	**10**	**11**	**9**	2		

Fire Regime Departure Index

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	616	42	**69**	**99**	**105**	**93**	**82**	**82**	38	6	
Great Basin Xeric Mixed Sagebrush Shrubland	600	11	44	**76**	**114**	**130**	**93**	**62**	**66**	4	

Inter-Mountain Basins Mixed Salt Desert Scrub	573	**134**	**64**	**62**	33	45	40	48	**68**	**51**	28
Inter-Mountain Basins Montane Sagebrush Steppe	562	4	18	**52**	**133**	**145**	**111**	**65**	31	3	
Great Basin Pinyon-Juniper Woodland	550	13	19	**119**	**237**	**138**	24				
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	359	3	7	18	**91**	**102**	**96**	**36**	5	1	
Rocky Mountain Aspen Forest and Woodland	339	1	7	19	**57**	**79**	**96**	**49**	21	9	1
Inter-Mountain Basins Semi-Desert Shrub-Steppe	254	**47**	**43**	30	30	**44**	26	24	9	1	
Inter-Mountain Basins Semi-Desert Grassland	195	**134**	17	14	10	6	6	2	5	1	
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	114		3	1	4	20	**28**	**37**	**16**	5	
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	113	2	4	12	**31**	**40**	18	3	2	1	
Mojave Mid-Elevation Mixed Desert Scrub	98	16	11	15	14	15	15	4	5	2	1
Inter-Mountain Basins Big Sagebrush Steppe	76	10	7	**20**	**19**	9	7	4			
Great Basin Semi-Desert Chaparral	51	5	5	3	5	**9**	**15**	4	4	1	
Colorado Plateau Mixed Low Sagebrush Shrubland	27	2	4	**10**	4	6			1		
Rocky Mountain Alpine Turf	8	**6**	2								

KEA: Stressors on Biotic Condition

Invasive Annual Grass Index

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	629		1	52	**221**	**89**	50	46	59	35	**76**
Inter-Mountain Basins Montane Sagebrush Steppe	623			18	41	49	**60**	**69**	**91**	**107**	**188**
Inter-Mountain Basins Mixed Salt Desert Scrub	621		1	47	**171**	**72**	**68**	54	58	43	**107**
Great Basin Pinyon-Juniper Woodland	618	1	1	31	**58**	**69**	**80**	**87**	**90**	**77**	**124**
Great Basin Xeric Mixed Sagebrush Shrubland	611		1	43	**107**	**112**	**99**	58	58	55	**78**
Inter-Mountain Basins Cliff and Canyon	567	1	11	33	**65**	**55**	**53**	46	47	**88**	**168**
Inter-Mountain Basins Semi-Desert Grassland	562	2	11	**81**	**134**	**68**	**44**	**41**	**49**	29	**103**
Inter-Mountain Basins Semi-Desert Shrub-Steppe	549	1	7	**106**	**136**	55	40	36	37	41	**90**

Inter-Mountain Basins Big Sagebrush Steppe	526	3	9	**70**	**131**	**88**	**60**	46	26	33	**60**
Rocky Mountain Aspen Forest and Woodland	525	2	5	21	17	26	45	41	**77**	**87**	**204**
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	423	1	1	13	3	12	20	23	28	**49**	**273**
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	211		2	3					2		**204**
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	204			1	1	4	3	5	14	13	**163**
Mojave Mid-Elevation Mixed Desert Scrub	191	4	6	**41**	20	14	14	18	21	17	**36**
Great Basin Semi-Desert Chaparral	134		3	11	4	6	3	13	10	13	**71**
Inter-Mountain Basins Active and Stabilized Dune	100	1	1	**31**	13	11	3	5	3	6	**26**
Rocky Mountain Alpine Turf	65							2	1	1	**61**
Colorado Plateau Mixed Low Sagebrush Shrubland	33	1	1	**11**	**6**	**7**	1	3			3

<u>Maps of terrestrial coarse filter CEs current distribution and ecological status</u>

The current distribution and the spatial results of the ecological status assessment for a selection of the terrestrial coarse filter CEs are presented in Figure B - 32 through Figure B - 41. These are organized within the ecoregional conceptual model, with Montane Dry Land systems presented first; then the Basin Dry Land systems. Within each group systems are sorted from high to low elevation.

MONTANE DRY LAND SYSTEMS

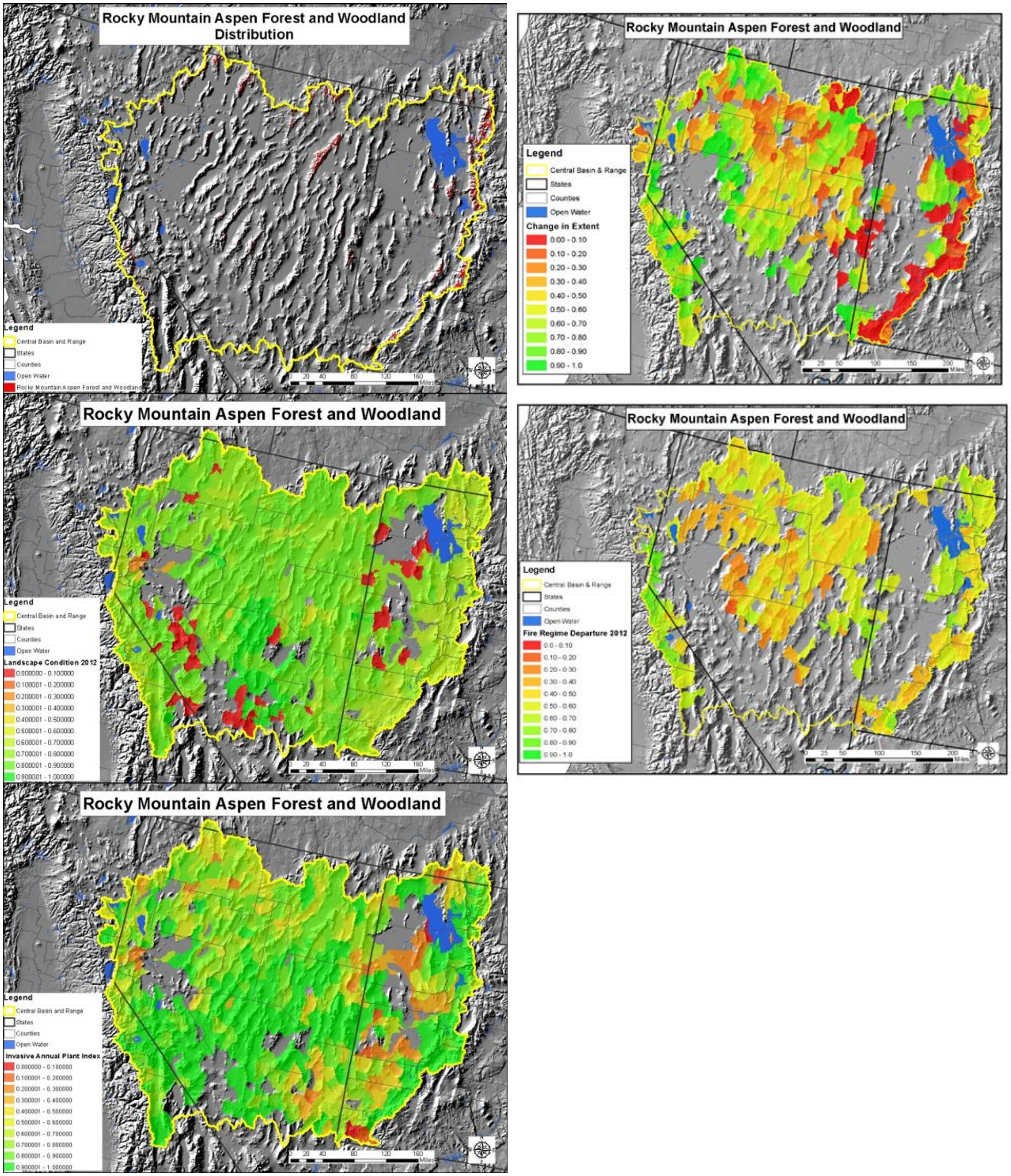


Figure B - 32. Rocky Mountain Aspen Forest and Woodland distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom)

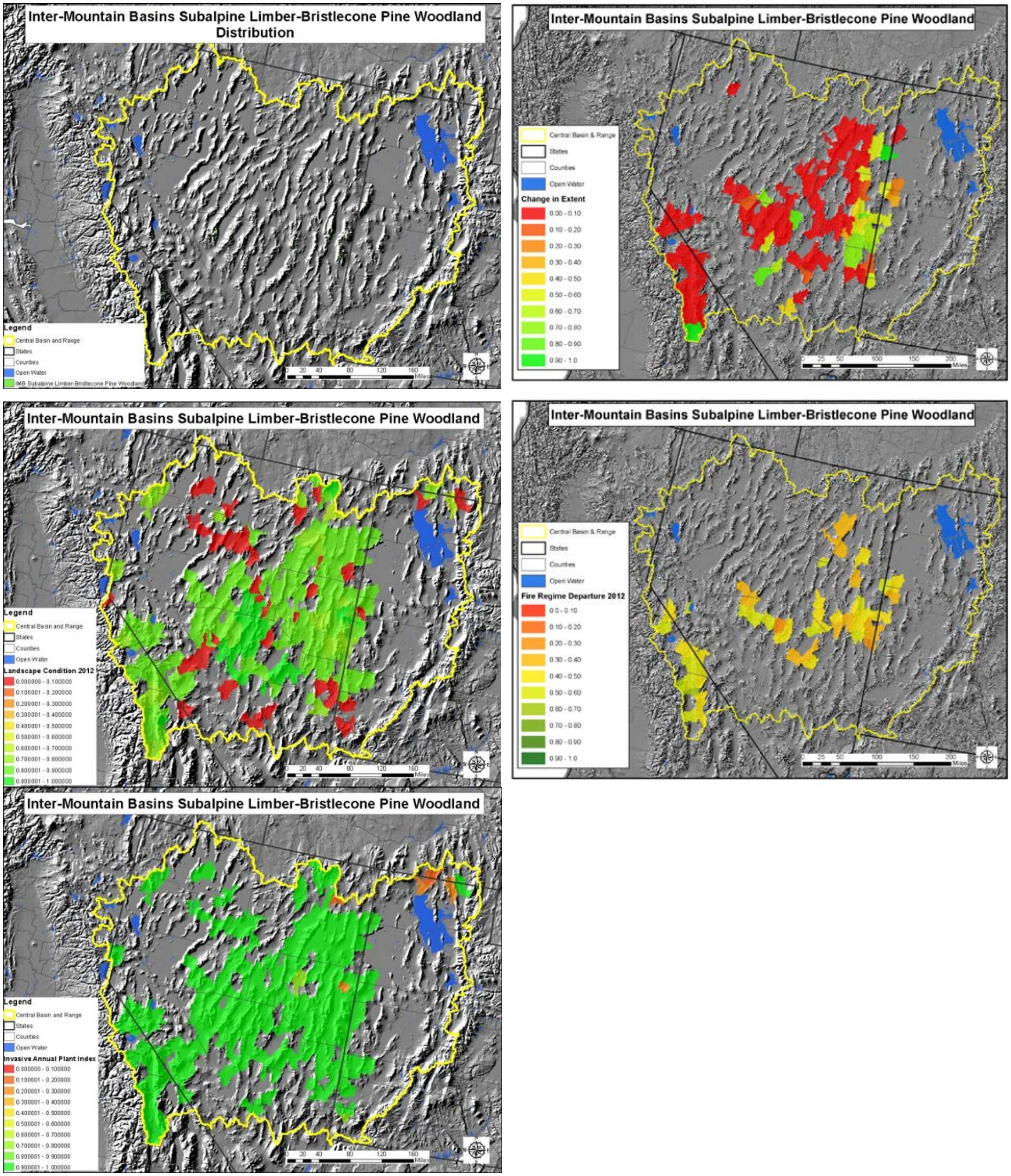


Figure B - 33. Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom)

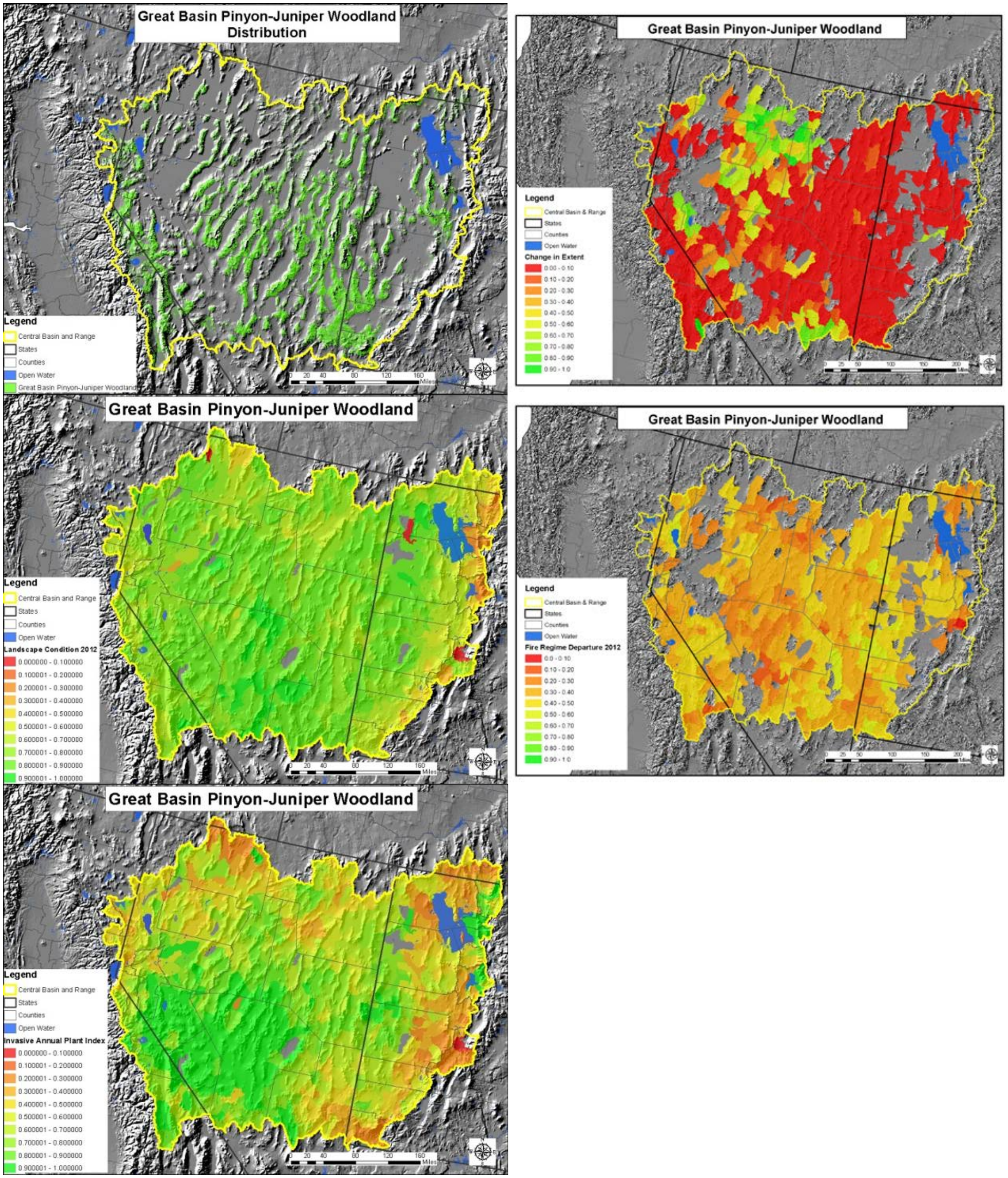


Figure B - 34. Great Basin Pinyon-Juniper Woodland distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom)

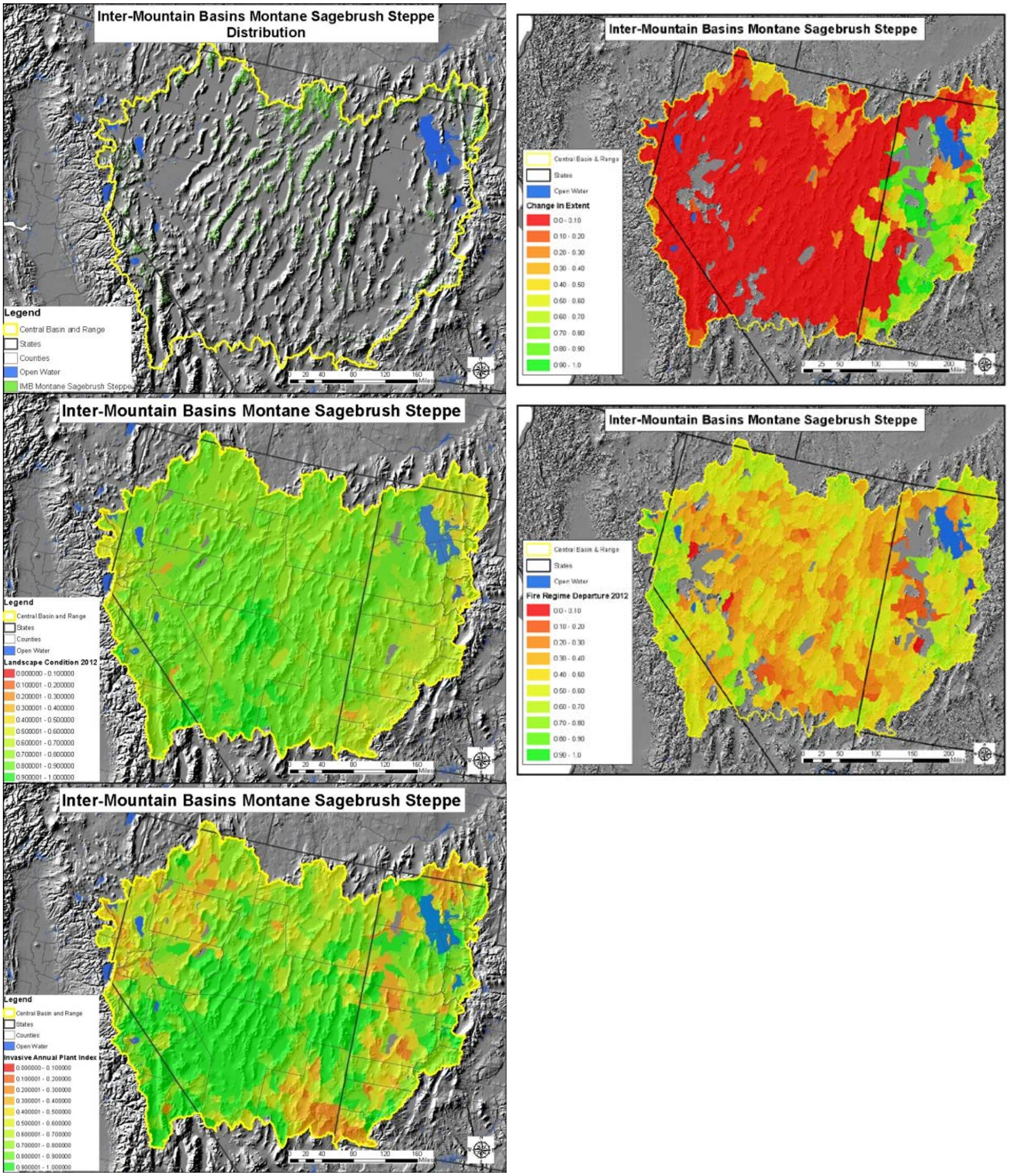
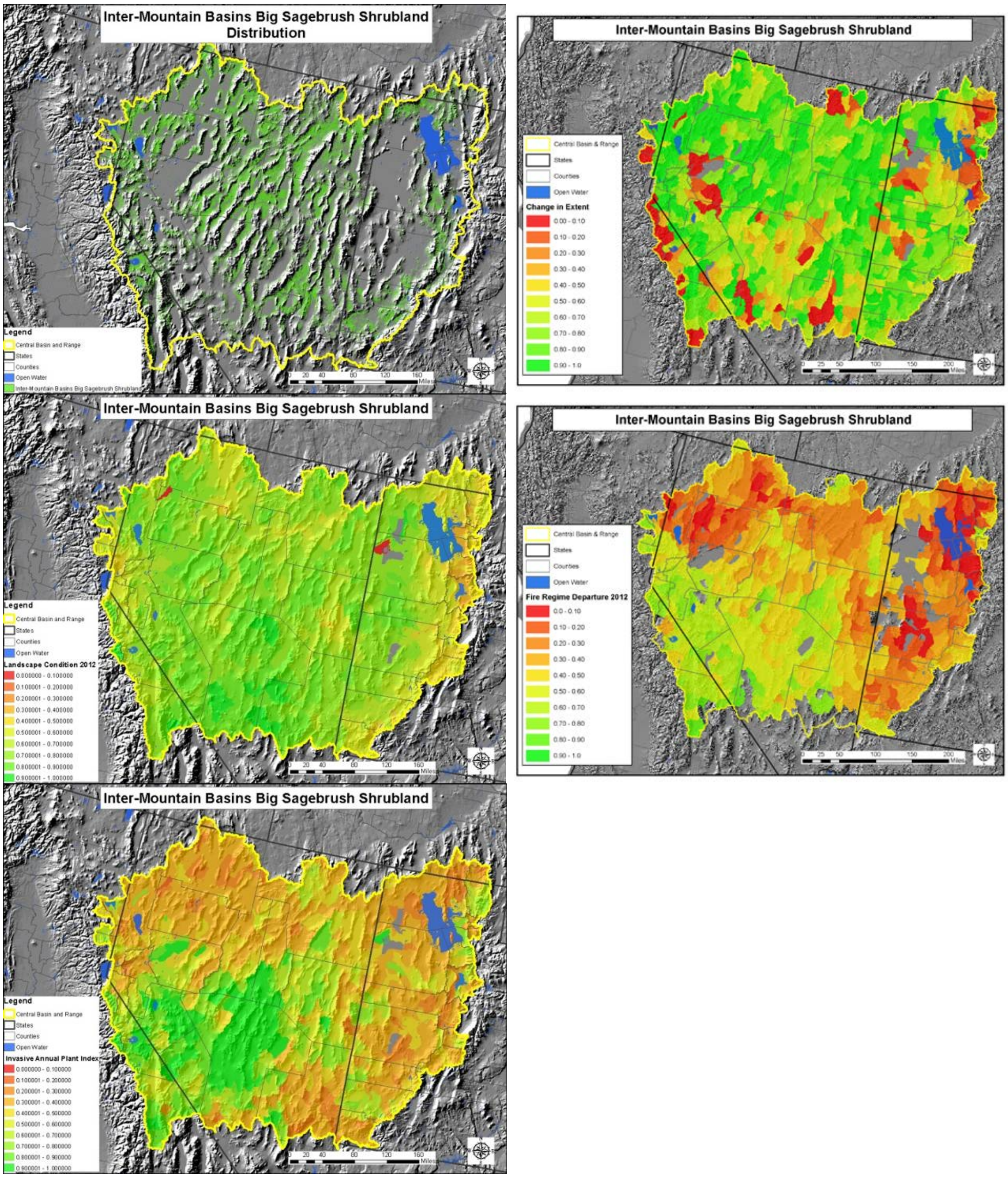


Figure B - 35. Inter-Mountain Basins Montane Sagebrush Steppe distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom).

BASIN DRY LAND SYSTEMS



Inter-Mountain Basins Big Sagebrush Shrubland Distribution

Inter-Mountain Basins Big Sagebrush Shrubland

Inter-Mountain Basins Big Sagebrush Shrubland

Inter-Mountain Basins Big Sagebrush Shrubland

Inter-Mountain Basins Big Sagebrush Shrubland

Figure B - 36. Inter-Mountain Basins Big Sagebrush Shrubland distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom)

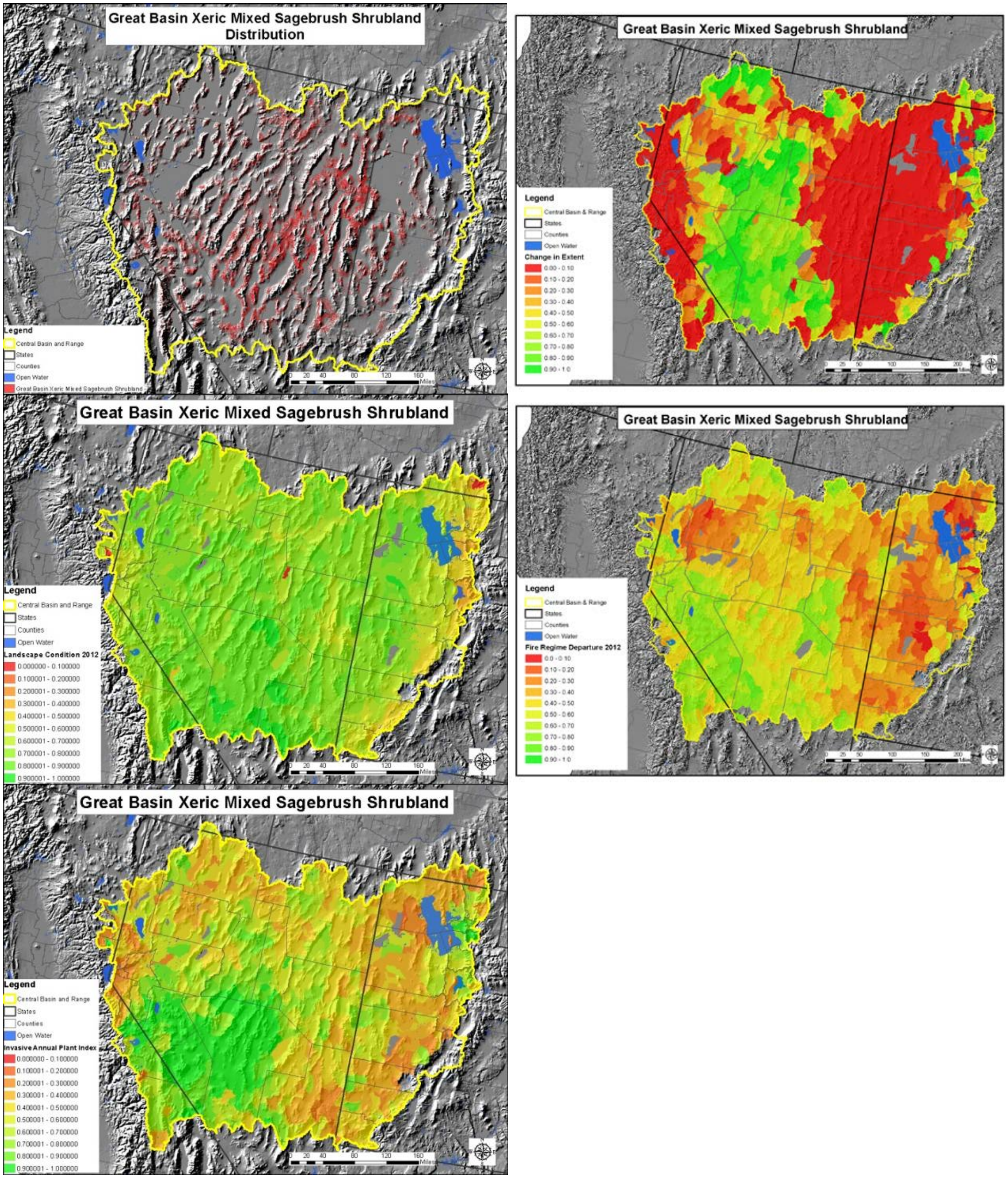


Figure B - 37. Great Basin Xeric Mixed Sagebrush Shrubland distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom)

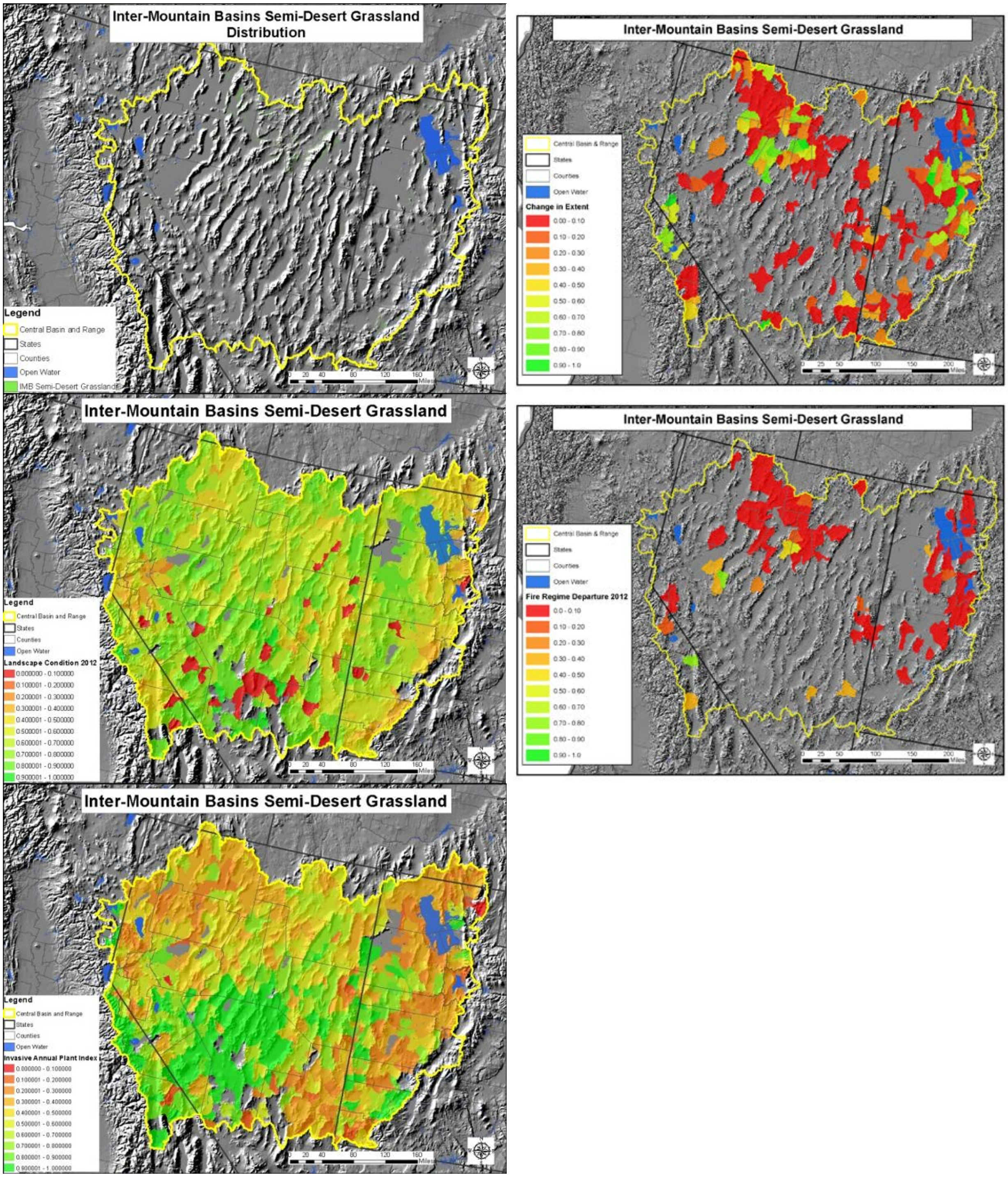


Figure B - 38. Inter-Mountain Basins Semi-Desert Grassland distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom). As described in the methods, watersheds with too little areal extent were excluded fro.m having scores for change in extent and fire regime departure. While this CE is widely distributed, occurring in most watersheds, its extent in many watersheds is very small, generally less than 200 hectares (496 acres).

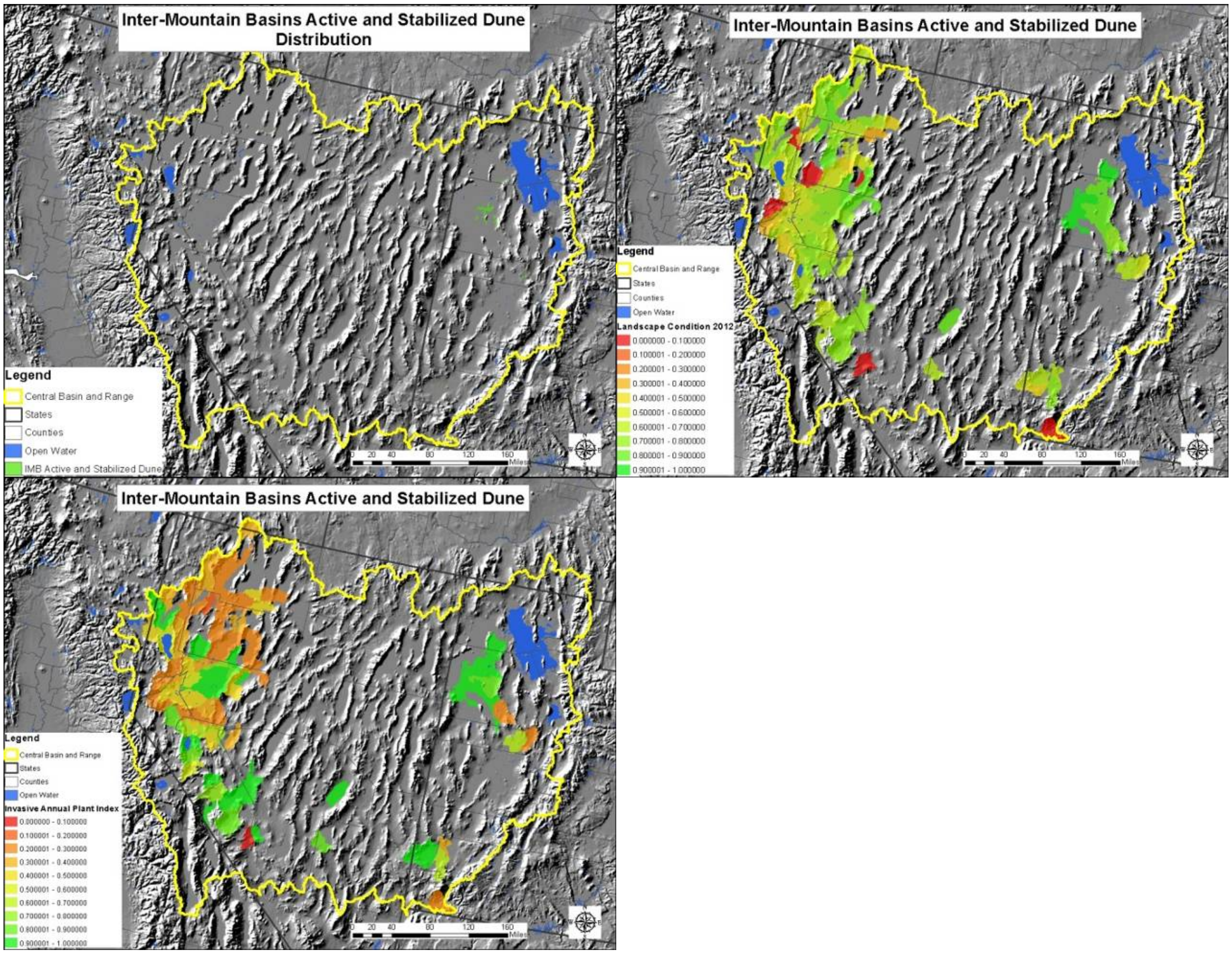


Figure B - 39. Inter-Mountain Basins Active and Stabilized Dune distribution and status : current distribution (top left), current Landscape Condition Index scores (top right), Invasive Annual Grass Index scores (bottom)

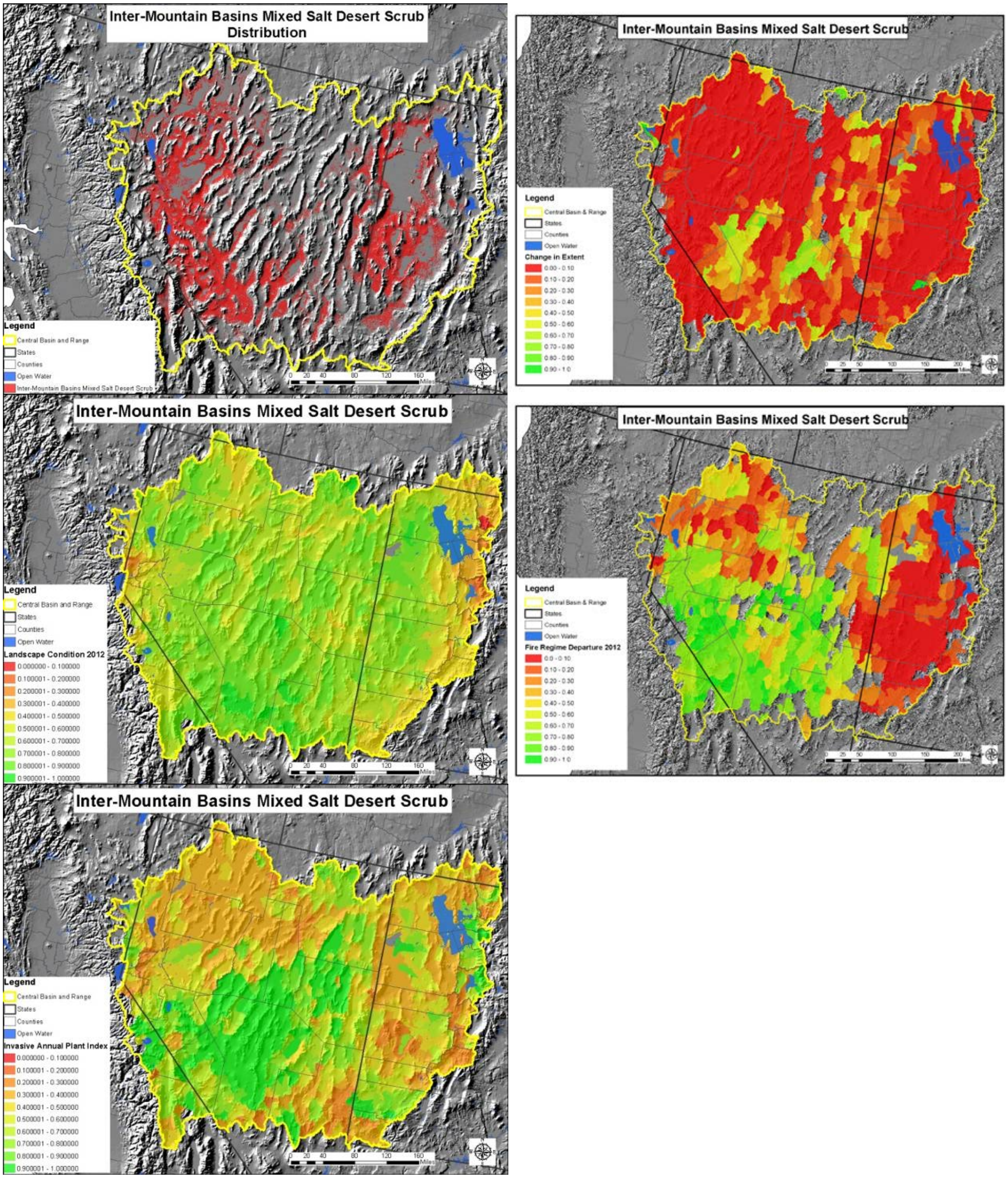


Figure B - 40. Inter-Mountain Basins Mixed Salt Desert Scrub distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Fire Regime Departure Index scores (middle right), Invasive Annual Grass Index scores (bottom)

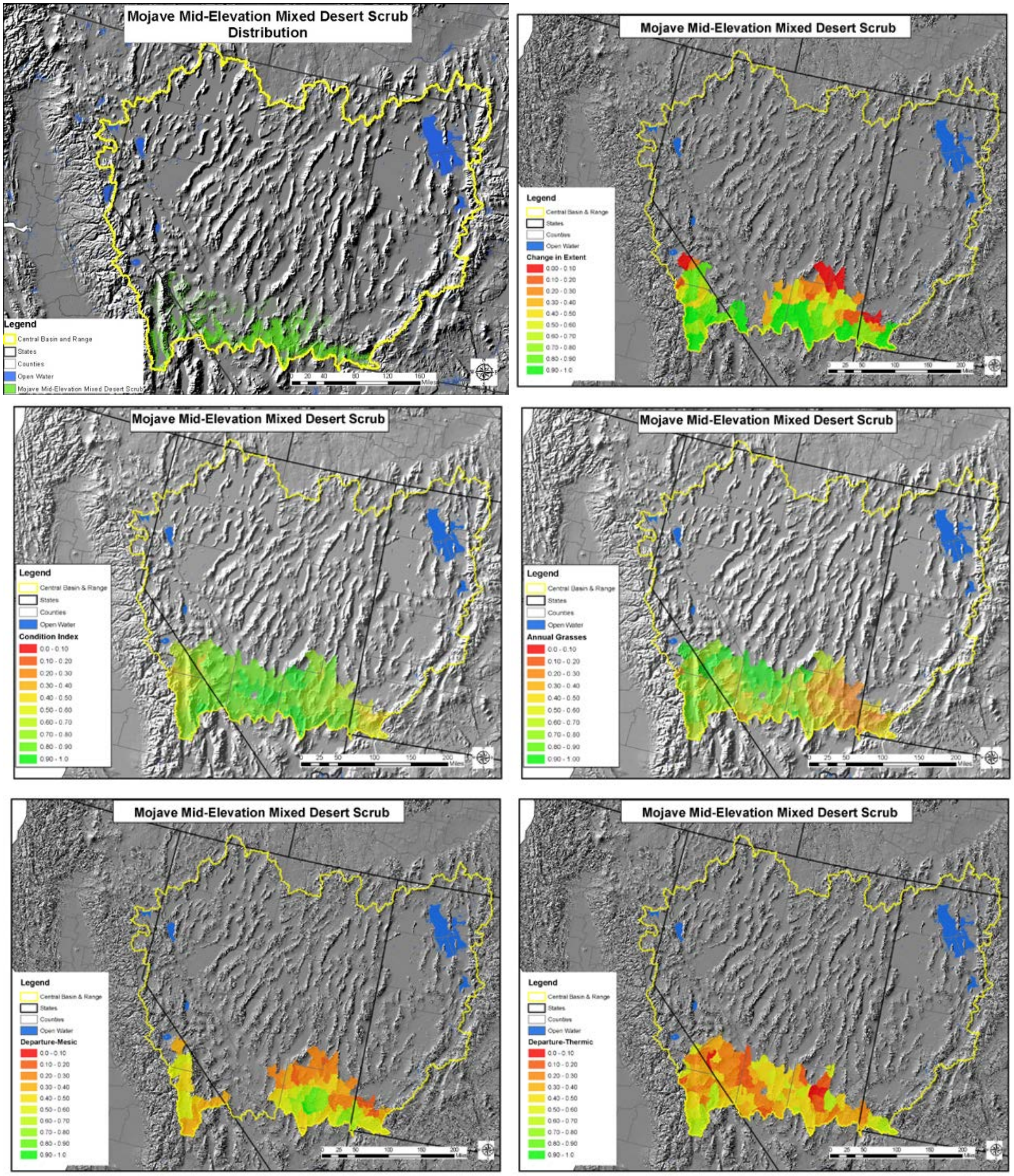


Figure B - 41. Mojave Mid-Elevation Mixed Desert Scrub distribution and status: current distribution (top left), Change in Extent scores (top right), current Landscape Condition Index scores (middle left), Invasive Annual Grass Index scores (middle right), and Fire Regime Departure Index scores (bottom) for mesic and thermic variants.

B-2.1.2 Ecological Status: Landscape Species

Assessment of ecological status for landscape species was completed for each distribution and summarized by 4 X 4 km grid. A total of 22,333 grid cells blanket the CBR ecoregion. This was in contrast to 5th level watersheds, the spatial analysis units used for coarse filter CE assessments. Table B - 30 includes summary scores for grid cells in the same format utilized above for terrestrial coarse filter CEs. Fewer indicators were available for use in assessment of landscape species. The emphasis was on using the landscape condition model (for most species) and for others, invasive annual grasses vulnerability was an additional indicator. Table B - 30 is sorted alphabetically by the species common name, so as to keep the different habitat components together for those species with several modeled habitats (mule deer, greater sage-grouse, brewers sparrow).

Among the 28 landscape species in this ecoregion, landscape condition tends to be moderate to high across most of their distribution but with concentrated areas of low scores. This reflects the relatively dispersed, but also pervasive, effects of roads and other localized development change agents occurring across these generally widespread CE distributions (averaging 37,000 km^2). However, where landscape species tend to occur at lower elevations in all or part of the habitat range, lower scores becomes evident where roads and others forms of development tend to be concentrated. One exception to this generalized pattern appears to be for Loggerhead shrike, known to occur in open lands; including converted agricultural lands. The other consistent pattern among landscape species is a common bimodal distribution for Invasive Annual Grass scores, with on the one hand, large percentages of grid cells falling in the upper-most intervals of scores (0.9 to 1.0) while the second largest percentage falls in the lower intervals of scores (0.2 to 0.4). Given that this pattern is common among sage-brush associated species, such as Greater Sage-grouse, Pygmy Rabbit, Brewer’s Sparrow, Sage Thrasher, etc., this reflects preponderance of invasive annual grass infestation among lower-elevation portions of these species habitats, while higher-elevation portions appear to be less affected.

Greater sage-grouse, in general, shows good status scores for connectivity, especially for the 4 different lek densities; however, the occupied habitat / range distribution of this species has some poor connectivity scores in a portion of it’s range (Figure B - 48).

Table B - 30. Indicator results by 4 x 4 km grid cell for landscape species CEs (Current). For each indicator the count of 4 x 4 km grid cells is shown for each CE, broken out by indicator score interval.

KEA: Landscape Condition											
Landscape Condition Index											
	Count of 4 x 4 km grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Bald Eagle	421			50	**115**	**101**	**72**	49	29	5	
Big Brown Bat	22,216	1	1	123	744	1057	1975	**3731**	**5947**	**7097**	1540
Brazilian Free-tailed Bat	20,677		1	109	466	840	1828	**3446**	**5748**	**6843**	1396
Brewer's Sparrow - Breeding Habitat	20,093		5	96	506	1145	**2134**	**3706**	**5762**	**6060**	679
Brewer's Sparrow - Migrating Habitat	1,619				1	3	10	46	**251**	**850**	**458**
Clark's Nutcracker	12,873			16	100	383	993	**2168**	**3662**	**4798**	753
Coachwhip	9,097		1	15	142	415	775	**1395**	**2548**	**3215**	591
Columbian Sharp-tailed Grouse	1,599				7	32	210	**444**	**487**	**403**	16
Common Kingsnake	9,679			11	112	315	660	**1345**	**2816**	**3743**	677
Cooper's Hawk	18,184	3	7	200	791	1055	1673	**2985**	**4691**	**5905**	874
Desert Bighorn Sheep	3,408			1	6	33	130	**376**	**1012**	**1628**	222

Ferruginous Hawk	5,184	1	1	114	473	464	**724**	**1018**	**1299**	**936**	154
Golden Eagle	368			15	**63**	**81**	**65**	**78**	52	14	
Great Basin Collared Lizard	17,777		8	24	336	846	1620	**3032**	**5084**	**5816**	1011
Greater Sage-Grouse Lek	5,600			2	37	133	458	**1074**	**1743**	**2023**	130
Greater Sage-Grouse Lek 25	293						15	42	**94**	**135**	7
Greater Sage-Grouse Lek 50	701				2	3	45	146	**239**	**254**	12
Greater Sage-Grouse Lek 75	2,224				11	34	113	**399**	**708**	**895**	64
Greater Sage-Grouse Range	9,233				40	197	716	**1656**	**2972**	**3362**	290
Kit Fox	15,862		5	100	473	950	1722	2699	**4330**	**4563**	1020
Loggerhead Shrike	565			18	**141**	**87**	**104**	**135**	75	5	
Mule Deer Summer	4,907	1	1	2	30	85	322	1047	**1496**	**1728**	195
Mule Deer Winter	6,632			11	96	318	797	1279	**1808**	**2089**	234
Mule Deer Yearlong	3,191		1	23	143	172	187	346	**799**	**1273**	247
Northern Harrier	15,667		1	133	642	897	1674	**2776**	**4413**	**4611**	520
Northern Rubber Boa	8,942		1	131	608	686	977	**1577**	**2297**	**2442**	223
Northern Sagebrush Lizard	22,051	1	1	96	469	1058	2103	**3752**	**6066**	**7071**	1434
Prairie Falcon	21,619	1	1	129	814	1086	2001	**3741**	**5924**	**6824**	1098
Pygmy Rabbit	11,643		4	75	409	870	1363	**2141**	**3303**	**3180**	298
Sage Sparrow	14,696	2	4	67	309	691	1506	**2705**	**4368**	**4604**	440
Sage Thrasher	20,462		3	101	496	1128	2161	**3731**	**5768**	**6216**	858
Savannah Sparrow	14,966			158	907	1015	1639	**2797**	**4215**	**3881**	354
Swainson's Hawk	19,602	3	1	163	949	1114	1795	**3161**	**5038**	**6316**	1062
Western Patch-nosed Snake	4,569			9	82	133	294	**581**	**1182**	**1820**	468
White-tailed Jackrabbit	13,914		1	83	305	715	1458	**2592**	**4026**	**4264**	470

KEA: Connectivity

Landscape Connectivity Index

	Count of 4 x 4 grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Greater Sage-Grouse Lek	5,525				6	17	13	23	42	**117**	**5307**
Greater Sage-Grouse Lek 25	290										**290**
Greater Sage-Grouse Lek 50	697										**697**
Greater Sage-Grouse Lek 75	2,201				4	3	5	11	19	66	**2093**
Greater Sage-Grouse Range	9,113				**1462**	**2813**	506	323	265	311	**3433**

KEA: Stressors on Biotic Condition

Invasive Annual Grass Index

	Count of 4 x 4 grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Brewer's Sparrow - Breeding Habitat	19,963		23	**2349**	**3729**	1876	1419	1302	1324	1455	**6486**
Brewer's Sparrow - Migrating Habitat	1,609			71	**119**	**127**	100	108	127	182	**775**
Greater Sage-Grouse Lek	5,564	3	32	**796**	**988**	533	483	466	461	544	**1258**
Greater Sage-Grouse Lek 25	292			17	**33**	**34**	21	22	22	30	**113**
Greater Sage-Grouse Lek 50	700		2	77	**114**	70	57	66	58	70	**186**
Greater Sage-Grouse Lek 75	2,214		11	**268**	**382**	214	181	186	187	251	**534**
Greater Sage-Grouse Range	9,201	4	68	**1880**	**1462**	844	682	678	607	715	**2261**

Pygmy Rabbit	11,212		238	**3807**	**1692**	724	675	504	511	530	**2531**
Sage Sparrow	14,605		31	**2015**	**2398**	1249	1026	965	1042	1119	**4760**
Sage Thrasher	20,365		20	**2040**	**3584**	1938	1497	1372	1437	1555	**6922**

Maps of landscape species CEs current distribution and ecological status

The current distribution and the spatial results of the ecological status assessment for a selection of the landscape species CEs are presented in Figure B - 42 through Figure B - 55. These are organized within the ecoregional conceptual model, with species associated with Montane Dry Land System presented first, then the species found in Basin Dry Land System. Species associated with either Basin or Montane Wet System are presented as a third group of CEs.

