SYNTHESIS OF CONSERVATION PRIORITIES

As indicated in the Approach chapter, conservation actions were constructed based on: 1) SGCN, 2) key habitats, 3) problems affecting species or habitats, 4) information gaps that limit our ability to make informed conservation decisions, 5) research, survey, and monitoring needs that if met would enhance our ability to make conservation decisions, and 6) desired future outcomes for habitats or SGCN. The Assessment and Strategies for SGCN and Key Habitats (Chapter 5) provides descriptions of each of these components for each key habitat within ecological frameworks.

> Conservation actions provided in this chapter were prioritized based on the number of key habitats in which they were identified, and their priority rank in each key habitat within ecological frameworks.

Below, we offer a summary of statewide conservation concerns. We present a discussion of factors that influence New Mexico habitats and wildlife. We also provide summarized information gaps and research, survey, and monitoring needs from the ecological frameworks and key habitats (Chapter 5) as well as additional points that limit our ability to make informed conservation decisions.

We also summarize the top five conservation actions listed in each key habitat within ecological frameworks (Chapter 5). Conservation actions provided in Chapter 4 were prioritized based on the number of key habitats in which they were identified, and their priority rank in each key habitat within ecological frameworks. As such, conservation actions that were in multiple habitats and received higher prioritization in Chapter 5 were given higher prioritization ranks below.

Priorities collectively identified in Chapter 4 should not supersede those identified in Chapter 5. Rather, Chapter 4 organizational framework takes a broader-scale approach to synthesizing prioritized conservation actions applicable to the statewide scale. We anticipate that those who will use this Strategy as a resource and planning guide will reference conservation actions under each ecological framework and key habitat as well as this synthesized approach.

Factors that Influence Species and Habitats

Over the past century, New Mexico's landscapes have changed dramatically. Natural flows of aquatic systems have been altered by human development and dams. Terrestrial ecosystems have been altered by development and other human activities. All of these changes have influenced New Mexico's wildlife.

> Many legal and accepted human activities and practices have the potential to be either beneficial or detrimental to wildlife. It is the manner in which activity is conducted that determines if it has a negative or positive effect on wildlife populations.

NMDGF recognizes that many human activities across today's landscapes have the potential to be either beneficial or detrimental to wildlife. Many factors that influence New Mexico landscapes are based on legal and accepted practices. It is not the intent of the CWCS to debate the benefits and detriments of historical activities on New Mexico's landscapes. Our intent is to evaluate landscapes as they exist today and develop strategies on how best to make meaningful improvements to benefit species of greatest conservation need. At times, we reference historic land management practices, as these practices have helped shape today's landscapes. In doing so, we do not intend to imply that historic land management practices still occur today.

Our assessment of factors that influence species or habitats is primarily focused at the habitat scale, as these factors directly affect wildlife communities and SGCN populations. A description of the process used for this assessment and evaluation of factors that influence habitats can be found in the Approach chapter. We also identify individual factors that most influence the persistence of each SGCN, based on literature review and professional knowledge. We provide this information in Appendix I. Given that most of the species-specific factors that influence the long-term persistence of SGCN are habitat conversion, loss, and degradation, fire (burning and suppression), and improper grazing practices, we do not discuss species-specific factors separately from habitat factors. We also provide a more spatially explicit discussion on the factors that adversely influence SGCN in ecoregions and habitat types in the Assessments and Strategies for SGCN and Key Habitats chapter.

Our assessment of factors that influence species or habitats is primarily focused at the habitat scale, as these factors directly affect wildlife communities and SGCN populations.

In our discussion of factors that influence species and habitats, we primarily discuss those practices that are harmful to wildlife at certain levels of use or extent. It should be understood that it is the manner in which a human activity or practice is conducted that determines if it has a negative or positive effect on wildlife populations. For example, livestock grazing can be a valuable tool to improve wildlife habitat. However, if livestock grazing is applied improperly, it can be detrimental to plant communities and wildlife.