MONTANE DRY LAND ASSOCIATED SPECIES

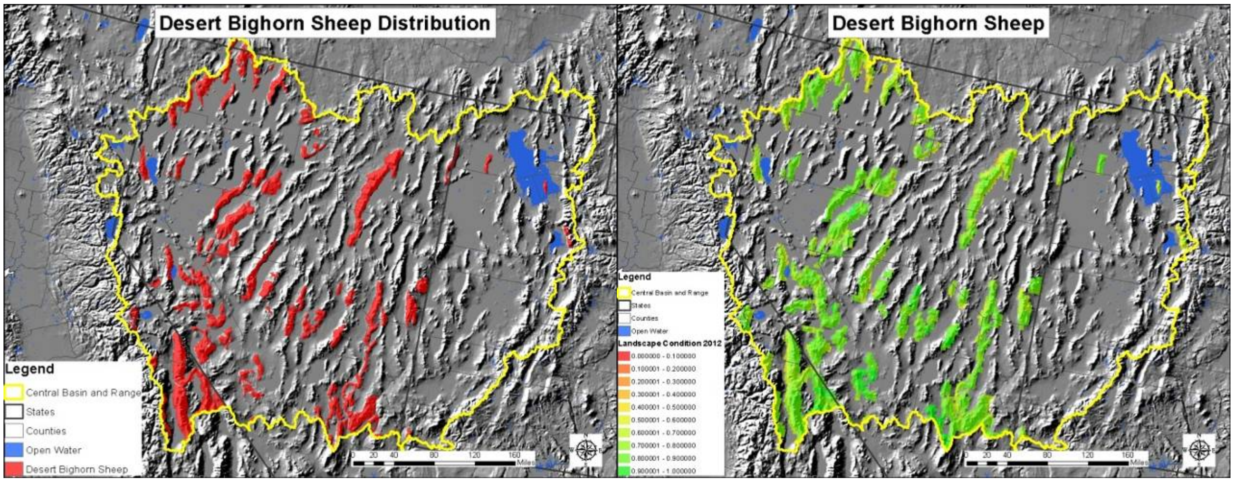


Figure B - 42. Desert Bighorn Sheep current distribution and current Landscape Condition Index scores

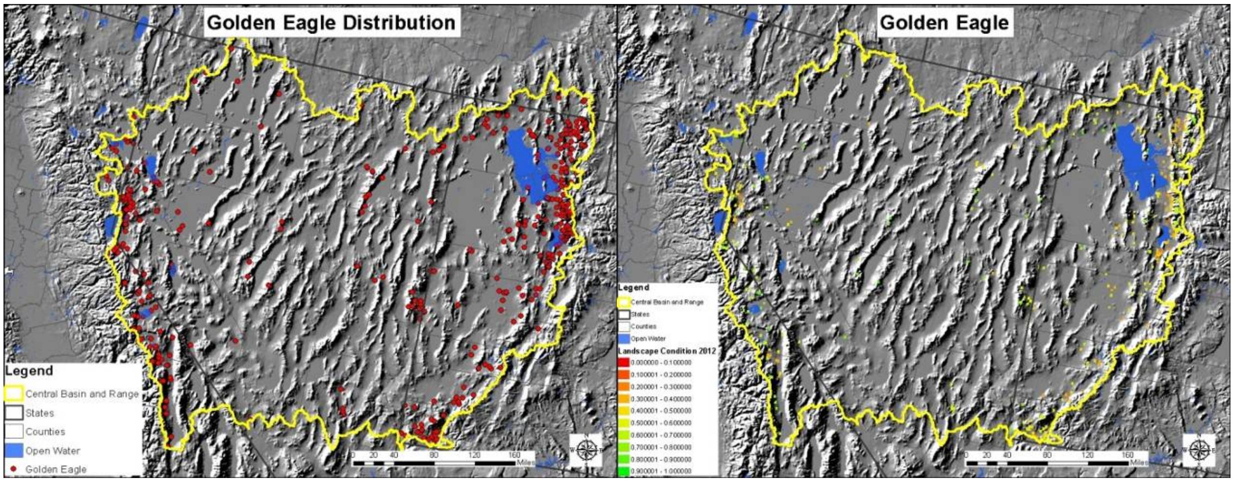


Figure B - 43. Golden Eagle current distribution and current Landscape Condition Index scores

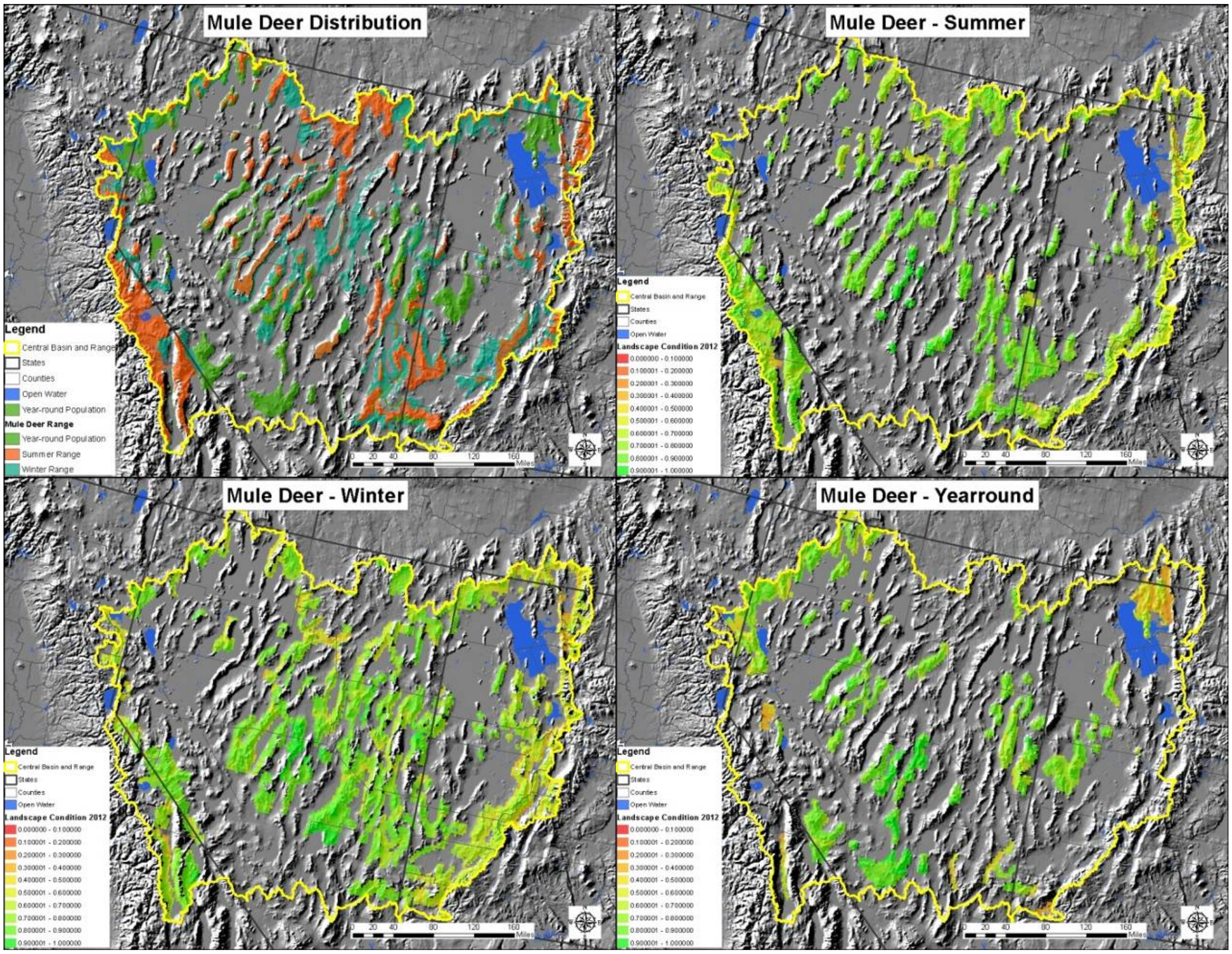


Figure B - 44. Mule Deer current distribution and current Landscape Condition Index scores for Summer, Winter, and Yearlong ranges

BASIN DRY LAND ASSOCIATED SPECIES

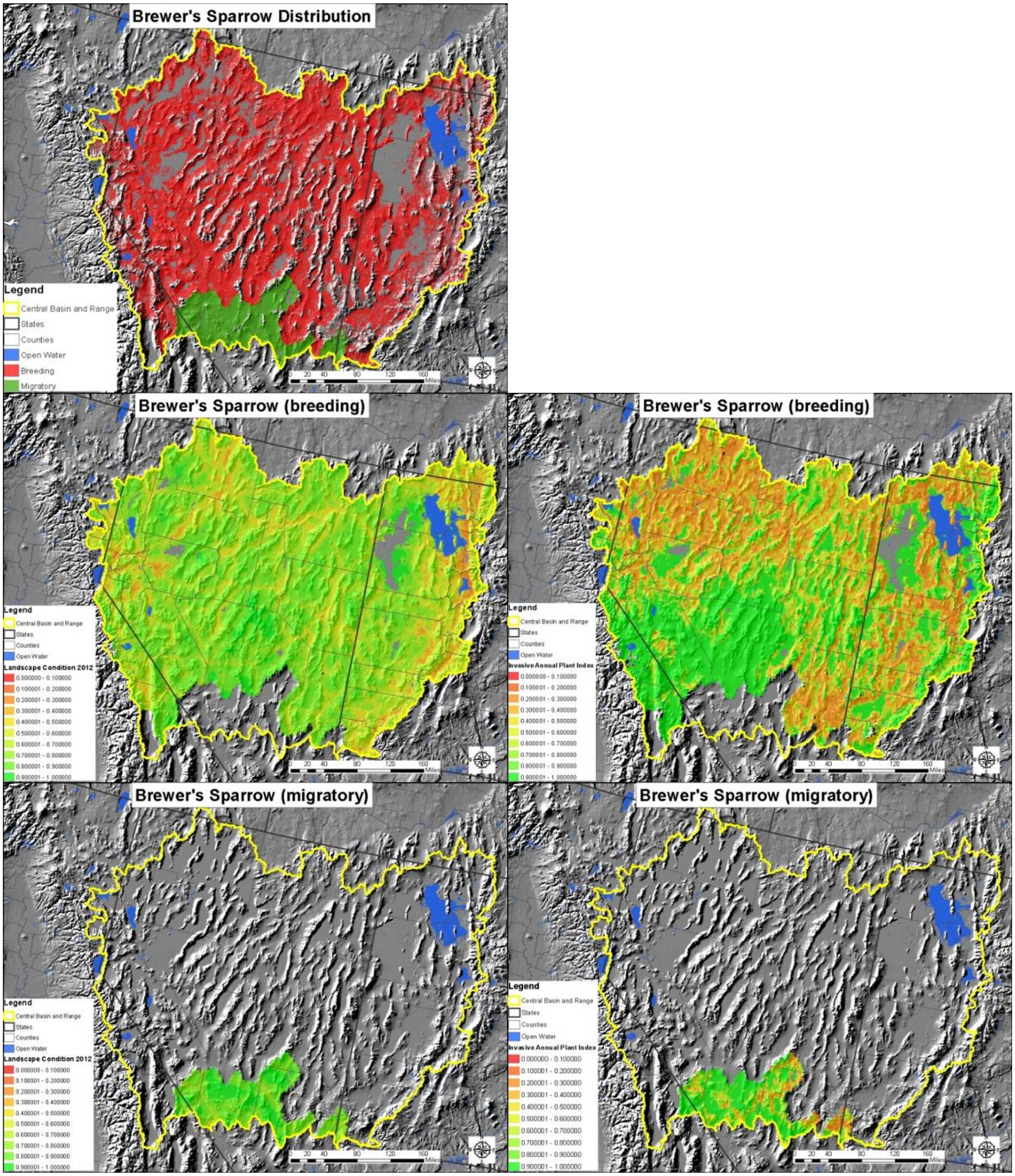


Figure B - 45. Brewer's Sparrow distribution and status: current distribution (top) and current Landscape Condition Index scores (left) and Invasive Annual Grass Index (right) for Breeding (middle) and Migratory (bottom) habitats.

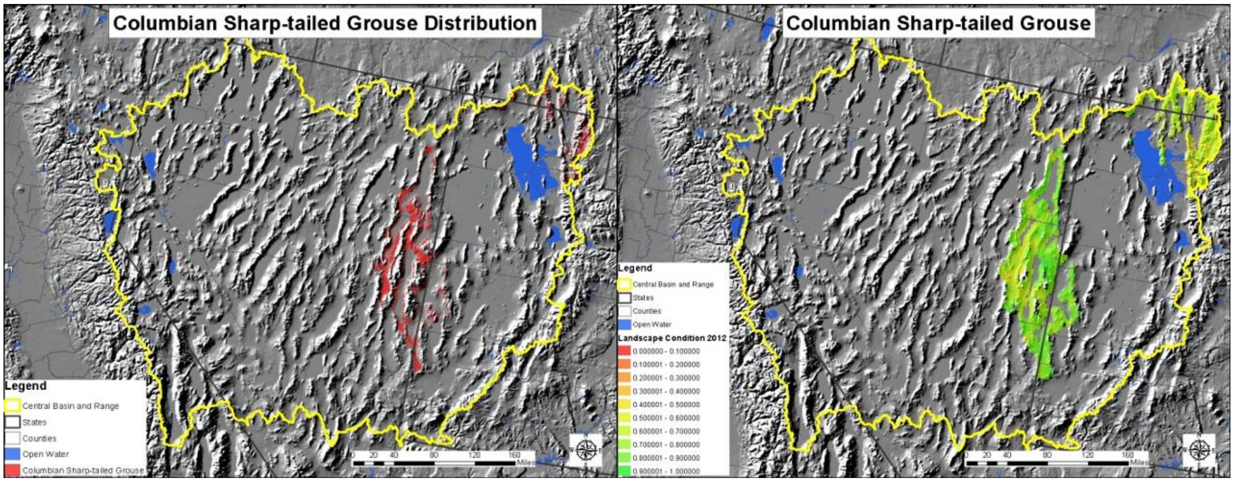


Figure B - 46. Columbian Sharp-tailed Grouse current distribution and current Landscape Condition Index scores

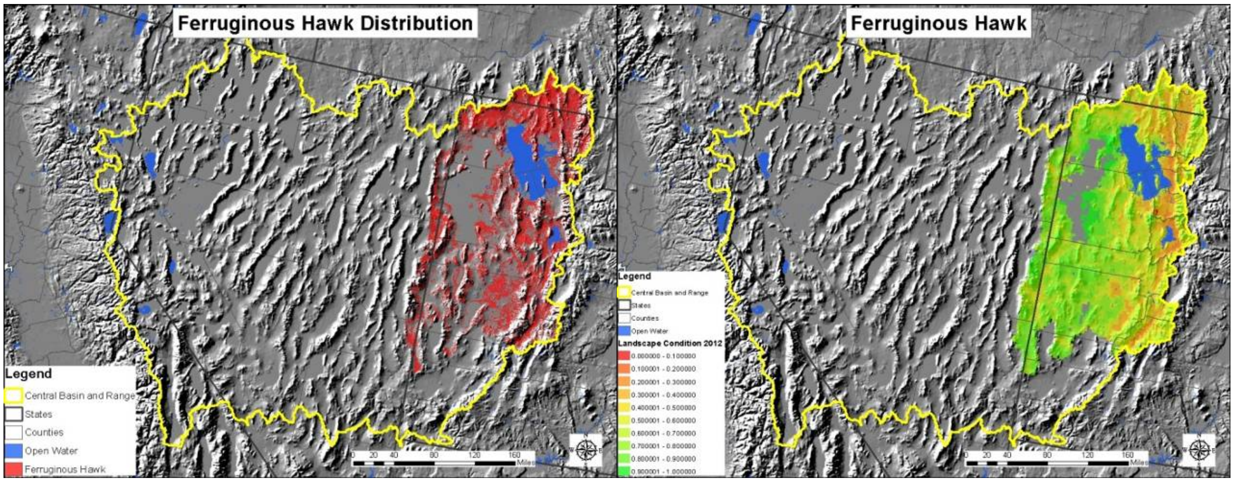


Figure B - 47. Ferruginous Hawk current distribution and current Landscape Condition Index scores

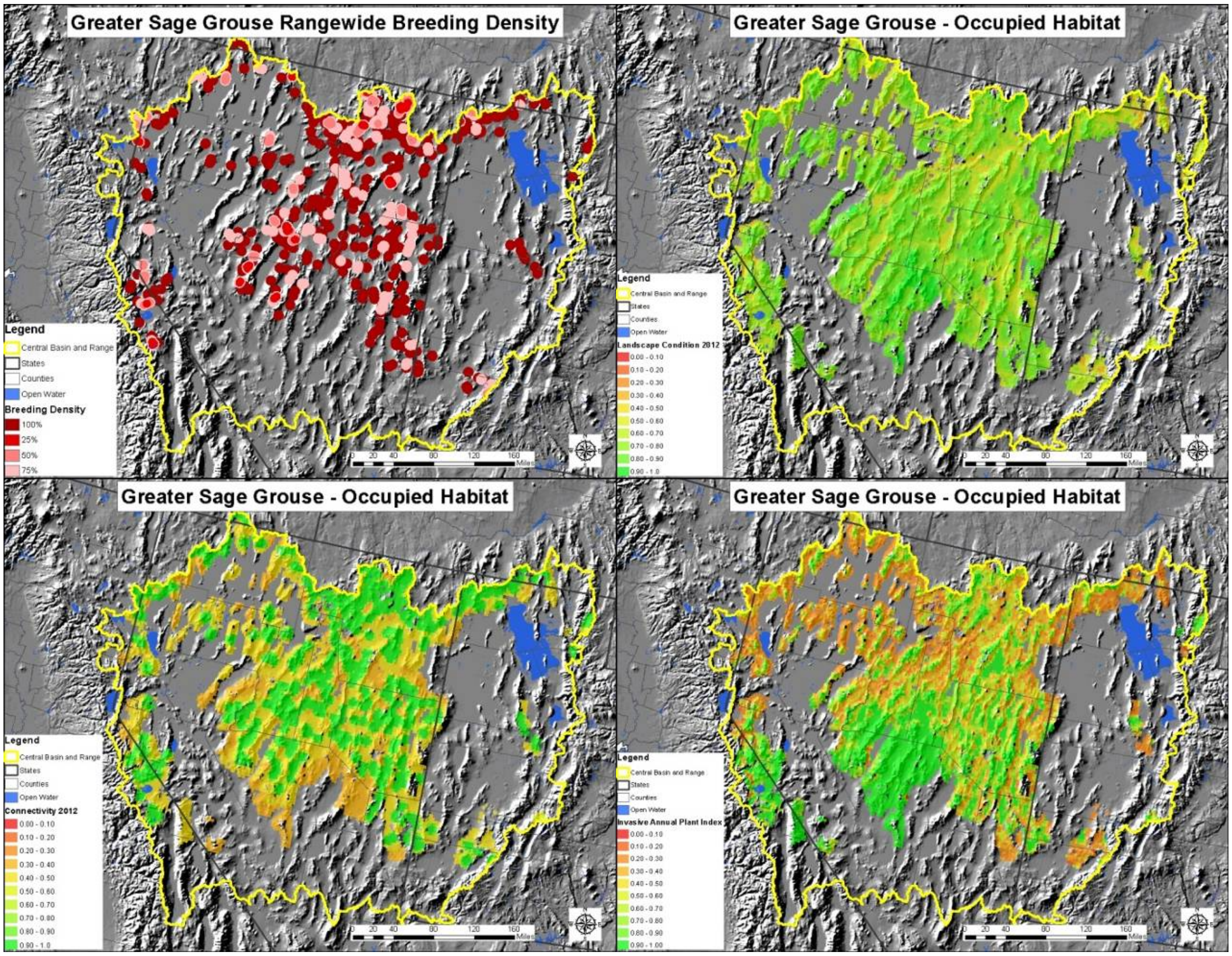


Figure B - 48. Greater Sage-Grouse rangewide breeding density and status of Occupied Habitat (range). Current status scores are shown for occupied habitat Landscape Condition Index (top right), Landscape Connectivity (bottom left), and Invasive Annual Grass Index (bottom right).

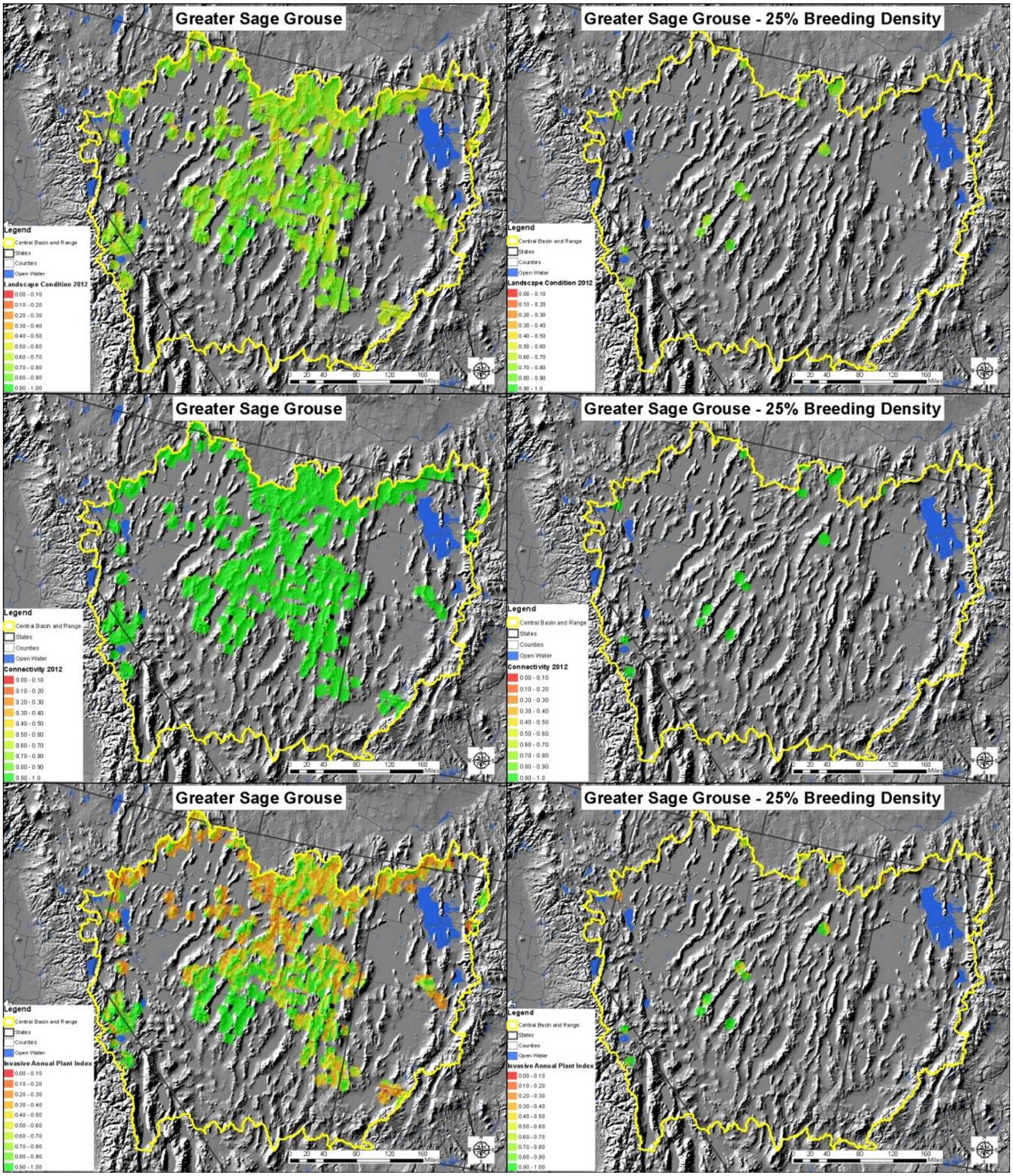


Figure B - 49. Greater Sage-Grouse status of Leks (left) and Leks with 25% breeding density (right). Current status scores are shown for Landscape Condition Index (top), Landscape Connectivity (middle), and Invasive Annual Grass Index (bottom). (See next figure for 50% and 75% breeding densities.)

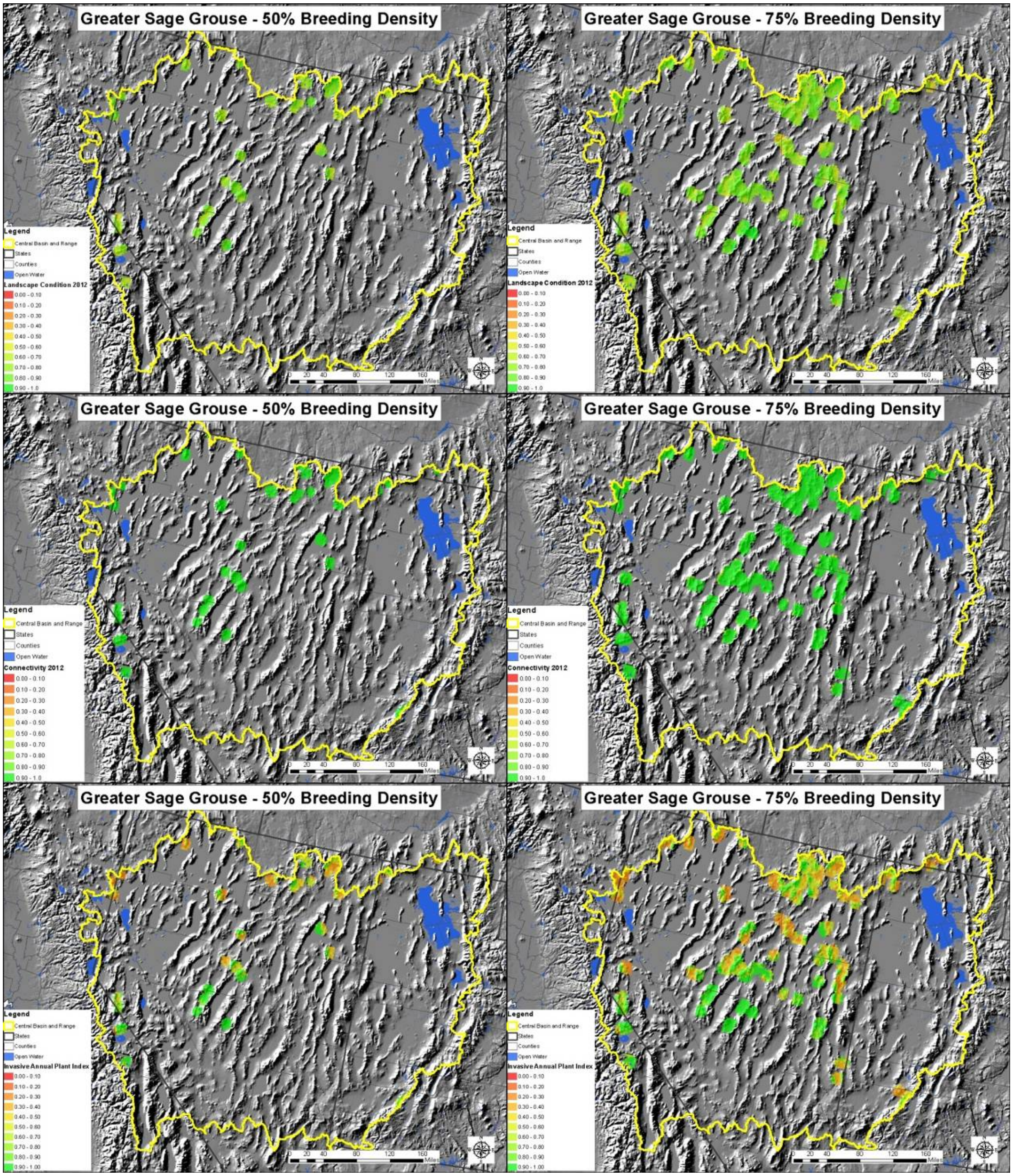


Figure B - 50. Greater Sage-Grouse status of Leks with 50% breeding density (left) and Leks with 75% breeding density (right). Current status scores are shown for Landscape Condition Index (top), Landscape Connectivity (middle), and Invasive Annual Grass Index (bottom). (See previous figure for all leks and 25% breeding densities.)

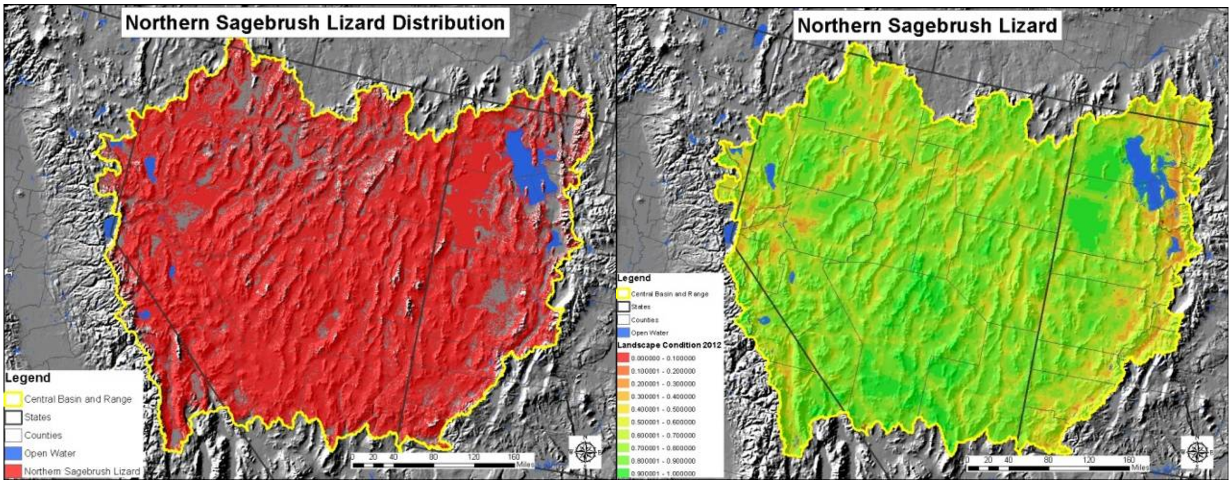


Figure B - 51. Northern Sagebrush Lizard current distribution and current Landscape Condition Index scores

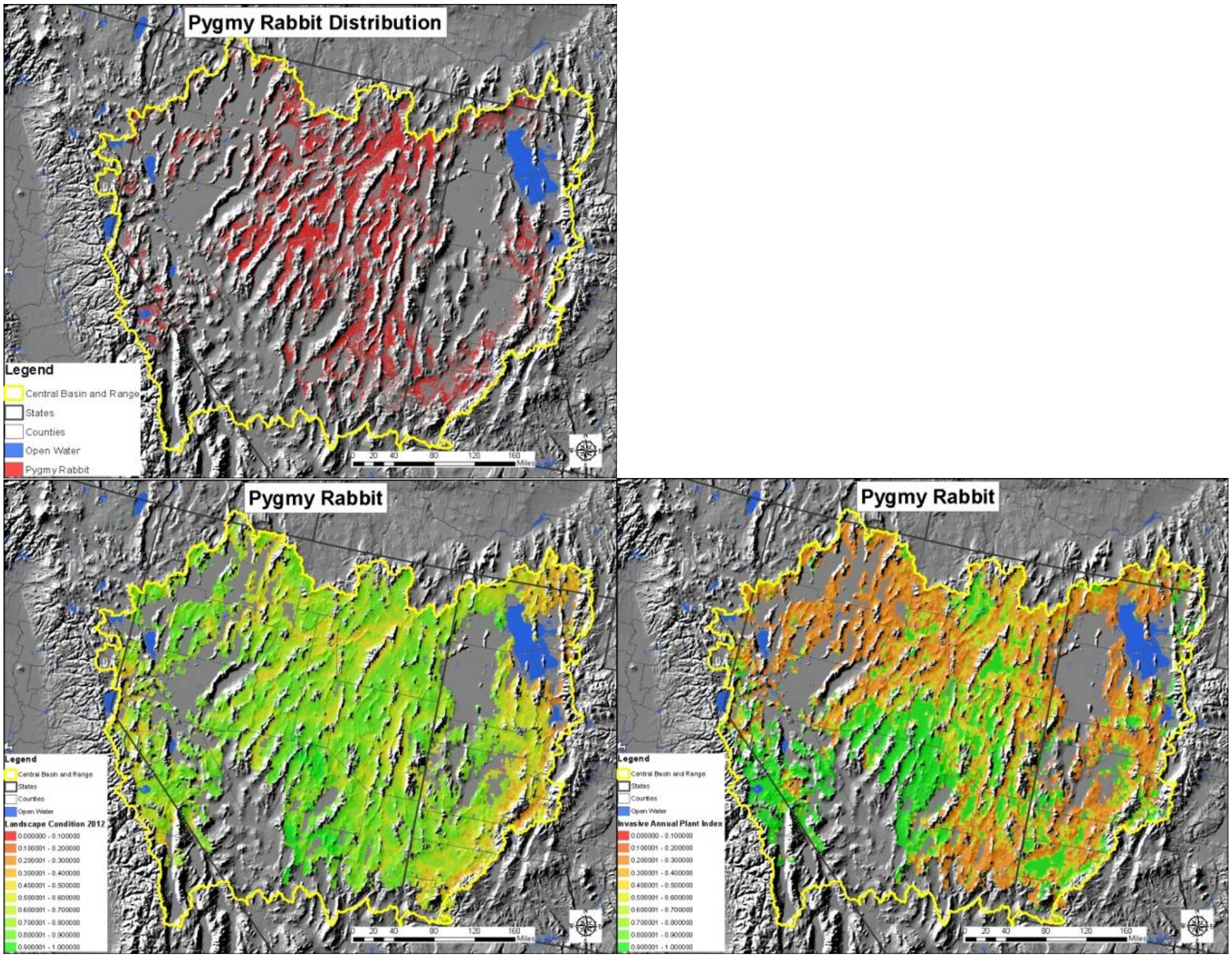


Figure B - 52. Pygmy Rabbit current distribution and status: current distribution (top), current Landscape Condition Index scores (left), and Invasive Annual Grass Index scores (right)

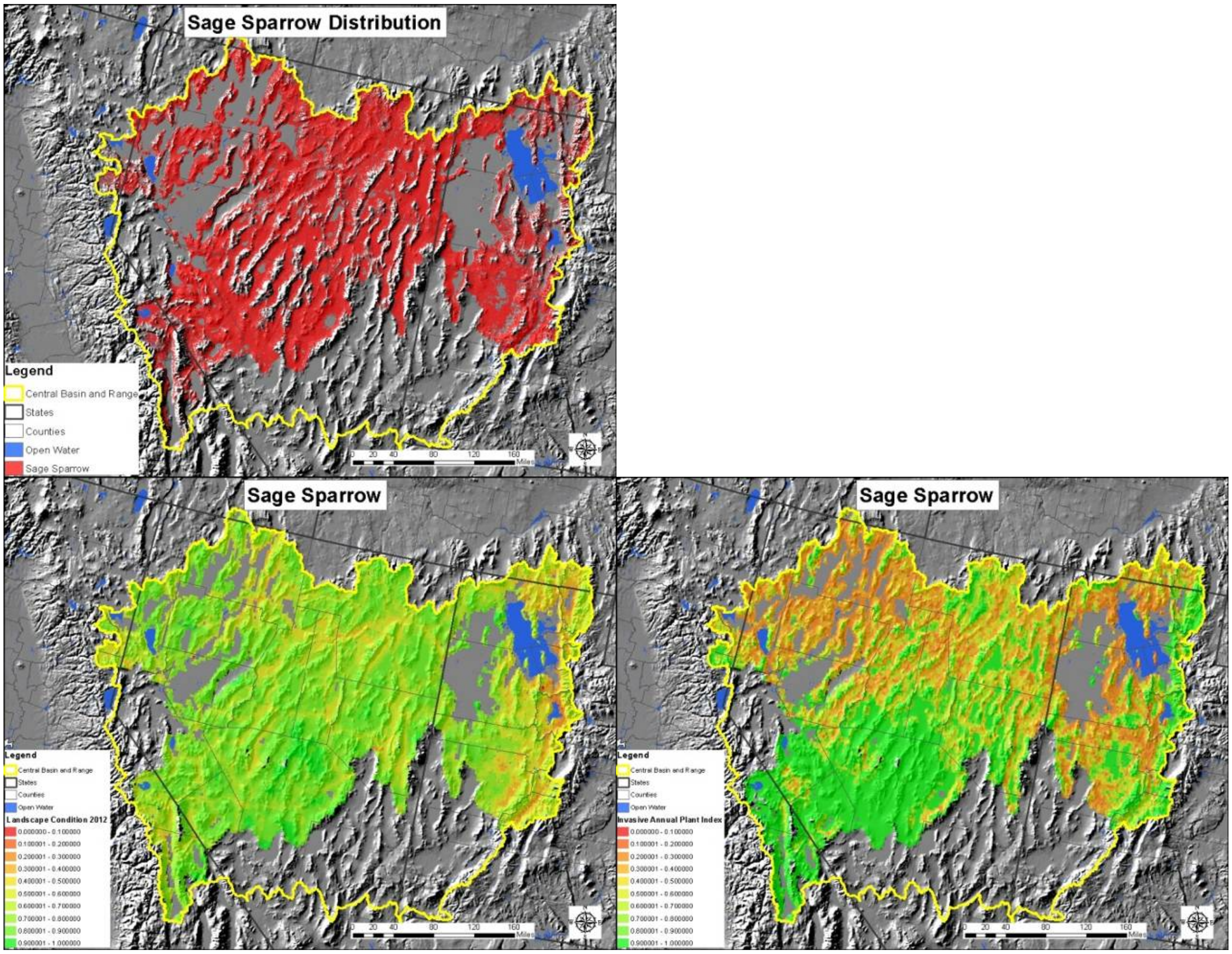


Figure B - 53. Sage Sparrow current distribution and status: current distribution (top), current Landscape Condition Index scores (left), and Invasive Annual Grass Index scores (right)

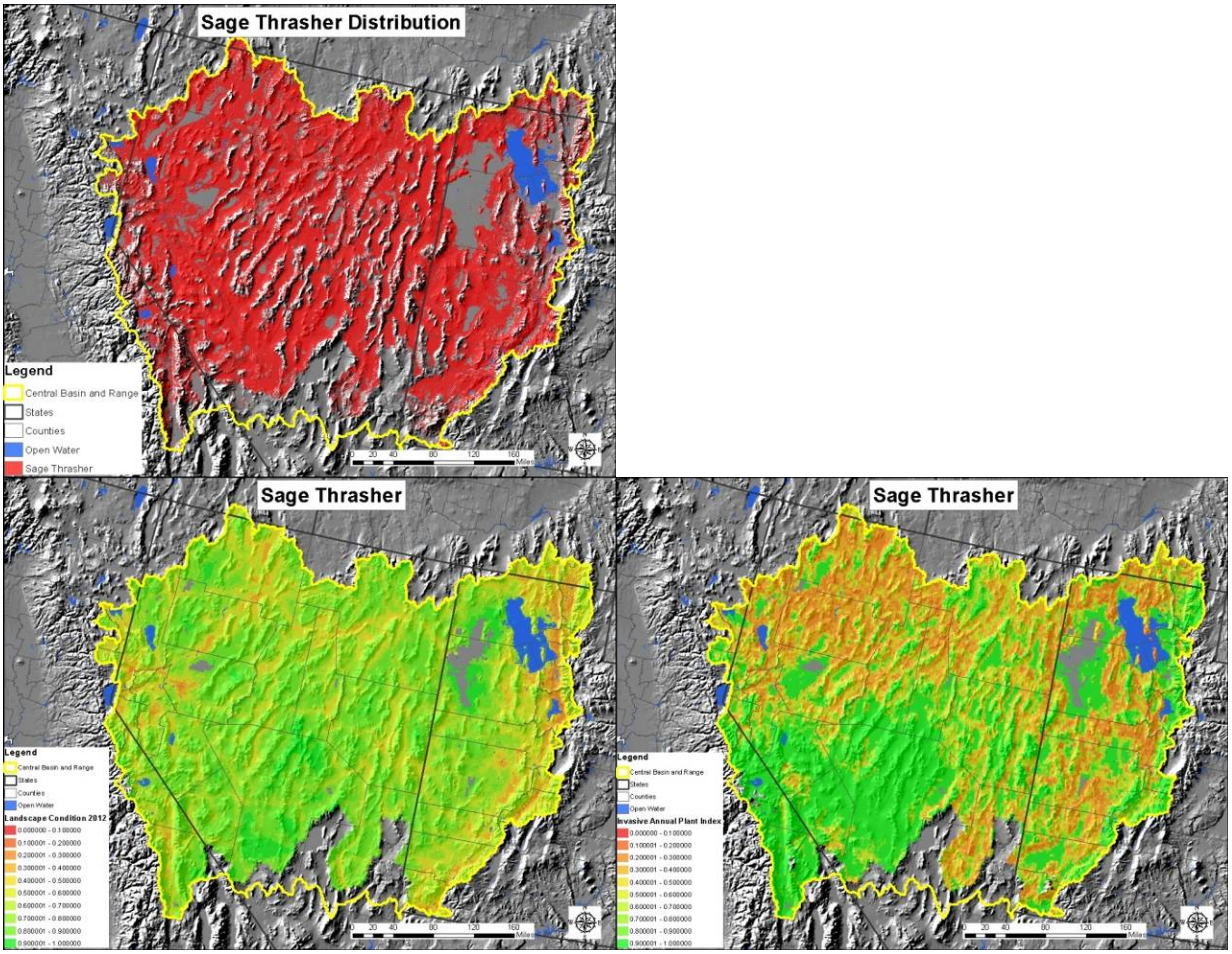


Figure B - 54. Sage Thrasher current distribution and status: current distribution (top), current Landscape Condition Index scores (left), and Invasive Annual Grass Index scores (right)

MONTANE OR BASIN WET ASSOCIATED SPECIES

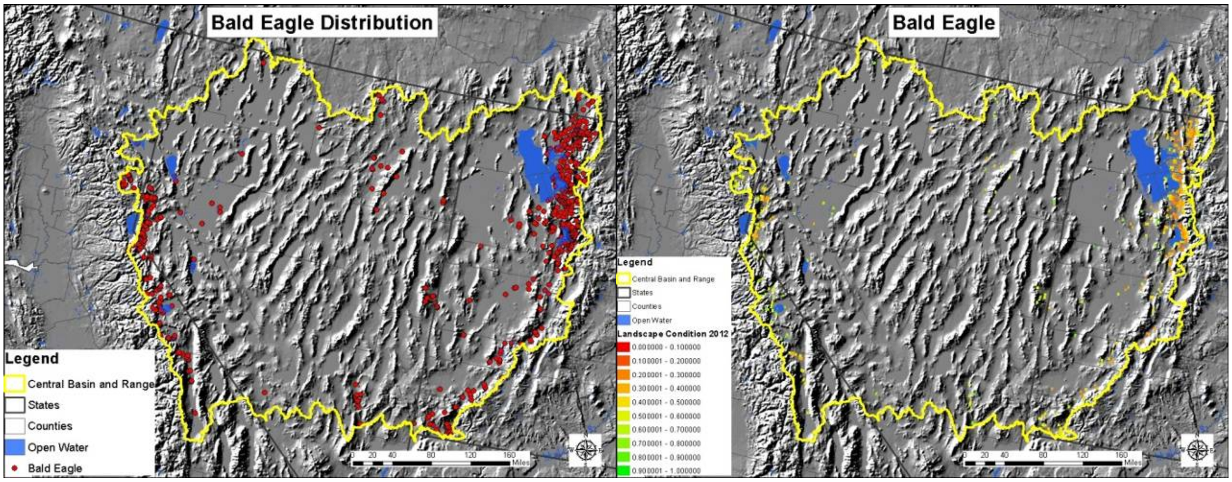


Figure B - 55. Bald Eagle current distribution and current Landscape Condition Index scores

B-2.1.3 Ecological Status: Vulnerable Species Assemblages

Distributions for vulnerable species assemblages were assessed for status across their ecoregional extent using 4x4 km grid cells. Indicators were limited to landscape condition and invasive annual grass models, both of which were developed at 90x90m spatial resolution, which was the same resolution for the modeling of assemblage distirbutions; scores were rolled up to the 4x4 km grid cells.

Landscape condition appears to be relatively high for the majority of the distribution for each of these CEs, although for Migratory waterfowl & shorebird sites, all of which include margins of waterbodies, generally fragmented landscapes are more characteristic (Table B - 31). The invasive annual grass indicator results appear to vary much more among these CEs. In each of these cases, there is a distinct bimodal distribution, where some relatively high percentage of each distribution occurs in a relatively high-quality (low invasive abundance) context. Another significant percentage though occurs within the lower intervals of scores for this indicator. This likely indicates a common elevational gradient where portions of these CEs occur above the current elevation for abundant annual invasive grasses, and another portion of the distribution falls below and squarely within the range of landscapes vulnerable to annual invasive species.

Table B - 31. Indicator results by 4 x 4 km grid cell for vulnerable Species Assemblage CEs (Current). For each indicator the count of 4 x 4 km grid cells is shown for each CE, broken out by indicator score interval.

KEA: Landscape Condition											
Landscape Condition Index											
	Count of 4 x 4 km grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Montane conifer	11,013		1	216	657	666	912	**1697**	**2726**	**3631**	507
Clay soil patches	5,501			6	45	164	386	**928**	**1783**	**1849**	340
Migratory waterfowl & shorebirds	3,205		4	131	**589**	**526**	**547**	**573**	**494**	303	38
Azonal non-carbonate rock crevices	2,167				2	13	51	164	**529**	**1100**	**308**
Azonal carbonate rock crevices	1,841	1	7	38	70	57	73	144	**414**	**862**	175
Sand dunes/sandy soils (when deep and loose)	1,801			6	77	154	241	**371**	**489**	**407**	56
Carbonate (Limestone/Dolomite) alpine	834				1	1	10	53	**190**	**506**	73
Non-carbonate alpine	535						6	33	**153**	**307**	36
Gypsum soils	27				**4**	3	3	3	**4**	**8**	2
KEA: Stressors on Biotic Condition											
Presence of Invasive Plant Species											
	Count of 4 x 4 km grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Montane conifer	11,030		178	**2082**	**1019**	732	658	632	653	759	**4317**
Clay soil patches	5,509		224	**1398**	**520**	303	237	210	236	265	**2116**
Sand dunes/sandy soils (when deep and loose)	1,801		65	**519**	**151**	80	71	67	61	72	**715**
Gypsum soils	27		1	2		1	1		1	1	**20**

Maps of Vulnerable Species Assemblage CEs Current Distribution and Ecological Status

The current distribution and the spatial results of the ecological status assessment for a selection of the vulnerable species assemblages CEs are presented in Figure B - 56 and Figure B - 57.

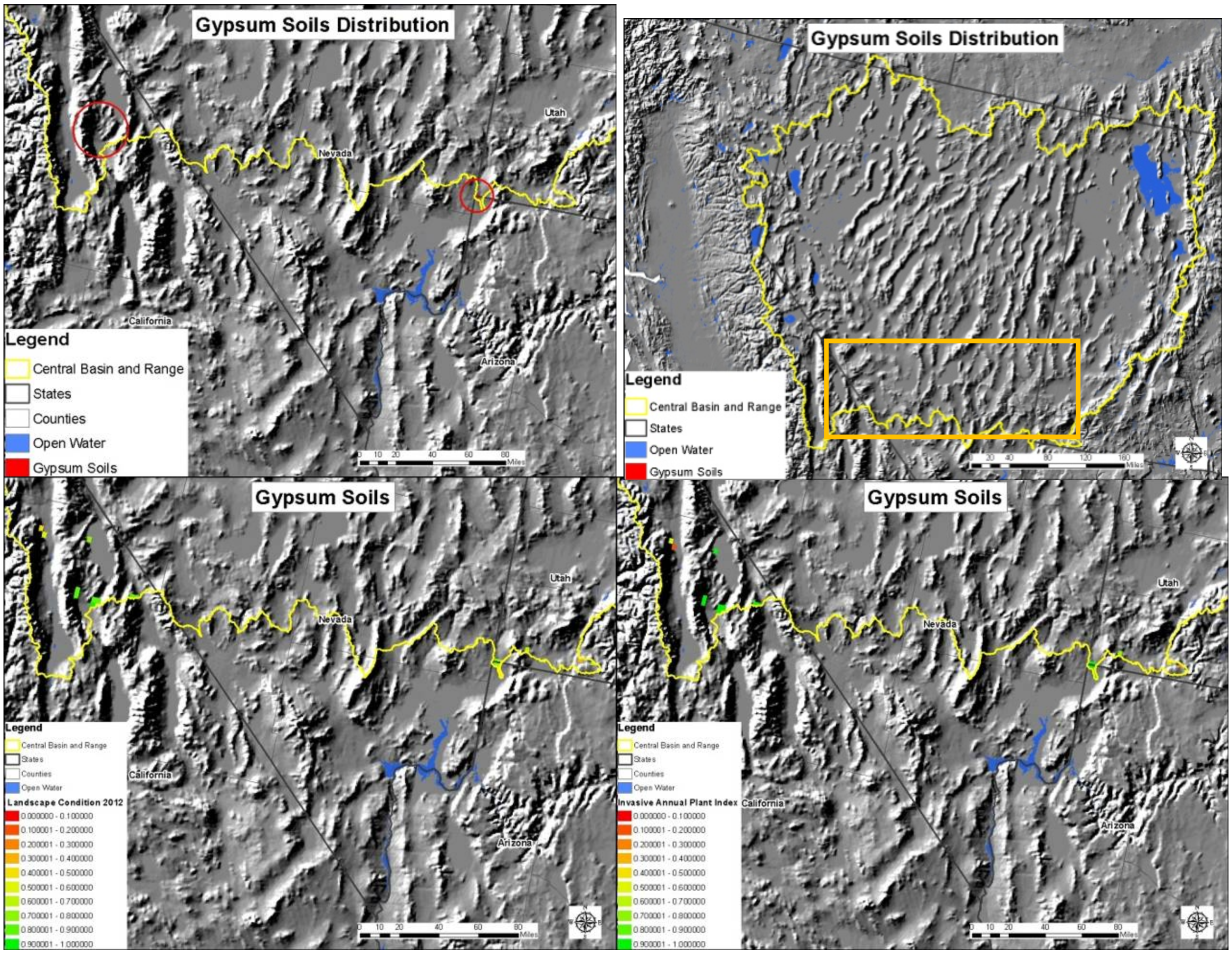


Figure B - 56. Gypsum Soils Species Assemblage distribution and status: current distribution (top left; areas of distribution shown in red circles), current Landscape Condition Index scores (bottom left), and Invasive Annual Grass Index scores (bottom right). As indicated by the orange box in the inset figure (top right), only a small southern portion of the ecoregion is shown in these maps, so that the data will be visible.

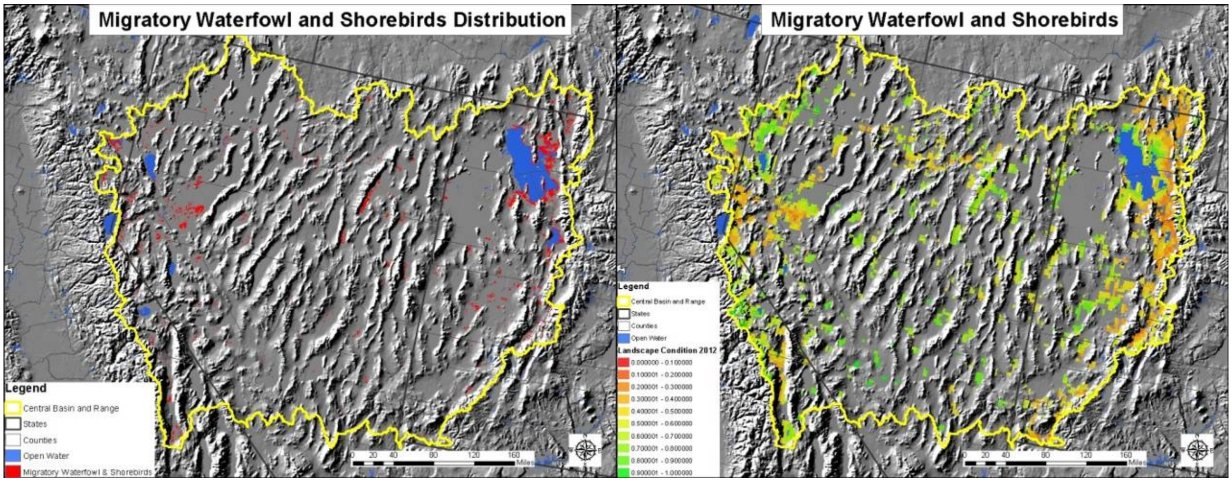


Figure B - 57. Migratory Waterfowl and Shorebirds Species Assemblage current distribution and current Landscape Condition Index scores

B-2.1.4 Ecological Status: Aquatic Conservation Elements (Methods and Results)

The ecological status of aquatic conservation elements (see Table B - 33 below) shows a consistent pattern across all coarse filter CEs. Most of the impact arises in the more developed areas of the ecoregion, where agriculture and urban development are greatest. Water quality is potentially affected by Nitrate atmospheric deposition. Atmospheric deposition of Mercury, while present, occurs at rates among the lowest in the country. Riparian areas, washes, playas, greasewood flats, springs and lakes at lower elevations are experiencing greater degrees of stressor impacts than occurrences of these CE types at higher elevations. In exception to this pattern, however, flow modification by dams has a greater impact on upper elevation riparian resources, as dams are generally located higher in the watershed. Of the 16 calculated metrics (Table B - 32), 9 are measured at the watershed scale such that the scores do not vary by CE. The remaining 7 are measured at the local scale, at the CE occurrence. These indicators scores change based on the CE type. So overall watershed summary statistics are best found in the watershed scale indicators and local, site specific scores, are available by CE by watershed.

Table B - 32. Aquatic Key Ecological Attributes and their nested indicators by scale of measurement.

Key Ecological Attribute	Occurrence Scale Indicators	Watershed Scale Indicators
I. Change in Extent/Size	01. Riparian Corridor Continuity	
II. Surrounding Land Use Context	03. Fragmentation by Dams	02. Landscape Condition Index
III. Stressors to Hydrology Condition		04. Surface Water Use
		05. Groundwater Use
		06a. Perennial Flow Modification by Diversion Structures
	06b. Flow Modification by Dams	
		07. Condition of Groundwater Recharge Zone
		KEA-Hydrology Condition (average of Indicators 4-7)
IV. Stressors to Water Quality		08a. Atmospheric Deposition - Nitrate Loading (NO_3)

		08b. Atmospheric Deposition - Toxic Mercury Loading (Hg)
	09. State-Listed Water Quality Impairments	
	10. Sediment Loading Index (within 100 m buffer)	
		KEA- Water Quality (average of indicators 8-10)
V. Stressors on Biotic Condition	11. Presence of Invasive Plant Species	
	12. Presence of Invasive Aquatic Species	

B-2.1.4.1 Aquatic Indicator Summary

I. Change in Extent/Size

Indicator 01 Riparian Corridor Continuity

Definition: Changes in riparian corridor connectivity affect the flow of animals and nutrients with larger, longer corridors providing greater extent of habitat for wildlife and increased buffering capacity to the aquatic resource. **Corridor Connectivity**—a measure of the degree to which the riparian area buffered to 200 m exhibits an uninterrupted (linear, un-fragmented) vegetated corridor.