Our list of potential factors that may influence habitats in New Mexico is based on some guidelines provided by Salafsky *et al.* (2003) for describing categories and factors and the proceeding discussion is primarily organized by these categories and individual factors.

Habitat Conversion

Declines in populations of plants and animals are usually caused by more than one event. However, habitat conversion through human-caused degradation and alteration is one of the most serious factors adversely affecting wildlife and plants worldwide. There are many causes of habitat conversion. Examples include urban, residential, commercial, or recreational development, agricultural and livestock production, drainage of wetlands, altered hydroperiods, and development of dams and channels that regulate water flows. Habitat conversion factors affect habitats on a statewide basis.

Development Activities

Human resource use has led to a condition in which large areas of formerly continuous landscapes have become increasingly fragmented and isolated (Finch 2004). Urban, residential, commercial, and recreational development, agriculture and other such activities have accelerated over the past century, subdividing the natural world into disjunctive remnants of native ecosystems embedded in a matrix of anthropogenic land uses (Saunders *et al.* 1991). Urban and commercial development contributes greatly to the loss of native vegetation, increased water use, ground water depletion, and increased erosion through soil compaction and runoff concentration. These activities may ultimately cause further habitat fragmentation and loss through landscape conversion, land clearing, road development, and increased vehicular traffic.

The negative ecological impacts of fragmentation on natural systems have led many ecologists to identify habitat fragmentation as one of the greatest threats to biodiversity (Harris 1984, Wilcox and Murphy 1985, Noss and Cooperrider 1994). Adverse effects of habitat fragmentation upon wildlife species and populations are numerous. Habitat fragmentation causes increased isolation of populations or species, which leads to decreased genetic diversity and increased potential for extirpation of localized populations or even extinction. Habitat fragmentation alters vegetative composition and cover and the type and quality of the food base. Further, habitat fragmentation changes microclimates by altering temperature and moisture regimes, changes nutrient and energy flows, and increases opportunities for predation and exploitation by humans.

> The negative ecological impacts of habitat fragmentation on natural systems are one of the greatest threats to biodiversity.

Aquatic Habitat Conversion Factors
Many aquatic habitats in New Mexico have been altered and fragmented by dams and water diversions. Dams modify natural flows and alter water quality. Reservoirs act as sediment traps and disrupt or alter the sediment budgets of downstream reaches. Decreases in sediment inputs alter the natural dynamics of mesohabitat creation and maintenance. Dams also fragment species ranges, preventing up and downstream movement of fishes and other aquatic species. Altered hydroperiods of seasonally astatic pools may reduce hydrologic connection to other wetlands, or other waters, reducing the quality of these habitats.

Abiotic Resource Use

Habitat disturbances from abiotic resource uses such as mining, oil and gas development, wind energy, ground water depletion, and hydropower occur throughout New Mexico, although they typically have localized impacts. Oil and gas development concerns are greatest in the shortgrass prairie, Colorado Plateau, and Chihuahuan Desert regions. There are concerns about mining in the Arizona-New Mexico Mountain Ecoregion.

Extractive Resource Uses
Extractive resource uses such as mining and oil and gas development occur throughout New Mexico and can influence ecosystem function, resilience and sustainability. On federal lands these activities are conducted under standards established by the Bureau of Land Management and are subject to further regulation by the New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division. Extractive resource uses may result in habitat fragmentation and loss through associated land clearing, road building, and disturbance from traffic, hauling and maintenance activities. Associated point-source pollution causes heavy-metal and highly acidic water pollution (Drabkowski 1993, Starnes and Gasper 1996, Reece 1995, Hilliard 1994), groundwater pollution (Miller *et al.* 1996), air pollution, noise, and habitat conversion (Dinerstein *et al.* 2000). Any of these activities and their adverse outcomes may ultimately lead to the reduction of wildlife populations (Sias and Snell 1998).

Wind Energy Development

Wind energy facilities are not yet widespread in New Mexico. However, as alternative sources of energy become more important to the state and nation and related technology improves there is potential for more wind-energy sites to be developed. Wind-generated electrical energy is environmentally friendly. It does not create air-polluting and climate-modifying emissions. Nevertheless, wind turbines, particularly in the large arrays, can adversely affect wildlife and wildlife habitats. Effects include habitat fragmentation due to access roads and pads and direct killing of bats and birds (particularly raptors) that strike moving blades. Lighted wind towers over 200 feet have the same potential as communication towers to attract and kill night-flying migratory birds and bats (NMDGF 2004b).

Ground Water Depletion

Groundwater levels in New Mexico have dropped considerably due to pumping for agricultural and urban needs. Several proposals and plans exist for desalination plants in New Mexico. The surface water loss resulting from the water withdrawal and dewatering necessary to support anthropocentric water needs, exacerbated by drought conditions, will continue to influence habitats in New Mexico. Lowered water tables affect all of New Mexico's habitats, but can have considerable affects on small cienegas, springs, seeps and marshes and their associated SGCN.

Pollution

Concerns about pollution sources influencing New Mexico's habitats are primarily focused on aquatic habitats. Pollution factors such as agricultural chemicals, livestock and dairy groundwater contamination, and solid waste can negatively affect the long-term persistence of SGCN in affected habitats. Runoff from livestock feedlots, dairy operations, and urban road surfaces introduces nutrients and numerous contaminants to aquatic habitats. Petrochemical pollutants reach aquatic habitats from various refinery operations. Mercury and petrochemicals have been identified in many of New Mexico's reservoirs. Typically, pollution sources are regulated by various federal and state agencies, such as the New Mexico Environment Department, Surface Water Quality Bureau, which monitors water quality in New Mexico's reservoirs. However, more information on the extent and sources of pollution in New Mexico will aid conservation decisions.

Consumptive Biological Uses

Consumptive biological uses such as improper grazing practices, logging, fuel wood collection, and deforestation have the potential to affect SGCN and their habitats throughout New Mexico. Where multiple consumptive biological uses occur (e.g. national forests), concerns persist regarding the ability to maintain habitats in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN. Whether or not national forests can host a variety of land uses without heightened resource conflicts is a serious question.

> Improper grazing practices are those practices that reduce long-term plant and animal productivity, and include both domestic livestock and wildlife.

Grazing Practices
Domestic animal grazing is an extensive land use activity across the New Mexico land surface (See Chapter 3, New Mexico's Biodiversity). Thus, it has significant association with factors that widely influence condition of wildlife habitat. Discussion here and elsewhere in the CWCS acknowledges this pattern while also recognizing that livestock operations are a permissible and important part of the New Mexico culture and economy.

Improper grazing practices have influenced vegetation communities and fish and wildlife habitat throughout New Mexico. Improper grazing practices are those practices that reduce long-term plant and animal productivity (Wilson and MacLeod 1991), and include both domestic livestock and wildlife. Major changes in vegetation composition in New Mexico and the southwest have been linked to improper livestock grazing that occurred in the late 1800s when livestock numbers peaked (Leopold 1924, Cottam and Stewart 1940, Cooper 1960, Buffington and Herbel 1965, Humphrey 1987, Grover and Musick 1990, Archer 1994, Fleischner 1994, Pieper 1994). Preferred forage plants such as cool-season grasses declined, while weedy and unpalatable plants and shrubs increased (Wooton 1908, Bohrer 1975, Bahre and Shelton 1993). Improper grazing practices and climatic fluctuations were recognized as major triggers of soil erosion, flooding, and arroyo cutting in the southwest (Cooperrider and Hendricks 1937, Cottam and Stewart 1940, Smith 1953, Hastings and Turner 1965, Cooke and Reeves 1976, Branson 1985, Humphrey 1987, Bahre 1991, Webb and Betancourt 1992, Felger and Wilson 1995). These acts reduced and/or eliminated fine herbaceous fuels which practically eliminated high-frequency, low-intensity wildfires across New Mexico and the southwest (Savage and Swetnam 1990, Swetnam 1990, Swetnam and Baisan 1996). All of these acts perpetuated further landscape degradation. By the 1930's, Congress recognized that western rangelands were being degraded, and approved the Taylor Grazing Act of 1934. This act regulated grazing on the public lands through the use of permits. The Taylor Grazing Act provided a way to regulate the occupancy and use of the public land, preserve the land from destruction or unnecessary injury, and provide for orderly use, improvement, and development. The Federal Land Policy and Management Act of 1976 and the Public Rangelands Improvement Act of 1978 further guide the management of livestock grazing on public lands and are designed to speed restoration of public rangelands while improving the delivery of services to public land users.