Rationale: Historic land contemporary and use practices have impacted hydrologic, geomorphic, and biotic structure and function of riparian areas. Human land uses both within the riparian area as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian patches and riparian and upland areas. The intensity of land use within the buffered area of the riparian area is a surrogate measure for direct impact land use limiting movement of water, sediments, nutrients and animals within the aquatic corridor. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrology regime. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. The extent of this conservation element (riparian ecosystem) has decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Methods: NatureServe Terrestrial Ecosystems and Land Cover 2000-2003 and the NatureServe Landscape Condition, data current as of 2005. The distribution of a riparian CE was buffered it by 100 m (each side), and calculated the number of continuous polygons within a 5th level watershed. The Landscape Condition Model 30 m grid was overlain and where values were <.70 within the polygon, the riparian corridor was considered fragmented or broken at that point. The number of resulting polygons was divided by the original number to calculate the % or degree of continuity. Continuity was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value), where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Of the three riparian CEs, the Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland/Stream is the most abundant riparian CE and occurs at the lowest elevations within the ecoregion. This CE has the most degree of fragmentation because it primarily occurs along valley bottoms where roads, towns, power lines and other development tends to be concentrated. The Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland/Stream CE occurs at similar elevations as the former, but has a more limited distribution along the Rocky Mountain front, on the eastern side of the ecoregion. This riparian CE shows a similar pattern of highly fragmented areas within only a handful of watersheds. The upper elevation riparian CE, the Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland/Stream, occurs in the upper reaches of watersheds throughout the Central Basin ERA, and shows less fragmentation as less development has occurred in the upper elevations of each watershed. (Figure B - 58)

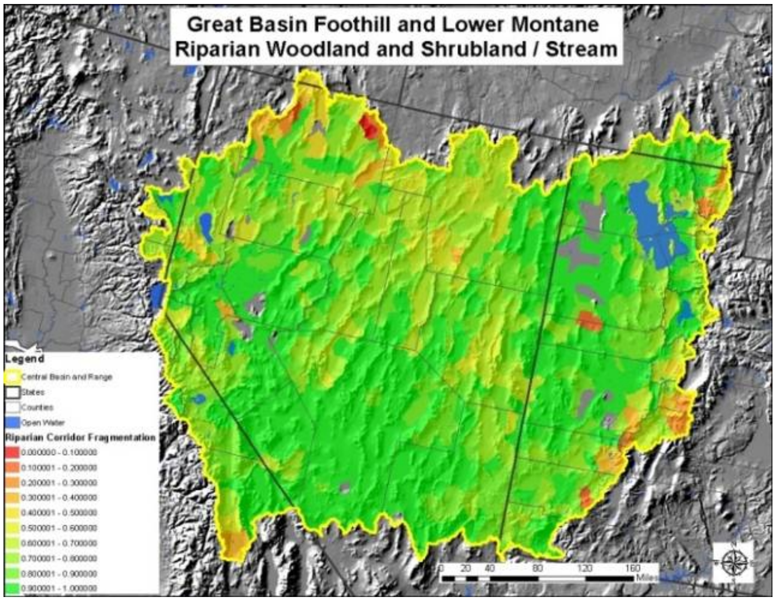


Figure B - 58. Riparian Corridor Continuity

II. Surrounding Land Use Context

Indicator 02 Landscape Condition Index

Definition: Surrounding Land Use Context—a measure of landscape condition related to land use that affects aquatic and wetland conditions. **Landscape Condition Model Index**—a measure of the intensity of various land uses on ecosystem processes, including intensity of nutrient, pollutant, sediment and surface water runoff into aquatic CEs. The Landscape Condition Index is a 30 meter by 30 meter resolution map or surface that incorporates a land use intensity rating and a distance decay function, reflecting decreasing ecological impact with distance from the source. The results are a score for landscape condition from 0 to 1 with 1 being very high landscape condition and values close to 0 likely having very poor condition.

Rationale: There are growing sets of information on various kinds of stressors that impact ecosystems. Danz et al. (2007) noted that "Integrated, quantitative expressions of anthropogenic stress over large geographic regions can be valuable tools in environmental research and management." When they take the form of a map, or spatial model, these tools initially characterize ecological conditions on the ground; from highly disturbed to apparently unaltered conditions. They can be particularly helpful for screening candidate reference sites; i.e., a set of sites where anthropogenic stressors range from low to high. Ecological condition of reference sites are further characterized to determine how ecological attributes are responding to apparent stressors. This knowledge may then apply in other similar sites. Anthropogenic stressors come in many forms, from regional patterns of acid deposition or climate induced ecosystem change, to local-scale patterns in agricultural drainage ditches and tiles, pointsource pollution, land-conversion, and transportation corridors, among others. To be effective, a landscape condition model needs to incorporate multiple stressors, their varying individual intensities, the combined and cumulative effect of those stressors, and if possible, some measure of distance away from each stressor where negative effects remain likely. Since our knowledge of natural ecosystems is varied and often limited, a primary challenge is to identify those stressors that likely have the most degrading effects on ecosystems or species of interest. A second challenge is to acquire mapped information that realistically portrays those stressors. In addition, there are tradeoffs in costs, complexity, the often varying spatial resolutions in available maps, and the variable ways stressors operate across diverse land and waterscapes.

Historic land contemporary and use practices have impacted hydrologic, geomorphic, and biotic structure and function of aquatic resources. Human land uses both within buffer zones as well as in adjacent and upland areas have fragmented many riparian reaches which has reduced connectivity between riparian and wetland patches and upland areas. The intensity of land use within the surrounding watershed affects downstream wetlands and riparian areas. Land use impacts vary in their intensity, affecting ecological dynamics that support ecological systems. This includes indices for Nutrient Loading, Sediment loading, and Surface water runoff in the surrounding 5th level watershed (10 digit watershed). The Landscape condition Model index is a surrogate measure for direct impact land use affecting the amount and timing of water, sediments, nutrients and animals movement within the surrounding landscape that supports the aquatic corridor and other resources. Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrology regime. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. The extent of this conservation element (riparian ecosystem) has decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Methods: NatureServe Landscape Condition, data current as of 2011. This index of landscape condition is modeled on the presence of various infrastructure features, anthropogenic land uses, and other factors (e.g., invasive species) that may negatively affect native biodiversity. The condition model goes beyond a basic anthropogenic footprint by incorporating the intensity of the impact of the footprint feature or land use (e.g., an interstate highway has a greater impact than an unpaved road) and the distance to which the effects of the feature or land use are felt (i.e., for some features the impact extends with decreasing intensity to some distance away from that feature). The model is 30 m pixel raster. For Aquatic conservation elements this model represents the surrounding landscape context for aquatic CEs. We averaged the values of all 30 m pixels by watershed for a 5th level watershed single value. This single average value was applied to all aquatic CEs within each watershed.

Results: The Landscape Condition Index is a summary of the total human footprint within each watershed. This 30 m by 30 m pixel grid was averaged for each watershed; therefore, all aquatic CEs within the same watershed receive the same score. The results show a slightly skewed bell shaped curve, with the most watersheds falling within the 0.6-0.7 values, slightly more watersheds fell within the 0.4-0.5 value range than in the 0.7-1.0 values range. The lowest scores are represented by a single watershed with a value of 0.2-0.3, and no watersheds fell below that. The highest impacted watersheds are located primarily in the northwestern and northeastern sections of the ecoregion, the least impacted are in the south-central portion. (Figure B - 59)

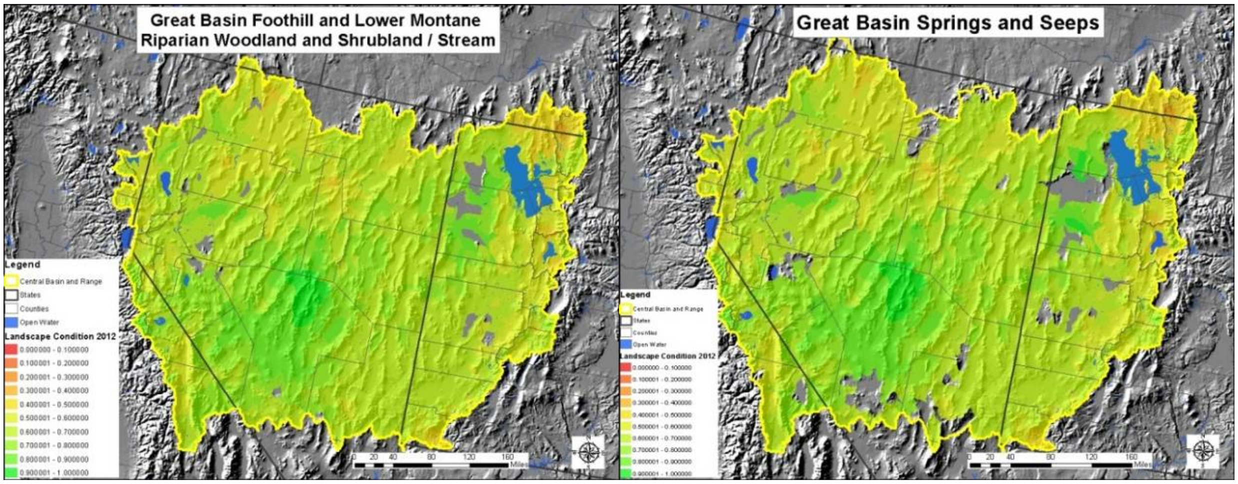


Figure B - 59. Landscape Condition Index

Indicator 03 Perennial Flow Network Fragmentation by Dams

Definition: Changes in perennial flow affect the flow of animals and nutrients with longer corridors providing greater extent of habitat for wildlife and increased buffering capacity to the aquatic resource. **Perennial Flow fragmentation by dams**—a measure of the degree to which the perennial flow is interrupted by dams (as provided by the NHD data).

Rationale: Reservoirs, water diversions, ditches, roads, and human land uses in the contributing watershed can have a substantial impact on the hydrology regime. Specifically dams limit the movement of water, sediments, nutrients and animals within the aquatic corridor. Management effects on woody riparian vegetation can be obvious, e.g., removal of vegetation by dam construction, roads, logging, or they can be subtle, e.g., removing beavers from a watershed, removing large woody debris, or construction of a weir dam for fish habitat. The extent of this conservation element (riparian ecosystem) has decreased in extent due to dams for water, agricultural and recreational development, and other flood-control activities.

Methods: National Hydrography Dataset - 1:100,000, data current as of 2005. The number of dams (designated by the National Inventory of Dams) that occur on NHD designated perennial streams were summed by each 5th level watershed. The number of Dams per watershed was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Dams are not common in the ecoregion. Only a handful of watersheds (19 or 3 %) have many (>5) dams interrupting perennial flow, and many more (75 or 12%) have only 1-3 dams. The bulk of the ecoregion watersheds have no dams (according to the NHD data). The majority of dams are located in watersheds along the eastern and western edges of the CBR, in the same general areas exhibiting high agricultural and urban development, but often at higher elevations than the areas of intensive development. (Figure B - 60)

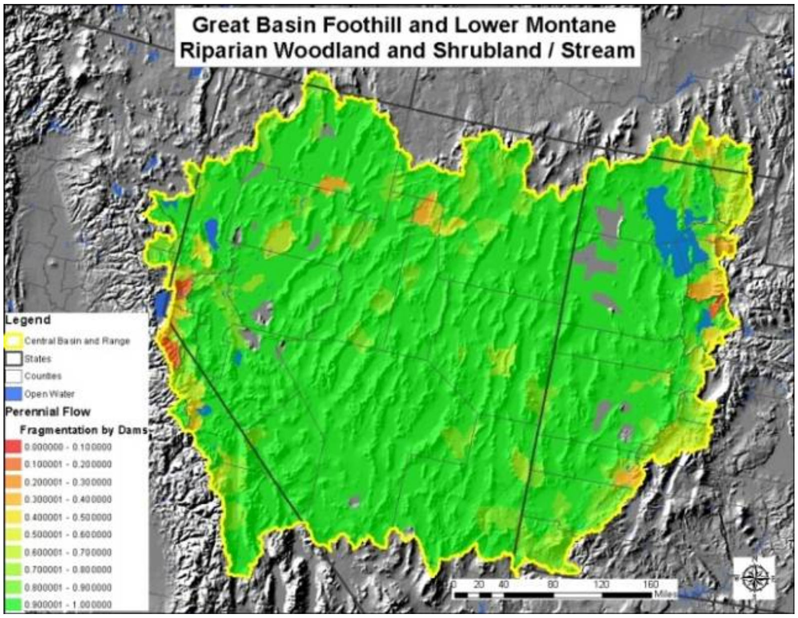


Figure B - 60. Perennial Flow Network Fragmentation by Dams

III. Stressors to Hydrology Condition

Indicator 04 Surface Water Use

Definition: Surface Water Use measures the intensity of use of surface water resources within a watershed for agricultural irrigation and for public water supply. Intensity is defined not as the absolute volume of annual consumption of surface water resources, but as the ratio of this annual consumption to the average amount of surface water available for discharge by the watershed. This ratio represents the annual rate of surface water use relative to natural surface water availability, in order to control for (i.e., cancel out) the effects of natural differences in surface water availability between watersheds due to differences in watershed size, weather, and topography. The calculation does not assume that the surface water consumed in a watershed derives exclusively from natural runoff within the watershed. It merely provides a convenient basis for making comparisons among watersheds. As the results indicate, importation of surface water (through inter-basin transfers) provides significant amounts of the surface water consumed in some watersheds.

Raw annual surface water consumption is calculated from the results of the USGS Southwest Principal Aquifers (SWPA) Study (Anning et al. 2009; McKinney and Anning 2009). The methodology for this study rests on the long-term USGS program for reporting on water use in the conterminous U.S., which reports on water use by county on a five-year cycle. The SWPA used the county values for the year 2000, and allocated water use within counties to 100 x 100 meter cells. Specifically, it allocated agricultural consumptive water use based on the distribution of irrigated lands; and allocated public water supply consumptive use based on the distribution of "urban" lands. Urban lands were defined as areas with a population density greater than 386 persons per square kilometer, based on the 2000 census. Average annual surface water availability is calculated from the National Hydrography Dataset. The raw ratio of annual surface water consumption to average annual water availability has a theoretical range from 0 to >100% for any given year, depending on weather conditions and the availability of imported surface water.

Rationale: Surface water use for agriculture and public water supply in desert ecoregions removes water from natural surface waters where it otherwise would have supported natural aquatic ecosystems. Consumptive use of surface waters reduces the total amount of surface water available to support these natural ecosystems; the timing of water withdrawals alters the timing of water availability (i.e., the hydrologic regime) in these natural ecosystems; and return flows (if any) from surface water use may alter the chemistry of natural surface waters as well as contribute to further changes in their hydrologic regime. Impoundments built to store surface water for later use also cause further alterations to the hydrologic regime of natural surface waters downstream. And water use built on imported surface water has the potential to result not only in greater water consumption but greater recharge of local aquifers and greater return flows, both of which can affect the chemistry and hydrologic regime of natural surface waters. Surface water use is thus a potentially significant stressor affecting overall water availability and the hydrologic regime of natural surface waters. These latter factors are critical to the ecological integrity of these natural surface waters. The indicator identifies watersheds in which surface water use is low or high relative to the natural availability of surface water, in order to identify those watersheds in which the risk of impacts to natural surface waters from surface water use is low or high.

Methods: USGS Southwest Principal Aquifer Study, 2008 and the National Hydrography Dataset - 1:100,000, data current as of 2005. We calculated watershed average annual surface discharge in acre-feet/year (afy) by summing the total annual flow (cfs) from NHD perennial reaches per watershed. We calculated surface water use (afy) for each watershed by summing the gridded (100m x 100m) values provided by the USGS Southwest Principal Aquifer Study for that watershed. To compare values across watersheds, we needed to correct the data for watershed size and amount of precipitation or wetness, otherwise larger and more wet watersheds would always show the highest values. By calibrating the use data by the total surface runoff we can compare water use watershed to watershed. We then calculated the ratio of surface water use to average annual surface discharge, for each watershed. To do this we had to convert the NHD-derived data on average annual surface discharge in cubic-feet/second (cfs) to acre-feet/year (afy) by multiplying cfs by 724 (rounded conversion factor). [A stream flowing at 1 cfs, 24 hours/day, 365 days/year, will discharge a total of 31,536,000 cubic feet of water, which is enough to cover an area of 1.13 square miles a foot deep in water. There are 640 acres in a square mile, and therefore 640 acre-feet in a square mile of water that is one foot deep. Hence, that dribble of 1 cfs produces 1.1312 * 640 = 724 acre-feet of water in a year.]

The resulting ratio of Surface water usage per watershed was subject to a log (base 10) transformation. To normalize the scores between 0 and 1, the lowest value was added back to each score to create all positive value scores, then converted to a normalized score by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: A persistent indicator falling into lower scores across all CEs, surface water use ranges from 0 to >23,000% of the annual available flow with individual watersheds. Once scores are log-transformed and normalized, it is clear that only a few watersheds fall into the 0.1 – 0.0 category (1,000 - 23,000% usage). Watersheds with use rates greater than 100% fall within the 0.2 - 0.3 range; with rates less than 100% fall within the 0.6 – 0.8 range; and watersheds with no usage data score 1.0. The latter three categories are the most numerous. Surface water use in the CBR ecoregion, relative to watershed size/wetness, is greatest in four sections of the ecoregion: (1) the basin floor and toe of the slope of the Rocky Mountains along the Wasatch Front, along the eastern side of the ecoregion, from the vicinity of the Great Salt Lake south to the Virgin River valley; (2) a cluster of valleys in northwestern Nevada, northwest of Winnemucca; (3) scattered watersheds along the basin floor and toe of the slope of the Sierra Nevada Range, both north and south of Carson City; and (4) along streams flowing out of scattered mountain ranges in the center of the Central basin, including in the vicinity of Elko, NV. Most of these instances involve only the use of local surface water supplies, without contributions from inter-basin transfers other than perhaps from immediately adjacent watersheds. Alterations to natural stream, river, and possibly lake hydrologic regimes are likely significant in these watersheds. (Figure B - 61)

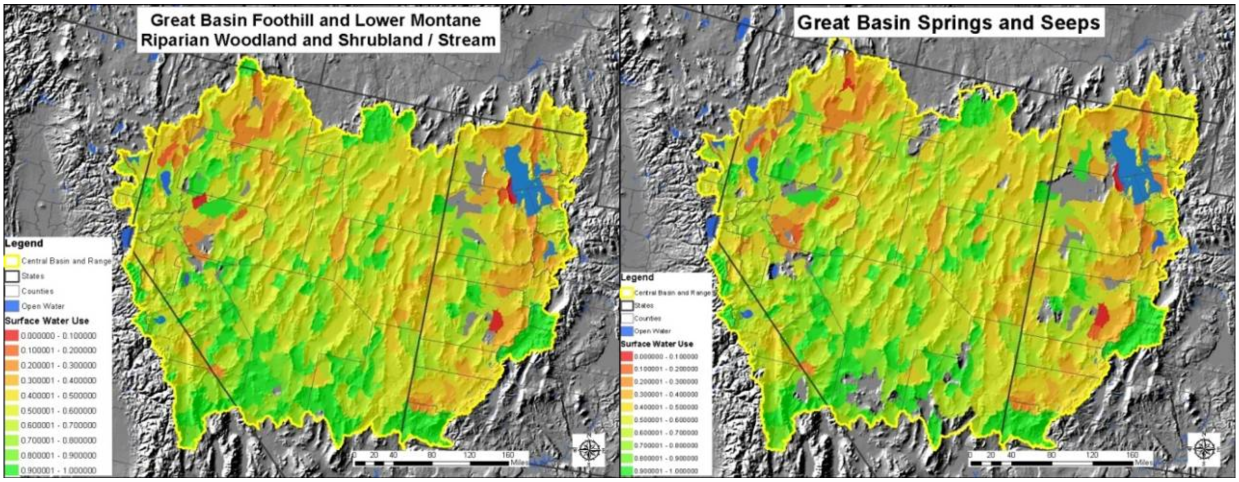


Figure B - 61. Surface Water Use

Indicator 05 Groundwater Use

Definition: Groundwater Use measures the intensity of use of groundwater resources within a watershed for agricultural irrigation and for public water supply. Intensity is defined not as the absolute volume of annual consumption of groundwater resources, but as the ratio of this annual consumption to the average amount of surface water naturally available for discharge by the watershed. This ratio merely provides a convenient basis for making comparisons among watersheds, which differ in the availability of groundwater due to differences in their size and geology, particularly the size of their basin-fill aquifer(s) and the connection of these basin-fill aquifers to regional aquifers (e.g., Heilweil and Brooks 2011). No systematic, map-ready data on groundwater resource distributions were available for the ecoregion as a whole, against which to compare groundwater use rates. Such data are available only for select areas subject to individual resource studies (e.g., BLM 2011; Heilweil and Brooks 2011). Nevertheless, some basis was needed to assess groundwater use at the watershed scale while controlling for the effects of variation in watershed size, topography, and the availability of precipitation to supply recharge. In the absence of direct measures of these effects, the availability of surface water was used instead as a basis for standardization, since this latter variable is readily quantified and is at least sensitive to variation in watershed. Use of this ratio does not require any assumption that the groundwater consumed in a watershed was recharged exclusively from the natural runoff within the watershed; or that there was any other hydrologic connection between the runoff of a watershed and its groundwater system. The ration merely allows more meaningful comparisons between watersheds.

Raw annual groundwater consumption is calculated from the results of the USGS Southwest Principal Aquifers (SWPA) Study (Anning et al. 2009; McKinney and Anning 2009). The methodology for this study rests on the long-term USGS assessment of water use in the conterminous U.S., which reports on water use by county on a five-year cycle. The SWPA used the county values for the year 2000, and allocated water use within counties to 100 x 100 meter cells. Specifically, it allocated agricultural consumptive water use based on the distribution of irrigated lands; and allocated public water supply consumptive use based on the distribution of "urban" lands. Urban lands were defined as areas with a population density greater than 386 persons per square kilometer, based on the 2000 census. Average annual surface water availability is calculated from the National Hydrography Dataset.

The raw ratio of annual groundwater consumption to average annual surface water availability for a given year can register as low as 0%, in watersheds with no groundwater use; and can register as far greater than 100% in watersheds with very high levels of groundwater use. However, a value greater than 100% *may or may not* indicate groundwater withdrawals are occurring at a rate greater than local (within-watershed) average annual recharge. The relationship between average annual surface water availability and local recharge depends on the interplay of numerous factors. These factors include the magnitude of local recharge and evapotranspiration; the effects of regional groundwater systems; and the connectivity among alluvial, basin-fill, and regional aquifers. These factors are subject to intense debate wherever conflicts arise – as they frequently do – over groundwater withdrawals (e.g., BLM 2011; GBWN 2011; Burns et al. 2011). In general, however, regional aquifer systems and rivers with alluvial deposits that span multiple watersheds may support groundwater levels in individual watersheds independent of locally available recharge (BLM 2011; Heilweil and Brooks 2011).

The raw within-watershed ratio of annual groundwater consumption to average annual surface water availability in the CBR ecoregion varies from 0% to 6,702%, but with a highly skewed distribution; most values fall toward the lower end of the scale. This skewing makes it difficult to distinguish significant differences. For example, there may be little practical difference between a watershed with a use ratio of 1,000%, from a watershed with a ratio of 6,000%; both represent instances of very intense groundwater use. Conversely, a use ratio of 50% may represent a far lower rate of use than a ratio of 100%. To facilitate analysis, therefore, the raw values were transformed to their logarithms ($\log_{10}$), resulting in a far less skewed distribution. watersheds with a raw use rate of 0 were assigned a log value equal to that of the lowest non-zero percentage measured for any watershed in the ecoregion ($\log_{10} = -3.7$). The resulting range of log values from -3.7 to +3.8 better distinguishes among use rates by their order of magnitude. For purposes of the scorecard, the results were then normalized to range from 0 to 1.

Rationale: Natural groundwater discharges in desert ecoregions, including the CBR ecoregion, support islands and corridors of aquatic and riparian biodiversity within these ecoregions, which in turn often support rare or unique biotic assemblages. The integrity of ecosystems strongly affected by groundwater discharges depends both on the amount of groundwater discharged to the ecosystem; and (usually) on the unique temperature and chemistry regimes of the groundwater, as well (e.g., Winkler, ed., 1977; Constantz 1998; Manning 1999; Deacon et al. 2007; Patten et al. 2007; Jones et al. 2009; Abele, ed. 2011; BLM 2011). Groundwater use for agriculture and public water supply in these ecoregions removes water from aquifer systems, the potentiometric surfaces and natural discharges of which originally supported groundwater levels in wetlands; spring discharges and stream baseflows; subsurface discharges to lakes; and surface water levels in wetlands that received inflows from these latter sources. The removal of groundwater therefore has the potential to disrupt several kinds of natural aquatic ecosystem types in desert ecoregions in general, including the CBR ecoregion. Groundwater withdrawals in an individual watershed potentially may also affect groundwater dependent ecosystems in other watersheds, by intercepting groundwater that otherwise would have flowed to these other watersheds along regional and alluvial aquifer flow paths.

Groundwater use is thus a potentially significant stressor affecting overall water availability, temperature, and chemistry in natural groundwater dependent habitats. The indicator identifies watersheds in which groundwater use is low or high relative to the natural availability of surface water, in order to identify those watersheds in which the risk of impacts to natural surface waters from groundwater use is low or high. These risks may apply within the immediate watershed where the use takes place, or in additional watersheds that lie down-gradient along regional and alluvial groundwater flow paths. Mapping such possible groundwater flow paths, however, was not possible within the scope of this rapid assessment; such flow paths are in fact commonly topics of great uncertainty and debate (e.g., Deacon et al. 2007; BLM 2011; GBWN 2011; Burns et al. 2011).

Development of the CBR ecoregion for human settlement and farming has necessarily involved withdrawals of groundwaters. These withdrawals have reduced or eliminated natural groundwater contributions to springs, streams, seeps, and wetlands. The sustainability of this development of water resources is a topic of increasing heated debate, particularly as surface water supplies become increasingly over-allocated and uncertain (e.g., Gleick 2010; Deacon et al. 2007; BLM 2011; GBWN 2011; Burns et al. 2011; SNWA 2011).

Methods: USGS Southwest Principal Aquifer Study, 2008 and the National Hydrography Dataset - 1:100,000, data current as of 2005. We calculated watershed average annual surface discharge in acre-feet/year (afy) by summing the total annual flow (cfs) from NHD perennial reaches per watershed. We calculated groundwater use (afy) for each watershed by summing the gridded (100m x 100m) values provided by the USGS Southwest Principal Aquifer Study for that watershed. To compare values across watersheds, we needed to correct the data for watershed size and amount of precipitation or wetness, otherwise larger and more wet watersheds would always show the highest values. By calibrating the use data by the total surface runoff we can compare water use watershed to watershed. Even though the amount of surface runoff may have no bearing on the amount of groundwater available or its rate of re-charge, there are no groundwater data available for this REA, and again we wanted to calibrate the use data in order to compare watershed to watershed use data. We then calculated the ratio of groundwater use to average annual surface discharge, for each watershed. To do this we had to convert the NHD-derived data on average annual surface discharge in cubic-feet/second (cfs) to acre-feet/year (afy) by multiplying cfs by 724 (rounded conversion factor). [A stream flowing at 1 cfs, 24 hours/day, 365 days/year, will discharge a total of 31,536,000 cubic feet of water, which is enough to cover an area of 1.13 square miles a foot deep in water. There are 640 acres in a square mile, and therefore 640 acre-feet in a square mile of water that is one foot deep. Hence, that dribble of 1 cfs produces 1.1312 * 640 = 724 acre-feet of water in a year.]

The resulting ratio of groundwater usage per watershed was subject to a log (base 10) transformation. To normalize the scores between 0 and 1, the lowest value was added back to each score to create all positive values, then converted to a normalized score by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Groundwater use ranges from very high to no use at all, with the greatest number of watersheds falling into the .3-.6 range (4-35% use), while a few very intensive agricultural use watersheds with trans-basin inputs score the worst .1- 0.0 (500% - 6000%). Groundwater use is the CBR ecoregion is highest in approximately the same four sections of the ecoregion where surface water use also is highest: (1) the basin floor and toe of the slope of the Rocky Mountains along the eastern side of the ecoregion, from the vicinity of the Great Salt Lake south to the Virgin River valley; (2) a cluster of valleys in northwestern Nevada, northwest of Winnemucca; (3) scattered watersheds along the basin floor and toe of the slope of the Sierra Nevada Range, both north and south of Carson City; and (4) in scattered valleys in the center of the Central basin, including in the vicinity of and just west of Elko, NV. Most of these instances involve center-pivot irrigation. Withdrawals from alluvial, basin fill, and regional aquifers have the potential to affect the hydrologic regime of perennial streams, wetlands, and springs in all affected watersheds. It should be noted that these results are for existing conditions. Projections of future groundwater use in the basin are addressed elsewhere in this assessment; they are subject to estimates of future population growth and density, and to decisions about possible proposed projects to withdraw and transport groundwater from several watersheds to support water consumption in the Las Vegas metropolitan area (SNWA 2011). (Figure B - 62)

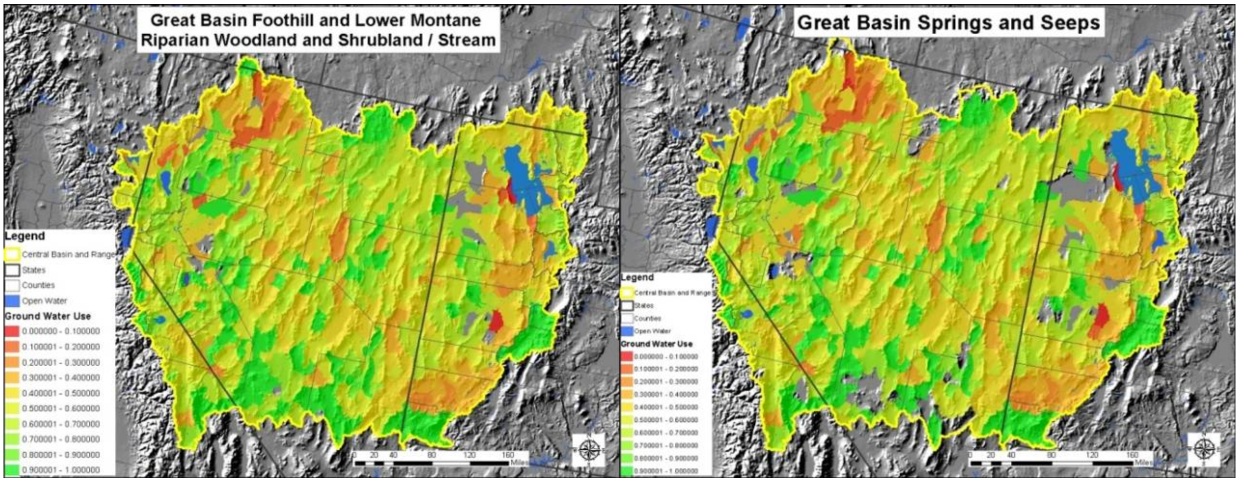


Figure B - 62. Groundwater Use

Indicator 06a Perennial Flow Modification by Diversion Structures

Definition: Flow modification by diversion structures (aqueducts) is measured by a tally of the number of diversions per watershed. During the growing season and periods of high flow, diversions modify the downstream flow and can lower the peak flow, changing the dynamics of the stream flow, nutrient and oxygen inputs, thereby altering the habitat for aquatic species and other species that utilize the stream habitat. Data on the timing and amount of flow diverted was not available ecoregion-wide, so the number of diversions per watershed is a surrogate for the degree of potential flow modification by diversion within the watershed.

Rationale: Most diversions on natural river channels operate on a schedule designed to divert water when it is abundant. The diversions are mainly for irrigation (Graf 1999; Collier et al. 2000). These actions can significantly alter the flow regime downstream from the diversion point in a watershed, at the very least by reducing high-flows, diversions from the reservoirs can reduce total annual discharge (see also Poff and Hart 2002; Graf 2006; Poff et al. 2007; Richter and Thomas 2007). The resulting flow alterations can restructure the entire aquatic and riparian ecosystem, reducing or eliminating the natural pattern of variation in water availability and flow velocities to which the native plant and animal communities have evolved their unique adaptations (e.g., Richter et al. 1996; Richter et al. 1997; Poff et al. 1997; Merritt et al. 2010; Poff et al. 2010).

Methods: National Hydrography Dataset - 1:100,000, data current as of 2005. The number of aqueducts intersecting or branching from NHD perennial streams, total per Huc. The number of aqueducts that intersected perennial reaches as defined by NHD were summed per watershed. These values were applied to riparian and lake CEs. The number of diversions per watershed was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Aqueducts impact stream flow and lake levels, but the number of watersheds with aqueducts is limited in this ecoregion. Watersheds with high numbers of diversion structures, not surprisingly, generally lie uphill from watersheds with high intensities of surface water use (see Indicator 04, above). The only exception to this pattern is in northwestern Nevada, northwest of Winnemucca, where surface water use is high but the density of diversion structures is low. This exception probably indicates only that the diversions in this latter area are too small and localized to appear in the National Hydrology Dataset. The watersheds with the absolute highest numbers of diversion structures are all located at higher elevations along the east slope of the Sierra Nevada Range, suggesting a high potential for hydrologic alteration among streams emerging from these elevations within these watersheds. (Figure B - 63)

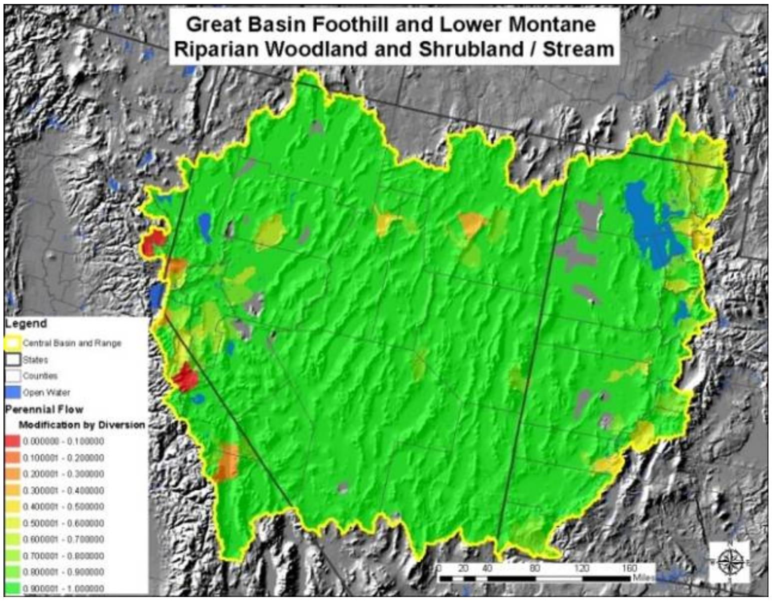


Figure B - 63. Perennial Flow Modification by Diversion Structures

Indicator 6b. Flow Modification by Dams

Definition: Flow Modification by Dams measures the capacity of dams within a watershed to alter the flow regime of the watershed. Specifically, it uses the "F" Index developed by Theobald et al. (2010) to assess the cumulative storage capacity of dams within a watershed relative to the average annual unaltered stream discharge from that watershed. A higher value of this Index in a watershed indicates that the dams in that watershed have a greater cumulative capacity to alter flows by storing and releasing water. Use of the index does not require any assumptions about dam operations, which can vary in the extent to which they alter the flow regime. The index merely provides a convenient basis for making comparisons among watersheds based on the potential capacity of dams to modify the flow regime in each watershed.

The specific methods used to calculate the raw values are presented in Theobald et al. (2010). Their analysis used data on dams and their associated reservoirs from the 2007 National Inventory of Dams (NID; USACE 2008). The NID contains data on dams that meet any of several criteria related to height, hazard classification, and reservoir storage volume. Average annual unaltered discharge per watershed was estimated using regression-based equations developed by Vogel et al. (1999). The equations estimate average annual discharge as a function of catchment area, average annual precipitation, and average temperature.

The raw values for the Index were calculated on a 6th-Level watershed scale. In order to attribute these values to specific riparian/stream CE types, these raw values were averaged separately for lower (<1,200 m elevation) and higher (>1,200 m elevation) portions of each 5th-Level watershed. This elevation break corresponds to the difference between the lower- versus higher-elevation riparian/stream CE types in the ecoregion.

The raw value for the index can register as low as 0.0 in watersheds with no dams; and can register above 1.0 in watersheds with reservoirs designed to hold more than a single year of runoff and/or to store water transferred from another basin (Theobald et al. 2010). The present analysis capped high values at 1.0 to minimize the effects of such unusual conditions on the overall distribution of F values.

The raw watershed values of the index in the MBR ecoregion therefore range from 0.0 to 1.0 (least to most altered). For purposes of the scorecard, these raw results were then normalized to range from 1.0 to 0.0 (least to most altered).

Rationale: Most dams on natural river channels operate on a schedule designed to store water when it is abundant and release it when it is less so. The reasons for these operations may be to minimize downstream flooding; shift the time of year when water is available for irrigation, navigation, or hydropower generation; or any combination of these purposes (Graf 1999; Collier et al. 2000). These actions can significantly alter the flow regime downstream from the dam(s) in a watershed, at the very least by reducing high-flows, increasing low-flows, and changing the timing of both; and diversions from the reservoirs can reduce total annual discharge (see also Poff and Hart 2002; Graf 2006; Poff et al. 2007; Richter and Thomas 2007). The resulting flow alterations can restructure the aquatic and riparian ecosystem, reducing or eliminating the natural pattern of variation in water availability and flow velocities to which the native plant and animal communities have evolved their unique adaptations (e.g., Richter et al. 1996; Richter et al. 1997; Poff et al. 1997; Merritt et al. 2010; Poff et al. 2010).

Dam storage capacity is a key variable determining the ability of dam operations to alter the flow regime of a watershed. Individual dams within a watershed typically operate in tandem, so that the operations at individual dams enhance or, at the very least, do not interfere with each other (Graf 1999; Collier et al. 2000; Poff and Hart 2002; Graf 2006; Poff et al. 2007; Richter and Thomas 2007). The combined storage capacity of the reservoirs in a watershed, relative to the volume of water normally discharged by that watershed, thus provide a useful indicator of the capacity of reservoirs in a watershed to alter the flow regime (Theobald et al. 2010). However, the analysis requires careful consideration of the placement of dams within a watershed. Dams placed at higher elevations may cause significant changes to flow patters at these higher elevations. However, unless dams are also present at lower elevations, cumulative inflows from other tributaries at lower elevations below the higher-elevation dams can reestablish the basic shape of the flow regime.

This indicator therefore measures the potential for flow alteration associated with dams, rather than actual flow alteration. Measuring actual flow alteration across an ecoregion requires a dense network of stream gages with long-term records. Unfortunately, long-term stream gage data are extremely scarce in the CBR ecoregion, except for the few perennially flowing river reaches on valley floors, and these records are highly altered by the history of water use in these valleys. As a result, this assessment focuses on factors that are predictive of flow alteration, i.e., at stressors rather than actual stress.

Development of the CBR ecoregion for human settlement and farming has necessarily involved the use of dams to control and divert surface waters for human consumption, and for flood control. A need for hydropower generation has never driven dam construction in the ecoregion. The use of large reservoirs to store inter-basin transfers appears minimal. The sustainability of surface water use is a topic of increasing debate (e.g., Gleick 2010). The CBR ecoregion contains only a few rivers and perennial streams with sufficiently predictable and potable discharges to support large-scale diversions, and these are heavily used, as shown in the results for this indicator and for Indicators 04, Surface Water use and 06a, Perennial Flow Modification by Diversion Structures.

Results: Most dams in this ecoregion are located in upper reaches of watersheds and therefore affect more of the Rocky Mountain Subalpine Riparian CE than any other aquatic CE type. This indicator provides information consistent with the findings for 04 and 06a: Watersheds with impoundments that have the capacity to store a large fraction of the drainage network runoff occur exclusively along the Wasatch Front of the Rocky Mountains and the eastern front of the Sierra Nevada Range. However, only three watersheds have significantly low score values for this indicator, indicating a high level of flow modification by dams: one watershed southeast of the Great Salt Lake; one in the Virgin River basin; and one just north of Reno/Sparks, NV. (Figure B - 64)

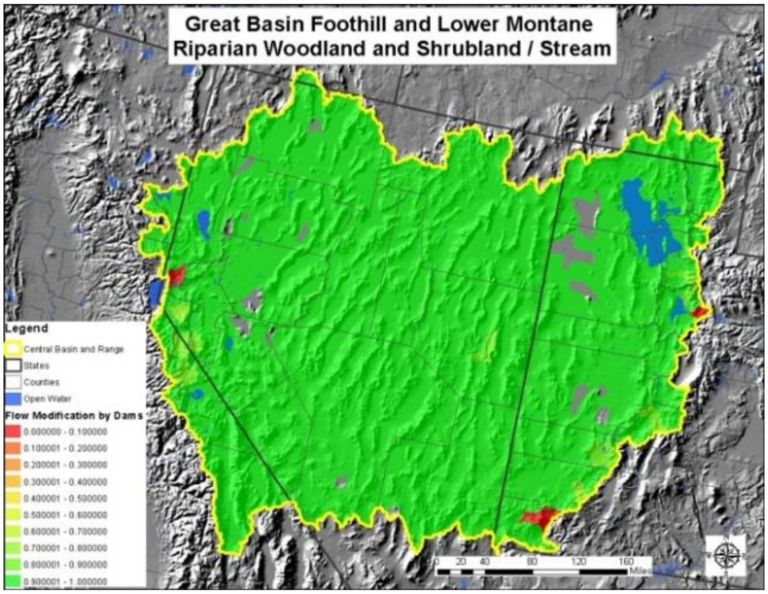


Figure B - 64. Flow Modification by Dams

Indicator 07 Condition of Groundwater Recharge Zones

Definition: Groundwater Recharge Zone Condition is a measure of the degree of human footprint that prevents or inhibits groundwater recharge. Groundwater recharge zones are specific areas where runoff is likely to seep into shallow and deep aquifers. A simple model of likely groundwater recharge zones was developed, identifying topographic areas above 6,562 feet (2,000 m) as likely recharge zones (see below). The amount of hard surface development (pavement, asphalt, buildings, roads, paved parking areas and the like) within these zones prohibits water from entering the aquifers.

Rationale: Regional groundwater flow in the CBR occurs primarily within the carbonate-rock aquifer system (Heilwell and Brooks 2011). Much of the carbonate-rock aquifer system is fractured and, where continuous, forms a regional ground-water flow system that receives recharge from high-altitude areas where fractured carbonate rocks are exposed (Flint and Flint 2007; Heilwell and Brooks 2011). Water moving through this regional aquifer system provides vertical recharge to basin-fill aquifers, which also receive local recharge along the mountain fronts, where runoff from higher elevations first encounter the basin fill sediments. The regional aquifer system sustains many perennial low-altitude springs; and hydraulically connects similar aquifers in adjacent basins. The basin fill aquifers, composed primarily of gravel and sand deposits, sustain additional low-altitude springs and wetlands; and the primary source of perennial flow and seasonal baseflow in mid- to lower-elevation streams. These basin-fill aquifers are the primary targets of wells for agricultural, domestic, or municipal use (Flint and Flint 2007). The land use activity on top of the groundwater recharge zones can greatly modify the amount of recharge entering the both the regional and basin-fill aquifers. Loss of groundwater recharge can adversely impact the health of springs, streams, and wetlands and the yield of water supply wells and can do so over very long time-spans (NJSWBMP 2004). The amount of hard-surface development on top of a recharge zone is a measure of the reduced capacity of the recharge zone to absorb runoff waters.

Methods: A simple model of likely groundwater recharge zones was created, consisting of areas above 6,562 feet (2,000 m) in elevation, based on maps published by USGS but not obtained by NatureServe (Flint & Flint, Regional Analysis of Ground-Water Recharge, 2007). These maps were overlaid the National Land Use/ Land Cover map and the percentage of area of lands with hard surfaces were calculated. Hard surfaces include urban high and medium density, and roads, called “non-natural”, and occurs within the modeled likely recharge zone are per watershed. The percent “non-natural” land use per watershed was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value), where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Most of the hard surface development within this ecoregion is located in the valley bottoms. Groundwater recharge zones occur only at higher elevations above 6,562 feet (2,000 m), in the mountains and at the interface between bedrock and basin fill surface geology along the foothills of mountain ranges. Therefore these zones are in fairly good condition throughout the ecoregion. Specifically, groundwater recharge zones are affected only by development in specific clusters of watersheds, particularly along the western front of the Rocky Mountains between Nephi and Cedar City, UT; and along the eastern front of the Sierra Nevada Range in the general vicinity of Mono Lake in CA. Additional, smaller clusters are present in the vicinities of Ogden, UT, and Ely, NV, with a few isolated watersheds with low values (highly altered condition) for this indicator scattered across central Nevada. (Figure B - 65)

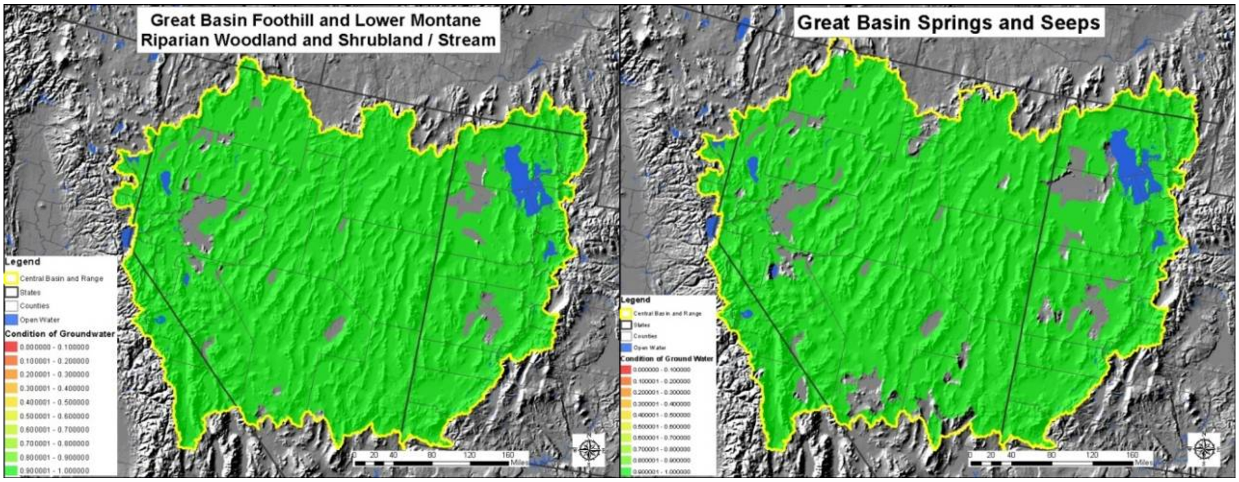


Figure B - 65. Condition of Groundwater Recharge Zone

<u>KEA Stressors on Hydrology Condition</u>

Definition: Key Ecological Attribute-Hydrology Condition is an average of Indicators 4, 5, 6a, 6b and 7. It provides a way to summarize all of the impacts or stressors to hydrologic function occurring within 5th level watersheds.

Rationale: The roll-up or summarization is a way to combine many indicators of stress into a single variable, and will underline areas of cumulative stressor effects. Rolling up several indicators into a single KEA score is part of the Ecological Integrity Method (Faber-Langendoen et al. 2008), and provides a means of a “quick” look summary of impacts from different scales.

Methods: This is a summary, or roll-up, of all the hydrologic indicators into a single score. We calculated the average of the normalized scores for four indicators: Surface water Use, Groundwater Use, Flow modification by Dams “F”-index, and Groundwater Recharge Zone Condition. Not all of these indicators were applied to all CEs, so the KEA varies by CE .

Results: This KEA is tracked by Indicators 04-07, discussed individually above. As noted for these indicators, natural hydrologic conditions in aquatic CEs are most likely affected by water use, diversions, impoundments, and development of the recharge zone. These conditions occur primarily along the Wasatch Front of the Rocky Mountains, the eastern front of the Sierra Nevada Range, and lands that lie at the foot of these fronts. Alterations are concentrated in areas of greater arable and developable land.

The watersheds that show alteration for any one hydrology indicator, however, are not always the same watersheds that show alteration for another. For example, dams and diversions tend to occur in watersheds upstream from and therefore at higher elevations than associated watersheds with high levels of surface water use; and development of groundwater recharge zones is typically associated with urban and exurban development, which is affected in part by the distribution of roads. As a result, fewer watersheds score as highly altered for the KEA overall than score highly for any single indicator of hydrology. The watersheds with the highest levels of alteration for KEA occur in central Utah, along the Sevier River; and around, north, and northwest of Reno/Sparks, Nevada. Altered watersheds also occur along the eastern front of the Sierra Nevada Range in California south of Lake Tahoe; in the Virgin River valley in southwestern Utah; around Elko, Nevada; and three other scattered locations in central Utah including one immediately west of the Great Salt Lake. Otherwise, this KEA overall is unaltered or only slightly altered across most watersheds in the ecoregion, based on the five included indicators. (Figure B - 66)

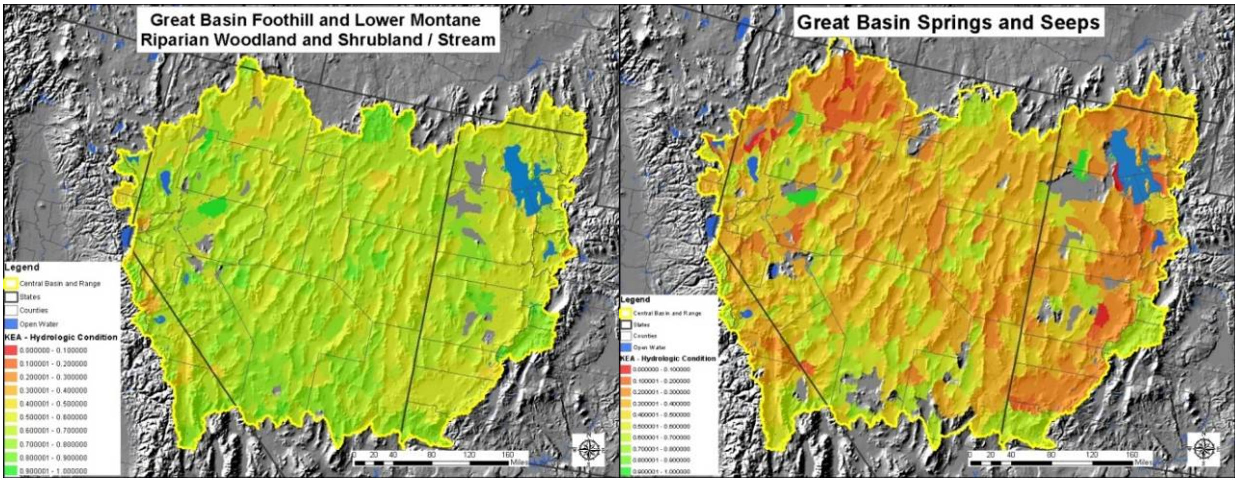


Figure B - 66. KEA Stressors on Hydrology Condition

IV. Stressors on Water Quality

Indicator 08a Atmospheric Deposition-Nitrate Loading (NO_3).

Definition: Indicator 08a, Atmospheric Deposition-Nitrate Loading, measures the intensity of wet deposition of nitrate (NO_3^-) ions within a watershed from air pollution. The raw values have units of kg-N/ha/yr (kilograms of Nitrogen per hectare per year). The indicator serves as a representative of a broad class of common air pollutants, consisting of oxides of nitrogen and sulfur (often denoted NO_x and SO_x). When deposited back on the earth surface through precipitation (i.e., carried with rainfall, snowfall, etc.), these compounds can alter the pH and/or the nutrient balances of the soils and waters into which they are deposited, with ecological consequences. Geographically comprehensive data do not exist for this ecoregion on water pH and nutrient concentrations, nor on bioassessment indicators, with which to assess stresses to water quality. The assessment of nitrate deposition therefore provides a means to assess a common *source* of alteration (stressor) that may affect water pH and nutrient concentrations.

Nitrate deposition per watershed is calculated using data from the National Atmospheric Deposition Program (NADP), National Trends Network (NADP 2012), which maintains a network of monitoring stations throughout the nation. These stations are located irregularly across the CBR ecoregion and surrounding ecoregions, mostly at higher elevations. The NADP integrates these data with spatial models that produce 2.5 km x 2.5 km gridded estimates of deposition rates for a suite of acids, nutrients, and base cations. The gridded data for nitrate wet deposition were integrated by watershed to calculate the average deposition rate per watershed. Raw values range from 0.6613 to 2.9311 kg-N/ha/yr. For purposes of the scorecard, the results are normalized to range from 0 to 1.

Rationale: Atmospheric deposition introduces pollutants into watersheds and their aquatic ecological systems from distant sources. As summarized for the western U.S. by Fenn et al. (2003a, 2003b), nitrate emissions arise from a variety of urban and agricultural sources. These can include internal combustion engines (e.g., cars and trucks), incinerators, and fuel-burning power plants; and concentrated animal feeding facilities. Even low levels of N-deposition can result in biological changes, by causing acidification in waters with naturally low buffering capacity (*aka* acid-neutralizing capacity), such as exist in alpine and upper montane zones in the CBR ecoregion; and can act as a nutrient pollutant in well-buffered waters at both high and low elevations, as documented in the Sierra Nevada and Rocky Mountain regions (e.g., Brooks and Williams 1999; Baron et al. 2000; Williams and Tonnesen 2000; Coats and Goldman 2001; Wolfe et al. 2001, 2003; Burns 2003, 2004; Hunsaker et al. 2007; Fenn et al. 2008; 2010; Ingersoll et al. 2008; Allen et al. 2009a, Allen et al. 2009b; Saros et al. 2010; Pardo et al. 2011). Acidification presents a stress to all aquatic organisms; in extreme cases it leads to the elimination of most native organisms from an affected water body. Nutrient enrichment boosts aquatic productivity (e.g., phytoplankton and periphyton productivity), changing the algal assemblage in an individual water body. This in turn can lead to changes in the assemblage of organisms that consume the algae, and in the assemblage of organisms that prey on these primary consumers, thus altering the composition of the natural aquatic community. Nitrate uptake along streams and riparian zones is a natural process, further, but increased nitrate availability can alter not only in-stream biotic composition but riparian vegetation dynamics (Ranalli and Macalady 2010).

As documented in the deserts along the southwestern margin of the CBR ecoregion, chronic N deposition also can lead to increased terrestrial plant productivity across watersheds and favor the spread of non-native grasses, leading to increases in fuel for wildfire that affect the frequency and intensity of fire. Such changes in wildfire, in turn, can alter watershed runoff dynamics and degrade riparian vegetation, resulting in increased stress to riparian-stream ecosystems (see also Bytnerowicz et al. 2001; Allen et al. 2009a, 2009b; Fenn et al. 2010; Rao and Allen 2010; Rao et al. 2010; Pardo et al. 2011). Finally, Nitrogen deposition during droughts has been implicated in the spread of the Western pine beetle and Mountain pine beetle in the San Bernardino and San Jacinto Mountains of southern California (Jones et al. 2004). Although this study took place outside the CBR, the species involved also occur in the CBR. This suggests an additional pathway by which N-deposition could affect aquatic ecosystems in the CBR ecoregion, not only through altered watershed fire dynamics but through altered organic litter production in forested watersheds, where such litter may be an important source of nutrients to streams.

Fenn et al. (2003a, 2003b) further note that N deposition is highly uneven in the western U.S., with "hotspots" of deposition surrounded by wide areas of low deposition. Wet deposition in particular requires precipitation, and therefore in the CBR ecoregion is concentrated at higher elevations, especially immediately down-wind from major source areas. Fenn et al. (2008) suggest a critical load of 3.1 kg-N/ha/yr as for mountain and desert regions in California, above which ecological changes occur in alpine/montane environments. Other researchers working both in California and in the Rocky Mountains suggest higher or lower thresholds for this critical load in the western or southwestern U.S. (e.g., Baron 2006; Bowman et al. 2006; Allen et al. 2009a, 2009b; Fenn et al. 2010; Rao et al. 2010; Saros et al. 2010; Pardo et al. 2011), with historic and paleoecological data pointing to the lower values (e.g., 1.4 to 1.5 kg-N/ha/yr – Baron 2006; Saros et al. 2010).

Methods: National Atmospheric Deposition Program (NADP) Atmospheric Deposition Nitrogen, data current as of 1994- 2011 (varies by station). These data are a measure of the annual rate of deposition of Nitrate in Kg/ha. This continuous surface raster data, obtained from the National

Atmospheric Deposition Program (NADP), was summarized by 5th level hydrologic units. The Nitrate deposition per watershed was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Atmospheric deposition of nitrate across the CBR ecoregion follows a clear pattern, with high rates of deposition across all of western Utah and along the Owens Valley in California. The high rates in Utah presumably are caused by the concentration of urban and industrial activity along the western front of the Rocky Mountains, with air circulation patterns carrying the emissions westward into the Central Basin. The high rates along the Owens Valley may be a result of air transport from the greater Los Angeles area to the south, emissions from Edwards AFB and the China Lake military reserves, or local farming practices and/or vehicle emissions along US 395. However, although the zone of high concentration along the Owens Valley extends well southward into the MBR ecoregion, it does not extend south of Edwards AFB. This distribution suggests that the source(s) of the deposition along the Owens Valley is/are located in the military reserves and/or along the highway. Some of these patterns of deposition do not conform to the overall direction of regional from west to east. This regional atmospheric flow carries in pollutants from intensely developed areas of California to the west. However, air pollutants generated within the ecoregion are dispersed and moved around first by air currents specific to the immediate localities and valleys where they are generated, before getting caught up in the regional flow. Locally and at the valley scale, air circulation is affected by thermal gradients and stratification, which can cause both north-south and east to west dispersion. Around Salt Lake City, for example, local air circulation can push air pollutants north, south and west into the Great Basin (Allwine et al. 2002; Chen et al. 2004). Emissions from sources along the Wasatch Front therefore can spread westward into the ecoregion. Trace elements from smokestack emissions in the Battle Mountain area of Nevada, similarly, can register in air samplers as far north as Boise, Idaho (Abbott 2005). As a result, the distribution of Nitrate deposition within the CBR ecoregion can be interpreted as a product of a combination of regional transport from the west, moving mostly west to east; and emissions within the basin that are dispersed by local air circulation patterns that can result in their distribution north, west, and south as well as east of the emissions sources. (Figure B - 67)

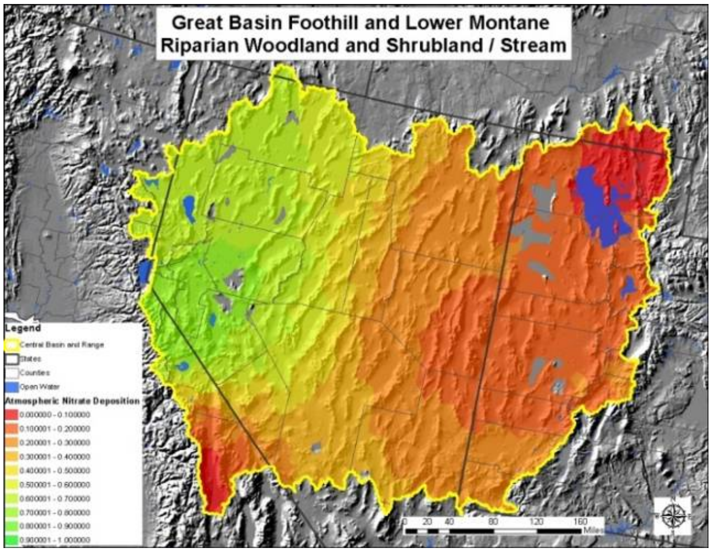


Figure B - 67. Atmospheric Deposition-Nitrate Loading (NO_3)

Indicator 08b Atmospheric Deposition-Toxic Mercury Loading (Hg)

Definition: Atmospheric Deposition-Mercury Loading, measures the intensity of wet deposition of Mercury within a watershed from air pollution. The raw values have units of μg-Hg/m^2/yr (micrograms of Mercury per square meter per year). The indicator serves as a representative of a broad class of air pollutants, consisting of metals and organic compounds that have toxic effects on wildlife and have the ability to bioaccumulate in food webs, particularly those anchored in aquatic ecosystems. When deposited back on the earth surface through precipitation (i.e., carried with rainfall, snowfall, etc.), these compounds and their byproducts can impair the health and reproduction of invertebrates and vertebrates contaminated by these compounds, with ecological consequences. Methyl-mercury, a byproduct of Mercury, is particularly toxic. Geographically comprehensive data do not exist for this ecoregion on Mercury or Methyl-mercury concentrations in water or tissues, nor on bioassessment indicators, with which to assess stresses to water quality. The assessment of Mercury deposition therefore provides a means to assess a common *source* of alteration (stressor) that may affect ecological water quality in the ecoregion.

Mercury wet deposition per watershed is calculated using data from the National Atmospheric Deposition Program (NADP), Mercury Deposition Network (NADP 2012), which maintains a network of monitoring stations throughout the nation, some placed to monitor specific emission sources. Fewer than ten stations are located irregularly across the CBR ecoregion and immediately surrounding ecoregions, mostly at higher elevations. The NADP integrates these data with spatial models that produce 2.5 km x 2.5 km gridded estimates of deposition rates. The gridded data for Mercury wet deposition were integrated by watershed to calculate the average deposition rate per watershed. Average rates per watershed range from 4.5503 to 8.3653 μg-Hg/m^2/yr. For purposes of the scorecard, the results are normalized to range from 0 to 1.

Rationale: Atmospheric deposition introduces pollutants into watersheds and their aquatic ecological systems from distant sources. As summarized by the states of California, Nevada, and Utah (California OEHHA 2012; Nevada DEP 2012; Utah DEQ 2012) and in numerous scientific publications (e.g., Driscoll et al. 2007a; Peterson et al. 2009; Selin 2009; USEPA 2009; Chalmers et al. 2010; Nydick and Williams 2010), Mercury (Hg) atmospheric deposition arises mostly from the burning of coal and industrial wastes in power generation plants, cement manufacturing plants, and incinerators. Coal-fired power plant and incinerator emissions are regulated in the US, but the best available technologies for the removal of Hg are not fully effective; and other industrial sources are not regulated (e.g., Driscoll et al. 2007a, 2007b). Individual emission sources identified within and immediately surrounding the CBR ecoregion consist entirely of coal-fired power plants and industrial facilities (e.g., Abbott 2005; NPCA 2008). Incineration, cement manufacturing, and power-generation sources also exist upwind, in California west of the Sierra Nevada range (NADP 2012). In addition, Hg emissions can travel thousands of miles in the atmosphere before returning to the earth surface; deposition in any locality always includes Hg from both near and distant sources (e.g., Selin 2007), although nearby sources contribute the most. Deposition of Hg occurs in both “dry” and “wet” forms. The former consists of deposition along with dry particulate matter; the latter consists of deposition along with rainfall, snowfall, and other forms of precipitation. Wet deposition is more easily measured and has the longest history of measurement in the U.S. (NADP 2012).

Mercury deposition per se does not cause direct ecological damage. However, microbes that live in wet soils, wetlands – including riparian wetlands – and aquatic sediments with high organic matter content convert Hg into a biologically reactive, toxic compound, Methyl-mercury (MeHg) (e.g., Driscoll et al. 2007a, 2007b; McNaughton 2008; Ward et al. 2009). Hg deposited or washed into these settings bio-accumulates through the food web in these environments, and in lakes and streams that receive inflows from these environments. Top aquatic predators (e.g., native trout) and insectivorous and larger avian predators (e.g., bald eagle) that feed along these lakes and streams accumulate MeHg in their body tissues sufficient to cause biological harm, consisting of reduced reproductive success and impaired neurological development in offspring (e.g., Driscoll et al. 2007a, 2007b; Schwindt et al. 2008; see recent reviews in Chalmers et al. 2010; Nydick and Williams 2010). Long-lived predator species are particularly at risk. Such biological effects can alter predator-prey dynamics in aquatic ecosystems. The processes leading to bioaccumulation work somewhat differently in saline lakes such as Pyramid Lake and the Great Salt Lake because of their unique chemistry and biota, but the result is the same: top predators accumulate potentially harmful body loads (Weimeyer et al. 2007; Darnall and Miles 2009; Naftz et al. 2009; Wurtsbaugh et al. 2011).

High levels of MeHg bioaccumulation in fish also makes them unhealthy for human consumption, leading to fish consumption advisories. California, Nevada, and Utah regulatory agencies have all posted such advisories for water bodies within the CBR ecoregion (California OEHHA 2012; Nevada DEP 2012; Utah DEQ 2012). However, the Hg responsible for these advisories may also derive from past mining ore processing, as is the case in the Carson River basin, including Lahontan Reservoir (Bevans et al. 1998; Scudder et al. 2009).

Mercury deposited in forested settings in the CBR ecoregion may accumulate in the upper (organic) soils and forest floor litter, without undergoing methylation (e.g., Perry et al. 2009; Obrist et al. 2009, 2011). High levels of organic matter (with high levels of Carbon and Nitrogen) contribute to this storage. However, fires in these settings can release the accumulated Hg, allowing it to move into wetter settings where it may be methylated and drawn into aquatic, wetland, or terrestrial food webs (see also Burke et al. 2010). Changes in wildfire regimes – which in turn may be driven by changes in climate, fuel accumulations supported by nitrate deposition, and other factors – therefore could alter the rate at which Hg enters aquatic food webs (see discussion of nitrate deposition and wildfire for Indicator 08a). Nitrate deposition, by stimulating primary productivity in lakes and streams, may increase the concentration of dissolved organic matter (DOM) in these waters, another potential factor promoting methylation and, therefore, promoting MeHg bioaccumulation (McNaughton 2008).

Mercury deposition is highly uneven across the western U.S., with “hotspots” of deposition surrounded by wide areas of lower deposition (NADP 2012). For example, current deposition rates for total Hg for the CBR can range above 70 μg-Hg/m^2/yr in the eastern Sierra Nevada range (Sanders et al. 2008), and above 140 μg-Hg/m^2/yr along the Rocky Mountain crest well to the east of the ecoregion (e.g., Mast et al. 2010). However, wet deposition rates reported at individual study sites in the CBR ecoregion mostly range an order of magnitude less, even in high elevations (e.g., Lyman et al. 2007, 2008; Sanders et al. 2008; Peterson et al. 2009; Drevnick et al. 2010; Mast et al. 2010; NADP 2012). Wet deposition may account for as little as 30% or up to 90% of total Hg deposition in some settings within and immediately east of the CBR ecoregion (Lyman et al. 2007, 2008; Sanders et al. 2008; Drevnick et al. 2010; Mast et al. 2010). Wet deposition in particular requires precipitation, and therefore in the CBR ecoregion is concentrated at higher elevations, especially immediately down-wind from major source areas. Studies in both the Sierra Nevada and Rocky Mountain ranges point to natural, pre-industrial deposition rates of 2-4 μg-Hg/m^2/yr in these higher-elevation settings (Lyman et al. 2007; Sanders et al. 2008; Drevnick et al. 2010; Mast et al. 2010). Natural wet deposition would have been correspondingly lower in areas with lower precipitation.

Methods: National Atmospheric Deposition Program (NADP) Atmospheric Deposition Mercury, data current as of 1994- 2011 (varies by station). These data are a measure of the annual rate of deposition of Mercury in μg/m^2. This continuous surface raster data, obtained from the National Atmospheric Deposition Program (NADP), was summarized by 5th level hydrologic units. Mercury scores were calibrated against background natural mercury amounts using the equation: 1-((score-minscore)/(maxscore-minscore)). The mercury deposition per watershed was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Atmospheric Mercury Loading affects all Aquatic CEs except Springs and Seeps which are thought to be too small to be affected. Atmospheric deposition of mercury across the ecoregion follows a clear pattern, with two zones of higher deposition: (1) along the western front of the Rocky Mountains, especially from Provo to Cedar City, Utah; and (2) within a cluster of watersheds north and northwest of Battle Mountain and Winnemucca, Nevada. The high rates in Utah presumably are caused by the concentration of urban and industrial activity along the western front of the Rocky Mountains, with air circulation patterns carrying the emissions westward into the Central Basin. Mercury deposition also occurs at higher rates at higher elevations, in association with precipitation. The high rates in northern Nevada are associated with well-documented emissions from several mining ore processing facilities in this area. As noted above concerning Nitrate deposition, the spatial distribution of Mercury deposition within the CBR does not conform simply to the overall direction of regional from west to east. This regional atmospheric flow carries in pollutants from intensely developed areas of California to the west. However, air pollutants generated within the ecoregion are dispersed and moved around first by air currents specific to the immediate localities and valleys where they are generated, before getting caught up in the regional flow. Locally and at the valley scale, air circulation is affected by thermal gradients and stratification, which can cause both north-south and east to west dispersion. Around Salt Lake City, for example, local air circulation can push air pollutants north, south and west into the Great Basin (Allwine et al. 2002; Chen et al. 2004). Emissions from sources along the Wasatch Front therefore can spread westward into the ecoregion. Trace elements from smokestack emissions in the Battle Mountain area of Nevada, similarly, can register in air samplers as far north as Boise, Idaho (Abbott 2005). As a result, the distribution of Mercury deposition within the CBR ecoregion can be interpreted as a product of a combination of regional transport from the west, moving mostly west to east; and emissions within the basin that are dispersed by local air circulation patterns that can result in their distribution north, west, and south as well as east of the emissions sources. (Figure B - 68)

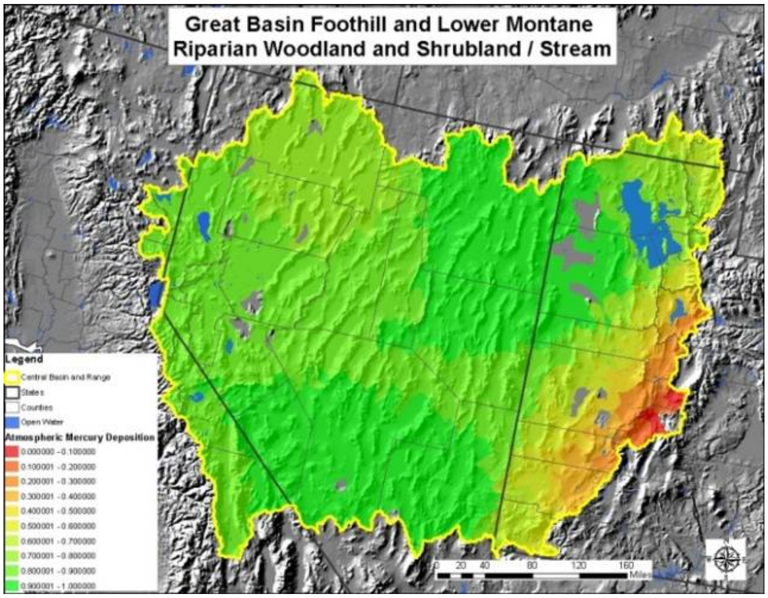


Figure B - 68. Atmospheric Deposition-Toxic Mercury Loading (Hg)

Indicator 09 State-Listed Water Quality Impairments

Definition: Presence and severity of water quality impairments identified in State 303(d) report , where the State Listed Water Quality of Impaired Waters includes are those waters that exceed standards for total phosphates, temperature, turbidity, suspended solids, pH, nitrates, and other pollutants. These standards are applied to stream reaches and to lakes and ponds.

Rationale: Impaired water quality is a measure of aquatic stress on aquatic life integrity. Pollutants can cause harm or death and may accumulate in upper food chain (fish) tissues; increased sediment loading can reduce oxygen availability and reduce spawning habitat.

Methods: (USEPA National Database of State Water Quality Status Listings, data current as of 2009). State listed impairment is documented by stream reach and by waterbody or lake. For riparian CEs we divided the number of impaired stream miles by the total miles of a given riparian CE to determine the percent impairment. For lakes, we divided the number of listed impaired lakes by the total number of lakes by watershed to determine the percentage of lake CEs impaired. The percent impairment per watershed was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value) where 0 = worst or highest degree of impact and 1 = best or least impacted score.

Results: Only18 watersheds within the CBR ecoregion had listed impaired water quality issues. For riparian CEs the % of the total stream miles impaired was calculated, while for lakes/reservoirs, we calculated the percentage of impaired water bodies per watershed. The locations of these impacted waters are scattered throughout the ecoregion with the majority of impacted watersheds in the western, eastern and northern portions of the ecoregion. (Figure B - 69)

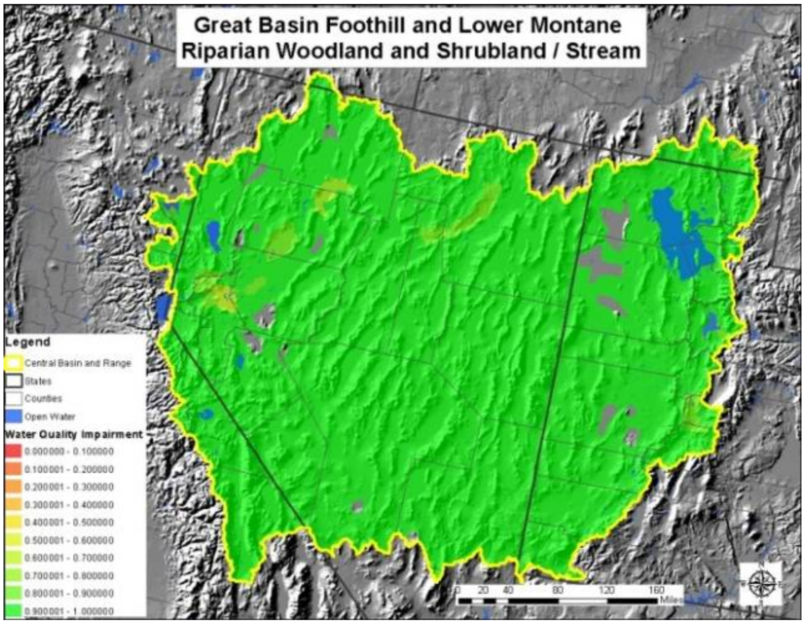


Figure B - 69. State-Listed Water Quality Impairments

Indicator 10 Sediment Loading Index

Definition: Percent cover by land use/cover within a 200 m buffer area of each aquatic CE multiplied by a nationally standard sediment loading index for that type of land use/cover. This is a surrogate for a direct measure of the amount of suspended solid sediment. It is important to estimate both the surrounding landscape (see Indicator Surrounding Land Use Context) and the immediate buffer area to get a more accurate picture of impact on the aquatic resources, because the amount of natural vegetative cover within the buffer area can decrease the larger surrounding area use sediment loading, and conversely, certain land use/cover may be a source of sediment within the buffer zone that may otherwise be surrounded by non-sediment producing land use/cover. We cross-walked land use sediment loading indices used in NSPECT with land cover classes mapped for the ecoregion. Values ranged from 0.5 for high sediment loading uses such as paved roads, bare ground, and tilled agriculture to 0.89, for very low sediment loading land cover such as natural forest or grassland cover. We did not use NSPECT itself because we wanted to compare the land use/land cover within the buffered area of each aquatic resource to the surrounding land use context. NSPECT would have only provided a watershed-based sediment load at the terminal pour point for the watershed. In addition, NSPECT would show that the most downstream watershed within the ecoregion has, by default definition, the greatest sediment loading. This scale of analysis is too course for an aquatic CE assessment.

Rationale: Sediments in aquatic recourses can have detrimental effects on biotic life, change the chemical and physical parameters of the aquatic and substrate habitat, and can be a source of pollutants. Sediments have been shown to reduce oxygen levels, bury fish spawning gravels, reduce visibility, clog gills and be a source of heavy metals and other pollutants such as polychlorinated dibenzo-p-dioxins (PCDDs), furans (PCDFs), biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), brominated flame retardants (BFRs), heavy metals, and pesticides (Apitz et al. 2005, Curry et al. 2004, Chapman 1988, Salomons 1987, Culp et al. 1986).

Methods: This index measures the sediment load index based on land use with 100 m of each CE occurrence. We buffered each CE occurrence by 100 m. We took the sediment loading index for a given land use (as listed in Non-point Source Pollution and Erosion Comparison tool (N-SPECT: Technical Guide 2008 v.1.5, page 25) and cross walked the land uses to the National Land Cover/Land Use map categories. The index values were summed by the amount of each land use within the buffered area.

Results: The greatest potential for sediment loading occurs within the Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland/Stream CE. Over 450 watersheds with this CE scored between 0.75 and 0.5 for sediment loading index. This is likely because this riparian CE is the most abundant riparian aquatic CE and it occurs along valley bottoms where most roads, ranch operations, and other developments occur. (Figure B - 70)

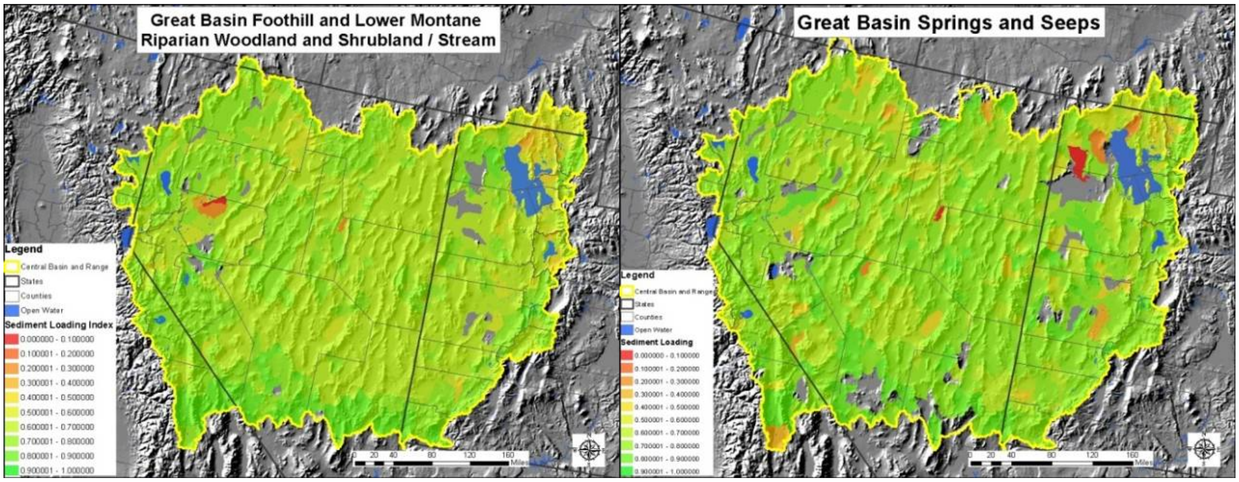


Figure B - 70. Sediment Loading Index

KEA Stressors on Water Quality

Definition: An average of water quality indicators 8-10.

Rationale: A summarization of several stressors, to show cumulative effects.

Method: This is a summary, or roll-up, of all the water quality indicators into a single score. We calculated the average of the normalized scores for four indicators Nitrate Atmospheric Deposition, Mercury Atmospheric Deposition, State Impaired Waters, and Sediment Loading Index. Not all of these indicators were applied to all CEs, so the KEA varies by CE.

Results: This KEA is tracked by Indicators 08-10, discussed individually above. As noted for these indicators, water quality is most affected in this ecoregion by nitrate and mercury deposition. (Figure B - 71)

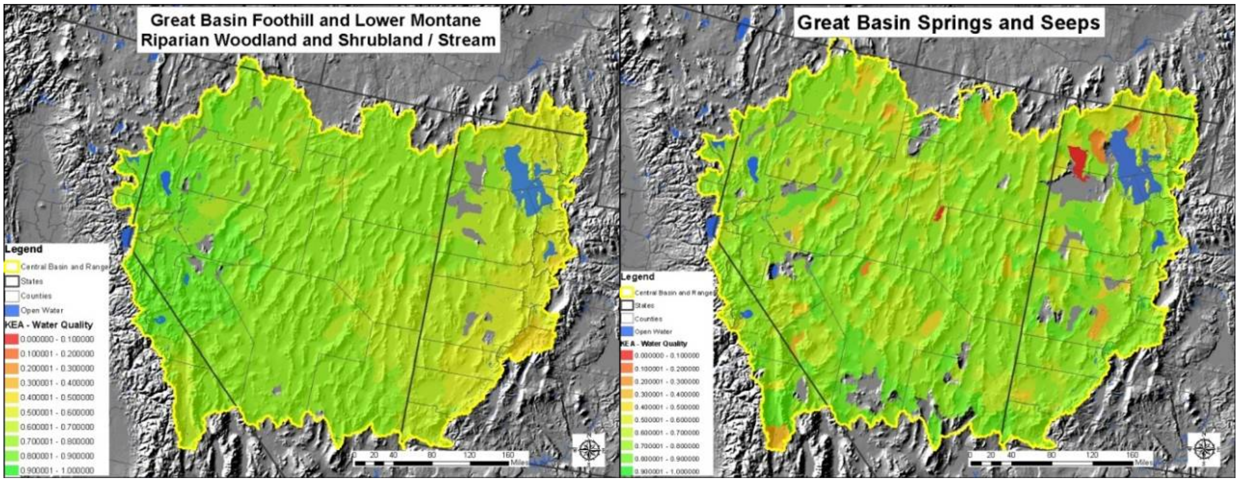


Figure B - 71. KEA Stressors on Water Quality

V. Stressors on Biotic Condition

Indicator 11 Presence of Invasive Plant Species

Definition: Presence of Exotic/Non-native Invasive Plant Species: Not all non-native species are aggressive. This indicator measures the presence of aggressive non-native plant species known to invade wetlands, especially those with human disturbance.

Rationale: Globally terrestrial non-native (aka "exotic") invasive plant species can have detrimental effects and some documented positive effects on native ecosystems. From a conservation perspective, where possible, maintaining the native biodiversity of an ecosystem helps the resiliency and resistance of the ecosystem to climate change and other stressors. The presence of terrestrial non-native invasive plant species is a rapidly observed indicator of current or past disturbance and is a direct measure of current plant species composition within an ecosystem. The negative effects of terrestrial non-native invasive plant species on native ecosystems are becoming increasing well documented. They can cause of biotic homogenization of ecosystems (Houlahan and Findlay 2004). Non-native invasive species have been documented to have a competitive advantage over native species by altering the rate of decomposition and litter nitrogen loss (Ashton et al. 2005), reducing soil moisture and changing wildfire frequency and intensity (Smith et al. 2008, Wisdom and Chambers 2009). Invasive non-native species have been documented to have larger seed sizes in their introduced range than their native range, indicating a high competitive advantage over local native species (Buckley et al. 2003). Invasive non-native species in grasslands have lowered N availability by outcompeting native plants for mineral N, making it difficult for native species to reestablish and promoting the spread of the non-native invasive over native grass species (Scott et al. 2001).

Within this ecoregional assessment we focus on three non-native invasive plant species: Cheatgrass (*Bromus tectorum*), Tamarisk (*Tamarix* spp.) and Russian Olive (*Eleagnus angustifolia*). Each has their own impact on native ecosystems. Cheatgrass (*Bromus tectorum*) begins growth earlier in the spring than most native perennials, depletes soil moisture and causes excessive competition when they emerge with other native species (Smith et al. 2008). Cheatgrass can change the timing and frequency of wildfires in such a way that completely eliminates native sagebrush species (Wisdom and Chambers 2009). Tamarisk (*Tamarix* spp.) causes changes to ecosystems structure, function and animal use. These changes include: supporting fewer bird species and individuals than native trees (Sogge et al. 2008), a reduction in stream flow volume and groundwater levels, an increase wildfire frequency, an increase soil salinity on controlled rivers, reduced agricultural production and drop in recreational use of invested reaches (Lewis et al. 2003). While the amount of water use by tamarisk has been disputed (Stromberg et al. 2009) and the fact that Southwest willow flycatcher, an endangered species, successfully nests in Tamarisk trees (Sogge et al. 2008), efforts to remove this species may better be served by restoring ecosystems processes that supports riparian areas (i.e. flooding) rather than targeting tamarisk removal *per se* (Stromberg et al. 2009). Russian Olive (*Eleagnus angustifolia*) reduces the habitat for some invertebrates which can affect the food chain for aquatic species (Moline and Poff 2008). A reduction in the density of Russian Olive can be beneficial to native lizard populations (Bateman et al. 2008).

Results: The combined data from known tamarisk, Russian olive and annual invasive grass species reveal infestations in just 12% of the aquatic conservation element locations. All the Aquatic CEs show the same trend of 1-2 watersheds with many invasives, 10-20 watersheds with 4-8 invasive species points, and many (100s) with much less. The table of number of watersheds by score illustrates this data trend, which holds for all Aquatic CEs except for the upper elevation Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream which had almost no data at all. We believe this low number is due to a lack of specific inventory for invasive species. (Figure B - 72)

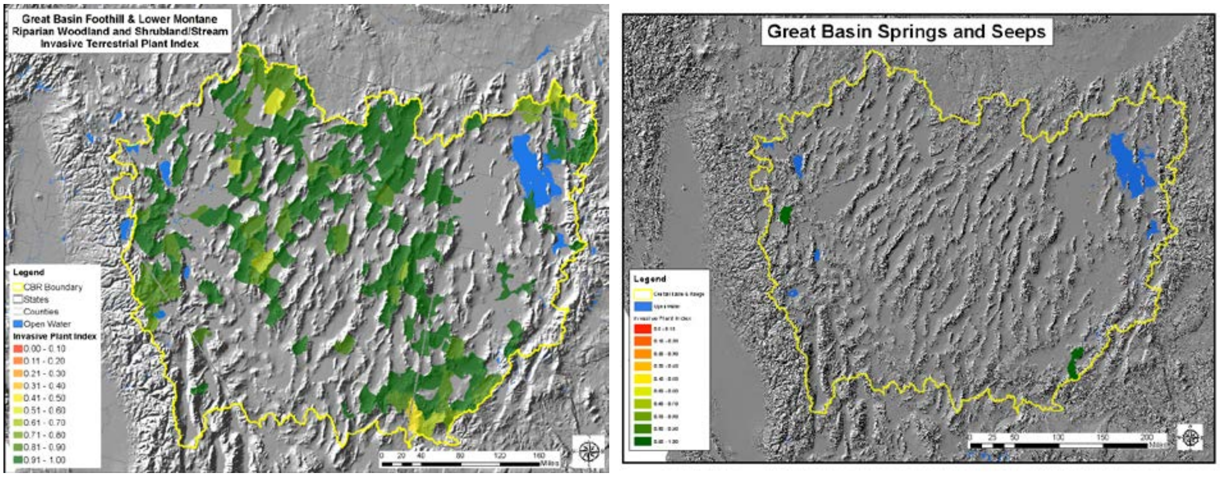


Figure B - 72. Presence of Invasive Plant Species. Watersheds lacking scores did not have any invasive plants occurring in the CE, based on the available data.

Indicator 12 Presence of Invasive Aquatic Species

Definition: The most important metric (and most heavily weighted) in the entire suite of metrics is the number of invasive taxa present. This is simply because the greater the number of invasive taxa there are in a CE, the greater the loss of 'ecological integrity'. Obviously, if no invasive taxa are in a CE within a watershed there is no invasive impact to that CE although there is always future potential.

Rationale: The Known Status Index contains a single metric 'the number of invasive taxa in a CE'. Other than the didymo database, which also included absence data, available databases only contained reported presence sites. Unreported sites do not imply absences. If a taxon was reported in our database then the taxon was most likely well established and had reached some detection threshold. Unreported sites could have been a result of two factors; 1) no surveys were conducted or 2) surveys were below detection threshold levels of invasive taxa. Detection threshold is a function of observer survey methods and skills, amount of search effort used, observability of the taxon (e.g. some taxa are more easily observed than others ex. carp vs. didymo), and the density of the taxon. There were no metadata available relating survey methods or amount of search effort used for any of our invasive taxa data points in the database. We assume that many different types of survey methods and amounts of search effort were used and were not standardized. This most likely resulted in reported false absences or in locations not being reported. Also, timeliness (time lag) of reporting, lack of awareness of centralized invasive species databases, or failure to understand the importance of a centralized database, were also factors that most likely resulted in under reporting of invasive taxa in the databases. Thus the number of invasive taxa metric should be considered as under representative. Most likely the number of invasive taxa in CEs and watersheds in the ecoregions are much higher. The Known Status Index metric was scored conservatively to take these factors into consideration.

Method: USGS Nonindigenous Aquatic Species database (NAS), data current as of 2010, and the Didymo (*Didymosphenia geminata*) distribution map: USGS Fort Collins, data current as of 2008. Of the reported locations of invasive species most included verbal descriptions of the water body where they were found (e.g. Anderson Springs). This allowed us to directly model which CE type had invasives present in a watershed. However, some of the reported invasive species locations were not at a high enough resolution to determine the exact type of water body (CE) that the species occurred in (i.e. data were reported at the watershed level or the narrative description was vague, e.g. Muddy River drainage). For the inexact, vague data, we used the available literature and our knowledge of each invasive species' habitat requirements and ecology to narrow the possible water body types. We also identified the point location using GIS to further verify their probable CE type.

Results: Only 38 records of aquatic invasive species occurrences were located for the ecoregion. However, this lack of data/observations does not mean aquatic invasives have been confirmed to not occur. Worst scores occur in watersheds with high human traffic either in the form of roads, highways and railroads, or associated with popular boating destinations such as Washoe Lake. (Figure B - 73)

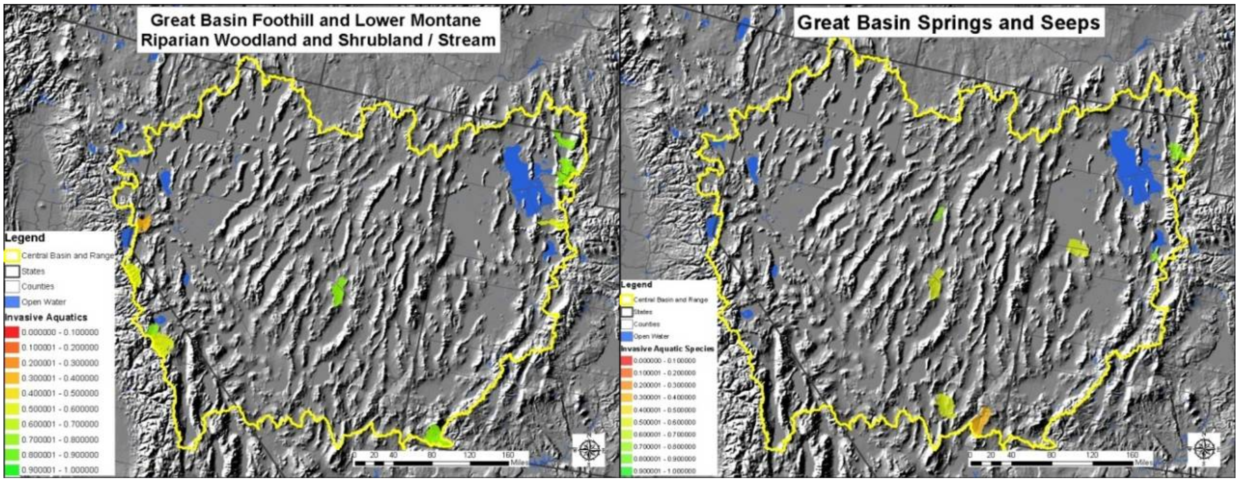


Figure B - 73. Presence of Invasive Aquatic Species

Table B - 33. Indicator results by watershed for Aquatic coarse filter CEs (Current). For each indicator the count of 5th level watersheds is shown for each CE, broken out by indicator score interval.

KEA: Change in Extent/Size

Riparian Corridor Continuity

	Count of watersheds by Score interval										
	Total	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	1	3	6	10	11	24	66	102	104	283
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271			2		2	3	9	14	48	193
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	245				2	6	1	2	13	33	188

KEA: Surrounding Land Use Context

Landscape Condition Index

	Count of watersheds by Score interval										
	Total	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610				1	24	120	295	115	48	7
Great Basin Lake / Reservoir	385				1	23	96	191	51	21	2
Great Basin Springs and Seeps	571				1	24	119	276	97	45	9
Inter-Mountain Basins Greasewood Flat	600				1	21	120	285	112	52	9
Inter-Mountain Basins Playa	503				1	17	110	230	91	47	7
Inter-Mountain Basins Wash	609				1	24	122	292	110	52	8
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271				1	22	73	116	45	9	5
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246					15	61	117	38	10	5

Perennial Flow Network Fragmentation by Dams

	Count of watersheds by Score interval										
	Total	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	3	2	5	6	3		18	14	59	500
Great Basin Lake / Reservoir	385	3	2	5	6	3		18	14	55	279
Great Basin Springs and Seeps	571	3	2	5	6	3		17	14	57	464
Inter-Mountain Basins Greasewood Flat	600	3	2	3	6	2		16	12	54	502

Inter-Mountain Basins Playa	503	3	1	2	6	2		11	7	43	428
Inter-Mountain Basins Wash	609	3	2	5	6	3		18	14	59	499
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	3	1	5	6	1		16	11	42	186
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246	3	1	5	6	2		13	12	43	161

KEA: Stressors on Hydrology Condition

Surface Water Use

	Count of watersheds by Score interval										
	Total	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	3	6	18	41	118	140	94	63	16	111
Great Basin Lake / Reservoir	385	4	2	10	37	101	90	53	28	10	50
Great Basin Springs and Seeps	571	3	5	17	42	117	135	87	59	14	92
Inter-Mountain Basins Greasewood Flat	600	4	8	18	45	113	137	93	61	14	107
Inter-Mountain Basins Playa	503	4	8	16	43	104	114	79	50	11	74
Inter-Mountain Basins Wash	609	4	8	18	43	121	140	92	59	14	110
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	1	1	9	29	72	64	28	16	5	46
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246			4	18	71	66	33	22	2	30

Groundwater Use

	Count of watersheds by Score interval										
	Total	0-.1	.1-.2	.2-.3	.3-.4	.4-.5	.5-.6	.6-.7	.7-.8	.8-.9	.9-1
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	3	11	12	58	110	131	108	55	14	108
Great Basin Lake / Reservoir	385	4	4	8	50	78	92	64	29	7	49
Great Basin Springs and Seeps	571	3	10	11	59	110	126	99	50	13	90
Inter-Mountain Basins Greasewood Flat	600	4	12	13	61	111	126	103	53	13	104
Inter-Mountain Basins Playa	503	4	12	10	59	97	106	84	47	10	74
Inter-Mountain Basins Wash	609	4	12	13	61	112	129	104	53	14	107
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	1	4	6	37	59	58	45	12	4	45
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246		1	3	27	57	67	42	15	4	30

Perennial Flow Modification by Diversion Structures

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	2		2	2	3	3	13	6	29	550
Great Basin Lake / Reservoir	385	2		2	2	3	3	13	5	27	328
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	1		2	2	2	3	10	3	24	224
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	245	1		2	2	2	3	10	4	23	198

Flow Modification by Dams

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	4							2	10	594
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	4							1	10	256
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246	28	4	6	5	4	6	14	15	20	144

Condition of Groundwater Recharge Zone

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	4										4
Great Basin Lake / Reservoir	2										2
Great Basin Springs and Seeps	3										3
Inter-Mountain Basins Greasewood Flat	3										3
Inter-Mountain Basins Playa	1										1
Inter-Mountain Basins Wash	3										3
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	2										2

KEA Summary (Stressors on Hydrology Condition)

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610				3	17	185	264	117	19	5
Great Basin Lake / Reservoir	385			3	18	145	131	36	46	2	4
Great Basin Springs and Seeps	571	5	17	97	189	141	29	88	1	1	3
Inter-Mountain Basins Greasewood Flat	600	3	7	19	62	95	131	111	54	14	104
Inter-Mountain Basins Playa	503	3	7	17	60	82	113	90	47	10	74
Inter-Mountain Basins Wash	609	3	7	19	61	100	136	109	52	15	107
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271					3	8	62	112	39	47
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246					14	32	52	93	33	22

KEA: Stressors on Water Quality

Atmospheric Deposition-Nitrate Loading (NO3)

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	27	155	133	73	37	42	103	40		
Great Basin Lake / Reservoir	385	27	128	84	27	17	25	51	26		
Inter-Mountain Basins Greasewood Flat	600	23	149	131	67	36	42	108	44		
Inter-Mountain Basins Playa	503	21	127	91	50	33	39	100	42		
Inter-Mountain Basins Wash	609	26	157	128	67	37	42	107	45		
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	26	91	66	29	6	20	20	13		
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246	14	75	57	19	13	21	28	19		

Atmospheric Deposition-Toxic Mercury Loading (Hg)

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	4	2	12	14	15	19	31	81	219	213
Great Basin Lake / Reservoir	385	4	2	12	14	15	18	27	55	137	101
Inter-Mountain Basins Greasewood Flat	600	4	2	8	12	15	20	28	81	223	207

Inter-Mountain Basins Playa	503			7	10	14	14	20	80	186	172
Inter-Mountain Basins Wash	609	4	2	12	15	15	21	31	84	222	203
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	4	2	12	15	12	13	19	39	79	76
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246	4	2	10	10	7	10	12	31	95	65
State-Listed Water Quality Impairments											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610		1					2	2	12	593
Great Basin Lake / Reservoir	385	6	1		3	5		4	4	9	353
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271									5	266
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	245								2	1	242
Sediment Loading Index											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	1		2	3	10	31	299	222	42	
Great Basin Lake / Reservoir	385	7	5	11	9	23	45	87	121	60	17
Great Basin Springs and Seeps	571	3		3	8	10	24	144	318	61	
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271					3	7	80	104	77	
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246			1		3	3	37	131	70	1
KEA Summary (Stressors on Water Quality)											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610					8	69	126	328	79	
Great Basin Lake / Reservoir	385			1	6	57	173	116	32		
Great Basin Springs and Seeps	571	3		3	8	10	24	144	318	61	
Inter-Mountain Basins Greasewood Flat	600		7	24	46	41	147	186	127	22	

Inter-Mountain Basins Playa	503			21	40	31	119	155	117	20	
Inter-Mountain Basins Wash	609		8	30	51	43	144	184	127	22	
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271					4	53	65	115	34	
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246						33	52	119	42	

KEA: Stressors on Biotic Condition

Presence of Invasive Plant Species

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610					1	2	5	6	41	
Great Basin Lake / Reservoir	385										
Great Basin Springs and Seeps	571										
Inter-Mountain Basins Greasewood Flat	600							2	1	23	
Inter-Mountain Basins Playa	503								1		
Inter-Mountain Basins Wash	609								1	10	
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271				1			1	4	7	
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	246										

Presence of Invasive Aquatic Species

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	10				1		3		6		
Great Basin Lake / Reservoir	19				2		5		12		
Great Basin Springs and Seeps	7				1		3		3		
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	2								2		

B-2.2 Summary Indices of Ecological Integrity: Results

Six summary indices of integrity, reported by watershed, were developed. These six indicators, each scaled from 0.0 (= low integrity) to 1.0 (= high integrity) can each provide a complimentary perspective on the integrity of the ecoregional landscape (Table B - 34).

The first indicator summarized terrestrial landscape condition (Figure B - 74). As utilized in numerous places elsewhere in this assessment, this indicator was summarized here by 4km^2 grid cell. This indicator provides a concise visual summary of landscape intactness relative to built infrastructure and land conversion across the ecoregion. Generally, indicators score reflect the relative distance from major population centers and transportation corridors, clearly highlighting the most remote landscapes coinciding with the highest relative scores. Management directions aiming to restore landscape intactness in currently fragmented situations, and to maintain current levels of intactness where it currently remains, should be a consideration for meeting ecological goals across the CBR.

Table B - 34. Summary indices of ecological integrity with associated reporting units.

Summary Indicator	Montane Upland	Basin Upland	Aquatic/Wetland, and Riparian
Landscape Condition	4km^2 grid		
Invasive Annual Grass	4km^2 grid		
Fire Regime Departure	Watershed	Watershed	
Hydrologic Condition			Watershed
Water Quality			Watershed

The second summary indicator compliments landscape condition by summarizing the potential abundance of invasive annual grass; also summarized by 4km grid cell (Figure B - 75). Mapping this summary indicator required the combination of values from 5 distinct invasive annual grass models; each of which predicts the location of multiple invasive annual grass species at different cover abundances. An area and abundance weighting formula was used to combine per-pixel values from each model as they fell within each summary grid cell. This applied score areas with no invasive annual grass extent the greatest proportional weight and the calculated value will be equal to 1.

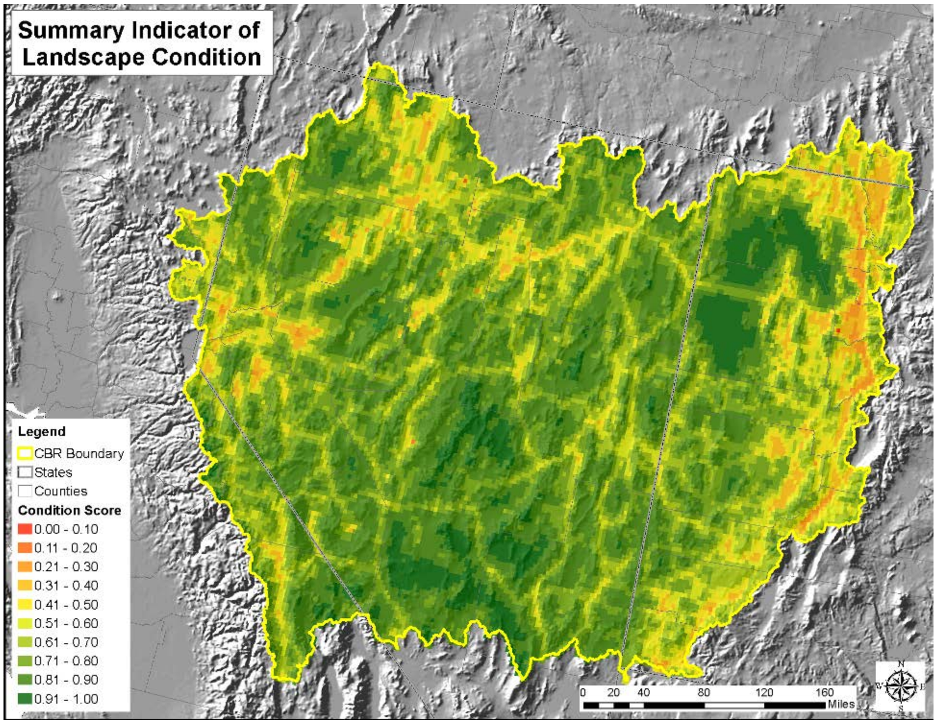


Figure B - 74. Summary Indicator of Landscape Condition for the CBR (by 4x4 km grid cells), scaled from 0.0 (= low integrity, red) to 1.0 (= high integrity, dark green).

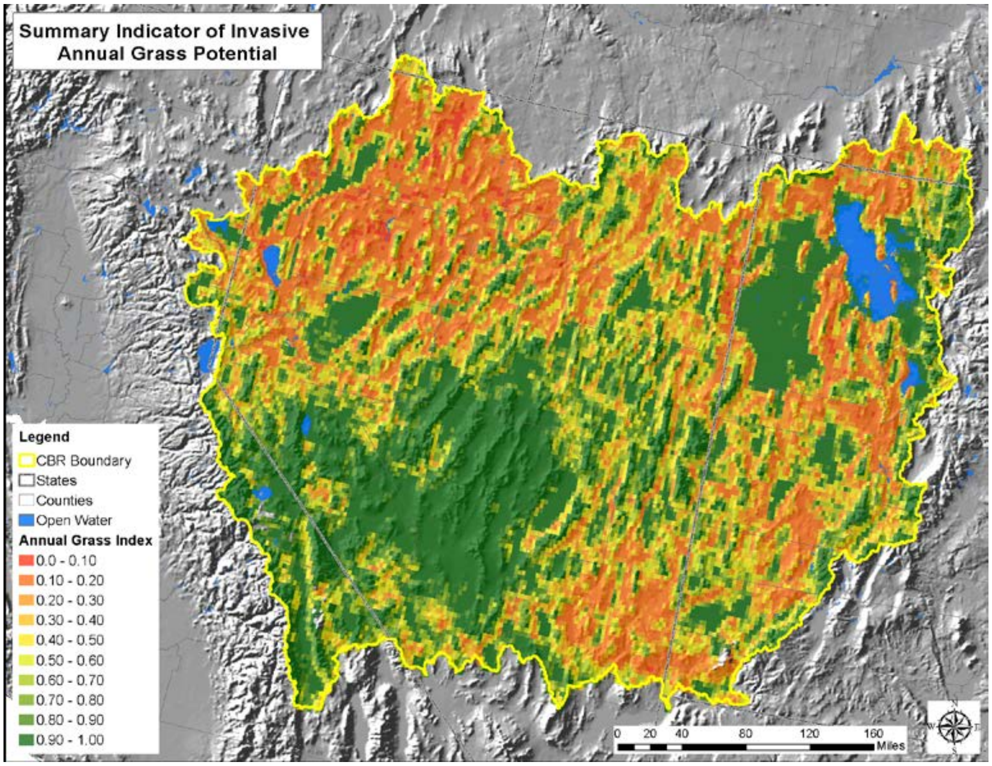


Figure B - 75. Summary Indicator of Invasive Annual Grass Potential for the CBR (by 4x4 km grid cells), scaled from 0.0 (= low integrity, red) to 1.0 (= high integrity, dark green).

As invasive annual grasses encroach into the analysis unit the maximum value of 1.0 is degraded progressively with pixels representing the >45% cover value having the greatest ability to drive down the maximum value.

This provides a distinct perspective indicative of this pervasive ecological change occurring across much of the ecoregional landscape, with the introduction of annual grasses through a variety of past and current land uses, and their extensive spread throughout most basins of the northern and eastern halves of the CBR. Basins in the central Nevada, and extending west into California, appear to be least impacted by invasive annual grasses. Management directions aiming to restore native vegetation where invasive grasses have become abundant, and to maintain current conditions where invasive grasses are at low levels, should continue to be a major consideration for meeting ecological and fire management goals across the CBR.

The third and fourth summary indicators summarize fire regime departure scores for types falling with Montane Upland and Basin Upland categories of the ecoregion-wide conceptual model. This distinction was made to better differentiate the distinctive fire regimes and fuel conditions that characterize the elevational gradients across the basin and range landscape. Since 5th level watersheds were used as spatial reporting units, they necessarily include vegetation from across this elevational gradient. But these two summary indicators were derived from vegetation CE scores that were organized within Montane Upland vs. Basin Upland categories of the ecoregional conceptual model (Table B - 6). These indicators suggest overall that substantial fire regime departure has occurred throughout the montane forest and shrubland vegetation of the CBR. Many watersheds, shaded in Figure B - 76 in the yellow (0.5 scores) to dark orange (0.2 scores) range, indicate quite severe departure. This indication of integrity is concentrated in central Nevada, and in the SE Nevada/SW Utah border watersheds of the ecoregion. Fire regime departure for basin uplands (Figure B - 77) is overall more severe, and reflects a similar spatial pattern to that provided by the invasive annual grass indicator. This was expected, as the occurrence and abundance of annual grasses has been a primary contributor to fire regime departure throughout the basin upland vegetation of the CBR.