Outcomes of improper grazing practices on wildlife include increased competition for limited water, forage, and space, alteration of vegetative composition and structure, impacts on stream hydrology and water quality, and reduced soil permeability and potential to support plants due to soil compaction (Armour *et al*. 1994, Fleischner 1994, The Wildlife Society 1996, Belsky and Blumenthal 1997). More informed grazing practices have been implemented on many private and public land tracts in recent years, but recovery of vegetation may take many years and is not possible on some sites.

> Impact of livestock grazing on rangeland wildlife is largely dependent on the grazing management practices used.

It is important to remember that the impact of livestock grazing on rangeland wildlife is largely dependent on the grazing management practices used (Holechek *et al.* 2004). Broad generalizations on the impact of livestock grazing on rangeland wildlife are typically incorrect because different grazing practices are unique and wildlife species have different habitat requirements. Grazing management variables that affect wildlife habitat include stocking rates, stocking density, the age and physiological condition of cattle, grazing season, forage selection, and cattle distribution. In addition, factors such as range condition, soil type, temperature, and precipitation also greatly influence the relationships between grazing and habitat quality for rangeland wildlife (Holechek *et al.* 2004). Grazing plans, therefore, need to be site-specific and consider the habitat needs of the wildlife species of interest.

Over the last couple of decades, there has been considerable research on interactions between rangeland wildlife and livestock, including comprehensive reviews by Holechek *et al.* (1982), Kie *et al.* (1994), Krausman (1996), Sarr (2002), and Holechek *et al.* (2004). Unfortunately, many of these scientific studies have been observational, anecdotal, based on unreplicated experiments, compromised by lack of true controls, employed weak methodologies, and used inaccurate or overly broad quantification of grazing intensity such as heavy vs. light or no grazing (Holechek *et al.* 2004, Lucas *et al.* 2004).

Holechek *et al.* (1982), Kirby *et al*. (1992), Launchbaugh *et al.* (1996), and Holechek *et al.* (2001) indicate that judicious grazing practices can have positive affects on wildlife and be a beneficial management tool. These include: 1) increase in vegetation composition diversity and improve forage availability and quality for early to mid-successional wildlife species, 2) creating patchy habitat with high structural diversity for feeding, nesting, and hiding, 3) opening up areas of dense vegetation to improve foraging areas for a variety of wildlife, 4) removal of rank, coarse grass that will encourage re-growth and improve abundances of high quality forages for wild ungulates, 5) stimulating browse production by reducing grass biomass, and 6) improving nutritional quality of browse by stimulating plant re-growth. There are a few examples in the literature which suggest that many wildlife species are tolerant of moderate grazing and many appear to benefit from light to conservative grazing. Smith *et al.* (1996) found that lightly grazed climax rangelands and conservatively grazed late seral rangelands had similar songbird and total bird populations. Smith *et al.* (1996) concluded that wildlife diversity was higher on the conservatively grazed late seral than the lightly grazed climax rangeland. Similarly, Nelson *et al.* (1997) reported that wildlife observations were greater on moderately grazed mid seral Chihuahuan Desert rangelands compared to conservatively grazed late seral rangelands. In a study comparing wildlife observations for grassland (late seral), shrub-grass (mid seral), and shrubland (early seral) communities in the Chihuahuan Desert of New Mexico, Nelson *et al.* (1999) found observations for birds and mammals were higher in shrub-grass than in grassland or shrubland. Studies in southeastern Arizona by Bock *et al.* (1984) support the hypothesis that conservatively to moderately grazed areas in mid or late seral condition supported greater diversity of wildlife than ungrazed areas in climax condition. However, these studies did not investigate livestock grazing intensity on wildlife population dynamics, or habitat requirements.