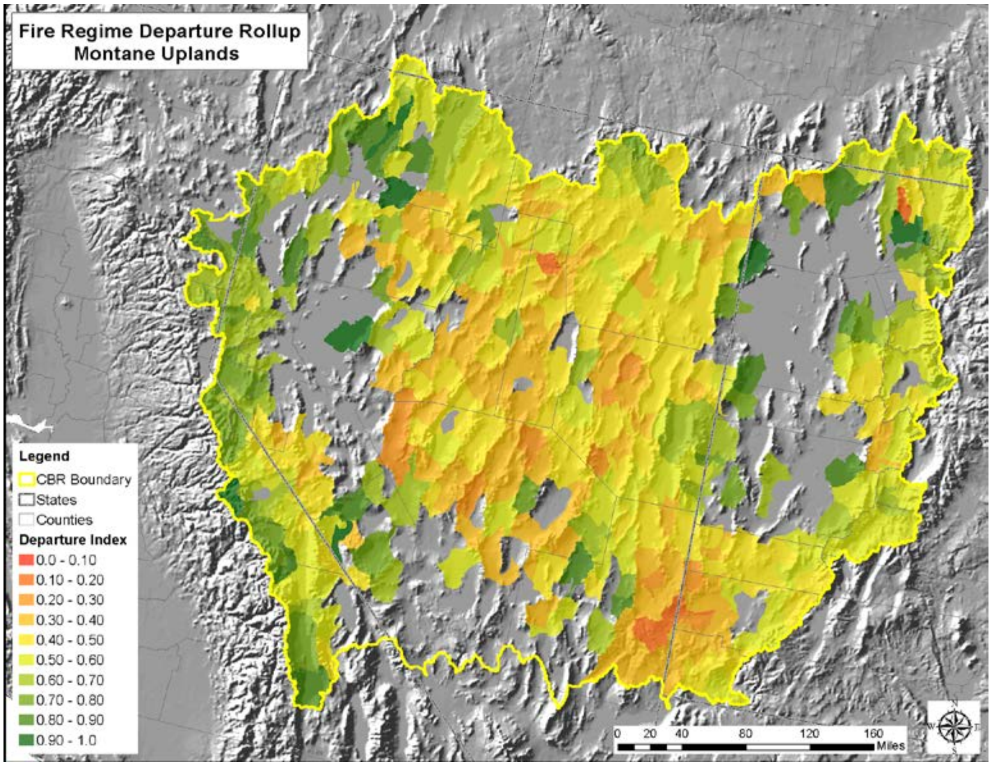


Figure B - 76. Summary Indicator of Fire Regime Departure – Montane Uplands for the CBR (by 4x4 km grid cells), scaled from 0.0 (= low integrity, red) to 1.0 (= high integrity, dark green).

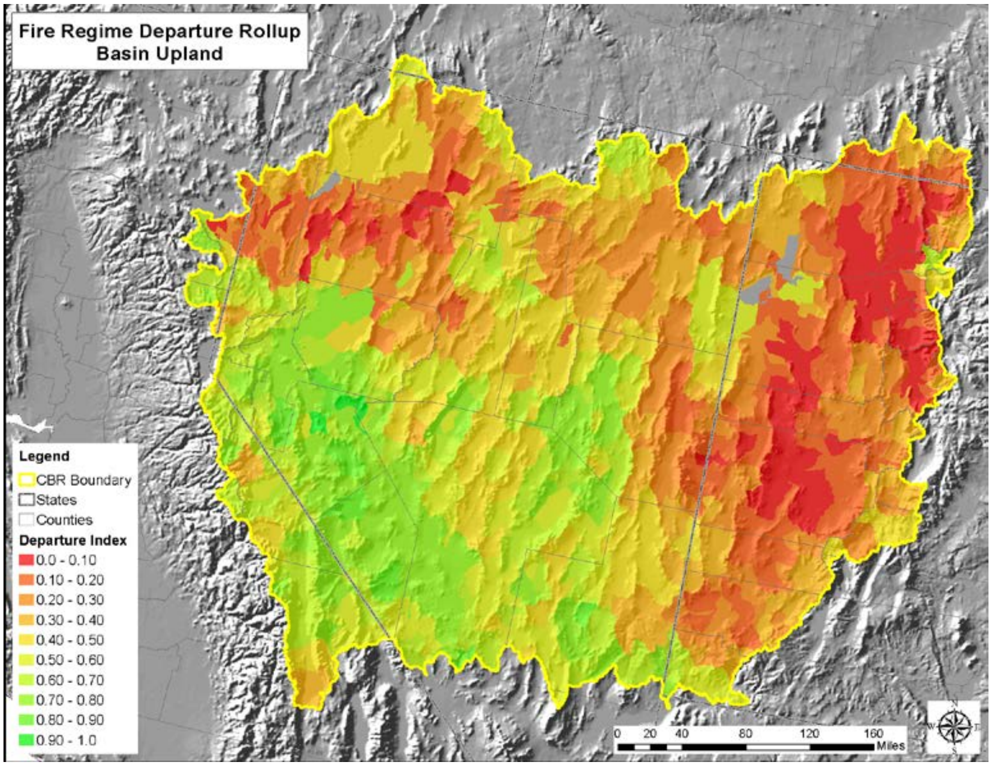


Figure B - 77. Summary Indicator of Fire Regime Departure – Basin Uplands for the CBR , scaled from 0.0 (= low integrity) to 1.0 (= high integrity).

The last two summary indicators address aquatic ecosystems and utilized estimates of hydrologic condition and water quality, also summarized by 5th level watershed (Figure B - 78 and Figure B - 79). Hydrologic Condition summarizes 5 individual measures of stress on hydrologic intactness, including surface water use, ground water use, number of diversions, flow modification by dams, and condition of groundwater recharge zones. Figure B - 78 indicates the high degree of variation in these summary scores across the ecoregion, with no clear regional pattern as is evident in other summary indices. While current population centers and most intensive land uses explain much of this pattern, there are impacts to hydrologic condition occurring in quite remote portions of the ecoregion.

Water Quality summarizes 4 measures, including nitrate and mercury deposition rates, state –listed water impairments and sediment load indices. A clearer regional gradient, with generally decreasing scores from west to east reflects both patterns of atmospheric deposition with major wind patterns (west to east) as well as concentrated land use patterns along the eastern portion of the ecoregion.

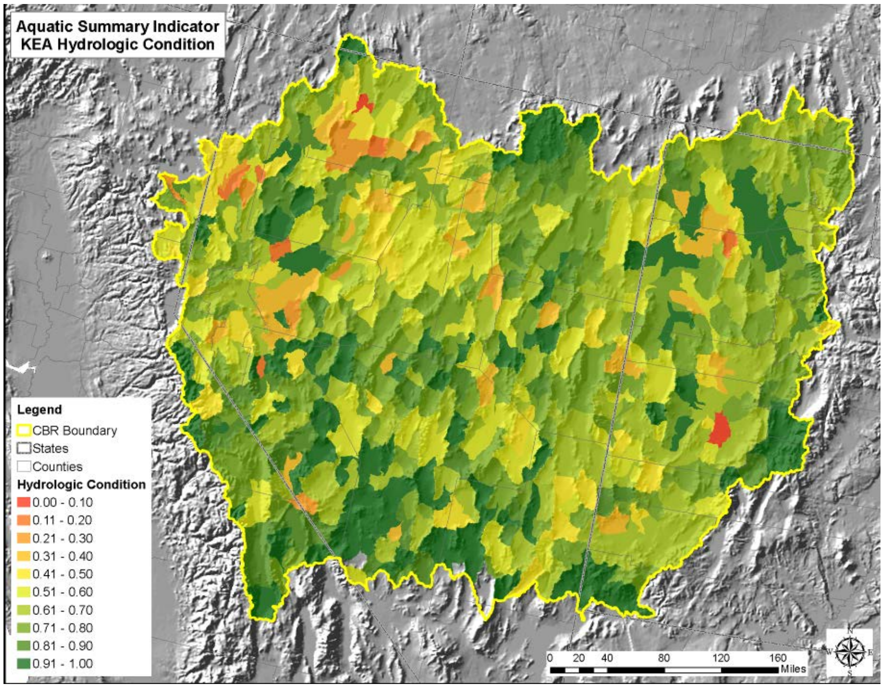


Figure B - 78. Summary Indicator of Hydrologic Condition for the Central Basin & Range, scaled from 0.0 (= low integrity, red) to 1.0 (= high integrity, dark green). This summary indicator for the KEA includes individual indicators of stress on surface water use, groundwater use, flow modification by diversion structures, flow modification by dams, and condition of groundwater recharge zones.

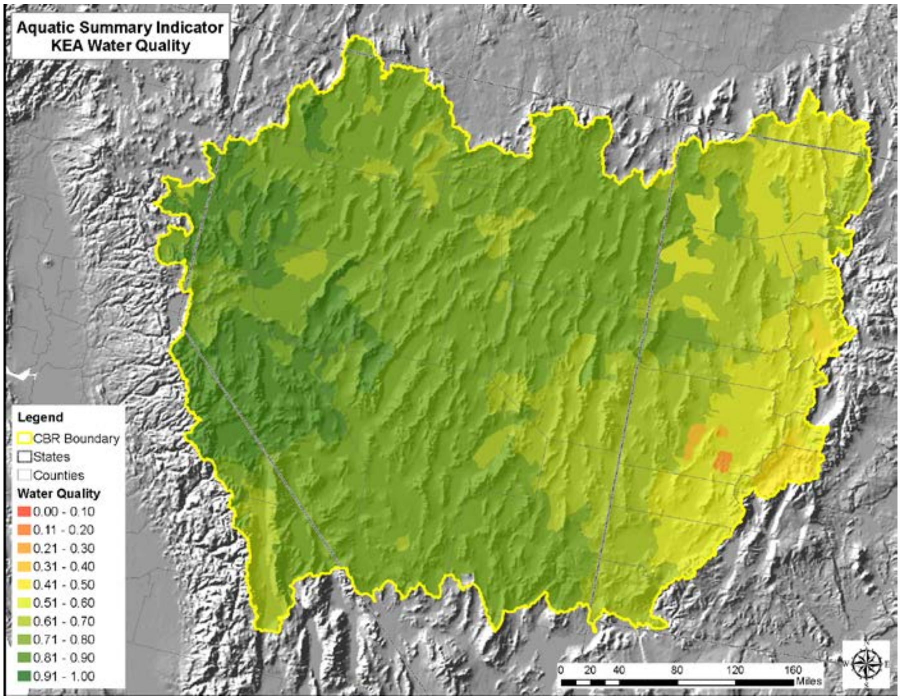


Figure B - 79. Summary Indicator of Water Quality for the Central Basin & Range, scaled from 0.0 (= low integrity) to 1.0 (= high integrity). This summary indicator for the KEA includes individual indicators of stress on water quality from mercury and nitrate deposition, state-listed water quality impairments, and sediment loading.

B-2.3 2025 Distribution and Status

B-2.3.1 2025 Status: Terrestrial Coarse-filter Conservation Elements

The tables below are organzied in the same way as for the current ecological status for terrestrial coarse filter CEs, with counts of 5th level watersheds scoring in each .1 interval (Table B - 35). Total watersheds for the CE x indicator are provided as well.

In general the pattern is as expected- most CEs score moderately well for future landscape condition. Overall, for the Landscape Condition and Fire Regime Departure indicators, ecological status over the upcoming decades appears to show stable or modestly decreasing trends from current conditions. Trends in Landscape Condition are consistent with previous discussion of development CA trends. However, some localized areas throughout the ecoregion are forecasted to experience substantial change due to urban growth or energy development. Generalizing from individual CE results, ecological status indicators for landscape condition tend to remain roughly stable, or decrease by several percentage points for each CE, when combining scores across all watersheds.

Trends in Fire Regime Departure also indicate some similar trends to those of the landscape condition indicator over the upcoming decades; i.e., where current status is already scoring lower, those low scores are forecasted to continue.

Table B - 35. Indicator results by watershed for Terrestrial coarse filter CEs (2025). For each indicator the count of 5th level watersheds is shown for each CE, broken out by indicator score interval.

KEA: Surrounding Land Use Context

Future Landscape Condition Index

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	629			7	14	36	75	**116**	**226**	**135**	20
Inter-Mountain Basins Montane Sagebrush Steppe	623		1		5	18	40	72	**227**	**234**	26
Inter-Mountain Basins Mixed Salt Desert Scrub	622	4	10	7	17	63	**74**	**129**	**191**	**111**	16
Great Basin Pinyon-Juniper Woodland	618	4	5	5	7	13	37	**84**	**204**	**241**	18
Great Basin Xeric Mixed Sagebrush Shrubland	611			12	12	20	46	**89**	**242**	**171**	19
Inter-Mountain Basins Cliff and Canyon	567	1	5		9	22	37	**96**	**178**	**195**	24
Inter-Mountain Basins Semi-Desert Grassland	563	2	3	4	31	**75**	**104**	**111**	**144**	**81**	8
Inter-Mountain Basins Semi-Desert Shrub-Steppe	551		3	4	19	52	**76**	**118**	**171**	**90**	18
Rocky Mountain Aspen Forest and Woodland	528		2		2	3	15	**78**	**194**	**215**	19
Inter-Mountain Basins Big Sagebrush Steppe	526			3	14	40	**55**	**76**	**189**	**141**	8
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	428					1	12	**61**	**126**	**207**	21
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	212						1	6	**42**	**139**	24
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	210				1		2	25	**64**	**104**	14
Mojave Mid-Elevation Mixed Desert Scrub	192	1			4	12	22	**29**	**55**	**56**	13
Great Basin Semi-Desert Chaparral	137				1	5	12	**23**	**40**	**50**	6
Inter-Mountain Basins Active and Stabilized Dune	101			1	4	9	14	**27**	**24**	**17**	5
Rocky Mountain Alpine Turf	66					2	1	5	**19**	**39**	
Colorado Plateau Mixed Low Sagebrush Shrubland	34				2	**9**	**12**	**9**	2		

2025 Fire Regime Departure Index

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	561		31	**73**	**73**	**100**	**75**	**156**	53		

Great Basin Xeric Mixed Sagebrush Shrubland	546			**108**		**181**	**90**	87	80		
Inter-Mountain Basins Mixed Salt Desert Scrub	439		**157**		17	65			**200**		
Inter-Mountain Basins Montane Sagebrush Steppe	411				12	**111**	**171**	44	47	26	
Great Basin Pinyon-Juniper Woodland	408				**278**	97		33			
Rocky Mountain Aspen Forest and Woodland	264						**68**	42	**120**	34	
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	256				3	**66**	**122**	**65**			
Inter-Mountain Basins Semi-Desert Grassland	110	**47**	**29**	14		9	8		3		
Inter-Mountain Basins Semi-Desert Shrub-Steppe	107			13	17	15	4	17	15	26	
Mojave Mid-Elevation Mixed Desert Scrub - thermic	102						18			**84**	
Mojave Mid-Elevation Mixed Desert Scrub - mesic	100		13			**25**	**42**	**20**			
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	83							**28**	**47**	8	
Great Basin Semi-Desert Chaparral	63		**27**			**36**					
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	57					**37**	**20**				
Inter-Mountain Basins Big Sagebrush Steppe	52			10		11		10	**21**		
Colorado Plateau Mixed Low Sagebrush Shrubland	15			3				**12**			
Rocky Mountain Alpine Turf	8										**8**

Maps of terrestrial coarse filter CEs 2025 ecological status

The 2025 spatial results of the ecological status assessment for a selection of the terrestrial coarse filter CEs are presented in Figure B - 80 through Figure B - 89. These are organized within the ecoregional conceptual model, with Montane Dry Land systems presented first; then the Basin Dry Land systems. Within each group systems are sorted from high to low elevation.

MONTANE DRY LAND SYSTEMS

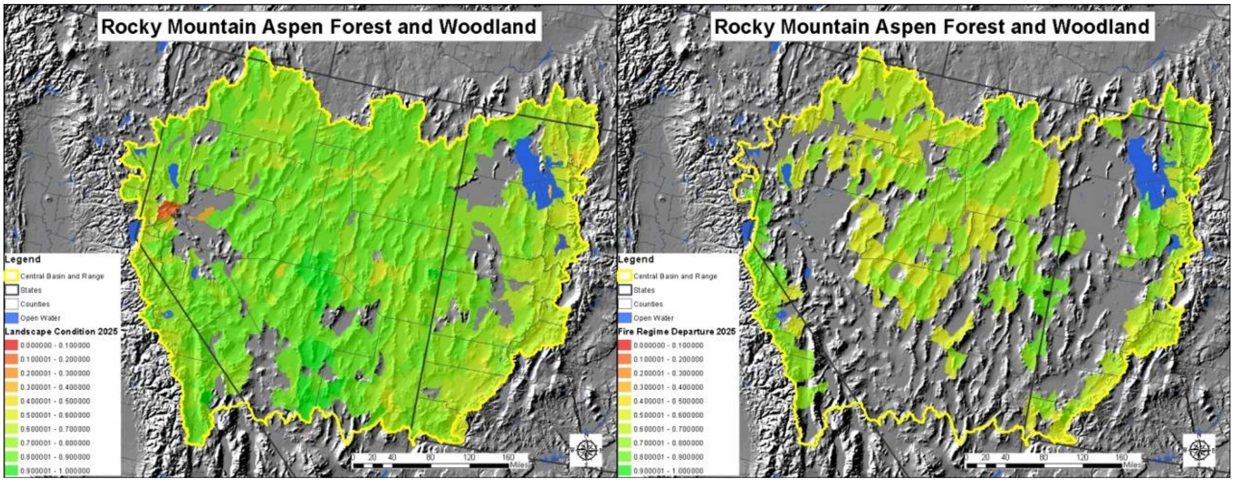


Figure B - 80. Rocky Mountain Aspen Forest and Woodland 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

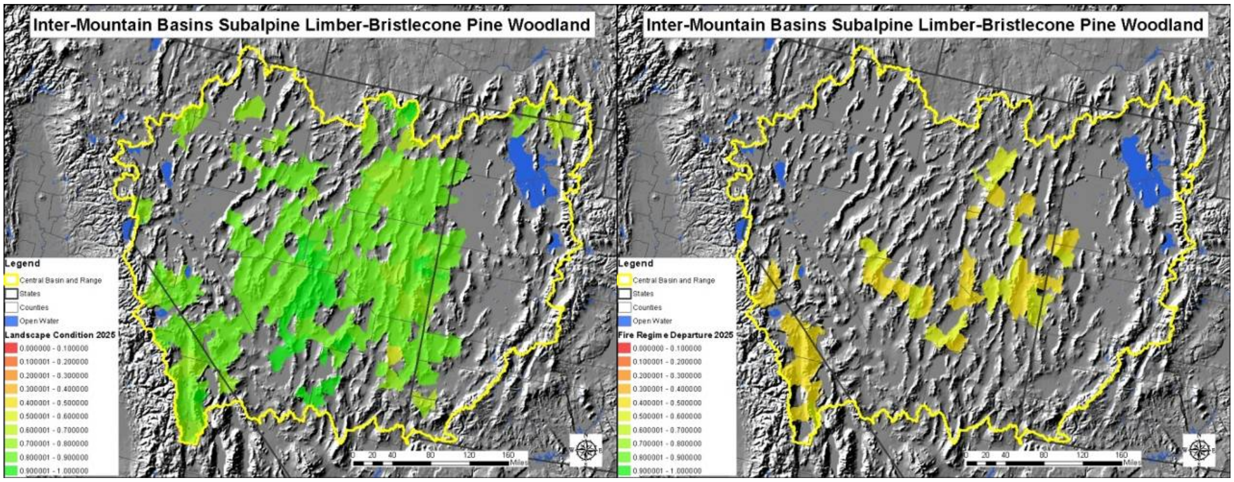


Figure B - 81. Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

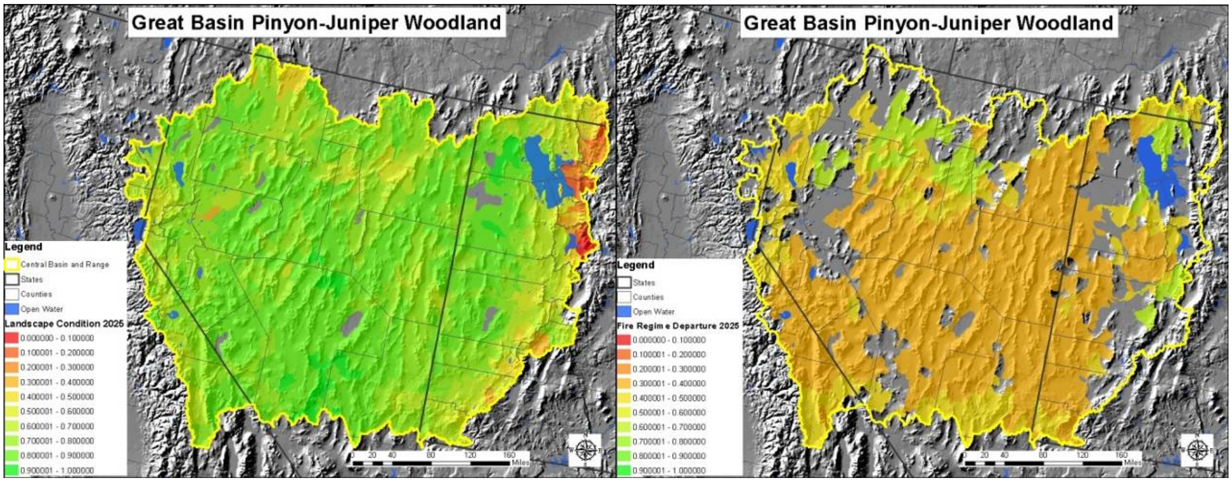


Figure B - 82. Great Basin Pinyon-Juniper Woodland 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

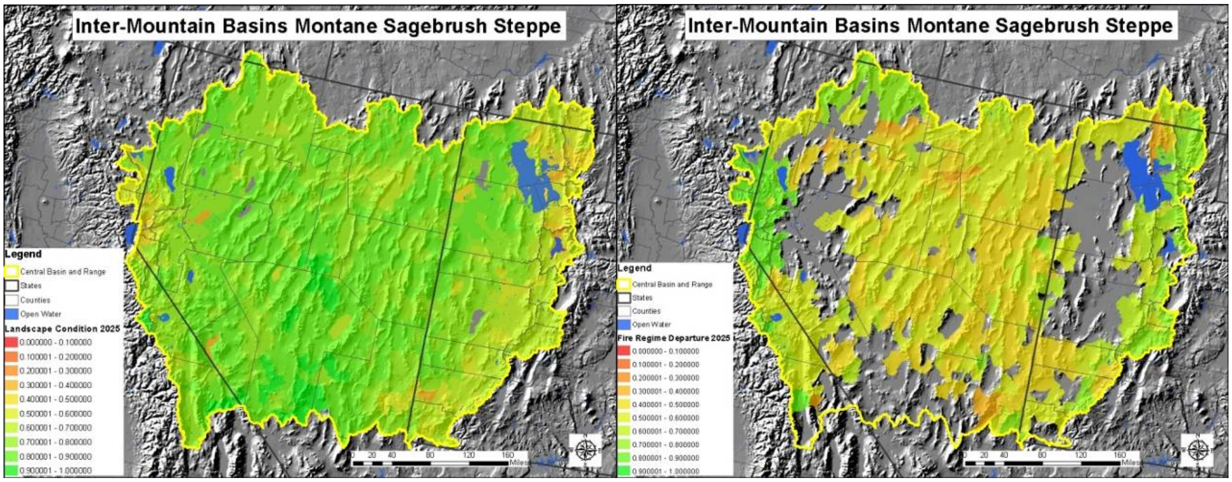


Figure B - 83. Inter-Mountain Basins Montane Sagebrush Steppe 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

BASIN DRY LAND SYSTEMS

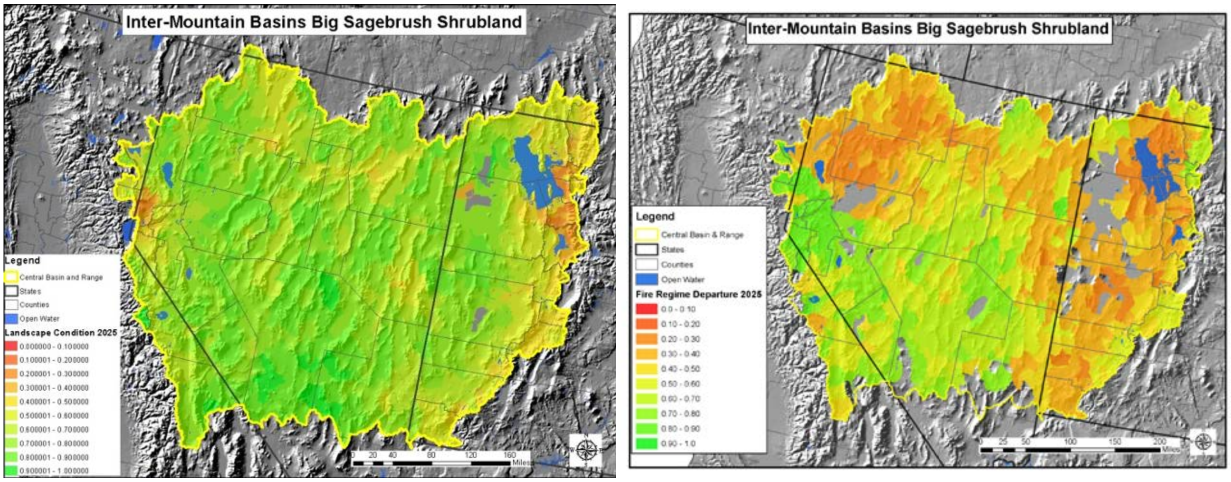


Figure B - 84. Inter-Mountain Basins Big Sagebrush Shrubland 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

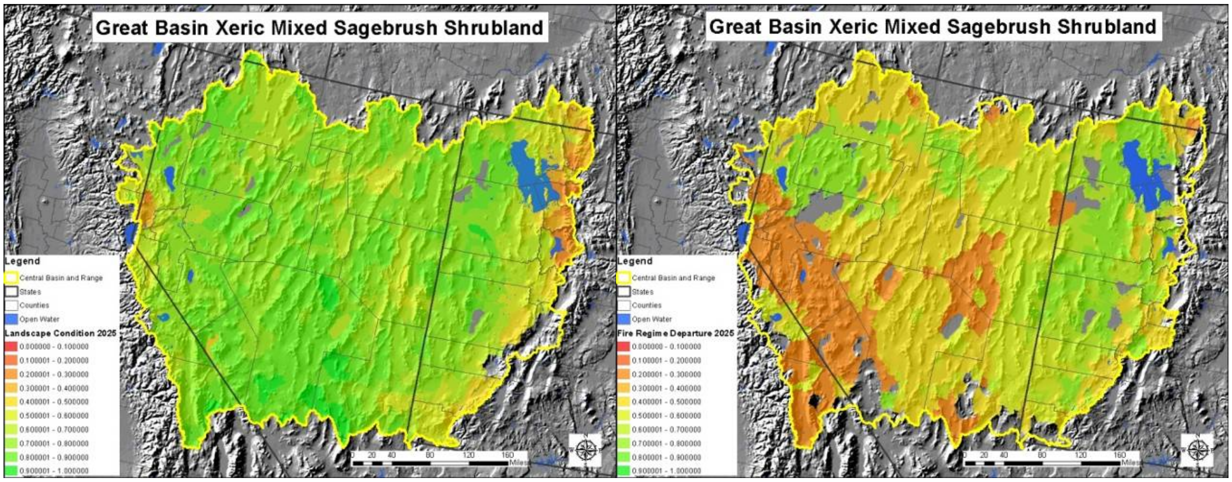


Figure B - 85. Great Basin Xeric Mixed Sagebrush Shrubland 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

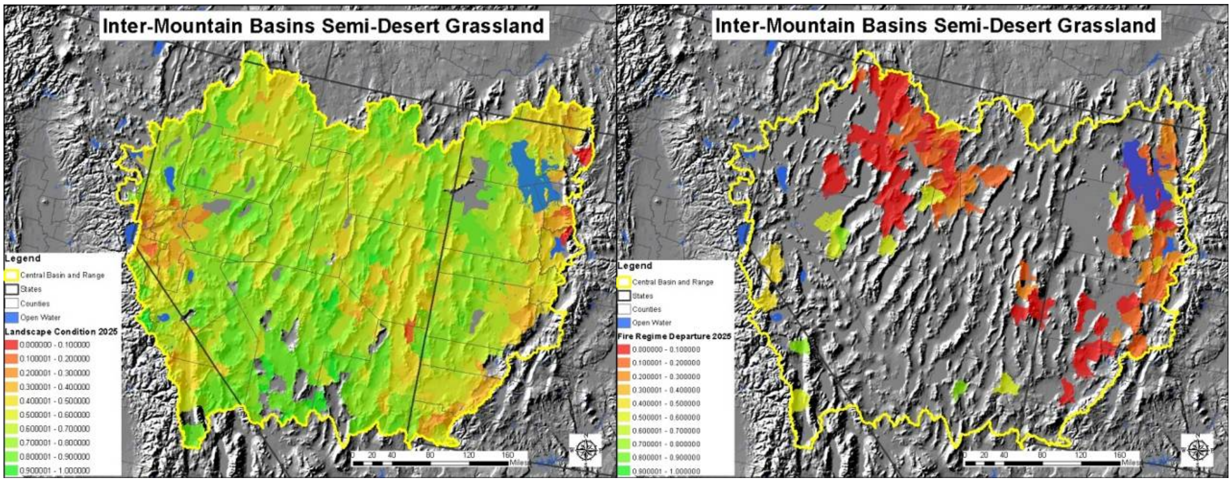


Figure B - 86. Inter-Mountain Basins Semi-Desert Grassland 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

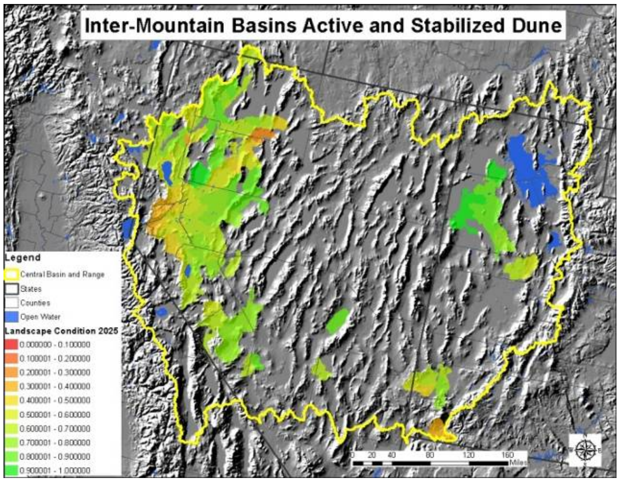


Figure B - 87. Inter-Mountain Basins Active and Stabilized Dune 2025 Landscape Condition Index scores

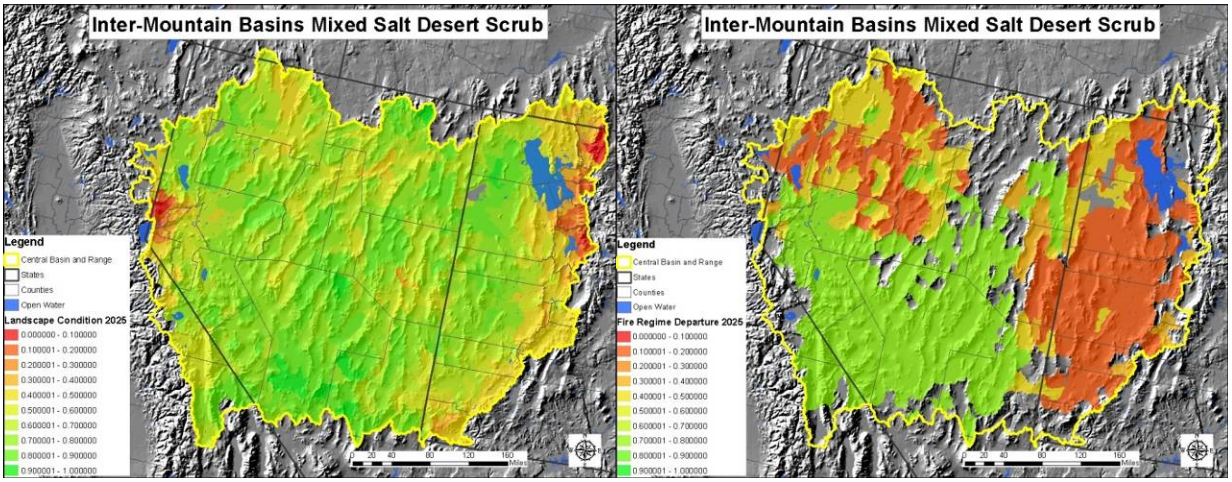


Figure B - 88. Inter-Mountain Basins Mixed Salt Desert Scrub 2025 status: 2025 Landscape Condition Index scores (left) and 2025 Fire Regime Departure Index scores (right)

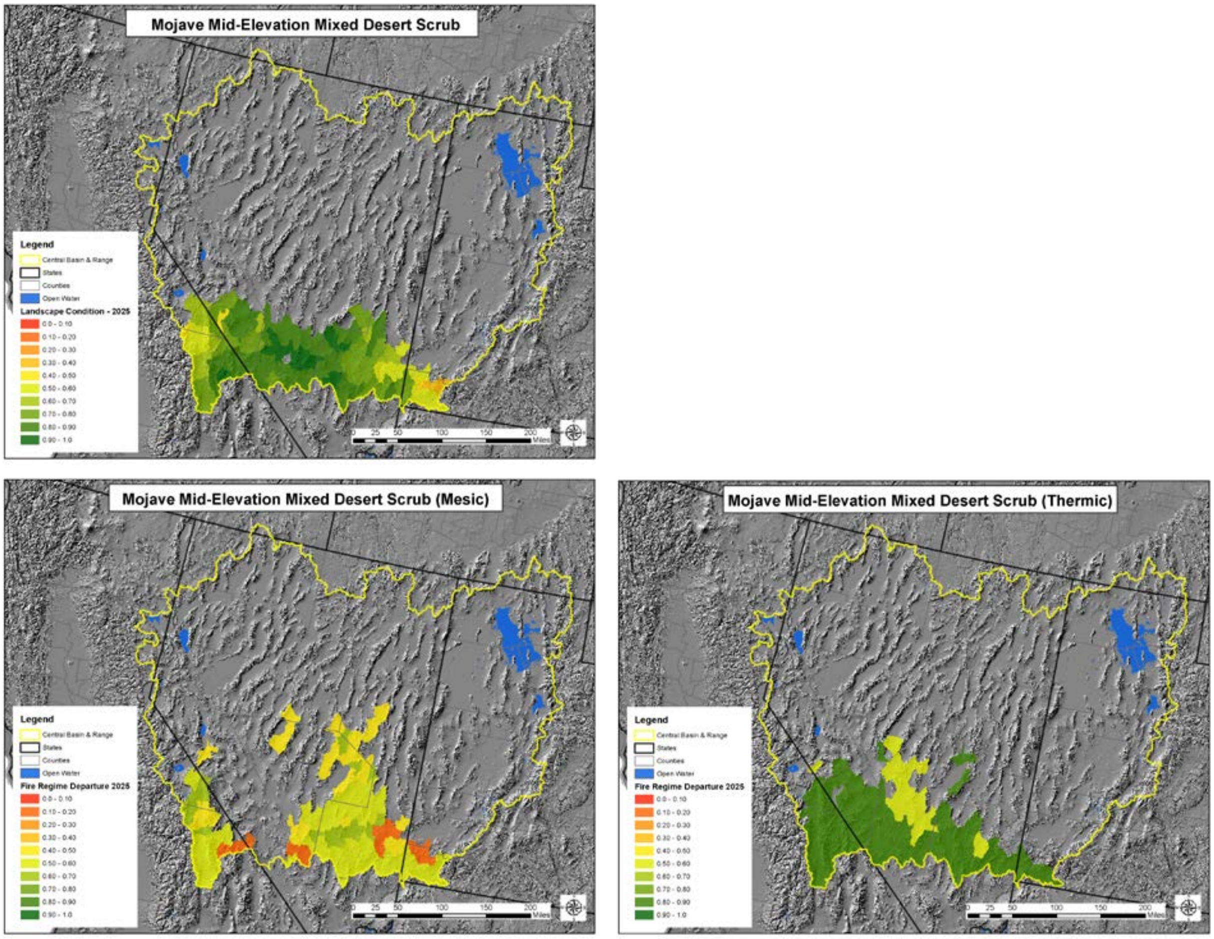


Figure B - 89. Mojave Mid-Elevation Mixed Desert Scrub 2025 status: 2025 Landscape Condition Index scores (top) and 2025 Fire Regime Departure Index scores (bottom) for mesic and thermic variants.

B-2.3.2 2025 Status: Landscape Species

Assessment of ecological status for landscape species for 2025 was completed for each distribution and summarized by 4 X 4 km grid. A total of 22,333 grid cells blanket the CBR ecoregion. Table B - 36 includes summary scores for grid cells in the same format utilized above for the current status of landscape species CEs. Only the 2025 landscape condition index was used for this assessment. The is sorted alphabetically by the species common name, so as to keep the different habitat components together for those species with several modeled habitats (mule deer, greater sage-grouse, brewers sparrow).

Table B - 36. Indicator results by 4 x 4 km grid cell for landscape species CEs (2025). For each indicator the count of 4 x 4 km grid cells is shown for each CE, broken out by indicator score interval.

KEA: Landscape Condition											
Future Landscape Condition Index											
	Count of 4 x 4 grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Bald Eagle	421	48	27	62	72	75	60	46	28	3	
Big Brown Bat	22,216	110	94	176	638	1082	2133	3872	6033	6769	1309
Brazilian Free-tailed Bat	20,677	95	80	130	419	862	1938	3602	5849	6485	1217
Brewer's Sparrow - Breeding Habitat	20,093	68	84	124	518	1162	2252	3833	5822	5673	557
Brewer's Sparrow - Migrating Habitat	1,619		1		1	3	13	68	284	825	424
Clark's Nutcracker	12,873	6	10	35	126	422	1138	2223	3787	4506	620
Coachwhip	9,097	13	26	43	156	411	837	1482	2658	2976	495
Columbian Sharp-tailed Grouse	1,599	2	6	8	19	48	222	414	488	378	14
Common Kingsnake	9,679	14	21	43	129	320	756	1445	2918	3448	585
Cooper's Hawk	18,184	147	148	222	659	1048	1850	3028	4848	5510	724
Desert Bighorn Sheep	3,407			1	18	42	154	395	1071	1536	190
Ferruginous Hawk	5,184	81	66	114	393	476	736	980	1285	905	148
Golden Eagle	368	14	19	34	54	59	58	74	45	11	
Great Basin Collared Lizard	17,777	28	40	51	370	846	1681	3221	5196	5476	868
Greater Sage-Grouse Lek	5,599	1	1	5	39	145	508	1132	1818	1862	88
Greater Sage-Grouse Lek 25	292						18	45	109	117	3
Greater Sage-Grouse Lek 50	700				2	3	50	153	258	227	7
Greater Sage-Grouse Lek 75	2,223				11	36	127	425	769	808	47
Greater Sage-Grouse Range	9,232	1	4	6	52	213	783	1765	3051	3134	223
Kit Fox	15,862	62	75	107	450	961	1778	2780	4411	4299	939
Loggerhead Shrike	565	7	12	46	121	94	102	112	67	4	
Mule Deer Summer	4,909	6	6	16	41	108	411	1027	1530	1609	155
Mule Deer Winter	6,633	5	13	32	103	344	849	1311	1836	1964	176
Mule Deer Yearlong	3,189	12	10	20	141	176	200	385	839	1230	176
Northern Harrier	15,667	85	88	133	563	915	1751	2869	4433	4412	418
Northern Rubber Boa	8,942	89	83	142	526	707	1120	1579	2290	2213	193
Northern Sagebrush Lizard	22,051	67	77	125	471	1075	2232	3888	6189	6671	1256
Prairie Falcon	21,619	86	92	186	745	1133	2108	3875	6019	6431	944
Pygmy Rabbit	11,643	56	33	68	415	842	1464	2221	3378	2921	245
Sage Sparrow	14,696	46	43	75	311	700	1591	2798	4390	4404	338
Sage Thrasher	20,462	66	85	129	504	1138	2254	3824	5820	5918	724
Savannah Sparrow	14,966	92	94	184	820	1046	1732	2847	4244	3620	287
Swainson's Hawk	19,602	100	104	202	852	1139	1950	3233	5198	5915	909
Western Patch-nosed Snake	4,569	9	12	19	91	141	324	630	1258	1658	427
White-tailed Jackrabbit	13,914	58	76	87	286	714	1552	2666	4081	4006	388

<u>Maps of landscape species CEs 2025 ecological status</u>

The 2025 spatial results of the ecological status assessment for a selection of the landscape species CEs are presented in Figure B - 90 through Figure B - 96. These are organized within the ecoregional conceptual model, with species associated with Montane Dry Land System presented first, then the species found in Basin Dry Land System. Species associated with either Basin or Montane Wet System are presented as a third group of CEs.

MONTANE DRY LAND ASSOCIATED SPECIES

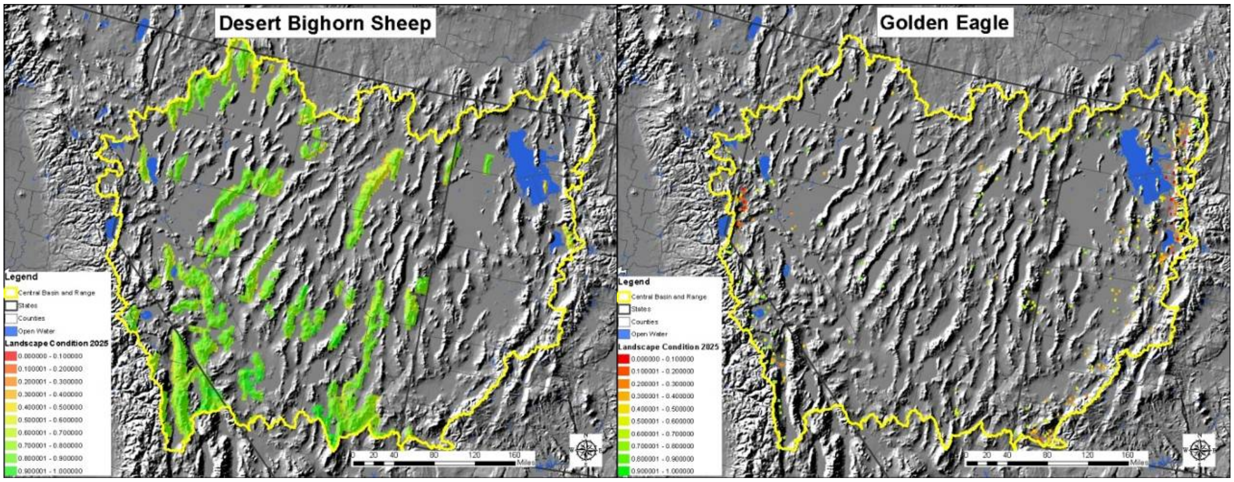


Figure B - 90. 2025 Landscape Condition Index scores for Desert Bighorn Sheep and Golden Eagle

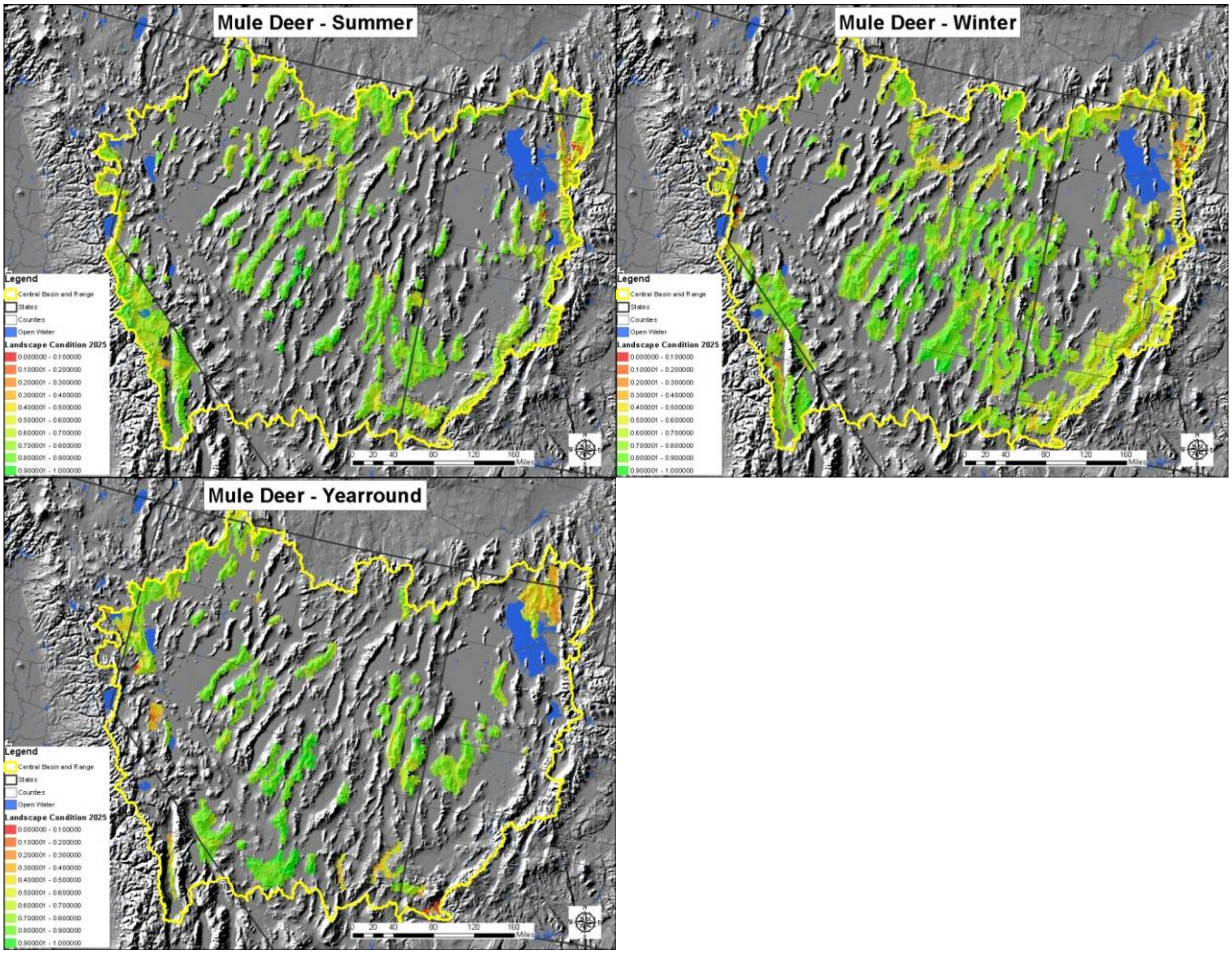


Figure B - 91. Mule Deer 2025 Landscape Condition Index scores for Summer, Winter, and Yearlong habitats

BASIN DRY LAND ASSOCIATED SPECIES

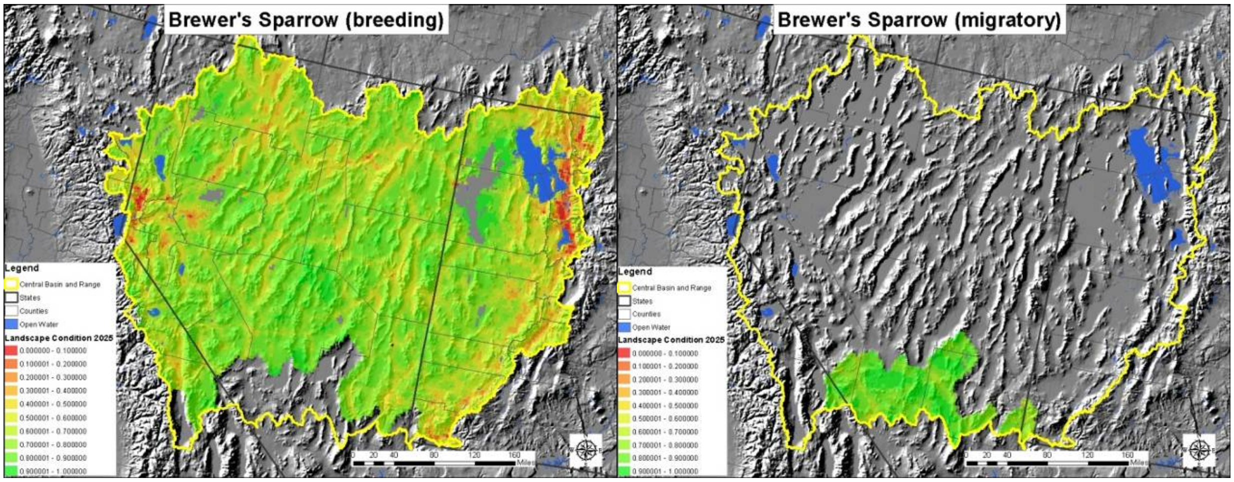


Figure B - 92. Brewer's Sparrow 2025 Landscape Condition Index scores for Breeding and Migratory habitats

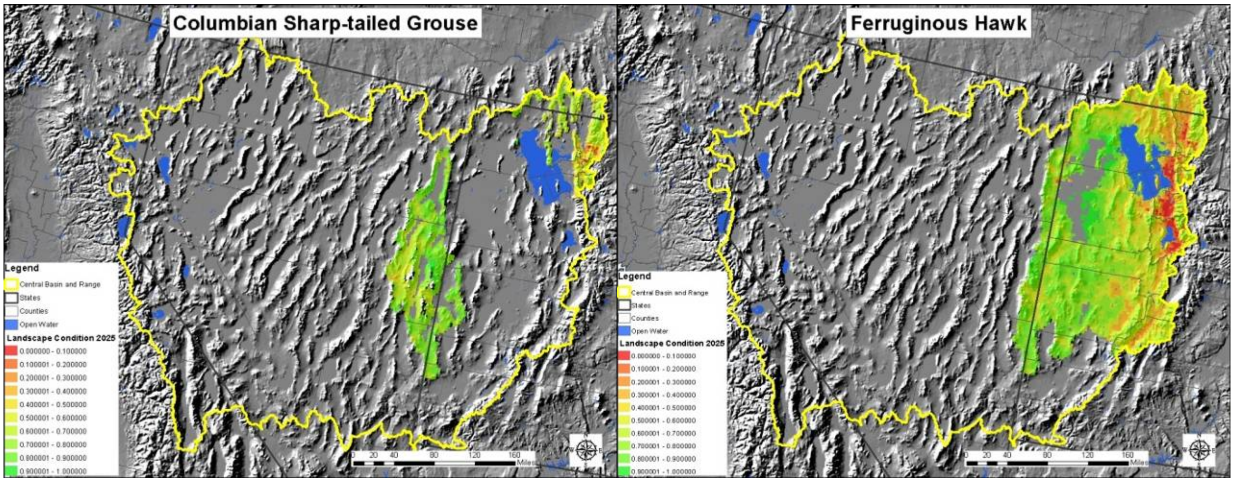


Figure B - 93. 2025 Landscape Condition Index scores for Columbian Sharp-tailed Grouse and Ferruginous Hawk

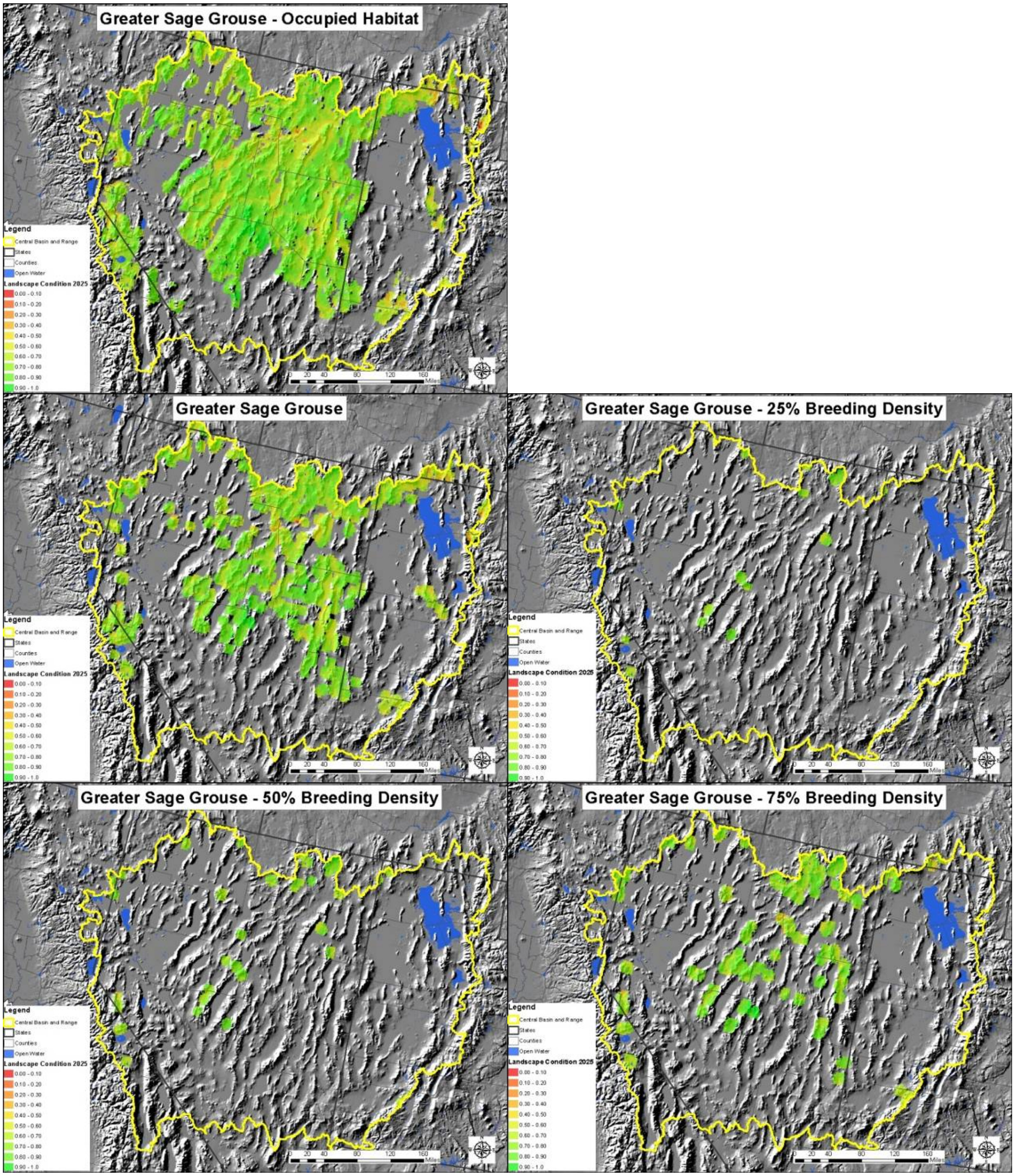


Figure B - 94. Greater Sage-Grouse 2025 Landscape Condition Index scores for Occupied Habitat (range) and Leks

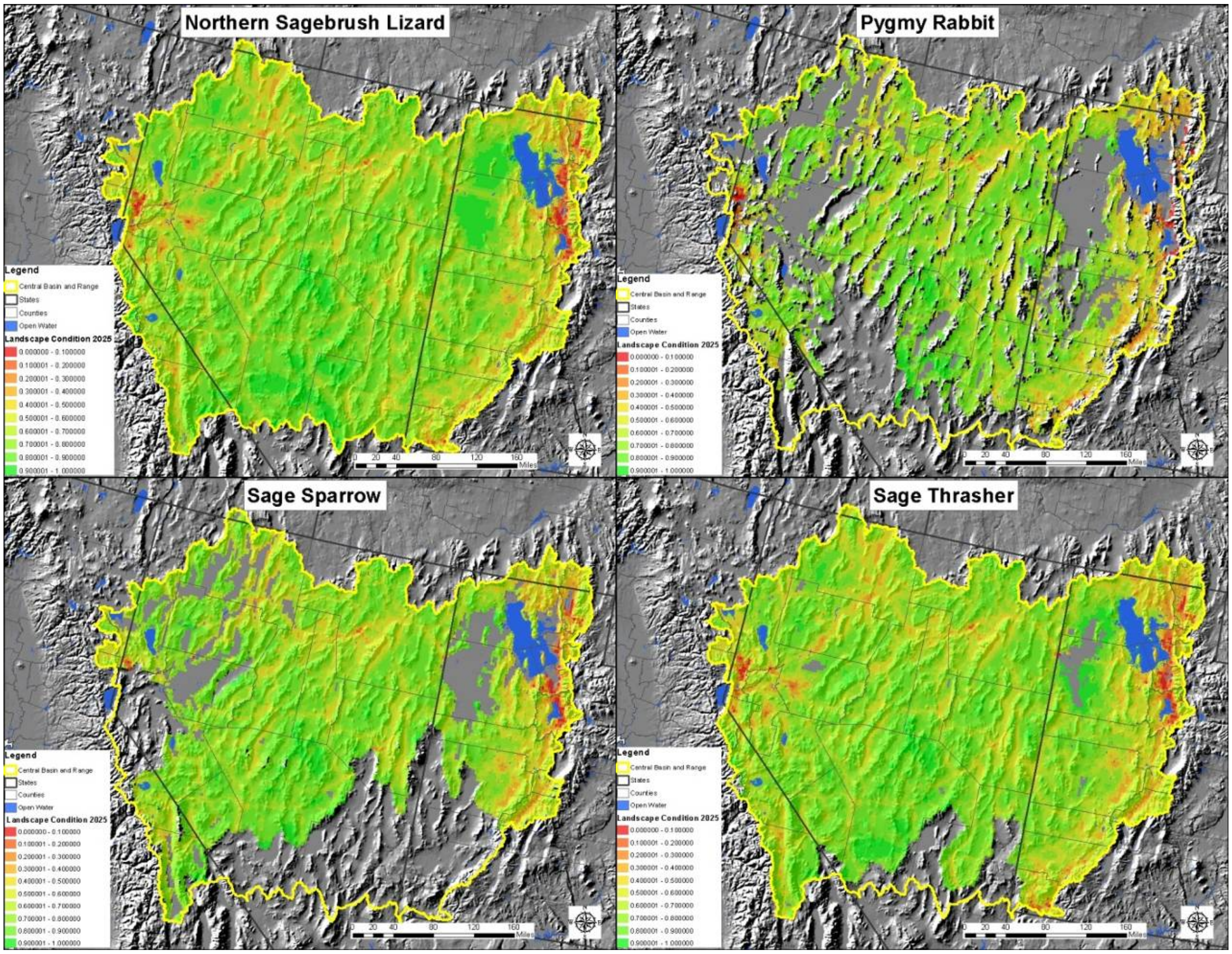


Figure B - 95. 2025 Landscape Condition Index scores for Northern Sagebrush Lizard, Pygmy Rabbit, Sage Sparrow, and Sage Thrasher

MONTANE OR BASIN WET ASSOCIATED SPECIES

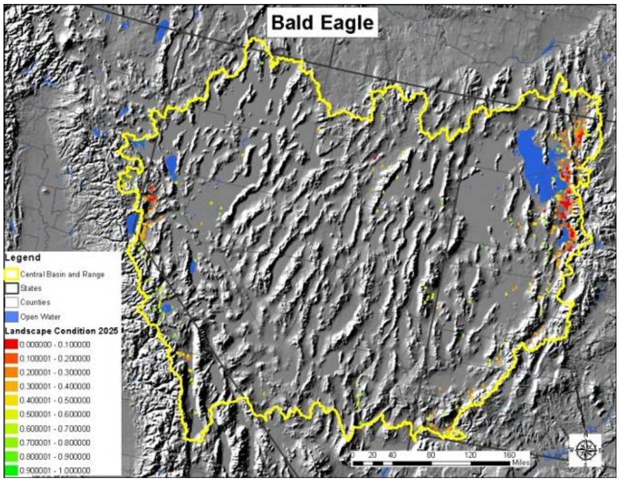


Figure B - 96. Bald Eagle 2025 Landscape Condition Index scores

B-2.3.3 2025 Status: Vulnerable Species Assemblages

Table B - 37. Indicator results by 4 x 4 km grid cell for species assemblage CEs (2025). For each indicator the count of 4 x 4 km grid cells is shown for each CE, broken out by indicator score interval.