There has also been research directed towards evaluating managed livestock grazing systems on targeted wildlife species, especially with upland gamebirds and large mammals. For example, Montezuma quail (*Cyrtonyx montezumae*) are sensitive to livestock grazing and require adequate residual bunchgrass cover following the growing season for nest and escape habitat. Research suggests that Montezuma quail require a minimum of 7.8 in (20 cm) height of bunchgrasses and at least 50% herbaceous cover (Bristow and Ockenfels 2003). Grazing practices that employ light to moderate grazing can benefit Montezuma quail by increasing availability of food plants

(Brown 1982, Bristow and Ockenfels 2000). Other studies on scaled quail (*Callipepla squamata*) indicated that they can be benefited by conservative to moderate grazing (on non-degraded rangelands) which improves their mobility by opening dense grass stands (Campbell *et al.* 1973, Saiwana *et al.* 1998). Livestock grazing can be used to enhance forage for elk (*Cervus elaphus*) and manage their distribution by increasing availability and nutritional value of preferred grasses in early growth stages (Holechek *et al.* 2004).

Scientific studies that clearly demonstrate a cause and effect relationship with grazing as the primary factor endangering a specific species are rare (Holechek *et al*. 2004). This is largely because studies that are specifically designed to detect these relationships are difficult to conduct in natural environments. Although there is certainly strong circumstantial evidence that heavy grazing can be a major factor resulting in the decline of several endangered rangeland wildlife species, carefully controlled studies are needed to better examine and understand the relationships between controlled grazing (i.e. light, conservative, and moderate grazing intensity) and endangered species (Sarr 2002, Holechek *et al*. 2004, Lucas *et al.* 2004).

Logging

Extraction of timber products is an important economic pursuit, but can have adverse effects on wildlife if not implemented wisely and responsibly. Over the last century, species composition and structure of New Mexico's forests have been altered by the combined effects of commercial logging, fire suppression, and improper grazing practices (US Forest Service 1993, Covington and Moore 1994). Logging practices in New Mexico and the Southwest have gone through differing management phases. In the late 1800s and early 1900s relatively indiscriminate cutting practices occurred (deBuys 1985), followed by selective logging in the mid-1900s, and even-aged timber stand management during the 1960s through 1980s (Bogan *et al.* 1998). Extensive road networks were developed within the forests to allow easy timber removal (Allen 1989).

Earlier logging practices tended to remove larger, older trees. More recently, logging techniques have moved toward more selective, uneven-aged silvicultural practices. Timber harvests from public forests have declined in recent years (Bogan *et al.* 1998). Some emphasis has been placed on federal endangered species habitat and ecosystem management. This has come about primarily through legal actions advanced under the Endangered Species Act, National Forest Management Act, and National Environmental Policy Act. Relatively recent Forest Service Region 3 directives require the maintenance of at least some old-growth forests for SGCN, such as the northern goshawk (*Accipiter gentilis*) and Mexican spotted owl (*Strix occidentalis lucida*). Fuel reduction is a focus of current forest management efforts, with millions of dollars directed at thinning understory trees and the reintroduction of prescribed fires to reduce the potential for widespread catastrophic wildfires (Bogan *et al.* 1998). Indications are that 50% of the allocated monies will be expended on protecting human structures and neighborhoods in the wildland urban interface areas.

Fuel Wood Collection

Fuel wood collection has reduced the abundance of large diameter snags and dead-and-down logs. Large diameter snags function as important nesting structures for cavity-nesting birds (Thomas *et al.* 1979, Hejl 1994) and as roost sites for bat species (Bogan *et al.* 1998). Dead-and-down logs provide important wildlife habitat and ecosystem functions. Legal and illegal roads created for access to fuel wood can further fragment forests and woodlands and adversely affect important habitats, such as wetlands and meadows, by transporting non-native organisms and draining wetlands. Fuel wood collection may also introduce disturbances from noise, off-road vehicle use, or accidental fire ignition.

Non-Consumptive Biological Uses

Habitat disturbances related to off-road vehicle use, military activities, and recreational use are a concern over most of New Mexico. The Chihuahuan Desert Ecoregion, Arizona-New Mexico Mountains Ecoregion, and the Southern Shortgrass Prairie Ecoregion in particular have been subjected to significant habitat alterations as a result of non-consumptive biological use.

> Off-road vehicle travel can cause damage to soils and vegetation and impact wildlife by destroying and fragmenting habitat, causing direct mortality of wildlife, or altered their behavior.

Off-Road Vehicles
Recreational off-road vehicle use can be found across the entire state. There are several organized events held each year in Doña Ana, Socorro, Otero, Eddy, Chaves, and San Juan counties. The New Mexico Statewide Comprehensive Outdoor Recreation Plan (SCORP), 2004-2009 identified a moderately increasing trend in off-road vehicle use from 1996-2001 (Henkel and Fleming 2004). The specific effects of off-road vehicle use on New Mexico habitats are poorly understood. Off-road vehicle travel can cause damage to soils and vegetation (Holechek *et al.* 1998) and impact wildlife by destroying and fragmenting habitat, causing direct mortality of wildlife, or altered behavior through stress and disturbance (Busack and Bury 1974, Brattstrom and Bondello 1983). The Forest Service has published in the Federal Register two proposed rules pertaining to off-road vehicle use. The first designates routes and areas for motor vehicle use and the second petitions states for inventoried roadless areas. Both of these proposed rules would impact future ATV use on Forest Service lands in New Mexico. Other regulatory initiatives seek to improve ATV safety requirements and increase registration fees, with revenues targeted for the development of designated ATV trails and facilities.

Military and Borderland Security Activities
The Department of Defense (DoD) manages 4% of the land in New Mexico. White Sands Missile Range (WSMR) is the largest DoD installation, covering approximately 2.2 million ac (0.9 million ha). It operates primarily for the support of research, development, testing, and evaluation of weapon and space systems, subsystems, and components. Other DoD installations in New Mexico contain sites for live bombing, air defense missile firing, mechanized brigade training exercises, battalion-size or smaller training exercises, ballistic missile testing, aircraft takeoff, landings and training courses, maintenance of fighter wing capabilities, and general military training exercises. While restricted access to many military lands provide substantial benefit to wildlife, military land uses also may destroy or fragment existing habitats.

Border security measures are being implemented throughout the New Mexico/Mexico borderlands region to intercept illegal drug shipments, illegal immigrants, and other unauthorized activities (US Department of Justice, Immigration and Naturalization Service 2000). Associated road building and traffic in the borderlands region causes additional habitat loss and fragmentation, reduces effective (usable) habitat for wildlife populations, increases road kill, poaching, illegal collecting of wildlife and general habitat destruction (Forman *et al.* 2003).

Recreation
Skiing, hiking, mountain biking, snowmobiling, off-road vehicle use, rock climbing, camping, sightseeing, bird watching, and picnicking are popular recreational pursuits in New Mexico (Conner *et al.* 1990). The overall impact of these activities is not fully understood, nor is there a full understanding of how much recreational use can be tolerated before there is an adverse effect on wildlife or wildlife habitat. However, recreational activities are increasing and their potential effects on habitats and species should be considered in conservation planning (Conner *et al.* 1990, McClaran *et al.* 1992).

Invasive and Non-Native Species

Many ecologists have acknowledged the problems caused by invasion of non-native species into communities or ecosystems and the associated negative effects on global patterns of biodiversity (Stohlgren *et al.* 1999). Once established, invasive species have the ability to displace native plant and animal species (including threatened and endangered species), disrupt nutrient and fire cycles, and alter the character of the community by enhancing additional invasions (Cox 1999, DeLoach *et al.* 2000, Zavaleta *et al.* 2001, Osborn *et al.* 2002).