KEA: Landscape Condition											
Future Landscape Condition Index											
	Count of 4 x 4 grid cells by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Montane conifer	11,013	142	156	205	512	665	1039	1745	2782	3341	426
Clay soil patches	5,501	6	10	22	56	174	421	956	1790	1776	290
Migratory waterfowl & shorebirds	3,205	112	78	109	507	503	568	555	475	266	32
Azonal non-carbonate rock crevices	2,167				2	19	58	179	579	1089	241
Azonal carbonate rock crevices	1,841	43	25	26	44	44	77	156	446	827	153
Sand dunes/sandy soils (when deep and loose)	1,801	6	6	11	78	146	247	380	492	390	45
Carbonate (Limestone/Dolomite) alpine	834	1	1	1	1	8	14	49	192	513	54
Non-carbonate alpine	535	1					12	58	153	276	35
Gypsum soils	27				4	3	4	2	5	9	

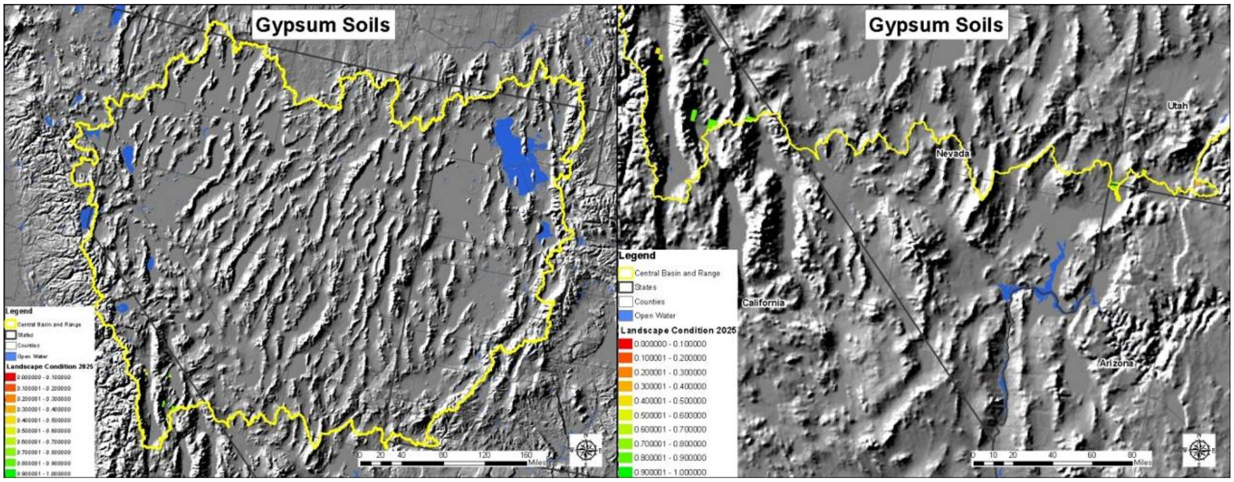


Figure B - 97. Gypsum Soils Species Assemblage 2025 Landscape Condition Index scores, full ecoregion (left) and small southern portion of ecoregion (right)

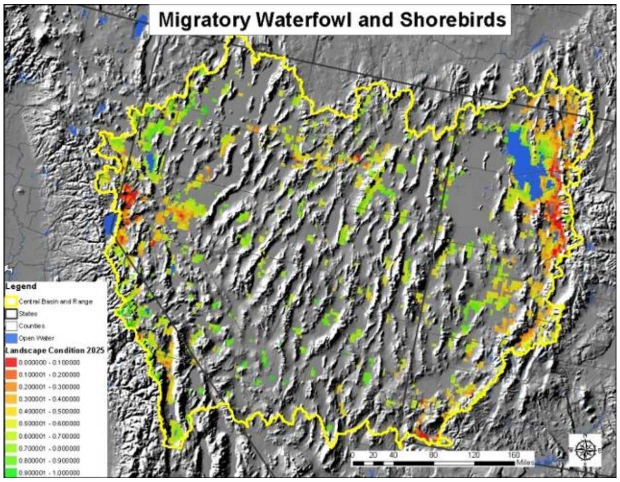


Figure B - 98. Migratory Waterfowl and Shorebirds Species Assemblage 2025 Landscape Condition Index scores

B-2.3.4 2025 Status: Aquatic Conservation Elements

In this section we address the impact of the projected future increase in Development, (urban growth) on Surface Water Use, Groundwater Use, and Riparian Corridor Continuity. We address future Aquatic Invasive Species infestation through the ‘At Risk’ Index which uses biology and dispersal mechanisms to measure risk of infestation on currently un-infested aquatic resources, and the ‘Future Impact’ Index, which looks at the degree of infestation of upstream watersheds and increased recreational usage to gage likelihood of future infestations. Table B - 40 provides the scores for 2025 ecological status of aquatic CEs; but the below sections explain and summarize the results.

B-2.3.4.1 Surface Water and Groundwater Use Change

MQ #54: WHERE WILL CHANGE AGENTS POTENTIALLY IMPACT GROUNDWATER-DEPENDENT AQUATIC CES?

MQ #60: WHERE ARE THE AREAS OF POTENTIAL FUTURE CHANGE IN SURFACE WATER CONSUMPTION AND DIVERSION?

This section builds on the separate assessment of future Development, focusing on the potential impacts on groundwater-dependent aquatic CEs from Development. Specifically (a) identifying where (in which watersheds) Development is forecast to change in ways that would affect water use, and (b) estimating how much of the resulting change in water use will involve a change in groundwater use.

The next management question concerns only the potential impacts on surface water use from Development. Specifically, (a) identifying where (in which watersheds) Development is forecast to change in ways that would affect water use and (b) estimating how much of the resulting change in water use will involve a change in surface water use.

Methods

Systematic databases are not available for enough of the CBR ecoregion, to attribute groundwater discharges at individual groundwater-dependent aquatic CE occurrences to specific aquifer sources (see discussion for Aquatic CE Indicator 05, Groundwater Use). However, the data assembled to assess Aquatic CE Indicator 05 do make it possible to assess the overall intensity of groundwater use in each watershed, as a potential source of stress to groundwater-dependent aquatic CE occurrences. It is also not possible with the data assembled for this rapid assessment to systematically identify individual watersheds where Development potentially will impact specific groundwater-dependent aquatic CE occurrences. Rather, the data available make it possible to identify watersheds containing groundwater-dependent aquatic CE types, in which Development potentially could lead to a change in groundwater use.

The separate assessment of the Development Change Agent, further, only provides estimates of future urban development, not development of agriculture. The assessment of these management questions therefore must focus on the potential impacts of urban development on groundwater and surface water use, respectively. The data on current water use required for this analysis come from the U.S. Geological Survey, Southwest Principal Aquifer (SWPA) study (Anning et al. 2009; McKinney and Anning 2009), as discussed in the assessments of Aquatic CE Indicators 04, Surface Water Use, and 05, Groundwater Use (Appendix B).

The SWPA study identified all water use associated with urban areas as "Public Water Supply" (PWS) use, with urban areas defined as those with a population density greater than 1,000 persons per square mile (386 persons per square kilometer). The SWPA study further divided PWS use into two components, consisting of the amount of PWS use supplied from surface water and groundwater sources, respectively. These two components are calculated from per-capita use rates for surface and ground water estimated for 2000, combined with population data from 2005 (Anning et al. 2009; McKinney and Anning 2009).

The separate assessment of the Development Change Agent has generated estimates of the change in area of urban development expected between the years 2010 and 2030. The estimates of urban development in this case come from a separate geographic analysis using U.S. Environmental Protection Agency methods from the Integrated Climate and Land Use Scenarios (ICLUS) project, Spatially Explicit Regional Growth Model (SERGoM) (USEPA 2010). The SWPA study "urban" threshold of 1,000 persons per square mile corresponds closely to the SERGoM threshold for housing density Class 8 (1,754 housing units per 12 km^2 grid unit).

The calculations required to evaluate where current and future development will impact groundwater dependent CE's involved five steps for each watershed, as follows:

1. *Total PWS water use for 2010*, *PWS surface water use for 2010*, and *PWS groundwater use for 2010* were calculated from the SWPA study data. These represent use rates for 2005 but based on per-capita water use rate estimates for 2000 combined with population data from 2005, as noted above. Units are in acre-feet per year (afy).
2. *Total PWS water use per unit of urban area for 2010* was calculated by dividing *Total PWS water use for 2010* by the *urban area for 2010* (acres) contained in each watershed, based on the area values estimated in the Development Change Agent analysis. Resulting units are in afy per acre.
3. *Total PWS water use for 2030* was calculated by multiplying the estimates of *urban area for 2030* (from the Development Change Agent analysis) by the value of *Total PWS water use per unit of urban area for 2010* calculated in Step. 2. Resulting units are in afy.
4. *Change in total PWS water use 2010-2030*, was calculated by subtracting the estimated *Total PWS water use for 2030* from *Total PWS water use for 2010* and expressing that difference as a percentage of *Total PWS water use for 2010*. Units are %.
5. *Change in PWS surface water use 2010-2030* and *change in PWS groundwater use 2010-2030* were calculated from the value for *Change in total PWS water use 2010-2030* based on the ratio of *PWS surface water use for 2010* to *PWS groundwater use for 2010.*

Rationale

The methods used to calculate *change in PWS surface water use 2010-2030* and *change in PWS groundwater use 2010-2030* entail two assumptions:

- The calculations assume that increases in PWS demand for water will be met through some as-yet unknowable combination of improvements in water-use efficiency (affecting per-capita water use), conversion of agricultural water use rights to public water supply rights, inter-basin transfers of surface water, and additional groundwater withdrawals. The additional withdrawals of groundwater could take place within the immediate watershed of interest, or take place in other watersheds from which the water is then transferred to the watershed of interest. The Southern Nevada Water Authority applications for groundwater rights in multiple basins in the CBR and Mojave Basin & Range ecoregions, to support water use in the Las Vegas metropolitan area, is an example of the latter method for acquiring additional ground water (SNWA 2011). At present there are no data or methods available with which to forecast the exact combination of methods that water authorities will be able to implement in the CBR ecoregion to meet future water demands. In fact, the topic is a matter of considerable debate (e.g., Cooley et al. 2007; Gleick 2010; BLM 2011; SNWA 2011).

- The calculations also assume that the ratio of PWS surface water use to PWS groundwater use will not change, between 2010 and 2030. That is, the calculations assume that, whatever combination of methods the water authorities use to meet future water demand between 2010 and 2030, the balance between PWS surface water use and groundwater use will not change. This assumption is necessary to allow the estimation of future PWS surface and groundwater use. However, water authorities in localities that presently rely in part on surface water supplies may seek to offset expected uncertainties in these supplies by using more groundwater resources. That is, they may seek to change the ratio of surface to groundwater use in their localities, as is proposed, for example, for the Las Vegas metropolitan area in the adjacent Mojave Basin & Range ecoregion (SNWA 2011).

In combination, the methods and assumptions result in estimates of PWS surface and groundwater use in 2030, per watershed, expressed as a percentage change from PWS surface and groundwater use in 2010. The estimates thus provide a specific scenario for change in water use, allowing an assessment of where large changes may take place that overlap with the distributions of aquatic CEs. The methods can be easily modified, for example, to assess the potential impacts of increased water-use efficiency (reduced per-capita PWS water use rates), or a switch in the relative use of surface versus ground water in a given watershed. However, an evaluation of such alternative future scenarios is outside the scope of the present rapid assessment.

The projected values for *change in PWS surface water use 2010-2030* range from a minimum of 0% to a maximum of 1,220.8%. The projected values for *change in PWS groundwater use 2010-2030* range from 0% to 6,079.2%. However, the distributions of values are highly skewed for both variables. Most watersheds show little or no change. To facilitate analysis, therefore, the raw values were transformed to their logarithms ($\log_{10}$), resulting in a far less skewed distribution. watersheds with a raw use rate of 0 were assigned a log value equal to that of the lowest non-zero percentage measured for any watershed in the ecoregion ($\log_{10} = -16.3$ for both surface and ground water use). The resulting ranges of logarithm values, from -16.3 to +1.1 for PWS surface water use and -16.3 to +1.8 for groundwater use, better distinguish among use rates by their order of magnitude. For ease of presentation, the results were then normalized to range from 0 to 1.

Results and Implications

As noted above, the projected values for *change in PWS surface water use 2010-2030* range from a minimum of 0% to a maximum of 1,220.8%, and the projected values for *change in PWS groundwater use 2010-2030* range from 0% to 6,079.2%. Thus, all changes are positive; no watershed is projected to exhibit a decrease in either PWS surface or groundwater use. As also noted above, further, the distributions of values are highly skewed for both variables. Most watersheds show little or no change, and only a handful show a large change. For PWS surface water use, only 10 watersheds out of 631 show a change greater than 25%. For PWS groundwater use, only 26 watersheds show a change greater than 25%, with only ten of these showing a change greater than 100%.

Watersheds with an estimated 2010-2030 increase in PWS surface water use greater than 10% occur in two major clusters: (1) a nearly continuous band of metropolitan areas extending southward from Logan to the area around Utah Lake, Utah; and (2) the Reno-Sparks metropolitan area. One watershed covering Cedar City, Utah, also has an estimated increase in PWS surface water use greater than 10%. In turn, watersheds with an estimated 2010-2030 increase in PWS groundwater use greater than 25% occur in five major clusters: (1) the metropolitan area around and immediately north of Logan, Utah; (2) the metropolitan area immediately south of Utah Lake, Utah; (3) the area including and surrounding Cedar City, Utah; (4) the area including and immediately south of Elko, Nevada, extending from around Wells in the east to Carline in the west; and (5) the general area of Reno-Sparks-Carson City, Nevada, extending east as far as the areas of Yerrington (SE of Carson City) and Fernley (east of Sparks), Nevada. These results correspond to the area of greatest projected urban growth in the ecoregion. The estimates of the potential impacts of this growth on surface and groundwater resources, respectively, depend on the present-day (2010) observed relative rates of PWS surface versus groundwater use.

All of the watersheds projected to see increases in PWS surface water use contain occurrences of the Great Basin Lake/Reservoir; Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland/Stream; Inter-Mountain Basins Wash; and Inter-Mountain Basins Playa Aquatic CE types. The watersheds projected to see increases in PWS surface water use also contain occurrences of the Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland/Stream and Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland/Stream aquatic CE types, except in those watersheds immediately east of Sparks, Reno, and Carson City, at lower elevations, where these latter two CBR aquatic CE types are not present. The projected increases in PWS surface water use from 2010 to 2030 therefore pose threats to almost the entire spectrum of aquatic CE types supported by surface water flows present in the ecoregion in the affected watersheds.

All of the watersheds projected to see increases in PWS groundwater use also contain occurrences of the Great Basin Spring and Seep and Inter-Mountain Basins Greasewood Flat aquatic CE types. They also contain individual reaches of Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland/Stream, Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland/Stream, and Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland/Stream aquatic CE types with perennial flow; and individual occurrences of the Great Basin Lake/Reservoir aquatic CE type that receive inflows from perennial streams. All of these CE types or reaches within them depend on groundwater discharges. Unfortunately, as discussed for Indicator 05, Groundwater Use, it is not possible to identify which aquifers support which CE occurrences, and which aquifers support PWS groundwater withdrawals, using the regional-scale data available. Consequently, it is impossible to assess the potential impacts of the projected increases in PWS groundwater use on specific individual groundwater-dependent CE types or occurrences. Nevertheless, watersheds with large projected increases in PWS groundwater use warrant close attention, to determine how such increases might affect individual aquatic CE types.

Indicator Data and Knowledge Gaps

As noted above, the estimates of change in PWS surface and groundwater water use rest on information assembled independently by the SWPA study and by the SERGoM analyses carried out for this REA. Two kinds of minor discrepancies are evident in the measurements of urban area per watershed, between the SWPA and SERGoM analyses, as follows:

- Five watersheds in the CBR ecoregion have positive values for total PWS water use, but SERGoM values of 0 for urban area (watersheds 1501001305, 1602030501, 1602030902, 1606001421, and 1808000314). These five watersheds present discrepancies, because the SWPA study estimated PWS use based on areas with urban development. Any watershed with a positive value for total PWS water use identified by the SWPA study therefore should have a positive value for urban area as well. These five discrepancies appear to arise for two reasons: (1) SERGoM assesses urban growth only on private lands, while SWPA addressed all urban cover. watersheds with urban areas enclosed entirely within military lands therefore would not register in the SERGoM analysis of urban growth. For example, watershed 1602030501 includes military urbanized areas associated with the Dugway Proving Grounds that did not register in the SERGoM analysis. (2) The methods for defining "urban" differ slightly between the SWPA and SERGoM analyses, and they take their demographic and land cover data from different years. The discrepancies therefore may also result simply from minor differences in methods and data, such as can easily arise in rapid assessments using data from multiple independent sources. In any case, the amounts of water use involved are small: except for watershed 1602030501 (180 afy in 2010), total PWS water use in these five watersheds falls well below 100 afy, less than 1/1000th the annual rate of PWS water use recorded in high-water-use watersheds in the ecoregion.

- Fifty-seven (57) watersheds in CBR have total PWS water use values of 0 afy, based on the SWPA data, but have more than an acre of urban area based on the SERGoM values data. These fifty-seven watersheds present discrepancies again because the SWPA study estimated PWS use based on areas with urban development. Any watershed with a positive value for urban area therefore should have a positive value for total PWS water use identified by the SWPA study as well. Most of this second set of discrepant cases involves small (< 25 acres) areas of urban cover. However, five watersheds have SERGoM values > 25 acres for urban area and still have total PWS water use values of 0 afy based on the SWPA study (watersheds 1501000808, 1501000809, 1603000303, 1603000306, and 1603000405). These latter five watersheds cluster in the extreme southeastern corner of the ecoregion, north and south of St. George, Utah. Similar discrepancies occur in the Mojave Basin & Range analysis in this same immediate area (e.g., watershed 1501001006 in the Virgin River valley around Mesquite, Nevada). These discrepancies therefore may represent another type of difference between the SWPA and SERGoM methods for classifying urban land cover, that are more affected by land cover data in this one particular area than anywhere else. In any case, none of the discrepant watersheds has more than 600 acres (less than 1 square mile) of urban area, based on the SERGoM analysis. The areas of urban cover in the five most discrepant watersheds are as follows: watershed 1501000808, 418 ac.; 1501000809, 586 ac.; 1603000303, 137 ac.; 1603000306, 37 ac.; 1603000405, 42 ac. Using the SWPA definition of urban (>1,000 persons per square mile), none of these five most discrepant watersheds involves PWS water use by more than 1,000 persons; and watersheds with less than 25 acres of urban area experience PWS water use by fewer than 40 people.

These discrepancies point to ways to improve the assessment in future cycles. Specifically, the estimates could be improved by standardizing the methods use to estimate per-household surface water, per-household surface water groundwater use, and urban area for the underlying assessment grid units; and by constructing the estimates using a single timeframe.

The methods used to estimate changes in PWS surface and groundwater water use also entail several assumptions, noted both implicitly and explicitly above, as follows:

(1) Change in urban area accurately predicts the areas subject to change in PWS surface and groundwater use;
(2) Increases in PWS demand for water will be met through some as-yet unknowable combination of improvements in water-use efficiency (affecting per-capita water use), conversion of

agricultural water use rights to public water supply rights, inter-basin transfers of surface water, and additional groundwater withdrawals or inter-basin transfers of groundwater; and

(3) The ratio of PWS surface water use to PWS groundwater use in each watershed will not change, between 2010 and 2030.

The estimates of change in PWS surface and groundwater water use therefore together constitute a specific future scenario, linked closely to the 2010-2030 Development scenario itself. Alternative future scenarios for PWS surface and groundwater water use could be devised and evaluated by modifying any of the assumptions noted here.

Finally, as also noted above, it is not possible with the available regional-scale data to estimate how changes in groundwater use might affect individual aquatic CE types and their individual occurrences (see also Aquatic CE Indicator 05, Ground Water Use). Any estimates of increased groundwater use in a watershed, whether for PWS or agricultural irrigation, need to be investigated individually, to assess whether such an increase might affect aquatic CE occurrences within that watershed based on the aquifers involved.

B-2.3.4.2 Changes in Riparian Corridor Connectivity

When we re-calculated the percent fragmentation based on the projected development Landscape Condition Index, we found that some sections of riparian habitat disappeared all together, such that when compared to current state, it would appear the percent fragmentation had gone down (Figure B - 99). To correctly account for an increase in riparian corridor connectivity loss, we compared the number of 30 m by 30 m pixels that had Landscape Condition Model Index scores <0.7. The degree of change is more accurately represented by comparing number of pixels with high impact scores, rather than comparing the percent fragmentation. The amount of change was converted to a normalized score (between 0 and 1) by the following formula: 1-(indicator value/maximum value), where 0 = worst or highest degree of impact and 1 = best or least impacted score.

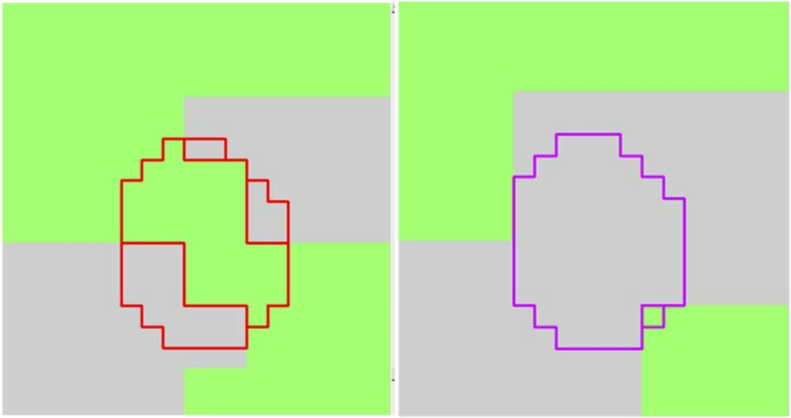


Figure B - 99. Fragmentation resulting in near complete loss of Riparian CE Corridor. Green = Landscape Condition Index >0.7, Gray = <0.7. Under Current 2010 LCM, riparian area is fragmented into 4 polygons (left). Under Future 2025 LCM, only single 30 m by 30 m pixel of original corridor remains (right).

About a dozen watersheds located in the heaviest urban use areas showed the greatest loss in riparian corridor connectivity, while about 70 watersheds experienced less than 50% loss. This is mainly due to the location of development increase, which generally shows a growth in the extent of existing urban areas.

B-2.3.4.3 Aquatic Invasive At Risk Status Index

The At Risk Status Index (Table B - 38) is based on data reported at the time the databases were modeled (circa 2010). It is not a future predicted index (see Future Impact Index next section). The At Risk Status Index models additional risk due to factors that were not reported within the individual CE. These include: novel invasive taxa that occurred in other CEs within the HUC, trophic status of novel taxa within the HUC, and the amount of aquatic recreational use within the HUC. All previously used metrics from earlier drafts of this report have been either modified or eliminated in order to develop and refine the At Risk Status Index.

Number of novel invasive taxa

Water quality, water temperatures and other physico-chemical conditions, and aquatic and riparian habitats in CE types within a watershed (5th level watershed) are more similar than are conditions in CE types that are further physical distance apart (e.g. 4th level watersheds or HUC4s) due to their relatively smaller sized areas and hydrological relatedness. Given a watershed's small size (mean = 220 mile^2) and hydrological relatedness; all of the invasive taxa (CAs) in our assessments have the potential to occupy any of the CE types within a watershed. This is not the case for larger HUC units and becomes less true as HUC unit areas increase. Therefore, any of the invasive taxa that already were reported in other CEs within a watershed likely were present in the CE but may not have been reported.

Trophic level

The invasive taxa used in the indices encompassed all trophic levels except for decomposer trophic level.

Connectivity and dispersal

A 5th level watershed is a relatively small hydrological unit (i.e. watershed), which infers a greater level of connectivity than larger sized units (e.g. sub basin 4th level watershed). All streams within a watershed are surficially connected, at least perennially or ephemerally. Lakes and reservoirs can be considered large temporary pools within the context of the geological history of the longer lived stream or rivers from which they arose and are by definition connected to these streams or rivers. Springs and seeps are typically more hydrologically connected within a watershed than between watersheds. However, it is difficult to remotely determine if CEs other than isolated springs in a watershed are truly connected or not. If there is any physical connectivity between CEs within a watershed, then invasive taxa will find ways to exploit these connections. An invasive taxon's spread is also inversely related to distance between infested and uninfested sites (often modeled as a decreasing power curve), with dispersal ability and rate of dispersal much greater at shorter distances. Therefore, invasive taxa disperse more rapidly within a watershed than between watersheds. We did not include a connectivity metric in the At Risk Index, given that dispersal within a watershed is such a short term limiting factor.

Invasive taxa generally disperse better downstream than upstream. However, invasive taxa were reported as point locations. An invasive taxon could have occurred either upstream or downstream of a reported site but was not reported. Thus, we do not know if an invasive taxon occurred upstream or downstream of that point location. The exception to this would be isolated springs which would have no connectivity associated with them. Therefore, we did not include an upstream/downstream metric in the At Risk Index.

Land Use

Invasiveness is strongly related to the amount of human use within a CE and HUC. The more human economic activity, the more likely a CE is to be impacted by invasives via increased spread rate or multiple introductions. In addition, invasion potential is also a function of human use and activity in nearby areas. The popularity of a CE for recreational use can supersede the distance function for many invasive taxa. Popular recreational areas disproportionally attract users from long distances and these users may inadvertently or intentionally harbor aquatic invasives (Bossenbroek et al. 2001). This phenomenon is often modeled in what are referred to as invasive species 'gravity' models. Given the importance of human economic activities in the spread of invasives, we have included recreational use in the At Risk Index.

Additional avenues of spread

There are additional known and postulated avenues of invasive species spread including dispersal by: waterfowl, biologists, irrigational use, city water supply, fire fighting water use, or other types of diversions, etc. (Aquatic Nuisance Species Task Force 2011). The dispersal levels for these avenues of spread are difficult to evaluate but are assumed to be, for the most part, less important than the types of spread that we have included in the At Risk and Future Impact Indices. We elected not to include other avenues of spread given the assumption that these addition spread agents were either correlated with the amount of recreational use and were thus implicit in the Use metric or not enough data were available for their inclusion.

Time

Time is inherent in any ecological model. Time since first invasion in a CE and HUC can affect the level of impact. The longer a taxon has been in a CE in a HUC the more time it has had to elicit a negative impact and to reduce ecological integrity. In general, very recent arrivals have not had enough time to reach their potential impacts but given enough time they may. Effects of invasives are often not manifested for 50 to 100 years since initial invasion.(

Many of the invasive taxa on our list are recent arrivals (e.g. New Zealand mudsnails, Eurasian water milfoil, Zebra and Quagga mussels, etc.) or have recently become problematic (e.g. Didymo). Alternatively, if a taxon has been present for a long time it most likely occurs in all CEs but again more recent surveys may not have been conducted and up- to- date status was not available for this analysis. If an invasive species was reported in any of our databases then it most likely was well established and had to have reached some minimum detection level. Given all of these unknowns and the limited data, a time metric was not included, although the effects of time on invasion impacts should be strongly considered in any management strategy.

Table B - 38. Aquatic Invasive Species Impact Index scoring criteria for **At Risk** status for each CE within a 5th level watershed that was scored ‘Undetermined’ or ‘Transitioning’ in Known Status Index.

At Risk Index					
Type of Indicator	**Metric category**	**Metric**	**Justification**	**Data Source**	**Evaluation and score**
Biotic	**Number of invasives**	2. Number of novel invasive taxa present in all CEs within 5th level watershed	The greater the number of invasive taxa there are in a HUC, the greater a CE is at risk	USGS NAS, USGS didymo database, Natural Heritage Programs attributed to specific CEs (~90% of the records). + Assignment of records in datasets that lack specific CE attributes (~ 10% of data) based on CE invasive potential (Appendix 1) and closest CE.	0 taxa = NA 1 taxon = 0.67 > 1 taxa = 0.33
	Trophic levels	3. Number of novel trophic levels in all CEs within 5th level watershed	The greater the number of trophic levels infested in the HUC, the greater the impairment	Based on data from Metric #2	0 taxa= NA 1 trophic level = 0.67 > 1 trophic level = 0.33
	Use	4. Number of Aquatic Recreational Use Sites within a 4th level watershed	Access sites are invasion hotspots. The greater the number of access sites, the greater the impact	NLUD_AQUATIC data set	0-1 sites = 1.00 2 sites = 0.67 > 2 sites = 0.33

Scoring for At Risk Status metrics

The following is the scoring method for At Risk Status for individual CEs**:**

1. If aquatic invasives were found in a CE then the At Risk Status score equals the product of Metrics 1, 2, 3, and 4. An At Risk Final Score of 0.67 = Transitioning and < 0.67 = Degraded.
2. If no invasive taxa were found in a CE in a HUC and its Known Status Index was rated as ‘undetermined’ but invasives were reported in other CEs within the HUC, then its At Risk Status score is equal to the CE in the same HUC with the highest At Risk Status Final score.
3. If no invasive taxa were found in a CE and its Known Status Index was rated as ‘undetermined’ and no invasives were reported in other CEs within the HUC, then its At Risk Status score is ‘undetermined’.

The following figure (Figure B - 100) is the flow chart for the At Risk Status Index scoring.

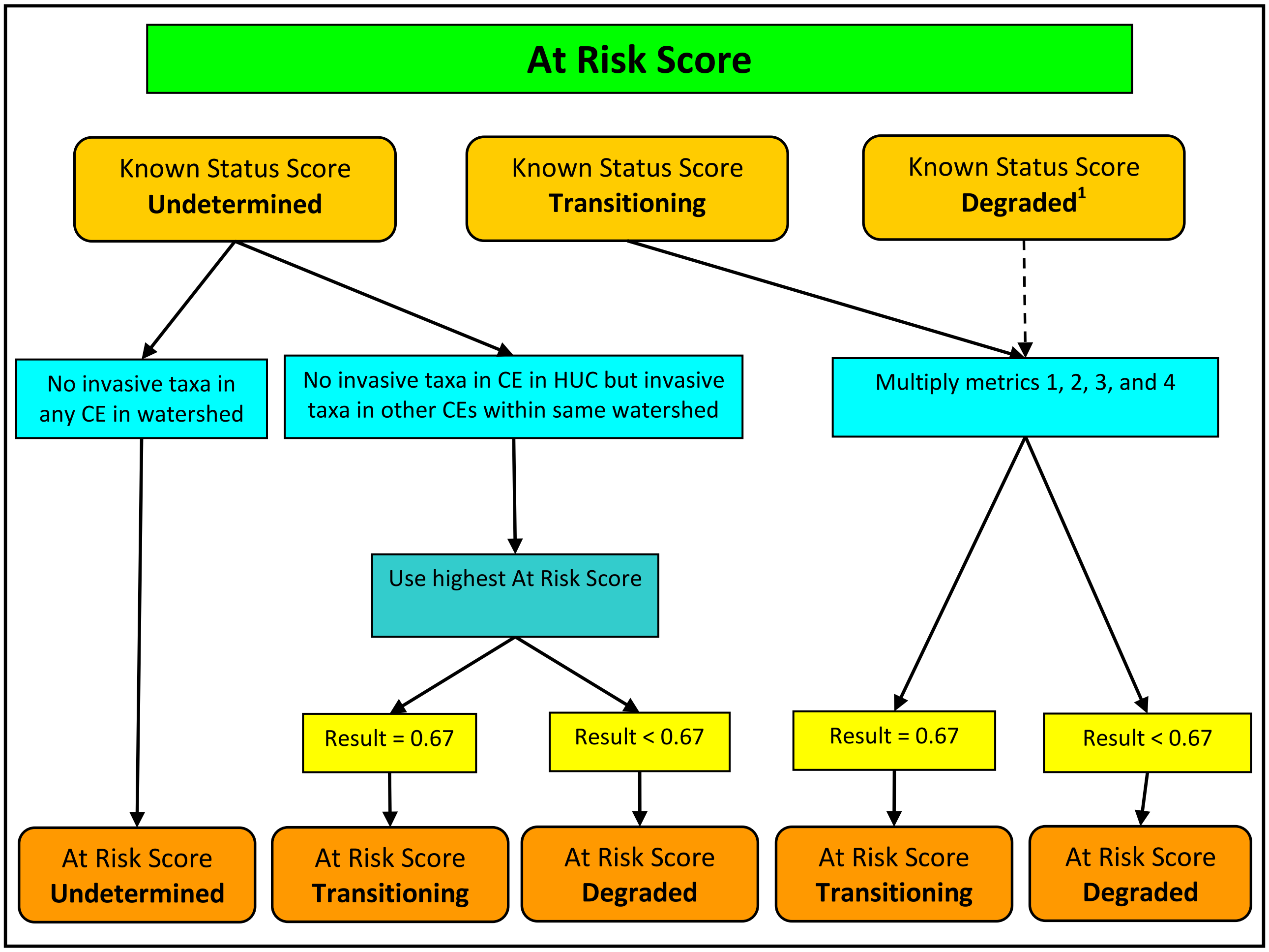


Figure B - 100. Flow chart of Scoring for At Risk Status Index

[1] If Known Score and At Risk Score = Degraded then it is not necessary to continue with evaluation, however an estimate of relative At Risk impact score for comparison with other CEs and watersheds can be made.

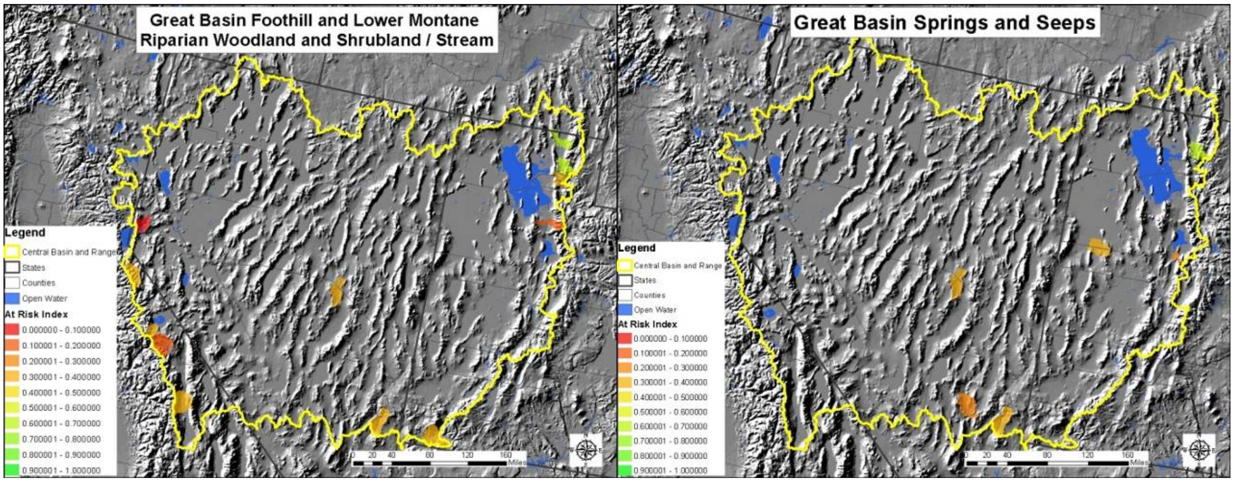


Figure B - 101. Aquatic Invasive At Risk Status Index 2025 Results for 2 CEs

At Risk status results show where CEs are likely to be infested by neighboring infested CEs (Figure B - 101). This risk assessement is based on know locations of aquatic invasive species and does not show risk of new infestations.

B-2.3.4.4 Future Aquatic Invasive Species Impact Index 2025

No CE or watershed is an island and invasion potential is strongly related to conditions in surrounding watersheds. Invasion potential is strongly correlated with distance from nearest invaded location and distance is considered to be one of the most important factors in invasion theory (Shigesada and Kawasaki 1997). Therefore, we included two metrics from surrounding 5th level watersheds within the same 4th level watershed for development of the Future Aquatic Invasives Impact Index: the Number of novel invasive taxa present in all CEs within 4th level watershed and the Number of novel trophic levels in all CEs within 4th level watershed metrics (Table B - 39).

Upstream and downstream dispersal and connectivity strongly affects invasion potential in freshwater ecosystems with invasive taxa more prone to downstream dispersal than upstream dispersal in connected systems. Thus, the location of a watershed relative to other watersheds is important. We included an upstream/downstream/closed basin metric in the Future Aquatic Invasives Impact Index: the Upstream or downstream from other 4th level watersheds metric (Table B - 39). This metric was based on whether a 4th level watershed was upstream, downstream, or in a closed basin regardless if any invasive species were reported in the other upstream or downstream 4th level watersheds. We did this because of the very limited data on invasives available (i.e. it was unknown if invasive species already occurred in many of the surrounding watersheds) and because in general, unknown future aquatic invasives are also expected to disperse more readily downstream than upstream and less readily from closed basins.

Human economic activity, particularly recreational activity, is also a major factor for the spread of aquatic invasive species in the future. Recreational activities and economic conditions are directly related but their relationship is often complex and difficult to predict. We do not know if the number of recreational use sites and users will decrease or increase in the future given economic uncertainties, therefore the Use metric, the Number of Aquatic Recreational Use Sites within a 4th level watershed (Table B - 39), was based solely on the known number of recreation sites at the time of the index generation.

Table B - 39. Future Aquatic Invasive Species Impact Index 2025 scoring criteria for each CE within a 5th level watershed

Future Aquatic Invasive Species Impact Index 2025					
Type of Indicator	**Metric category**	**Metric**	**Justification**	**Data Source**	**Evaluation and score**
Biotic	**Number of invasives**	5. Number of novel invasive taxa present in all CEs within 4th level watershed	The greater the number of invasive taxa there are in a watershed, the greater a CE is at risk	USGS NAS, USGS didymo database, Natural Heritage Programs attributed to specific CEs (~90% of the records). + Assignment of records in datasets that lack specific CE attributes (~ 10% of data) based on CE invasive potential (Appendix 1) and closest CE.	0 taxa = NA 1-2 taxa = 0.67 > 2 taxa = 0.33
	Trophic levels	6. Number of novel trophic levels in all CEs within 4th level watershed	The greater the number of trophic levels infested in the watershed, the greater the impairment	Based on data from Metric #1	0 taxa= NA=1.00 1 trophic level = 0.67 > 1 trophic level = 0.33
Physical	**Watershed Connectivity**	7. Upstream or downstream from other 4th level watersheds	Most invasive taxa are better able to disperse downstream (drift) than upstream	MSU Graphical Locator	Closed basin = 1.00 Upstream watershed = 1.00 Downstream watershed = 0.67
Landscape context	**Use**	8. Number of Aquatic Recreational Use Sites within a 4th level watershed	Access sites are invasion hotspots. The greater the number of access sites, the greater the impact	NLUD_AQUATIC data set	0 sites = 1.00 1-3 site = 0.67 > 3 site = 0.33

Scoring for Future Aquatic Invasive Species Impact Index 2025 Metrics

The following is our scoring method for Future Aquatic Invasive Species Impact Index 2025 (Figure B - 102), and Figure B - 103 shows the results for 2 CEs:

1. If a CE had a final score of 'degraded' in the Known Status Index and At Risk Status Index then no further calculations are necessary and its final Future Score is 'Degraded'(however, the Future

Index values can be calculated to generate a relative impact estimation compared to other CEs and watersheds but this is not necessary).

2. If a CE had a final At Risk Status score of 'undetermined' and there were no invasive species in any CE within the 4th level watershed, then its final Future Aquatic Invasive Impact score remains 'undetermined'.
3. If a CE had a final At Risk Status score of 'undetermined' and there were invasive species in other CEs within the 4th level watershed, then its final Future Aquatic Invasives Impact score is equal to the highest Future Aquatic Invasives Impacts score for other CEs within the 4th level watershed.
4. If a CE had a final At Risk Status score of 'transitioning' then multiply its final At Risk Status score by metrics 5, 6, 7, and 8. A final Future Aquatic Invasives Impact score of 0.67 = 'transitioning', a score < 0.67 = 'degraded'.

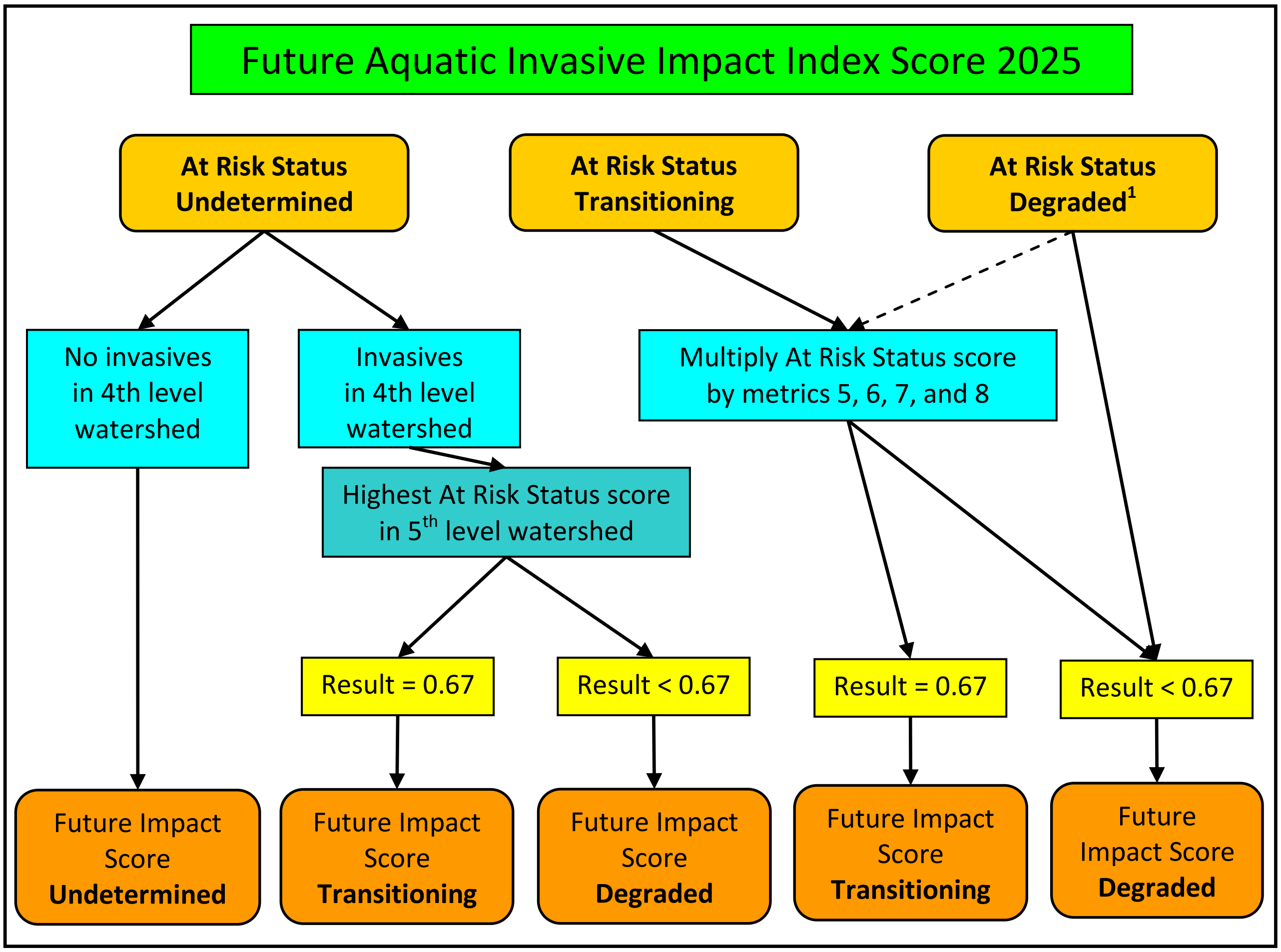


Figure B - 102. Flow chart of Scoring for Future Aquatic Invasive Impact Index

[1] If At Risk Status Score = Degraded then it is not necessary to continue with evaluation, however an estimate of relative Future Impact score for comparison with other CEs and watersheds can be made.

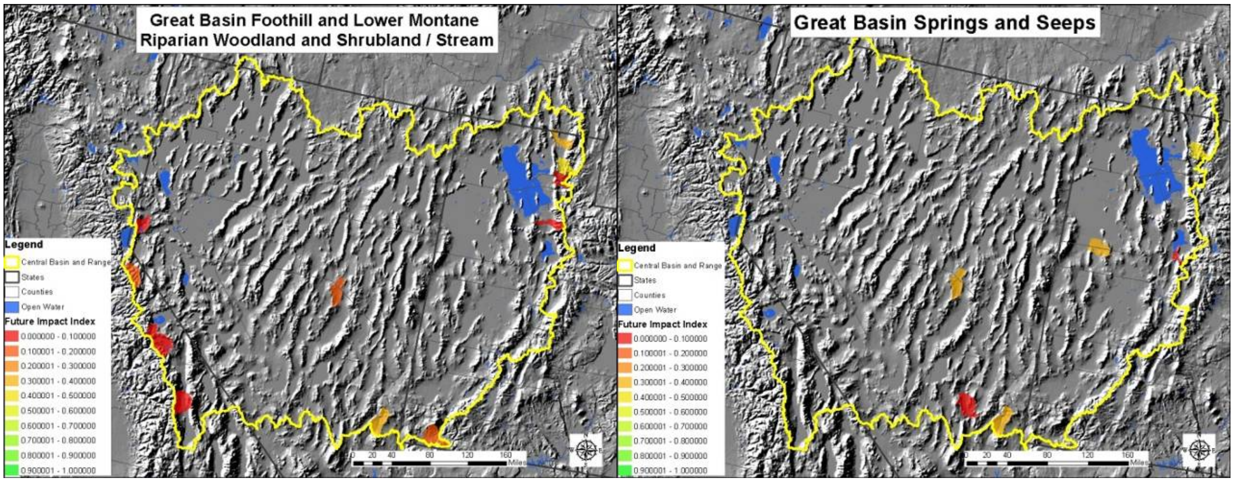


Figure B - 103. Aquatic Invasive 2025 Impact Index results for 2 CEs.

Table B - 40. Indicator results by watershed for Aquatic coarse filter CEs (Future). For each indicator the count of 5th level watersheds is shown for each CE, broken out by indicator score interval.

KEA: Change in Extent/Size

Future Riparian Corridor Continuity

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610	2			1	2	2	4	9	33	557
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271	2			3	1		3	6	5	251
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	245	1	1	2		1		2	8	10	220

KEA: Surrounding Land Use Context

Future Landscape Condition Index

	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	610			5	9	22	80	118	225	135	16
Great Basin Lake / Reservoir	309			5	9	21	69	83	96	25	1
Great Basin Springs and Seeps	571			5	8	22	77	116	206	123	14
Inter-Mountain Basins Greasewood Flat	600			4	8	19	75	118	228	129	19
Inter-Mountain Basins Playa	503			2	7	17	65	103	190	105	14
Inter-Mountain Basins Wash	610			5	9	22	80	119	231	126	18

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland / Stream	271			5	7	20	54	64	76	40	5
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	245			5	7	15	40	55	94	27	2
KEA: Stressors on Biotic Condition											
Aquatic Invasive At Risk Index											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	12	1	2		7			2			
Great Basin Lake / Reservoir	18	3	3	2	3	1		6			
Great Basin Springs and Seeps	6			2	3			1			
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	2	1			1						
Aquatic Invasive Future Impact Index											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland / Stream	12	6	3		2	1					
Great Basin Lake / Reservoir	18	9	4	1	1	2		1			
Great Basin Springs and Seeps	6	2			3	1					
Rocky Mountain Subalpine-Montane Riparian Woodland and Shrubland / Stream	2	2									

B-2.4 2060 Distribution

B-2.4.1 2060 Ecological Status: Terrestrial Coarse-filter Conservation Elements

Fire regime departure for mid-century (2060) was calculated for some of the terrestrial coarse filter CEs.

Table B - 41. Indicator results by watershed for Terrestrial coarse filter CEs (2060). For each indicator the count of 5th level watersheds is shown for each CE, broken out by indicator score interval.

KEA: Surrounding Land Use Context											
2060 Fire Regime Departure Index											
	Count of watersheds by Score interval										
	Total	**0-.1**	**.1-.2**	**.2-.3**	**.3-.4**	**.4-.5**	**.5-.6**	**.6-.7**	**.7-.8**	**.8-.9**	**.9-1**
Inter-Mountain Basins Big Sagebrush Shrubland	561			177	100	75	156		53		

Great Basin Xeric Mixed Sagebrush Shrubland	546				200		89	90	87	80	
Inter-Mountain Basins Mixed Salt Desert Scrub	439				200			82		157	
Inter-Mountain Basins Montane Sagebrush Steppe	411				12	111	142	73	47	26	
Great Basin Pinyon-Juniper Woodland	408				131	244		33			
Rocky Mountain Aspen Forest and Woodland	264									230	34
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	256					3	133	120			
Inter-Mountain Basins Semi-Desert Grassland	110	47	29	14		9	8		3		
Inter-Mountain Basins Semi-Desert Shrub-Steppe	107			13	17	19	17	24	17		
Mojave Mid-Elevation Mixed Desert Scrub - thermic	102							18		84	
Mojave Mid-Elevation Mixed Desert Scrub - mesic	100					20	42	25		13	
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	83									75	8
Great Basin Semi-Desert Chaparral	63				27		36				
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	57						37	20			
Inter-Mountain Basins Big Sagebrush Steppe	52					12	19	11	10		
Colorado Plateau Mixed Low Sagebrush Shrubland	15			3				12			
Rocky Mountain Alpine Turf	8										8

B-2.4.2 2060 Bioclimate Envelope Results and Synthesis

MQ9 - WHERE WILL LANDSCAPE SPECIES AND SPECIES ASSEMBLAGE CES EXPERIENCE CLIMATE OUTSIDE THEIR CURRENT CLIMATE ENVELOPE?

MQ13 - WHERE WILL CURRENT LOCATIONS OF THESE [PLANT] COMMUNITIES EXPERIENCE SIGNIFICANT DEVIATIONS FROM NORMAL CLIMATE VARIATION?

MQ67 - WHICH NATIVE PLANT COMMUNITIES WILL EXPERIENCE CLIMATE COMPLETELY OUTSIDE THEIR NORMAL RANGE?

MQ69 - WHERE ARE WILDLIFE SPECIES RANGES (ON THE LIST OF SPECIES CES) THAT WILL EXPERIENCE SIGNIFICANT DEVIATIONS FROM NORMAL CLIMATE VARIATION?

MQ66 - GIVEN ANTICIPATED CLIMATE SHIFTS AND THE DIRECTION SHIFTS IN CLIMATE ENVELOPES FOR CES, WHERE ARE POTENTIAL AREAS OF SIGNIFICANT CHANGE IN EXTENT?

Tabular summary tables (Table B - 42 and Table B - 43) are aimed at answering this management question by summarizing all model results and looking at patterns in species change in bioclimate under future climate scenarios. These summaries use the change summary layer, which is a raster of the difference between 2050 and current for each species or terrestrial coarse-filter ecosystem. From this layer we can determine the percent of pixels (area) projected to be lost, maintained, or gained for each species. Each species or coarse-filter ecosystem change summary layer was clipped to the greater regional boundary that encompasses CBR and MBR, from which their sample points came from. In other words, *the data presented in these tables is for the entire regional analysis boundary, rather than for the areas within either the CBR or MBR REA boundaries (see methods for bioclimate modeling presented in Appendix B).*

Percent model agreement is also added to the tabular summary tables. A change summary layer was created for each GCM output for a species or coarse-filter, and then these change summary layers were added to get model agreement for each condition: lost, maintained, and gained. Low model agreement = 1-2 models, Medium model agreement = 3-4 models, High model agreement = 5-6 models.

It is important to note that model agreement should not be judged for loss of bioclimate because it will always be low to no model agreement. This is because model agreement is conceptually stacking presence/absence outputs on top of each other. Therefore if a species loses a significant amount of bioclimate, and all models agree, there will be no presence values to stack to account for agreement. The stacking of models with lost bioclimate essentially adds up to nothing because there is no bioclimate to account for. Model agreement is only useful for maintained and gained bioclimate.

Table B - 44 shows an analysis of top 3 variable contributions for species of interest. The path that the Maxent code uses to get to the output defines these percent contributions. A different modeling algorithm could get to the output via a different path and therefore result in different percent contributions. Therefore, highly correlated variables should be interpreted with caution. However, variable contributions are a useful to see how the model came to its projection and a starting point for understanding how climate change might affect certain species differently.

Table B - 42. Terrestrial coarse-filter CE Tabular Summary; results are summarized for the entire regional analysis boundary.

Coarse-filter CE	**% Lost Bioclimate**	**% Maintained Bioclimate**	**% Gained Bioclimate**	**% Low Model Agreement**	**% Medium Model Agreement**	**% High Model Agreement**
Great Basin Pinyon-Juniper Woodland	34	46	20	69	26	4
Great Basin Xeric Mixed Sagebrush Shrubland	68	24	7	90	10	0
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	42	49	9	47	39	14
Inter-Mountain Basins Big Sagebrush Shrubland	43	41	16	63	31	7
Inter-Mountain Basins Big Sagebrush Steppe	85	11	4	96	4	0
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland	48	39	13	55	34	11
Inter-Mountain Basins Mixed Salt Desert Scrub	24	44	31	59	31	10
Inter-Mountain Basins Montane Sagebrush Steppe	57	34	9	75	23	2

Coarse-filter CE	% Lost Bioclimate	% Maintained Bioclimate	% Gained Bioclimate	% Low Model Agreement	% Medium Model Agreement	% High Model Agreement
Inter-Mountain Basins Semi-Desert Shrub-Steppe	20	56	24	54	34	12
Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	45	45	9	47	22	31
Mojave Mid-Elevation Mixed Desert Scrub	53	21	27	87	12	1
Rocky Mountain Aspen Forest and Woodland	52	40	8	56	40	4

Table B - 43. Landscape Species Tabular Summary; results are summarized for the entire regional analysis boundary.

Species CE	% Lost Bioclimate	% Maintained Bioclimate	% Gained Bioclimate	% Low Model Agreement	% Medium Model Agreement	% High Model Agreement
Bald Eagle	5	62	32	42	36	23
Brewer's Sparrow breeding	34	52	13	59	32	10
Brewer's Sparrow migratory	30	41	28	75	24	1
Clark's Nutcracker	28	50	22	59	34	7
Coachwhip	40	24	36	59	35	6
Columbian Sharp-tailed Grouse	73	7	20	90	10	0
Common Kingsnake	25	38	37	58	36	6
Cooper's Hawk	33	52	15	67	25	8
Desert Bighorn Sheep	23	61	16	58	27	15
Ferruginous Hawk	67	18	15	86	12	2
Golden Eagle	3	72	25	25	42	33
Greater Sage-Grouse	66	29	4	81	16	3
Mule Deer summer	39	45	17	58	36	6
Mule Deer winter	35	44	20	63	32	5
Mule Deer yearlong	12	55	32	48	38	15
Northern Harrier	74	17	9	81	16	2
Northern Rubber Boa	57	34	9	66	23	11
Northern Sagebrush Lizard	47	35	18	85	15	0
Pygmy Rabbit	77	15	7	90	8	1
Sage Sparrow	73	24	4	87	13	0
Swainson's Hawk	15	63	22	59	35	6
Western Patch-nosed Snake	52	22	26	67	32	2
White-tailed Jackrabbit	68	24	8	88	12	0

Table B - 44. Top 3 variables that contributed to current and future model results for species of interest. The number next to the variable refers to the month; for example, Prcp1 is January precipitation.

Species	Current variable contribution	2050 variable contribution
Greater Sage-Grouse	prcp7 21.2	prcp7 39.3
	prcp9 20	tmin6 14.4
	tmin6 18.3	prcp9 12
	prcp6 27.7	prcp6 27
	prcp8 7.8	prcp8 5.2
Northern Harrier	prcp7 62.8	prcp7 61.3
	prcp9 8.5	prcp9 8.5
	tmin11 5.6	tmin11 7.1
Pygmy Rabbit	prcp7 41.4	prcp7 45
	prcp9 15.1	prcp 9 15
	prcp10 11	prcp10 10.6
Sage Sparrow	prcp7 65.9	prcp 7 62.2
	tmin4 11.8	tmin4 8.8
	tmax1 5.5	tmax1 5.9
White-tailed Jackrabbit	prcp7 46	prcp7 46.6
	prcp9 9.7	prcp9 10.6
	tmin6 7.3	tmin4 9.4

B-2.4.2.1 Terrestrial Coarse-filter CEs

The bioclimatic model results for the coarse-filter ecosystems show different patterns of change among groups of coarse-filter ecosystems. One marked pattern is that some coarse-filters show maintained bioclimate at the higher elevations of their range and a loss of bioclimate at the lower elevations of their range. For example, Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland (Figure B - 104) shows a marked loss of bioclimate at lower elevations and valleys while the mid-elevation areas are maintained. There are even areas showing "gained" bioclimate at elevations higher than the current range, which suggests the bioclimate is moving up slope. This pattern can also be seen with the Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland, Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland, Rocky Mountain Aspen Forest and Woodland, and the Mojave Mid-Elevation Mixed Desert Scrub (Figure B - 104). Across the ecoregion, areas of topographic heterogeneity stand out as areas with maintained bioclimates.

Mojave Mid-Elevation Mixed Desert Scrub is an exception to the rest of the desert scrub systems in that it has maintained bioclimate at higher elevations and has significant loss of bioclimate in some areas of its range. The main trend with the desert scrub coarse filters is that when there is loss in bioclimate it is mainly in the southern end of the range. These patterns are also seen in the Inter-Mountain Basins Mixed Salt Desert Scrub (Figure B - 106).

Sagebrush coarse-filter ecosystems have the highest percentage in lost bioclimate (Table B - 42) and are potentially vulnerable to climate change. Inter-Mountain Basins Big Sagebrush Steppe model results show a loss of 85% of bioclimate from the current range(Figure B - 105). There is no obvious pattern in bioclimate in relation to elevation, but when sagebrush lost bioclimate is stacked, it appears the northern parts of CBR range are lost for most types of sagebrush.

In the maps below (Figure B - 104 and Figure B - 105), the areas of 2060 bioclimate expansion, contraction, and overlap with current bioclimate are shown for a selection of terrestrial coarse-filter CEs. The CEs are grouped into figures by ecoregional conceptual model group: Montane Dry Land System (Figure B - 104), Basin Dry Land System (Figure B - 105). Blue represents contraction, pink expansion, and green is areas of overlap. These areas will not always match the mapped current distribution of the individual CE, since this is the bioclimate niche of the CE, not its current distribution.

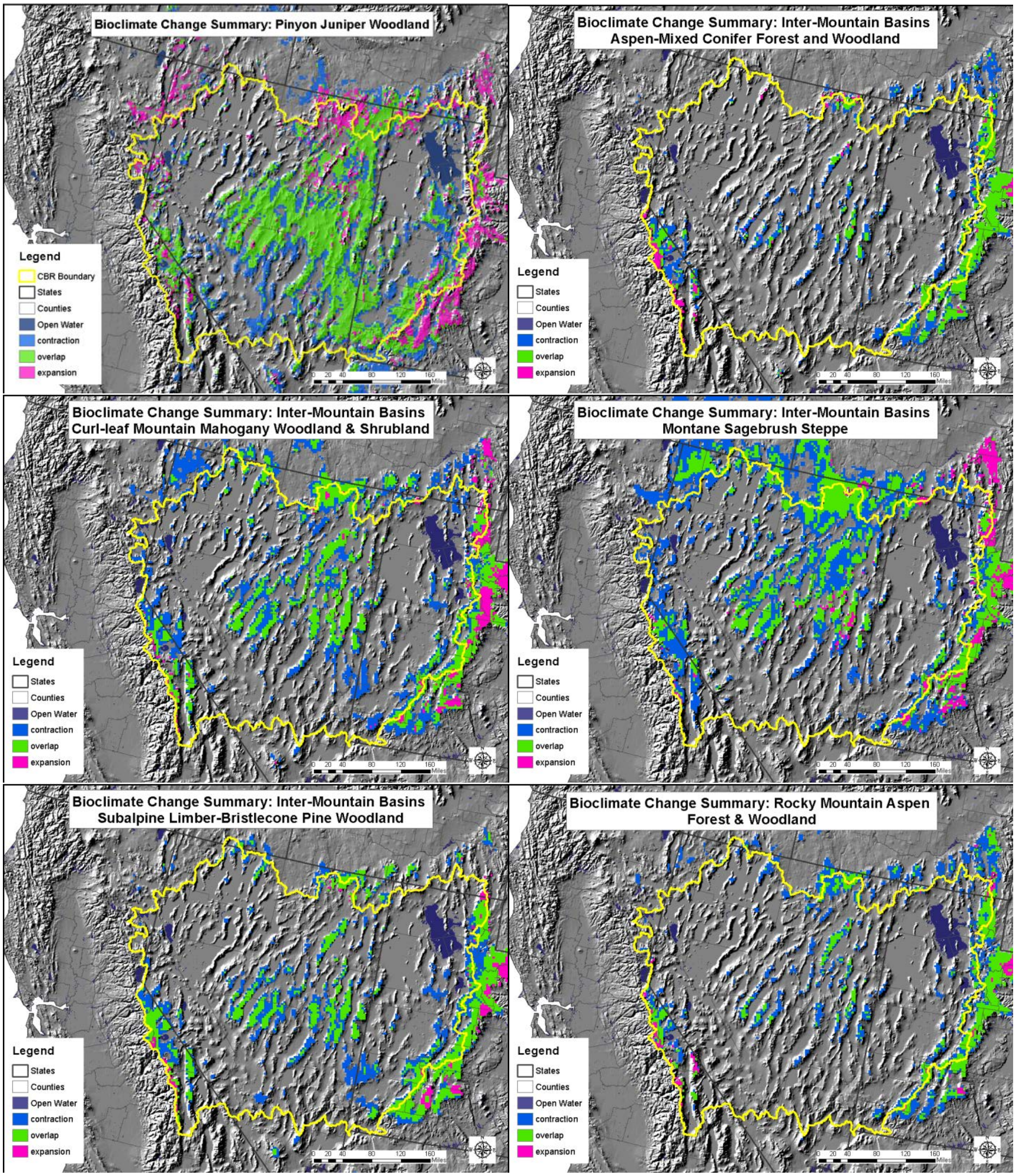


Figure B - 104. Bioclimate change summary for selected Montane Dry Land Ecosystems: Great Basin Pinyon-Juniper Woodland, Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland, Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland and Shrubland, Inter-Mountain Basins Montane Sagebrush Steppe, Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland, Rocky Mountain Aspen Forest and Woodland

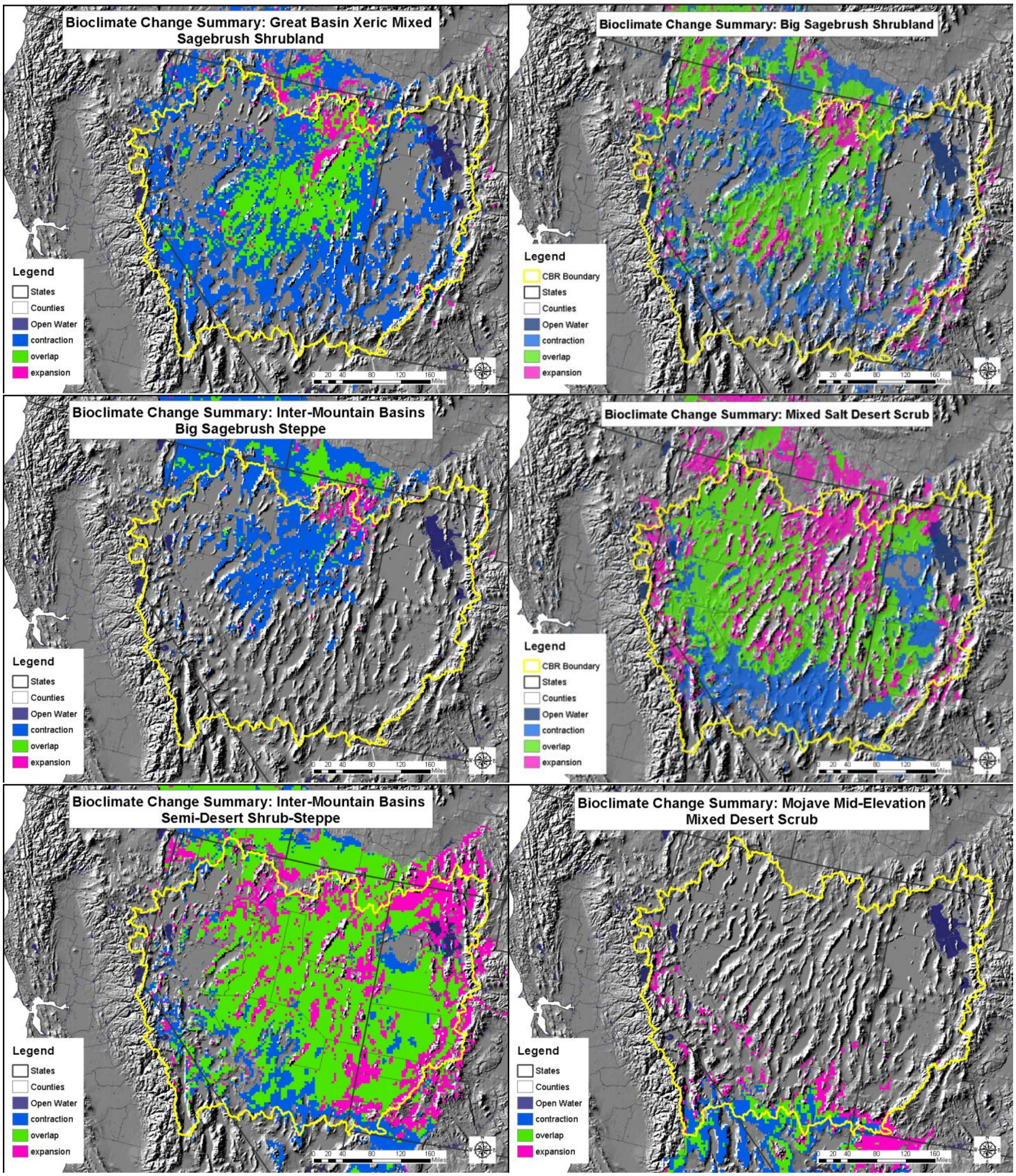


Figure B - 105. Bioclimate change summary for selected Basin Dry Land Ecosystems: Great Basin Xeric Mixed Sagebrush Shrubland, Inter-Mountain Basins Big Sagebrush Shrubland, Inter-Mountain Basins Big Sagebrush Steppe, Inter-Mountain Basins Mixed Salt Desert Scrub, Inter-Mountain Basins Semi-Desert Shrub-Steppe, Mojave Mid-Elevation Mixed Desert Scrub.

Potential climate change refugia

One additional application of climate envelope models is to explore the results of overlaying multiple forecasts for major vegetation types of the ecoregion. For each envelope summary, where "overlap" is indicating (in green from previous figures), this indicates that climate regimes characteristic of current distributions for the type are forecasted to be maintained. Therefore, by combining multiple envelope forecasts for major vegetation types, one can begin to identify portions of the ecoregion where multiple lines of evidence suggest that 2060 climate regimes will tend to be closer to current regimes. Figure B - 106 indicates that as many as seven major vegetation types show an overlap between current and forecasted climate envelopes. The mountain range and inter-montane basins of central Nevada, along with isolated mountain ranges along the west and eastern margins of the ecoregion, appear to be locations forecasted to experience the least severe shifts in climate regime, at least from the perspective of climate envelopes that characterize major vegetation.

However, this analysis also indicates several areas, primarily concentrated around the Great Salt and Bonneville basin, and basins throughout the southwestern portion of the ecoregion, where no climate envelope overlap is indicated for major vegetation. This provides additional indication of the potential for desert basins to experience effects of severe increases in temperature; likely resulting in expansion of sparsely vegetated desert pavements and bedrock exposures.

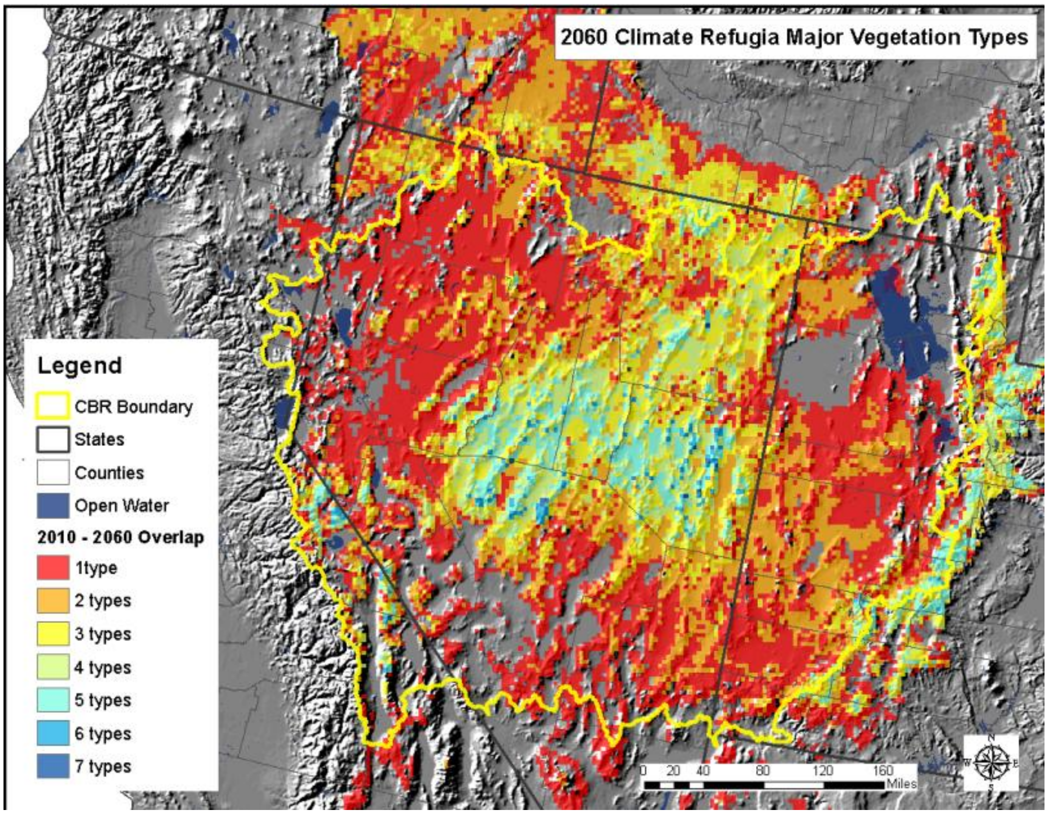


Figure B - 106. Potential climate-change refugia based on 2060 forecasts of climate envelopes for major vegetation types within the ecoregion. There are two grid cells with 8 ecological systems having maintained bioclimate, but these are not displayed in this map.

B-2.4.2.2 Landscape Species

Species that rely on sagebrush habitat have higher loss in bioclimate compared to other species. In particular Pygmy Rabbit, Sage Sparrow, and Columbian Sharp-tailed Grouse, are projected to experience more than 70% bioclimate loss under future climates. Greater Sage-Grouse is projected to lose 66% of its bioclimate, and Northern Sagebrush Lizard 47%. One species that shows high loss in bioclimate, but is not closely tied to sagebrush habitat is the white-tailed Jackrabbit.

Species that are high in maintained bioclimate are birds of prey and ungulates. The top species with the highest maintained bioclimate are Golden Eagle, Swainson's Hawk, Cooper's Hawk, and Bald Eagle. Ferruginous Hawk and Northern Harrier are the only raptors that seem to be the anomaly in that they are projected to have less than 20% of their bioclimate maintained. Ungulates such as Desert Bighorn Sheep and Mule Deer (yearlong range) are projected to maintain a majority of their bioclimate. Although Mule Deer yearlong range is resilient, the Mule Deer seasonal ranges (summer and winter) are 44-45% maintained bioclimate.

Some reptile species, although there is no pattern in lost or maintained bioclimate, do exhibit a pattern in the shift in bioclimate. Common Kingsnake, and Northern Rubber Boa all show a marked shift of bioclimate to the East/Northeast.

Bioclimate change summaries for selected landscape species CEs are shown in Figure B - 107 through Figure B - 110. The species are grouped into figures by ecoregional conceptual model group: Montane Dry Land System (Figure B - 107), Basin Dry Land System (Figure B - 108 and Figure B - 109), and Basin Wet System (Figure B - 110).

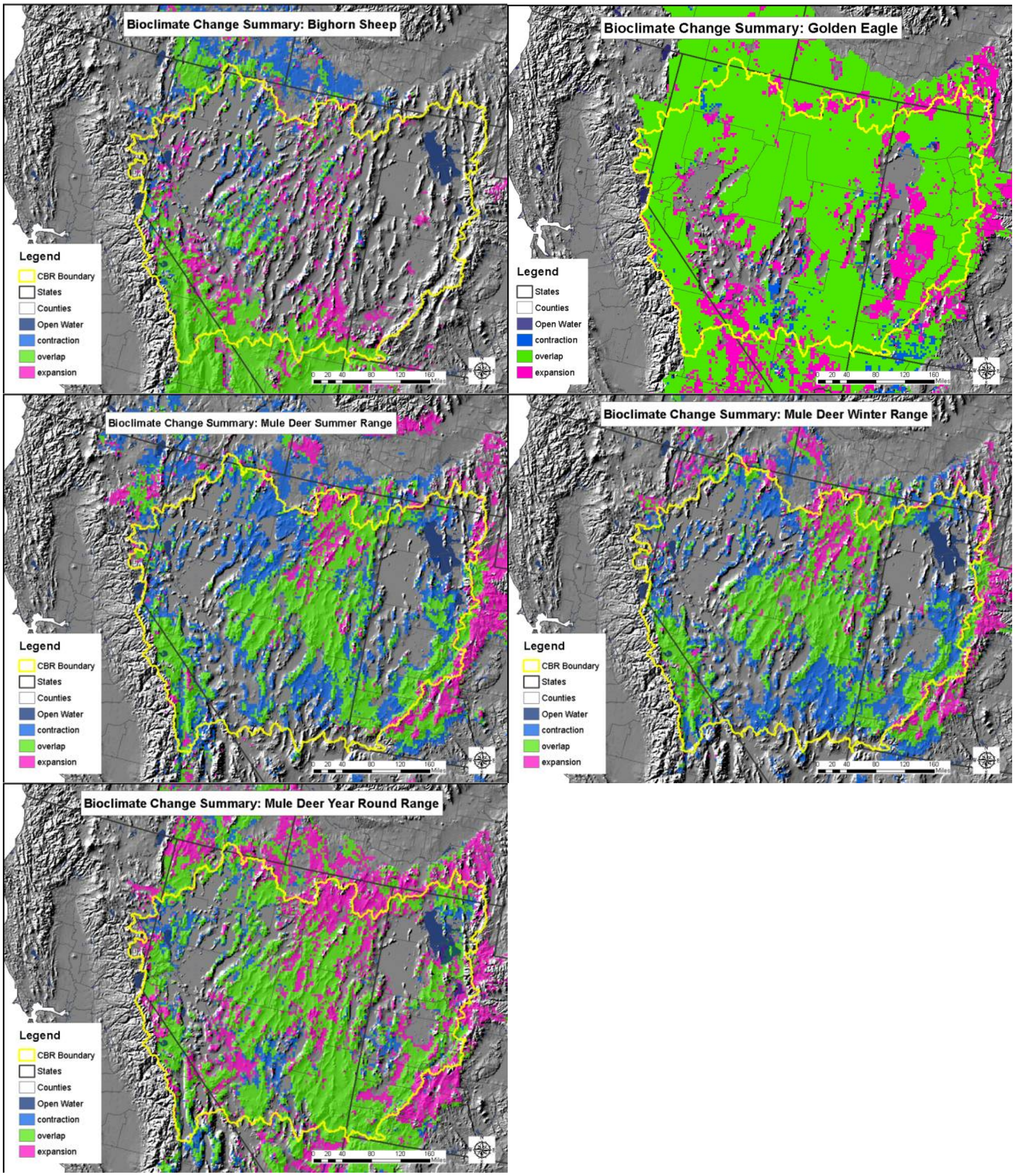


Figure B - 107. Bioclimate change summary of 3 landscape species CEs associated with the Montane Dry Land System: Desert Bighorn Sheep (top left), Golden Eagle (top right), and Mule Deer Summer (middle left), Winter (middle right,) and Year-round (bottom) ranges

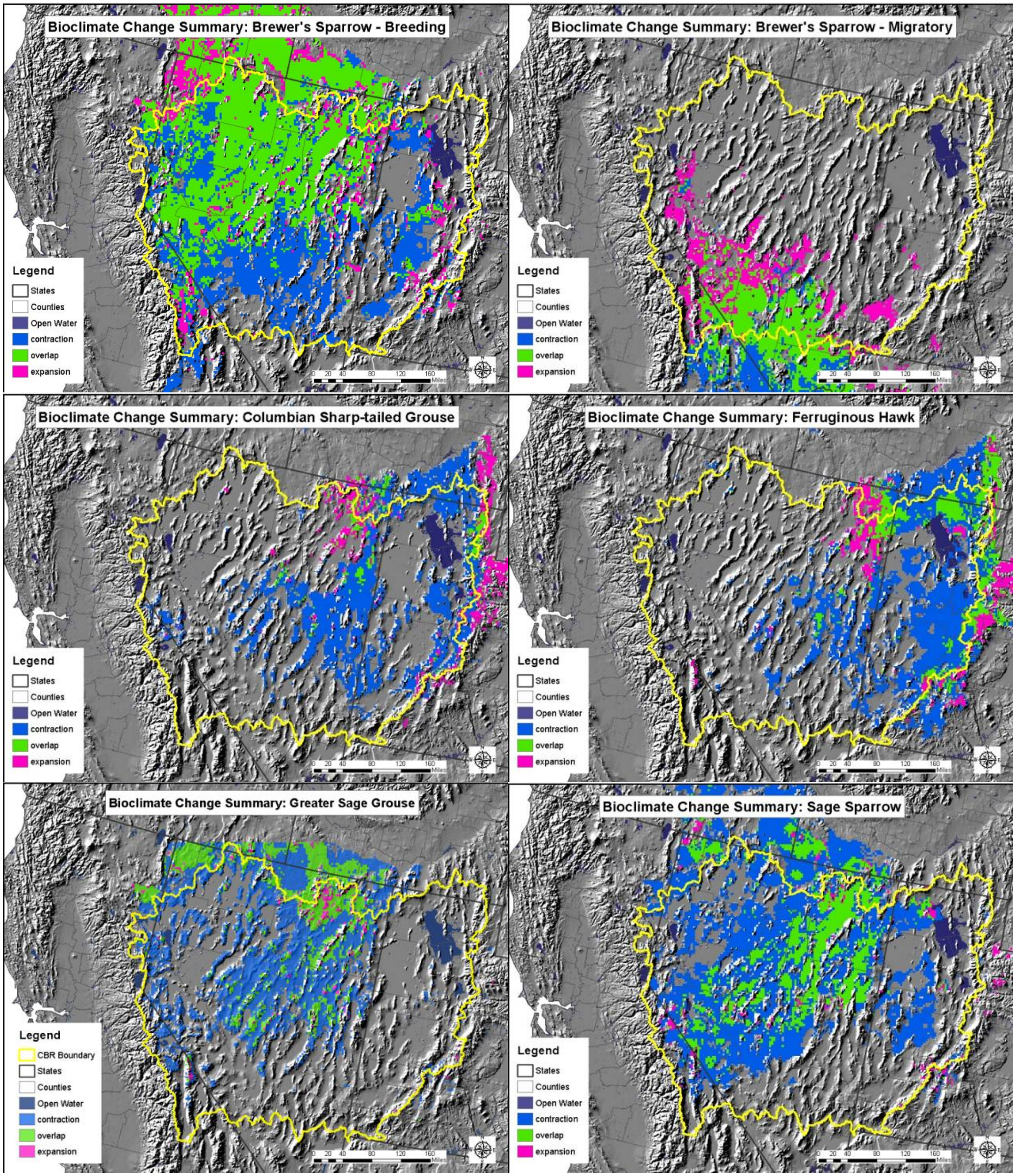


Figure B - 108. Bioclimate change summary of 5 bird species CEs associated with the Basin Dry Land System: Brewer's Sparrow (Breeding and Migratory ranges, top), Columbian Sharp-tailed Grouse (middle left), Ferruginous Hawk (middle right), Greater Sage-Grouse (bottom right), and Sage Sparrow (bottom right)

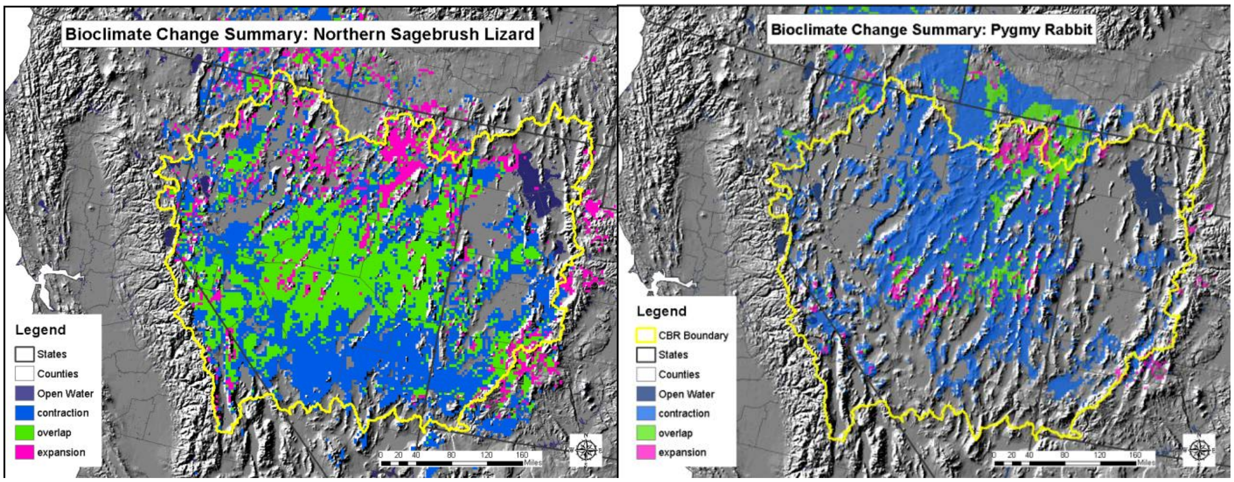


Figure B - 109. Bioclimate change summary of Northern Sagebrush Lizard and Pygmy Rabbit (associated with the Basin Dry Land System)

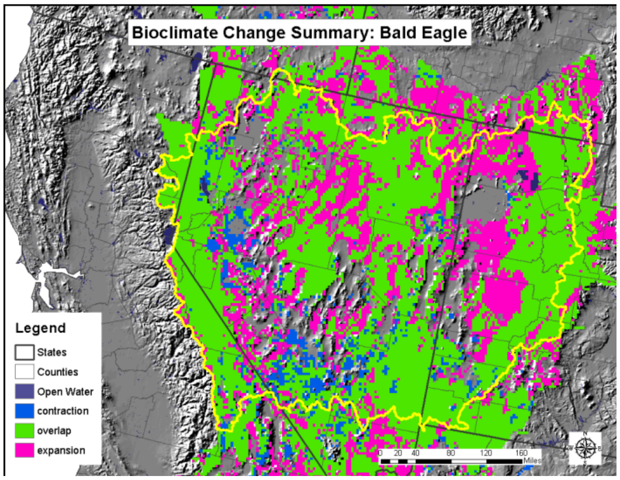


Figure B - 110. Bioclimate change summary of Bald Eagle (associated with the Basin Wet System)

B-2.5 Use in Assessment: Overall Uncertainty, Limitations and Data Gaps

Based upon this rapid assessment, numerous gaps in current knowledge and data were identified. Below are high-priority gaps where future investments would be productively focused.

- **Conservation Element distributions** – Most terrestrial and aquatic coarse-filter CEs were mapped for this assessment by building upon existing national data. Expert review and refinements were implemented, and as feasible, some measure of final map accuracy was documented. Given this, gathering and maintaining georeferenced samples for all major vegetation type, vegetation structure, and successional status, continues to be of highest priority. One cannot adequately evaluate the quality of critical data sets, such as maps for vegetation type, or succession class for fire regime models, without a robust field sample data set. Several thousand samples were used for these purposes in this REA, but a goal of several hundred samples per type, per MLRA, is advisable.

Sensitive soils were mapped using best-available map inputs, but efforts to apply expert-derived criteria for each type highlighted weakness in existing soils data sets, such as the digital soil survey (SSURGO), in this desert landscape. Clearly, investments to improve the completeness and accuracy of these data should be a high priority.

Landscape species distributions can generally be viewed as range maps; most of which were developed by the regional gap analysis projects. However, in order to provide meaningful answers to most management questions, a more rigorous characterization of habitat usage and quality is needed. Just as Mule deer or Greater sage-grouse were represented using seasonal range or habitat components (e.g., lek sites with relative densities), most landscape species worthy of REA attention require more specific characterization, mapping, and evaluation of seasonal range and/or populations. With this next level of information developed, tools aimed at evaluating landscape linkages, individually suited to each species, could be fruitfully deployed.

While local species played only a limited role in the REA, there remains substantial need to support ongoing, systematic field inventory for a majority of local species; in many cases where field surveys have only occurred through opportunistic research. Given the relatively high concentration of endemic and at-risk species in this ecoregion, this should be a continued priority, especially where knowledge of their potential occurrence coincides with areas forecasted for some form of habitat alteration or development.

- Treatment of grazing effects – given several management questions intended to clarify past, current, and forecasted future effects of grazing across the ecoregion landscape, it became clear that readily available, region-wide data were limited to a) the location of grazing allotments, and b) estimated numbers of grazing animals by allotment. Data on the actual effects of grazing, which vary based on interacting factors like allotment size, characteristic vegetation, and grazing intensity, were not readily available across the ecoregion. Gathering, organizing, and analyzing these data should be a clear, very high, priority for future assessment and planning decisions by BLM and other land managers.
- Landscape condition models – Following from development change agents, landscape condition modeling is also vulnerable to incomplete representations of surface disturbance. In particular, older roads that have been closed to traffic have been removed or are no longer maintained in roads data, although the effects from surface disturbance persists for decades after closure. Given the settings for landscape condition modeling fall into the realm of expert judgment, there remains considerable potential to test, calibrate, and customize the model used in this REA.
- Invasive species risk models – Invasive plant models face similar constraints as many CE distribution models. Many field-based and georeferenced samples indicting the species and cover of these species is required to develop robust models. Additional time and effort is needed to integrate processed satellite imagery; ideally multi-date images capturing early spring green-up, in order to better predict invasive plant species abundance and risk of invasion. Freshwater aquatic species were very poorly represented in existing data sets for this ecoregion, so all results and conclusions related to these should be viewed as preliminary. Substantial investment in the inventory and monitoring of aquatic nuisance and invasive species is needed throughout this ecoregion.
- Fire regime models – While a substantial base existed for this REA, as a result of prior national and regional efforts, this area of both conceptual and spatial modeling remains in early stages. One could expect substantial benefits from regionally customized and field-validation of models for most vegetation types in the ecoregion. Similarly, there are likely substantial benefits to be

gained by more rigorous characterization and mapping of selected landscape species habitats; and for those with considerable fire regimes (e.g., Pygmy rabbit), the customized development of new fire regime models would be warranted.

- Change in extent – as an indicator of ecological status for several major vegetation types, these analysis and results should be considered preliminary. The approach was vulnerable to errors present in LANDFIRE BpS predictions of historical extent for some types. This was accounted for in part by reporting at the relatively large watershed reporting units, there remains room for considerable error in selected locations throughout the ecoregion. Improvements to LANDFIRE BpS data, primarily through better integration of soils data, may address these concerns. Fortunately, this type of investment compliments development of Ecological Site Descriptions, so investments in this area could provide numerous benefits for future assessment, management, and monitoring and ecoregion and local scales.
- Landscape Linkages and Landscape Permeability – as mentioned above, more rigorous characterization and mapping of habitat for landscape species would present many new opportunities to model landscape linkages to better understand the likely pathways for movement across the landscape. Highest priority here would be for landscape species that are vulnerable to fragmentation.

B-2.5.1 Species Survey Effort

MQ6 - WHAT IS THE RELATIVE SURVEY INTENSITY TO DATE WITHIN THE ECOREGION FOR SPECIES CES?

Taxonomic experts from the Nevada Natural Heritage Program (botany and zoology) populated information on survey effort for many of the species identified in Table B - 1. For each species, the documentation was done for survey effort within the state of Nevada, pertinent to the portion of the CBR in Nevada. In addition, where they had knowledge of the species in its range within the other states (California, Arizona or Utah), survey effort was also populated (Idaho was not done). When possible the experts consulted published materials for the taxonomic groups outside of Nevada to attempt completion of the survey effort fields. These data were delivered to BLM in the MS Access Species Conservation Elements Database (MasterBLM_HabitatsDB_Deliverable28June2012.accdb).

For purposes of this assessment "survey" was defined as an effort targeting the particular species; in other words, if someone is surveying for plants and see a Gila monster and notes it in their notebook, that is not a Gila monster survey. In all likelihood such a record would not make it into the surveyor's database, and hence would not be available for review. It was particularly noted theat "cryptic species" that require specialized survey methods (e.g. aquatic snails, nocturnal and secretive reptiles). Surveying for birds and most plants is much less dificult than for many other animal groups.

For each species in each state, survey effort was populated in the database for three levels of effort using the definitions below. In addition "unknown" was used used when the level of effort wass not known. Each level of offort is relevant to the state by ecoregion for the species. The "low" effort category included situations where no known surveys have occurred; a Low survey effort suggests the lack of information about that species and the need for additional surveys. Comments were recorded about surveys for some species.

1. High = high extent, high or moderate intensity
2. Medium = medium extent, high or moderate intensity; or high extent, low intensity
3. Low = low extent, moderate or low intensity; or moderate extent, low intensity; or low extent, high intensity. Note: "Low" includes none .

4. Unknown = extent/intensity of survey effort too poorly known to allow categorization as high, medium, or low.

The results in Table B - 45 suggest that surveys for many species are lacking or have not been intensive or comprehensive across the range of that species in Nevada. Many species across all taxonomic groups have effort category of Low or Unknown. For flowering plants, the Nevada Natural Heritage Program Botanist attempted to rate survey effort for Arizona, California and Utah, but in many cases Unknown was applied.

The number of element occurrences needs to be interpreted with care, especially in conjunction with survey effort. Most natural heritage programs only survey and track occurrences for rare species, or species that are of conservation concern within the state. For example, American Beaver is a very common species, not of conservation concern across most of the west, but in Arizona it is listed in the State Wildlife Action Plan, and in Nevada has some status of concern. Yet, survey effort for American beaver in Nevada is Low, and there are no element occurrences records for it in the CBR.

In contrast, many of the freshwater snails (*Pyrgulopsis* spp.) are rare, of conservation concern, have very few populations or occurrences, yet survey effort, at least for some of them, has been Moderate and for many others is Unknown, at least in Nevada.

These results suggest a number of data gaps for species of concern, but again this work was only completed for the Nevada portion of the range of many species; further work should be done to categorize survey effort across the other states.

Table B - 45. Survey effort results for many species in the Central Basin & Range ecoregion. Each species was rated for survey effort using categories of High, Medium and Low, or Unknown, for each state overlapping the CBR. The number of Element Occurrences from Natural Heritage databases is also provided, as it can give an indication of whether the species has been catalogued in a state database. Comments are also provided when available.

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Freshwater Mussels								
Anodonta californiensis	California Floater	Coarse Filter	19	L				
Margaritifera falcata	Western Pearlshell	Coarse Filter		U				
Freshwater Snails								
Eremopyrgus eganensis	Steptoe Hydrobe	Coarse Filter	8	L				
Fluminicola dalli	Pyramid Lake Pebblesnail	Coarse Filter	4	L				
Fluminicola virginius	Virginia Mountains Pebblesnail	Coarse Filter	2	L				
Helisoma newberryi	Great Basin Rams-horn	Local		L				
Juga interioris	Smooth Juga	Coarse Filter		U				
Pyrgulopsis aloba	Duckwater Pyrg	Coarse Filter	4	M				Recent survey work
Pyrgulopsis anatina	Southern Duckwater Pyrg	Coarse Filter	2	M				Recent survey work
Pyrgulopsis anguina	Longitudinal Gland Pyrg	Coarse Filter	3	M				Recent survey work
Pyrgulopsis augustae	Elongate Cain Spring Pyrg	Coarse Filter	2	L				
Pyrgulopsis aurata	Pleasant Valley Pyrg	Coarse Filter	2	L				
Pyrgulopsis basiglans	Large Gland Carico Pyrg	Coarse Filter	4	L				
Pyrgulopsis bifurcata	Small Gland Carico Pyrg	Coarse Filter	2	L				
Pyrgulopsis breviloba	Flat Pyrg	Coarse Filter	6	L				
Pyrgulopsis bruesi	Fly Ranch Pyrg	Coarse Filter	2	L				
Pyrgulopsis bryantwalkeri	Cortez Hills Pebblesnail	Coarse Filter	2	L				
Pyrgulopsis carinata	Carinate Duckwater Pyrg	Coarse Filter		M				Recent survey work
Pyrgulopsis cruciglans	Transverse Gland Pyrg	Coarse Filter	8	U				
Pyrgulopsis dixensis	Dixie Valley Pyrg	Coarse Filter	2	L				
Pyrgulopsis gracilis	Emigrant Pyrg	Coarse Filter	4	U				
Pyrgulopsis hovinghi	Upper Thousand Spring Pyrg	Coarse Filter		U				
Pyrgulopsis hubbsi	Hubbs Pyrg	Coarse Filter	4	U				
Pyrgulopsis humboldtensis	Humboldt Pyrg	Coarse Filter	11	U				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Pyrgulopsis imperialis	Kings River Pyrg	Coarse Filter	4	U				
Pyrgulopsis kolobensis	Toquerville Springsnail	Coarse Filter	94	U				
Pyrgulopsis landyei	Landyes Pyrg	Coarse Filter	2	U				
Pyrgulopsis lata	Butterfield Pyrg	Coarse Filter	2	U				
Pyrgulopsis lentiglans	Crittenden springsnail	Coarse Filter		U				
Pyrgulopsis leporina	Elko Pyrg	Coarse Filter	4	U				
Pyrgulopsis limaria	Squat Mud Meadows Pyrg	Coarse Filter	13	L				
Pyrgulopsis lockensis	Lockes Pyrg	Coarse Filter	2	L				Recent survey work
Pyrgulopsis longiglans	Western Lahontan Pyrg	Coarse Filter	28	L				Recent survey work
Pyrgulopsis marcida	Hardy Pyrg	Coarse Filter	14	L				
Pyrgulopsis merriami	Pahranagat Pebblesnail	Coarse Filter	13	U				
Pyrgulopsis micrococcus	Oasis Valley Springsnail	Coarse Filter	8	L				Recent survey work, including habitat restoration efforts
Pyrgulopsis militaris	Northern Soldier Meadow Pyrg	Coarse Filter	2	L				
Pyrgulopsis millenaria	Twentyone Mile Pyrg	Coarse Filter		U				
Pyrgulopsis montana	Camp Valley Pyrg	Coarse Filter	2	U				
Pyrgulopsis neritella	Neritiform Steptoe Ranch Pyrg	Coarse Filter	2	U				
Pyrgulopsis notidicola	Elongate Mud Meadows Pyrg	Coarse Filter	3	L				
Pyrgulopsis orbiculata	Sub-globose Steptoe Ranch Pyrg	Coarse Filter	4	U				
Pyrgulopsis papillata	Big Warm Spring Pyrg	Coarse Filter	8	M				Recent survey work done.
Pyrgulopsis peculiaris	Bifid Duct Pyrg	Coarse Filter	11	U				
Pyrgulopsis pellita	Antelope Valley Pyrg	Coarse Filter	2	U				
Pyrgulopsis pictilis	Ovate Cain Spring Pyrg	Coarse Filter	2	U				
Pyrgulopsis planulata	Flat-topped Steptoe Pyrg	Coarse Filter	2	U				
Pyrgulopsis ruinosa	Fish Lake Pyrg	Coarse Filter		U				Extirpated
Pyrgulopsis sadai	Sada's Pyrg	Coarse Filter	13	L				
Pyrgulopsis sathos	White River Valley Pyrg	Coarse Filter	14	U				
Pyrgulopsis serrata	Northern Steptoe Pyrg	Coarse Filter	6	U				
Pyrgulopsis sterilis	Sterile Basin Pyrg	Coarse Filter	6	U				
Pyrgulopsis sublata	Lake Valley Pyrg	Coarse Filter	2	U				
Pyrgulopsis sulcata	Southern Steptoe Pyrg	Coarse Filter	4	U				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Pyrgulopsis umbilicata	Southern Soldier Meadow Pyrg	Coarse Filter	10	L				
Pyrgulopsis variegata	Northwest Bonneville Pyrg	Coarse Filter	11	U				
Pyrgulopsis villacampae	Duckwater Warm Springs Pyrg	Coarse Filter	4	M				Recent survey work done.
Pyrgulopsis vinyardi	Vineyards Pyrg	Coarse Filter	4	U				
Pyrgulopsis wongi	Wong's Springsnail	Coarse Filter	63	U				
Tryonia clathrata	Grated Tryonia	Coarse Filter	10	U				
Tryonia monitorae	Monitor Tryonia	Coarse Filter	4	U				
Freshwater & Anadromous Fishes								
Catostomus clarkii	Desert Sucker	Coarse Filter	16	H				
Catostomus clarkii intermedius	White River Desert Sucker	Coarse Filter	20	M				
Catostomus clarkii ssp. 2	Meadow Valley Wash Desert Sucker	Coarse Filter	27			H		Annual Surveys conducted, RIT team
Catostomus latipinnis	Flannelmouth Sucker	Coarse Filter	7	H				
Catostomus sp. 1	Wall Canyon sucker	Coarse Filter		L				
Chasmistes cujus	Cui-ui	Coarse Filter	2	L				
Cottus sp. 3	White River Sculpin	Coarse Filter	2	M				
Crenichthys baileyi albivallis	Preston White River Springfish	Coarse Filter	12	H				
Crenichthys baileyi baileyi	White River Springfish	Coarse Filter	4	H				
Crenichthys baileyi grandis	Hiko White River Springfish	Coarse Filter	6	H				
Crenichthys baileyi thermophilus	Moorman White River Springfish	Coarse Filter	7	H				
Crenichthys nevadae	Railroad Valley Springfish	Coarse Filter	42	H				
Empetrichthys latos latos	Pahrump Poolfish	Coarse Filter	2	H				
Eremichthys acros	Desert Dace	Coarse Filter	22	M				Increased survey efforts over the past two years, RIT Team formed in 2019
Gila alvordensis	Alvord Chub	Coarse Filter	1	L				OR Dept of Fish and Wildlife conducted extensive surveys in summer of 2010, Nevada populations are to be surveyed for in summer of 2011.

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Gila bicolor euchila	Fish Creek Springs Tui Chub	Coarse Filter	2	N				Access has not been granted by property owner since 1983.
Gila bicolor isolata	Independence Valley Tui Chub	Coarse Filter	4	M				
Gila bicolor newarkensis	Newark Valley Tui Chub	Coarse Filter	42	L				Comprehensive range wide survey conducted in 2004-05
Gila bicolor obesa	Lahontan Creek Tui Chub	Coarse Filter		L				
Gila bicolor ssp. 4	Fish Lake Valley Tui Chub	Coarse Filter	2	M				Single Known population surveyed sporatically
Gila bicolor ssp. 5	Hot Creek Valley Tui Chub	Coarse Filter	9	U				Undetermined if this taxon is distinct. Potential to exist at the Hot Cr. Ranch at lower end of Hot Cr. Canyon.
Gila bicolor ssp. 6	Little Fish Lake Valley Tui Chub	Coarse Filter	5	L				Surveyed sporadically in the past 10 years.
Gila bicolor ssp. 7	Railroad Valley Tui Chub	Coarse Filter	14	M				Surveyed every other year
Gila bicolor ssp. 8	Big Smokey Valley Tui Chub	Coarse Filter	14	U				
Gila robusta	Roundtail Chub	Coarse Filter		U				
Gila robusta jordani	A Roundtail Chub	Coarse Filter	10	H				Sporatic survey efforts in natural habitat, Two refugia have been created
Gila seminuda	Virgin River Chub	Coarse Filter	6	M				
Lepidomeda albivallis	White River Spinedace	Coarse Filter	17	H				Surveyed yearly
Lepidomeda copei	Northern Leatherside Chub	Coarse Filter	1	L				Occurrs in few stream reaches in northeastern NV, A working group has been formed in 2008 and increased efforts to survey this taxon are underway.
Lepidomeda mollispinis mollispinis	Virgin River Spinedace	Coarse Filter	5	M				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Lepidomeda mollispinis pratensis	Big Spring Spinedace	Coarse Filter	9	H				Surveyed every year. In 2008-09 USGS performed a mark/recapture and movement study in Condor Canyon
Oncorhynchus clarkii bouvieri	Yellowstone Cutthroat Trout	Coarse Filter		M				Survey efforts have increased in NE NV over the past 10 years to quantify and determine the extent of the population
Oncorhynchus clarkii henshawi	Lahontan Cutthroat Trout	Coarse Filter	300	H				Numerous reintroduction project, habitat enhancements and yearly surveys conducted
Oncorhynchus clarkii utah	Bonneville Cutthroat Trout	Coarse Filter	122	H				Gt. Basin N.P. has created a highly successful re-introduction and monitoring effort, East slope Snake Range pop. Monitored yearly by NDOW
Oncorhynchus mykiss gairdneri	Inland Redband Trout and Redband Steelhead	Coarse Filter	6	U				
Plagopterus argentissimus	Woundfin	Coarse Filter	7	M				
Relictus solitarius	Relict Dace	Coarse Filter	93	M				Recent compreshensive range wide survey for population and range extent completed 2007
Rhinichthys osculus	Speckled Dace	Coarse Filter	41	M				
Rhinichthys osculus lariversi	Big Smokey Valley Speckled Dace	Coarse Filter	8	M				Surveys conducted every other year by NDOW

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Rhinichthys osculus lethoporus	Independence Valley Speckled Dace	Coarse Filter	2	M				Surveys conducted everyother year by NDOW, RIT team formed
Rhinichthys osculus oligoporus	Clover Valley Speckled Dace	Coarse Filter	8	H				Annual Surveys, RIT Team
Rhinichthys osculus robustus	Lahontan Speckled Dace	Coarse Filter		M				
Rhinichthys osculus ssp. 10	Diamond Valley Speckled Dace	Coarse Filter	2	M				Potentially extirpated, continuted efforts to re-discover taxon
Rhinichthys osculus ssp. 5	Monitor Valley Speckled Dace	Coarse Filter	4	L				
Rhinichthys osculus ssp. 6	Oasis Valley Speckled Dace	Coarse Filter	16	M				
Rhinichthys osculus ssp. 7	White River Speckled Dace	Coarse Filter	44	L				
Rhinichthys osculus velifer	Pahranagat Speckled Dace	Coarse Filter	12	H				Annual surveys conducted
Reptiles								
Crotaphytus bicinctores	Great Basin Collared Lizard	Landscape	1	L				
Elgaria coerulea palmeri	Sierra Alligator Lizard	Local	8	M				
Sauromalus ater	Common Chuckwalla	Local	9	M				
Sceloporus graciosus graciosus	Northern Sagebrush Lizard	Landscape	2	L				
Birds								
Accipiter cooperii	Cooper's Hawk	Landscape	1	M				
Accipiter gentilis	Northern Goshawk	Coarse Filter	112	H				
Accipiter striatus	Sharp-shinned Hawk	Coarse Filter		M				
Aechmophorus clarkii	Clark's Grebe	Coarse Filter		L				
Aechmophorus occidentalis	Western Grebe	Coarse Filter		L				
Aeronautes saxatalis	White-throated Swift	Coarse Filter		L				
Aix sponsa	Wood Duck	Coarse Filter		M				
Ammodramus savannarum	Grasshopper Sparrow	Local	16	L				
Amphispiza belli	Sage Sparrow	Landscape	5	L				
Anas acuta	Northern Pintail	Assemblage		H				
Anas americana	American Wigeon	Assemblage		H				
Anas clypeata	Northern Shoveler	Assemblage		H				
Anas cyanoptera	Cinnamon Teal	Assemblage		H				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Anas discors	Blue-winged Teal	Assemblage		H				
Anthus rubescens	American Pipit	Local		L				
Aquila chrysaetos	Golden Eagle	Landscape	15	H				
Ardea alba	Great Egret	Local	14	L				
Ardea herodias	Great Blue Heron	Local		L				
Asio flammeus	Short-eared Owl	Local	100	L				
Asio otus	Long-eared Owl	Local	10	L				
Athene cunicularia hypugaea	Western Burrowing Owl	Local	230	M				
Aythya affinis	Lesser Scaup	Assemblage		H				
Aythya americana	Redhead	Assemblage		H				
Aythya valisineria	Canvasback	Assemblage		H				
Baeolophus ridgwayi	Juniper Titmouse	Coarse Filter		L				
Botaurus lentiginosus	American Bittern	Local		L				
Branta canadensis	Canada Goose	Assemblage		H				
Bubulcus ibis	Cattle Egret	Coarse Filter	1	L				
Bucephala islandica	Barrow's Goldeneye	Assemblage		M				
Buteo regalis	Ferruginous Hawk	Landscape	165	H				
Buteo swainsoni	Swainson's Hawk	Landscape	161	H				
Butorides virescens	Green Heron	Coarse Filter	3	L				
Calidris minutilla	Least Sandpiper	Assemblage		H				
Carpodacus cassinii	Cassin's Finch	Assemblage		L				
Catharus ustulatus	Swainson's Thrush	Coarse Filter		L				
Centrocercus urophasianus	Greater Sage-Grouse	Landscape	99	H				
Chaetura vauxi	Vaux's Swift	Local		L				
Charadrius alexandrinus nivosus	Western Snowy Plover	Coarse Filter	118	H				
Charadrius montanus	Mountain Plover	Coarse Filter		L				
Chlidonias niger	Black Tern	Coarse Filter	16	L				
Chondestes grammacus	Lark Sparrow	Local		L				
Cinclus mexicanus	American Dipper	Coarse Filter		L				
Circus cyaneus	Northern Harrier	Landscape	4	M				
Cistothorus palustris	Marsh Wren	Coarse Filter		L				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Coccothraustes vespertinus	Evening Grosbeak	Assemblage	11	L				
Coccyzus americanus occidentalis	Western Yellow-billed Cuckoo	Coarse Filter	51	H				
Contopus cooperi	Olive-sided Flycatcher	Assemblage		L				
Cygnus buccinator	Trumpeter Swan	Local	20	H				
Dendragapus obscurus	Dusky Grouse	Assemblage		M				
Dendroica nigrescens	Black-throated Gray Warbler	Coarse Filter		L				
Dendroica petechia brewsteri	A Yellow Warbler	Coarse Filter	9	L				
Dolichonyx oryzivorus	Bobolink	Local	33	L				
Dumetella carolinensis	Gray Catbird	Local	7	L				
Egretta thula	Snowy Egret	Coarse Filter	1	L				
Empidonax oberholseri	Dusky Flycatcher	Local		L				
Empidonax traillii adastus	A Willow Flycatcher	Coarse Filter		L				
Empidonax traillii brewsteri	Mountain willow flycatcher	Coarse Filter		L				
Empidonax wrightii	Gray Flycatcher	Coarse Filter	2	L				
Falco columbarius	Merlin	Local		M				
Falco mexicanus	Prairie Falcon	Landscape	41	H				
Falco peregrinus	Peregrine Falcon	Local	73	H				
Gallinago delicata	Wilson's Snipe	Coarse Filter		L				
Gavia immer	Common Loon	Assemblage	7	L				
Geothlypis trichas	Common Yellowthroat	Local	26	L				
Grus canadensis tabida	Greater Sandhill Crane	Coarse Filter	26	M				
Gymnorhinus cyanocephalus	Pinyon Jay	Coarse Filter	11	M				
Haliaeetus leucocephalus	Bald Eagle	Landscape	121	H				
Himantopus mexicanus	Black-necked Stilt	Assemblage	11	L				
Hydroprogne caspia	Caspian Tern	Coarse Filter	9	L				
Icteria virens	Yellow-breasted Chat	Local	7	L				
Ixobrychus exilis	Least Bittern	Coarse Filter	4	L				
Ixobrychus exilis hesperis	Western Least Bittern	Coarse Filter	13	L				
Lanius ludovicianus	Loggerhead Shrike	Landscape	1	L				
Larus californicus	California Gull	Coarse Filter	3	L				
Leucophaeus pipixcan	Franklin's Gull	Coarse Filter	1	L				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Leucosticte atrata	Black Rosy-finch	Local	9	L				
Leucosticte tephrocotis	Gray-crowned Rosy-finch	Local		L				
Limnodromus scolopaceus	Long-billed Dowitcher	Assemblage		M				
Lophodytes cucullatus	Hooded Merganser	Assemblage		H				
Loxia curvirostra	Red Crossbill	Assemblage		L				
Melanerpes lewis	Lewis's Woodpecker	Coarse Filter	14	L				
Melospiza lincolnii	Lincoln's Sparrow	Local		L				
Mergus merganser	Common Merganser	Assemblage	3	H				
Nucifraga columbiana	Clark's Nutcracker	Landscape		L				
Numenius americanus	Long-billed Curlew	Coarse Filter	86	M				
Nycticorax nycticorax	Black-crowned Night-Heron	Coarse Filter	2	L				
Oporornis tolmiei	MacGillivray's Warbler	Coarse Filter		L				
Oreortyx pictus	Mountain Quail	Coarse Filter	17	M				
Oreoscoptes montanus	Sage Thrasher	Landscape	1	L				
Otus flammeolus	Flammulated Owl	Assemblage	12	L				
Pandion haliaetus	Osprey	Coarse Filter	29	H				
Passerculus sandwichensis	Savannah Sparrow	Landscape		L				
Passerella iliaca	Fox Sparrow	Local		L				
Passerina caerulea	Blue Grosbeak	Coarse Filter	30	L				
Patagioenas fasciata	Band-tailed Pigeon	Assemblage	23	L				
Pelecanus erythrorhynchos	American White Pelican	Coarse Filter	86	H				
Phalacrocorax auritus	Double-crested Cormorant	Coarse Filter		L				
Phalaropus lobatus	red-necked phalarope	Assemblage		M				
Phalaropus tricolor	Wilson's Phalarope	Coarse Filter		M				
Picoides albolarvatus	White-headed Woodpecker	Local		M				
Picoides dorsalis	American Three-toed Woodpecker	Local	9	L				
Picoides pubescens	Downy Woodpecker	Coarse Filter		L				
Pipilo chlorurus	Green-tailed Towhee	Coarse Filter		L				
Plegadis chihi	White-faced Ibis	Assemblage	16	M				
Podiceps auritus	Horned Grebe	Local		M				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Podiceps nigricollis	Eared Grebe	Local	1	M				
Poecile atricapillus	Black-capped Chickadee	Coarse Filter		L				
Pooecetes gramineus	Vesper Sparrow	Coarse Filter		L				
Recurvirostra americana	American Avocet	Assemblage	30	M				
Regulus calendula	Ruby-crowned Kinglet	Assemblage		L				
Regulus satrapa	Golden-crowned Kinglet	Local		L				
Riparia riparia	Bank Swallow	Local	6	L				
Sayornis nigricans	Black Phoebe	Coarse Filter	1	L				
Selasphorus platycercus	Broad-tailed Hummingbird	Local	2	L				
Selasphorus rufus	Rufous Hummingbird	Local		L				
Sitta pygmaea	Pygmy Nuthatch	Assemblage		L				
Sphyrapicus nuchalis	Red-naped Sapsucker	Coarse Filter		L				
Sphyrapicus ruber	Red-breasted Sapsucker	Coarse Filter		L				
Sphyrapicus thyroideus	Williamson's Sapsucker	Coarse Filter	10	L				
Spinus psaltria	Lesser Goldfinch	Coarse Filter		L				
Spizella breweri	Brewer's Sparrow	Landscape	13	L				
Spizella passerina	Chipping Sparrow	Coarse Filter		L				
Stellula calliope	Calliope Hummingbird	Coarse Filter		L				
Sterna forsteri	Forster's Tern	Coarse Filter	1	L				
Tachycineta bicolor	Tree Swallow	Coarse Filter		L				
Tringa semipalmata	Willet	Assemblage		M				
Turdus migratorius	American Robin	Coarse Filter		L				
Tympanuchus phasianellus columbianus	Columbian Sharp-tailed Grouse	Landscape	59	H				
Tyrannus tyrannus	Eastern Kingbird	Coarse Filter	22	L				
Vermivora celata	Orange-crowned Warbler	Coarse Filter		L				
Vermivora virginiae	Virginia's Warbler	Coarse Filter	1	L				
Vireo vicinior	Gray Vireo	Coarse Filter	2	L				
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	Coarse Filter	2	L				
Zonotrichia leucophrys	White-crowned Sparrow	Coarse Filter		L				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Mammals								
Antrozous pallidus	Pallid Bat	Local	86	H				
Aplodontia rufa californica	Sierra Nevada Mountain Beaver	Local	21	H				
Bassariscus astutus	Ringtail	Coarse Filter	6	L				
Brachylagus idahoensis	Pygmy Rabbit	Landscape	330	H				
Castor canadensis	American Beaver	Local		L				
Corynorhinus townsendii	Townsend's Big-eared Bat	Local	262	H				
Dipodomys deserti	Desert Kangaroo Rat	Assemblage	2	L				
Dipodomys merriami	Merriam's Kangaroo Rat	Local	12	L				
Dipodomys panamintinus	Panamint Kangaroo Rat	Coarse Filter		L				
Eptesicus fuscus	Big Brown Bat	Landscape	48	H				
Euderma maculatum	Spotted Bat	Coarse Filter	50	H				
Glaucomys sabrinus	Northern Flying Squirrel	Assemblage	21	H				
Gulo gulo	Wolverine	Assemblage	52	L				
Lasionycteris noctivagans	Silver-haired Bat	Assemblage	52	H				
Lasiurus blossevillii	Western Red Bat	Coarse Filter	6	H				
Lasiurus cinereus	Hoary Bat	Assemblage	36	H				
Lasiurus xanthinus	Western Yellow Bat	Local		H				
Lemmiscus curtatus	Sagebrush Vole	Local		L				
Lepus americanus tahoensis	Sierra Nevada Snowshoe Hare	Local	4	H				
Lepus townsendii	White-tailed Jackrabbit	Landscape	26	L				
Lontra canadensis	North American River Otter	Local	36	L				
Martes americana sierrae	Sierra Marten	Local	38	M				
Microdipodops megacephalus	Dark Kangaroo Mouse	Assemblage	31	M				
Microdipodops pallidus	Pale Kangaroo Mouse	Assemblage	2	M				
Microtus montanus fucosus	Pahranagat Valley Vole	Local	12	M				
Myotis ciliolabrum	Western Small-footed Myotis	Local	139	H				
Myotis evotis	Long-eared Myotis	Assemblage	121	H				
Myotis lucifugus	Little Brown Myotis	Assemblage	26	H				
Myotis thysanodes	Fringed Myotis	Local	45	H				
Myotis volans	Long-legged Myotis	Assemblage	162	H				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Myotis yumanensis	Yuma Myotis	Local	44	H				
Neotamias dorsalis	Cliff Chipmunk	Local	2	L				
Neotamias minimus	Least Chipmunk	Local		L				
Ochotona princeps	American Pika	Local	307	H				
Odocoileus hemionus	Mule Deer	Landscape		H				
Ondatra zibethicus	Common Muskrat	Local		L				
Ovis canadensis nelsoni	Desert Bighorn Sheep	Landscape	14	H				
Parastrellus hesperus	Western Pipistrelle	Local	53	H				
Peromyscus boylii	Brush Deermouse	Local		L				
Peromyscus truei	Piñon Deermouse	Coarse Filter		L				
Scapanus latimanus	Broad-footed Mole	Coarse Filter		L				
Sciurus griseus griseus	Western Gray Squirrel	Assemblage		L				
Sorex merriami	Merriam's Shrew	Coarse Filter	1	L				
Sorex merriami leucogenys	Merriam's Shrew	Local	7	L				
Sorex monticolus	Montane Shrew	Coarse Filter		L				
Sorex palustris	Water Shrew	Coarse Filter	16	L				
Sorex preblei	Preble's Shrew	Local	8	L				
Sorex tenellus	Inyo Shrew	Local	10	L				
Sorex trowbridgii	Trowbridge's Shrew	Local	3	L				
Sorex vagrans	Vagrant Shrew	Coarse Filter		L				
Spermophilus elegans	Wyoming Ground Squirrel	Local		L				
Spermophilus mollis	Piute Ground Squirrel	Local	1	L				
Spermophilus variegatus	Rock Squirrel	Coarse Filter	5	L				
Tadarida brasiliensis	Brazilian Free-tailed Bat	Landscape	53	H				
Taxidea taxus	American Badger	Local	15	L				
Thomomys bottae abstrusus	Fish Spring Pocket Gopher	Local	1	H				
Thomomys bottae curtatus	San Antonio Pocket Gopher	Local	2	H				
Thomomys monticola	Mountain Pocket Gopher	Local	3	L				
Thomomys townsendii	Townsend's Pocket Gopher	Local		L				
Ursus americanus	American Black Bear	Local		H				
Vulpes macrotis	Kit Fox	Landscape	89	L				

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Vulpes vulpes	Red Fox	Local		L				
Vulpes vulpes necator	Sierra Nevada Red Fox	Local	21	L				
Zapus princeps	Western Jumping Mouse	Coarse Filter	39	L				
Mosses, Ferns, & relatives								
Orthotrichum spjutii		Local	1	L	U	U	U	
Botrychium crenulatum	Crenulate Moonwort	Local	22	L	U	U	U	
Flowering Plants								
Allium passeyi	Passey's Onion	Local	5	U	U	U	U	
Angelica wheeleri	Wheeler's Angelica	Local	10	L	U	U	U	
Antennaria arcuata	Meadow Pussytoes	Coarse Filter	15	M	U	U	U	
Arabis beckwithii	Beckwith's Rockcress	Local	4	L	U	U	U	
Arabis bodiensis	Bodie Hills Rockcress	Coarse Filter	51	M	U	M	U	
Arabis dispar	Unequal Rockcress	Local	27	L	U	U	U	
Arabis falcatoria	Grouse Creek Rockcress	Local	9	M	U	U	M	
Arabis falcifructa	Elko Rockcress	Local	2	M	U	U	U	
Arabis lasiocarpa	Wasatch Range Rockcress	Local	20	L	U	U	U	
Arabis ophira	Ophir Rockcress	Local	41	H	U	U	U	
Arabis pinzliae	Pinzl's Rockcress	Local	20	H	U	M	U	
Arabis pulchra var. munciensis	Darwin Rock Cress	Local	5	L	U	U	U	
Arabis shockleyi	Shockley's Rockcress	Local	53	L	U	U	U	
Asclepias eastwoodiana	Eastwood's Milkweed	Local	113	M	U	U	U	
Astragalus agrestis	Purple Milkvetch	Local	1	L	U	U	U	
Astragalus ampullarioides		Local	5	L	U	U	U	
Astragalus argophyllus var. argophyllus	Silverleaf Milkvetch	Local	9	L	U	U	U	
Astragalus avonensis		Local	1	L	U	U	U	
Astragalus beatleyae	Beatley's Milkvetch	Local	82	H	U	U	U	
Astragalus callithrix	Callaway Milkvetch	Assemblage	29	L	U	U	U	
Astragalus chamaemeniscus	Ground-crescent Milkvetch	Local	3	L	U	U	U	
Astragalus cimae var. cimae	Cima Milkvetch	Local	6	L	U	U	U	

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Astragalus convallarius var. margaretiae	Margaret's Rushy Milkvetch	Coarse Filter	25	L	U	U	U	
Astragalus diversifolius	Mesic Milkvetch	Coarse Filter	4	L	U	U	U	
Astragalus ensiformis var. gracilior	Pagumpa Milkvetch	Local	2	L	U	U	U	
Astragalus eurylobus	Peck Station Milkvetch	Local	14	L	U	U	U	
Astragalus geyeri var. geyeri	Geyer's Milkvetch	Assemblage	18	L	U	U	U	
Astragalus gilmanii	Gilman's Milkvetch	Local	7	L	U	U	U	
Astragalus hornii var. hornii	Horn's Milkvetch	Coarse Filter	1	L	U	U	U	
Astragalus inyoensis	Inyo Milkvetch	Coarse Filter	2	L	U	M	U	
Astragalus johannis-howellii	Long Valley Milkvetch	Local	29	L	U	M	U	
Astragalus lemmonii	Lemmon's Milkvetch	Coarse Filter	11	L	U	U	U	
Astragalus lentiginosus var. piscinensis	Fish Slough Milkvetch	Coarse Filter	4	L	U	H	U	
Astragalus lentiginosus var. sesquimetralis	Sodaville Milkvetch	Coarse Filter	8	H	U	H	U	
Astragalus monoensis	Mono Milkvetch	Local	24	L	U	M	U	
Astragalus oophorus var. clokeyanus	Charleston Milkvetch	Assemblage	52	M	U	U	U	
Astragalus oophorus var. lavinii	Lavin's Egg Milkvetch	Assemblage	87	M	U	M	U	
Astragalus oophorus var. lonchocalyx	Pink Egg Milkvetch	Local	31	L	U	U	U	
Astragalus perianus	Rydberg's Milkvetch	Local	4	L	U	U	U	
Astragalus pinonis	Pinyon Milkvetch	Local	4	L	U	U	U	
Astragalus pseudiodanthus	Tonopah Milkvetch	Assemblage	41	L	U	U	U	
Astragalus pterocarpus	Winged Milkvetch	Coarse Filter	55	L	U	U	U	
Astragalus pulsiferae var. coronensis	Pulsifer's Milkvetch	Local	2	L	U	U	U	
Astragalus pulsiferae var. pulsiferae	Pulsifer's Milk Vetch	Local	34	L	U	U	U	
Astragalus robbinsii var. occidentalis	Lamoille Canyon Milkvetch	Local	77	M	U	U	U	

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Astragalus straturensis	Silver Reef Milkvetch	Local	22	L	U	U	U	
Astragalus toquimanus	Toquima Milkvetch	Local	33	L	U	U	U	
Astragalus uncialis	Currant Milkvetch	Local	36	L	U	U	U	
Astragalus welshii	Welsh's Milkvetch	Local	2	L	U	U	U	
Astragalus yoder-williamsii	Mud-flat Milkvetch	Coarse Filter	3	L	U	U	U	
Atriplex bonnevillensis	Bonneville Saltbush	Coarse Filter		L	U	U	U	
Calochortus excavatus	Inyo County Mariposa-lily	Local	67	L	U	M	U	
Camissonia megalantha	Intermountain Evening-primrose	Local	32	M	U	U	U	
Camissonia nevadensis	Nevada Evening-primrose	Coarse Filter	24	M	U	U	U	
Castilleja parvula	Tushar Paintbrush	Local	13	L	U	U	U	
Castilleja revealii	Reveal's Indian-paintbrush	Local	3	L	U	U	U	
Castilleja salsuginosa	Monte Neva Paintbrush	Local	4	H	U	U	U	
Caulanthus barnebyi	Barneby's Caulanthus	Local	72	M	U	U	U	
Caulostramina jaegeri	Jaeger's Caulostramina	Local	9	L	U	M	U	
Collomia renacta	Barren Valley Collomia	Local	3	L	U	U	U	
Cordylanthus tecopensis	Tecopa Bird's-beak	Coarse Filter	4	M	U	M	U	
Cryptantha compacta	Compact Cat's-eye	Local	14	L	U	U	U	
Cryptantha ochroleuca	Yellow-white Catseye	Local	1	L	U	U	U	
Cryptantha roosiorum	Bristle-cone Cryptantha	Local	9	L	U	M	U	
Cryptantha welshii	Welsch's Cat's-eye	Local	1027	M	U	U	U	
Cusickiella quadricostata	Bodie Hills Cusickiella	Assemblage	50	L	U	L	U	
Cymopterus basalticus	Intermountain Wavewing	Local	26	L	U	U	U	
Cymopterus cinerarius	Gray Wavewing	Coarse Filter	7	L	U	L	U	
Cymopterus coulteri	Coulter's Biscuitroot	Local	35	L	U	U	U	
Cymopterus goodrichii	Toiyabe Spring-parsley	Local	19	M	U	U	U	
Cymopterus jonesii	Jone's Wavewing	Local	16	L	U	U	U	
Cymopterus minimus	Cedar Breaks Biscuitroot	Local	3	L	U	U	U	
Cymopterus ripleyi var. saniculoides	Sanicle Biscuitroot	Local	59	M	U	U	U	
Cypripedium fasciculatum	Clustered Lady's-slipper	Local	4	L	U	U	U	
Dedeckera eurekensis	July Gold	Local	27	M	U	M	U	

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Draba arida	Desert Whitlow-grass	Assemblage	50	M	U	U	U	
Draba californica	White Mountain Draba	Local	2	L	U	L	U	
Draba incrassata	Sweetwater Mountains Draba	Local	20	M	U	M	U	
Draba kassii	Kass's Rockcress	Local	4	U	U	U	U	
Draba monoensis	White Mountains draba	Local	10	L	U	L	U	
Draba pennellii	Pennell's Draba	Local	30	M	U	U	U	
Draba sphaeroides	Mountain Whitlow-grass	Coarse Filter	24	L	U	U	U	
Draba subumbellata	White Mountain Draba	Local	5	L	U	L	U	
Echinocereus engelmannii var. armatus	Engelmann's Hedgehog Cactus	Local		L	U	U	U	
Epilobium nevadense	Nevada Willowherb	Assemblage	23	L	U	U	U	
Ericameria gilmanii	Gilman Goldenweed	Local	1	L	U	U	U	
Erigeron cavernensis	Cave Mountain Fleabane	Assemblage	12	L	U	U	U	
Erigeron compactus	Mound Daisy	Local	16	L	U	L	U	
Erigeron miser	Starved Daisy	Local	1	L	U	U	U	
Erigeron ovinus	Sheep Fleabane	Assemblage	18	L	U	U	U	
Eriogonum ammophilum	Ibex Buckwheat	Local	18	L	U	U	U	
Eriogonum ampullaceum	Mono Buckwheat	Coarse Filter	8	M	U	U	U	
Eriogonum anemophilum	Wind-loving Buckwheat	Local	86	H	U	U	U	
Eriogonum argophyllum	Ruby Valley Buckwheat	Local	2	H	U	U	U	
Eriogonum beatleyae	Beatley's Buckwheat	Assemblage	89	L	U	U	U	
Eriogonum concinnum	Darin Buckwheat	Assemblage	36	L	U	U	U	
Eriogonum darrovii	Darrow's Buckwheat	Local	23	L	U	U	U	
Eriogonum diatomaceum	Churchill Narrows Buckwheat	Assemblage	70	H	U	U	U	
Eriogonum eremicum	Limestone Buckwheat	Local	21	L	U	U	U	
Eriogonum holmgrenii	Holmgren's Buckwheat	Assemblage	17	M	U	U	U	
Eriogonum lewisii	Lewis' Buckwheat	Local	81	H	U	U	U	
Eriogonum loganum	Logan Buckwheat	Local	11	L	U	U	U	
Eriogonum microthecum var. panamintense	Panamint Mountains Buckwheat	Local	4	L	U	U	U	

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Eriogonum microthecum var. schoolcraftii	Slender Buckwheat	Local	13	L	U	U	U	
Eriogonum natum	Son's Buckwheat	Local	15	L	U	U	U	
Eriogonum nutans var. glabratum	Deeth buckwheat	Local	19	L	U	U	U	
Eriogonum ovalifolium var. williamsiae	Steamboat Buckwheat	Local	20	H	U	U	U	
Eriogonum pharnaceoides var. cervinum	Wire-stem Buckwheat	Local	16	L	U	U	U	
Eriogonum phoeniceum	A Buckwheat	Local	6	L	U	U	U	
Eriogonum robustum	Altered Andesite Buckwheat	Local	410	H	U	U	U	
Eriogonum rubricaule	Lahontan Basin Buckwheat	Local	12	M	U	U	U	
Eriogonum soredium	Frisco Buckwheat	Local	6	L	U	U	U	
Eriogonum tiehmii	Tiehm's Buckwheat	Assemblage	31	H	U	U	U	
Escobaria vivipara var. rosea	Viviparous Foxtail Cactus	Local		L	U	U	U	
Frasera gypsicola	Sunnyside Green-gentian	Assemblage	105	H	U	U	U	
Galium hilendiae ssp. kingstonense	Kingston Bedstraw	Local	10	L	U	U	U	
Gilia nyensis	Nye Gilia	Assemblage	77	L	U	U	U	
Gutierrezia petradoria	Goldenrod Snakeweed	Local	24	L	U	U	U	
Hackelia brevicula	Poison Canyon Stickseed	Coarse Filter	9	M	U	U	U	
Hackelia ibapensis	Deep Creek Stickseed	Local	2	L	U	U	U	
Hackelia sharsmithii	Sharsmith's Stickseed	Local	26	L	U	U	U	
Helianthus deserticola	Utah Sunflower	Assemblage	38	M	U	U	U	
Horkelia hispidula	White Mountains Horkelia	Local	21	M	U	M	U	
Ivesia aperta var. aperta	Sierra Valley Ivesia	Coarse Filter	72	H	U	H	U	
Ivesia arizonica var. saxosa	Rock Purpusia	Assemblage	10	L	U	U	U	
Ivesia kingii	King's Ivesia	Coarse Filter	2	L	U	U	U	
Ivesia kingii var. kingii	King's Ivesia	Coarse Filter	15	L	U	M	U	
Ivesia pityocharis	Pine Nut Ivesia	Local	48	H	U	U	U	
Ivesia sericoleuca	Plumas Ivesia	Local	28	L	U	U	U	
Ivesia webberi	Webber Ivesia	Assemblage	46	H	U	H	U	

Scientific Name	Common Name	Assessment Approach	EOs	NV	AZ	CA	UT	Comments
Jamesia tetrapetala	Waxflower	Assemblage	42	M	U	U	U	
Lepidium nanum	Southwestern Pepper-grass	Local	585	M	U	L	U	
Lepidium ostleri	Ostler's Pepper-grass	Local	4	L	U	U	U	
Leptodactylon glabrum	Owyhee Prickly-phlox	Assemblage	6	L	U	U	U	
Lesquerella goodrichii	Tunnel Springs Mountain Bladderpod	Local	5	L	U	U	U	
Lesquerella hitchcockii	Hitchcock's Bladderpod	Assemblage	23	L	U	U	U	
Lesquerella pendula	Snake Range Bladderpod	Local	38	L	U	U	U	
Lesquerella rubicundula	Bryce Bladderpod	Local	4	L	U	U	U	
Lewisia maguirei	Maguire's Bitteroot	Local	31	M	U	U	U	
Loeflingia squarrosa ssp. artemisiarum	Sage-like Loeflingia	Local	21	L	U	U	U	
Lomatium packardiae	Packard's Desert-parsley	Assemblage	3	L	U	U	U	
Lupinus duranii	Mono Lake Lupine	Local	36	L	U	U	U	
Lupinus holmgrenianus	Holmgren Lupine	Local	9	L	U	U	U	
Lupinus magnificus var. hesperius	Mcgee Meadows Lupine	Local	2	L	U	U	U	
Lupinus padre-crowleyi	Father Crowley's Lupine	Local	11	L	U	U	U	
Lupinus uncialis	lilliput lupine	Local		L	U	U	U	
Mentzelia argillicola	Pioche Blazingstar	Assemblage	9	L	U	U	U	
Mentzelia argillosa	Arapien Stickleaf	Local	17	L	U	U	U	
Mentzelia inyoensis	Inyo balzingstar	Local	17	L	U	U	U	
Mentzelia mollis	Smooth Stickleaf	Assemblage	6	M	U	U	U	
Mentzelia tiehmii		Assemblage	227	L	U	U	U	
Mimulus ovatus	Eggleaf Monkeyflower	Local	31	M	U	U	U	
Mirabilis pudica	Bashful Four-o'clock	Local	10	M	U	U	U	
Musineon lineare	Rydberg's Musineon	Local	47	L	U	U	U	
Opuntia pulchella	Sand Cholla	Local	115	M	U	M	U	
Oryctes nevadensis	Nevada Oryctes	Assemblage	179	M	U	M	U	
Packera castoreus	Beaver Mountain Groundsel	Local	3	L	U	U	U	
Packera malmstenii	Podunk Groundsel	Local	2	L	U	U	U	
Parthenium ligulatum	Ligulate Feverfew	Local	2	L	U	U	U	

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Pedicularis centranthera	dwarf lousewort	Local		L	U	U	U	
Pediocactus simpsonii	Simpson's Hedgehog Cactus	Local	3	L	U	U	U	
Penstemon arenarius	Dune Beardtongue	Assemblage	67	M	U	U	U	
Penstemon bracteatus	Red Canyon Beardtongue	Local	3	L	U	U	U	
Penstemon concinnus	Tunnel Springs Beardtongue	Local	26	L	U	U	U	
Penstemon floribundus	Cordelia's Penstemon	Local	56	M	U	U	U	
Penstemon franklinii	Ben Franklin's Beardtongue	Local	3	L	U	U	U	
Penstemon leiophyllus var. francisci-pennellii	Charleston Beardtongue	Local	17	M	U	U	U	
Penstemon moriahensis	Mt. Moriah Beardtongue	Local	28	M	U	U	U	
Penstemon nanus	Low Beardtongue	Local	43	L	U	U	U	
Penstemon pahutensis	Pahute Mesa Beardtongue	Assemblage	103	M	U	U	U	
Penstemon palmeri var. macranthus	Lahontan Beardtongue	Coarse Filter	47	L	U	U	U	
Penstemon petiolatus	Petiolate Beardtongue	Local	8	L	U	U	U	
Penstemon pinorum	Pinyon Penstemon	Local	10	L	U	U	U	
Penstemon platyphyllus	Broadleaf Beardtongue	Local	33	L	U	U	U	
Penstemon pudicus	Kawich Range Beardtongue	Assemblage	16	L	U	U	U	
Penstemon rhizomatosus	Rhizome Beardtongue	Assemblage	17	L	U	U	U	
Penstemon rubicundus	Wassuk Beardtongue	Local	45	L	U	U	U	
Penstemon tidestromii	Tidestrom Beardtongue	Local	14	L	U	U	U	
Penstemon tiehmii	Shoshone Beardtongue	Local	8	L	U	U	U	
Penstemon tusharensis	Tushar Range Beardtongue	Local	5	L	U	U	U	
Penstemon wardii	Ward Beardtongue	Local	49	L	U	U	U	
Perityle inyoensis	Inyo Rock Daisy	Local	6	L	U	U	U	
Perityle villosa	Hanaupah rock daisy	Local	1	L	U	U	U	
Phacelia filiae	a Phacelia	Assemblage	10	M	U	U	U	
Phacelia inconspicua	Inconspicuous Scorpionweed	Local	7	M	U	U	U	
Phacelia inundata	Playa Phacelia	Local	6	M	U	U	U	
Phacelia inyoensis	Inyo Phacelia	Local	20	L	U	U	U	
Phacelia minutissima	Tiny-flower Phacelia	Coarse Filter	71	M	U	U	U	

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Phacelia monoensis	Mono County Phacelia	Assemblage	72	H	U	H	U	
Phacelia mustelina	Death Valley Roundleaf Phacelia	Local	17	L	U	U	U	
Phacelia parishii	Parish's Phacelia	Local	28	H	H	H	U	
Phacelia utahensis	Utah Phacelia	Local	11	L	U	U	U	
Plagiobothrys glomeratus	Clustered Popcorn-flower	Local	28	M	U	U	U	
Plagiobothrys parishii	Parish's Popcorn-flower	Local	14	L	U	U	U	
Plagiobothrys salsus	Desert Allocarya	Coarse Filter	1	L	U	U	U	
Polemonium chartaceum	Mason's Skypilot	Local	23	M	U	M	U	
Polyctenium williamsiae	Williams combleaf	Local	64	H	U	M	U	
Polygala heterorhyncha	Spiny Milkwort	Local	11	L	U	U	U	
Potentilla basaltica	Soldier Meadows Cinquefoil	Local	71	H	U	M	U	
Potentilla cottamii	Cottam's Potentilla	Assemblage	11	M	U	M	U	
Potentilla morefieldii	Morefield's Cinquefoil	Local	24	L	U	L	U	
Primula capillaris	Ruby Mountains Primrose	Assemblage	16	H	U	U	U	
Primula domensis	House Range Primrose	Local	5	L	U	U	U	
Primula nevadensis	Nevada Primrose	Assemblage	42	L	U	U	U	
Psorothamnus kingii	King's Indigo-bush	Assemblage	20	M	U	U	U	
Sclerocactus blainei	Blaine's Pincushion	Local	24	M	U	U	U	
Sclerocactus nyensis	Nye County Fish-hook Cactus	Local	24	M	U	U	U	
Sclerocactus polyancistrus	Mohave Fishhook Cactus	Local	46	L	U	U	U	
Sclerocactus pubispinus	Great Basin Fishhook Cactus	Local	53	L	U	U	U	
Sclerocactus schlesseri	Schlesser's Pincushion	Local	38	H	U	U	U	
Sclerocactus spinosior	Desert Valley Fishhook Cactus	Local	25	L	U	U	U	
Senecio pattersonensis	Mono Ragwort	Assemblage	15	L	U	U	U	
Sidalcea covillei	Owens Valley Checker-mallow	Coarse Filter	41	L	U	M	U	
Silene nachlingerae	Jan's Catchfly	Local	52	M	U	U	U	
Silene petersonii	Peterson's Catchfly	Local	13	L	U	U	U	
Smelowskia holmgrenii	Nye County Smelowskia	Local	43	L	U	U	U	
Sphaeralcea caespitosa	Jone's Globemallow	Local	12	M	U	U	M	
Sphaeralcea caespitosa var. williamsiae	Jone's Globemallow	Local	47	M	U	U	U	

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Spiranthes diluvialis	Ute Ladies'-tresses	Coarse Filter	19	H	U	U	M	
Spiranthes romanzoffiana	Hooded Ladies'-tresses	Coarse Filter	1	L	U	U	U	
Stipa shoshoneana		Local	2	L	U	U	U	
Streptanthus oliganthus	Masonic Mountain Jewelflower	Local	51	L	U	U	U	
Stroganowia tiehmii	Tiehm's Stroganowia	Local	80	H	U	U	U	
Tonestus alpinus	Alpine Goldenweed	Local	26	M	U	U	U	
Tonestus graniticus	Granite Haplopappus	Local	3	M	U	U	U	
Townsendia jonesii var. tumulosa	Charleston Ground-daisy	Local	103	M	U	U	U	
Trifolium andinum var. podocephalum	Currant Summit Clover	Local	8	L	U	U	U	
Trifolium dedeckerae	Dedecker's Clover	Local	11	L	U	M	U	
Trifolium friscanum	Frisco Clover	Local	6	L	U	U	U	
Trifolium leibergii	Leiberg's Clover	Assemblage	32	M	U	U	U	
Trifolium rollinsii	Rollins Clover	Local	39	M	U	U	U	
Viola lithion	Rock Violet	Assemblage	12	M	U	U	U	

B-2.5.2 Aquatics

Riparian Corridor Connectivity ("2010 Scenario")

Indicator Data and Knowledge Gaps

The coarse scale of the assessment for the Central Basins precludes on the ground measurements and observations of land use and activity within riparian corridors. For example it is possible that some road crossings may have used bridges rather than culverts. Well designed bridges allow for animal movement as well as unconfined water and sediment movement, much better than perched culverts. However we assumed roads within the buffered area cause stress and limit movement. Additionally small in-stream earth dams maybe present that are not included in the Landscape Condition Model data, and may be present but not accounted for. The cumulative effect of multiple stressors all in separate pixels within the same riparian corridor is not accounted for. No comprehensive data was available on the impact of livestock use on stream banks, riparian vegetation and water quality. Riparian areas that have no fragmentation issues may in fact be heavily impacted by livestock use.

Flow Modification by Dams, Current Condition ("2010 Scenario")

Indicator Data and Knowledge Gaps

The ratio of reservoir storage capacity to average annual surface water availability provides a reasonable but very coarse estimate of the potential ability of dams in a watershed to alter the flow regime. However, it presents a very simple picture. Reservoirs may not operate at their full capacity, and operating permits may stipulate that some water be released to satisfy in-stream flow requirements (Shafroth and Beauchamp 2006; Shafroth et al. 2010). Further, as noted above, this indicator measures a potential source of stress to aquatic ecosystems, not the degree of actual alteration of flows. A detailed scientific assessment of flow alteration associated with dams in the ecoregion requires long-term stream gage data, the ecoregion largely lacks.

A more complete assessment of this indicator might also include an analysis not only of reservoir capacity relative to average annual discharge, but relative to discharge during both significantly wet and dry years. Ecological conditions in the ecoregion along riparian/stream ecosystems depend on the natural occurrence both high- and low-flow years to shape channel habitat, reset riparian vegetation succession, and trigger other biological events. The U.S. Geological Survey, StreamStats information system (USGS 2011) will provide information not only on average annual discharge but on seasonal and inter-annual variation as well, when fully implemented for all states in the ecoregion. The F Index could be calculated separately for wet and dry years, to assess the capacity of dams to affect not just average discharges but natural extreme. Unfortunately, as noted in the discussion of data and knowledge gaps for Indicator 04, Surface Water use, Nevada and Arizona have not yet completed their implementations of StreamStats. Alternatively, the assessment of variation in natural discharge would be aided by completion of regional runoff and baseflow models or watershed water budget models. This presents significant challenges because of the unique topography, geology, and climate of the ecoregion. However, regardless of the methods used, future assessments would benefit from an improved quantitative representation of not merely average stream hydrologic behavior but also the natural range of variation in key hydrologic variables such as annual and seasonal stream discharge. Building and calibrating models that can generate such output may well require additional gauging data.

Surface Water Use, Current Condition ("2010 Scenario")

Indicator Data and Knowledge Gaps

The ratio of annual surface water consumption to average annual surface water availability provides a reasonable but very coarse estimate of relative surface water use by watershed. However, it presents a static picture. The runoff of individual watersheds varies naturally as a result of seasonal and inter-annual variation in precipitation and temperature. The natural flow regimes of streams and rivers varied in concert, with baseflows (where present) affected by local and sometimes regional aquifer dynamics as well. The native stream ecosystems of the ecoregion consist of species adapted to this natural variability. However, currently, years of greater runoff in areas of intensive surface water use in the ecoregion may not result in greater water availability for natural stream ecosystems. Rather, they may simply allow dam managers to store more water for later use, or may provide sufficient water to allow holders of junior surface water rights to exercise those rights. As a result, surface water use has the potential to alter not only average annual stream flow and its timing, but natural and ecologically important inter-annual variation in this flow as well. Unfortunately, the available data do not support an analysis of surface water use that addresses impacts to flow variation. Long-term stream gage data are extremely scarce, except for perennially flowing river reaches on valley floors – and these records are highly altered by the history of water use in these valleys.

The U.S. Geological Survey, StreamStats information system (USGS 2011) will provide information not only on average annual discharge but on seasonal and inter-annual variation as well, when fully implemented for all states in the ecoregion. Unfortunately, Nevada and Arizona have not yet completed their implementations. Alternatively, the assessment of surface water use and its impacts on stream flow regimes would be aided by completion of regional runoff and baseflow models or watershed water budget models. This presents significant challenges because of the unique topography, geology, and climate of the ecoregion. However, regardless of the methods used, future assessments would benefit from an improved quantitative representation of not merely average stream hydrologic behavior but also the natural range of variation in key hydrologic variables such as annual and seasonal stream discharge, timing of flow maxima and minima, timing of the annual snowmelt cycle and the "center point" of discharge, and so forth. Building and calibrating models that can generate such output may well require additional gauging data.

Perennial stream-flow and perennial discharge from springs also support surface water use in the CBR ecoregion. For scientific accuracy, it would be better to assess the use of such perennial flows separately from the use of water from runoff-driven streams. Similarly, it might be useful to assess the use of surface water imported via inter-basin transfers separately from the use of surface water diverted within the same drainage network. However, watersheds with high levels of use of water imported from other basins may also be highly modified in ways that "overwrite" the natural drainage network or incorporate it into the local water supply network.

KEA III, *Stressors to Hydrology Condition Current Condition ("2010 Scenario")*, has five indicators. None of these provides a direct measure of the degree or spatial extent of modification of hydrologic conditions such as stream or spring discharge, or spring or wetland water levels. Discharge and water table data are extremely sparsely available across the ecoregion; and where they exist, they are limited to highly localized conditions, short periods of record, and/or post-date major hydrologic modifications. For stream systems, the national StreamStats program often can provide a reasonable substitute for actual field data of sufficient spatial extent and record length. Unfortunately, Nevada has not completed its implementation of StreamStats at the time of this analysis, making it impossible to use this data system as a substitute even for flow data. Further, StreamStats data would not allow for an assessment of how hydrologic conditions may have changed over recent decades. As a result, we focused on measures of the dominant anthropogenic causes of hydrologic alteration in this desert ecoregion: surface water impoundment, diversion, and use; groundwater use and modifications of groundwater recharge zones. Measures of dominant causes of alteration serve as surrogate measures of actual alteration.

Ground Water Use, Current Condition ("2010 Scenario")

Indicator Data and Knowledge Gaps

The ratio of annual ground water consumption to average annual surface water availability provides a reasonable, but very coarse estimate of relative ground water use by watershed. The spatial data and regional ground water models available are inadequate across most portions of the ecoregion to identify which aquifers discharge to or support the potentiometric surfaces at which springs, streams, lakes, and wetlands; let alone to assess their relative contributions to the hydrology of each CE in each watershed. The controversies associated with almost any application for ground water withdrawal permits in the ecoregion highlight the importance of closing this data gap: the BLM Clark, Lincoln, and White Pine Counties Groundwater Development Project Draft Environmental Impact Statement (BLM 2011), and the competing groundwater models of the Southern Nevada Water Authority (SNWA) and other stakeholder groups concerned with this project (e.g., Burns et al. 2011; GBWN 2011), present a particularly clear example of such a controversy. The basins proposed for ground water withdrawals extend north from the Las Vegas area (in the Mojave Basin & Range ecoregion) into the center of the CBR, including a portion of Utah. Groundwater models continue to improve for the ecoregion (e.g., Heilweil and Brooks 2011), but may need to be coupled with improvements in the chemical "fingerprinting" of ground water discharges to better associate them with specific geological sources. Perennial flow along basin-floor riparian corridors in desert ecoregions may also occur in locations where these rivers pass over/through bedrock features that force ground water to the surface. Such geological constraints may make such bedrock-dependent stream reaches less sensitive to minor alterations in ground water flows, but still sensitive to major alterations. Better data are needed to differentiate between perennial flow reaches that depend on such bedrock features from those that do not, to better identify their unique sensitivities to withdrawals and support management.

Atmospheric Deposition-Nitrate Loading ("2010 Scenario")

Indicator Data and Knowledge Gaps

The values of nitrate deposition used in this assessment are interpolated values in the NADP deposition model for the U.S. Fewer than five NADP-National Trends Network monitoring stations are located within the ecoregion, with additional stations located in immediately adjacent areas. The assessment therefore is likely strongly affected by variation among these widely spaced stations and the interpolation methods used by the NADP. Matters such as (1) the exposure rates for particularly sensitive alpine wetlands and water bodies, (2) the reality of the cluster of higher rates in the Owens Valley-Death Valley-Edwards Air Force Base triangle, and (3) the spatial extent of the zone of high deposition identified across essentially all of western Utah, require a denser monitoring network and/or site-specific studies (e.g., Hunsaker et al. 2007) along with improved spatial modeling (e.g., Tonnesen et al. 2007). Studies of N-deposition and its effects in fact are concentrated west of the ecoregion, in California, and east of the ecoregion along the Front Range of the Rocky Mountains in Colorado (e.g., Brooks and Williams 1999; Baron et al. 2000; Williams and Tonnesen 2000; Coats and Goldman 2001; Wolfe et al. 2001, 2003; Burns 2003, 2004; Hunsaker et al. 2007; Fenn et al. 2008; 2010; Ingersoll et al. 2008; Allen et al. 2009; Saros et al. 2010; Pardo et al. 2011). These settings may provide information useful for understanding N-deposition and its effects along the western and eastern sides of the ecoregion, but their relevance to the center of the ecoregion requires confirmation. The potential interplay among N-deposition, non-native grasses, fuel loads, and wildfire appears well established in areas immediately southwest of the CBR ecoregion. These findings suggest a possible risk to watershed runoff and riparian vegetation in the CBR ecoregion, independent of changes to water chemistry. The interplay of bark beetle dynamics with these processes in a forested area south if the CBR ecoregion, along the southwestern side of the Mojave Basin & Range ecoregion, also may warrant additional investigation.

Atmospheric Deposition-Mercury Loading ("2010 Scenario")

Indicator Data and Knowledge Gaps

The raw estimates of Mercury wet deposition rates used in this assessment are interpolated values in the NADP deposition model for the U.S. Fewer than five NADP-Mercury Deposition Network monitoring stations are located within the ecoregion, with only a handful of additional stations located in immediately adjacent areas. The assessment therefore is likely strongly affected by variation among these widely spaced stations and the interpolation methods used by the NADP. However, the zones of highest deposition correspond to areas known through other studies as well, as noted above. Nevertheless, studies of Hg-deposition and bioaccumulation are concentrated west of the ecoregion, in California, and east of the ecoregion along the Front Range of the Rocky Mountains in Colorado (e.g., Lyman et al. 2007; Sanders et al. 2008; Drevnick et al. 2010; Mast et al. 2010). Further, studies of the biological and ecological effects of MeHg bioaccumulation are lacking even in these high-elevation settings, in contrast to other parts of the U.S. with high deposition rates (e.g., Driscoll et al. 2007a). The potential interplay among N-deposition, forest fuel loads, climate change, wildfire, and release of Hg stored in forest soils and litter also warrants further investigation, to determine if this interplay indeed poses additional biological and ecological risk within the CBR ecoregion.

Sediment Loading Index ("2010 Scenario")

Indicator Data and Knowledge Gaps

The coarse scale of the assessment for the Central Basis precludes on the ground measurements and observations of land use and activity within surrounding landscapes. Sediment Loading Index is based on the category of land use, which is a national standard provided by NSPECT (2004), and may not reflect actual values for each situation on the ground. The degree of surface slope, while a very important factor in determining sediment runoff, was not included due to computational and time limitation for this rapid, ecoregion-wide assessment. No comprehensive data was available on the impact of livestock use on stream banks, riparian vegetation and water quality. Riparian areas that have high Sediment Loading Index may in fact be heavily impacted by livestock use.

KEA IV, *Stressors to Water Quality*

Indicator Data and Knowledge Gaps

KEA--Water Quality, has four indicators, three of which are measures of causes of water quality impairment. Data on actual water quality conditions are very sparsely available outside of water-bodies that are subject to intensive human use or that have received discharges of pollutants. For example, data are readily available on waters in the Carson-Reno area related to studies of the impacts of historic mine wastes. The spottiness of water quality data made it necessary to use surrogate indicators based on causes of stress to water quality. We included data on State-Listed Water Quality Impairments, as reported by states to the U.S. Environmental Protection Agency. However, these data pertain only to water-bodies where concerns have been raised concerning potential failures to meet designated uses under the federal Clean Water Act. Within this ecoregion, these data therefore are also very sparsely distributed, and do not provide a representative sample of data on water quality across all water-body types and settings.

KEA V, *Stressors to Biotic Condition*

Indicator Data and Knowledge Gaps

KEA V, *Stressors to Biotic Condition*, has two indicators dealing with exotic invasive species, in order to answer the last management question listed above. Unfortunately these were the weakest indicators. The data available for known presence of invasive plant species (tamarisk, Russian olive, annual grasses) and aquatic invasive species), while available across the ecoregion, were sparsely distributed. As a result, these data give a false picture of reality on the ground. Early in the REA process, the assessment team considered using data on native species distributions and condition as indicators of biotic condition for aquatic CE types. For example, the distribution and condition of native trout species would provide information on the biotic condition of higher-elevation, coldwater streams. Unfortunately, this proved impossible within the limitations and criteria established for the REA. For example, it was decided not to use native fish species distribution data for four reasons: (1) maps of the historic or expected current geographic ranges of species were available but could not be used as substitutes for data on actual current distribution on a stream-by-stream basis; (2) data for the entire ecoregion were not available; (3) data on native fishes were available for Utah, but these data did not meet the ecoregion-wide criteria as stated in Chapter 2, section 2.7.1.1 Limitations: Issues of Scale & Certainty; and (4) the location and status of native fish species were not the subjects of any management questions.

We also actively sought to use data on stream benthic macroinvertebrates, collected as parts of systematic studies of stream biotic condition for purposes of building multi-variate measures of stream biotic integrity. The Western Center for Monitoring and Assessment of Freshwater Ecosystems (WMC) and the National Aquatic Monitoring Center (NAMC) maintains a regional database of such data, from which we hoped to obtain multi-variate measures of stream biotic integrity. Scott Miller, Director of the BLM "Buglab" at the NAMC provided a copy of this dataset for review, clipped to the ecoregion. Unfortunately, the available data were spatially very sparse – and necessarily limited to perennial stream reaches only. The individual states within the ecoregion are all developing stream bioassessment programs based on common methods, and it was hoped that state data could be used to complement the data provided by the NAMC. However, only Utah had bioassessment data available beyond those contained in the regional database. Nevada is rapidly building its stream bioassessment metrics, and its data should be available soon – but not in time for this REA. California reports that it is the process of building a digital database for its bioassessment data, but that this database will not be functional for data extraction for some time. Further, the data available from the NAMC included both reference and impacted sites. We found it difficult to summarize this information on a watershed scale, as a single stream might have highly impacted (negative scores) and reaches of highest quality. Integrating sparsely collected, very-fine scale data into a regional assessment always raises such challenges. As a result, we determined that it would not be feasible to use the stream bioassessment data for this REA.

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