Noxious weed infestation is now the second leading cause of native species being listed as threatened or endangered nationally. As of 1998, non-native species have been implicated in the decline of 42% of species federally listed under the Endangered Species Act (Center for Wildlife Law 1999). In addition to environmental problems, invasive plants also pose a serious economic problem. Rangelands infested with Russian knapweed, a serious problem in New Mexico, typically suffer reductions in livestock carrying capacity of 50% or more. The State Forest and Watershed Health Plan devotes significant planning to the management of non-native invasive phreatophytes (New Mexico Energy, Minerals, and Natural Resources Department 2004).

> Invasive species have the ability to displace native plant and animal species, disrupt nutrient and fire cycles, and alter the character of the community by enhancing additional invasions.

Non-native aquatic species have considerable affects on native fish, molluscs, and crustaceans in New Mexico's aquatic habitats. The integrity of native fauna populations is negatively affected by non-native species through resource competition, predation, hybridization, habitat alteration, and through the introduction of diseases and toxins.

Diseases, Parasites, and Pathogens
Many of the avian and mammalian SGCN are affected by diseases such as West Nile virus, rabies, hantavirus, pasturella pneumonia, and bubonic plague (Table 4-4). The growing wildland urban interface exposes wildlife to potentially infected domestic and feral pets and may contribute to the spread of these diseases. Increased exposure to refuse, pesticides or other toxins, and parasites may also affect wildlife at this interface.

Table 4-4. Potential diseases, hazards, toxins, and parasites contacted by wildlife at the wildland-urban interfaces.

Potential Diseases, Hazards, Toxins, and Parasites	Avifauna	Mammals
Rabies		X
Bubonic plague		X
Canine distemper		X
Electrocution	X	X
Tuberculosis		X
Foot and mouth disease		X
Contagious ecthyma		X
Pesticide poisoning	X	X
Lead poisoning	X	X
Gastroenteritis (clostridials)		X
Bovine diarrheal virus		X
Lungworm and pneumonia complex		X
Tapeworm larvae/hydatid cysts		X
Ear mites		X
Brucellosis (currently in Wyoming and Montana)		X
Vesicular stomatitis		X
Canine heartworm		X
Parvovirus		X
Tularemia		X
Feline panleukopenia (feline leukemia)		X
Salmonella	X	X
Giardia		X
Chronic wasting disease		X
Johne's disease		X
Bluetongue and hemorrhagic disease		X
Mycoplasma diseases (sinusitis)	X	
Pasturella (avian cholera)	X	
West Nile disease	X	
Blackhead disease	X	
Avian pox	X	
Trichomoniasis	X	
Avian influenza	X	

The presence of whirling disease in rainbow trout (*Oncorhynchus mykiss*) was confirmed in New Mexico the spring of 1999. Since this confirmation, four of the six New Mexico state hatcheries, several private ponds and salmonid populations in the San Juan, Rio Grande, Canadian, and Pecos drainages in New Mexico have tested positive for the disease. As a result, routine testing and remediation procedures have begun in New Mexico's hatcheries and a testing program has been initiated for 173 coldwater streams and reservoirs. These waters may have been contaminated through inadvertent stocking of infected rainbow trout or by natural or anthropogenic vectors. Although New Mexico has adopted a "no tolerance" policy that bans the stocking or importation of fish infected with whirling disease, the potential for accidental introduction still exists. The most devastating potential of the disease lies in the threat it poses to native salmonid populations that rely on natural reproduction.

Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*) presently occupies a fraction of its presumed historic range throughout the Rio Grande watershed (Stumpff and Cooper 1996, Calamusso and Rinne 1999) and is considered at risk by the NMDGF (Paroz *et al*. 2002). Recent surveys indicate populations of Rio Grande cutthroat trout are reproducing in the Jemez and Pecos drainages (DuBey and Caldwell 2003). Portions of the Pecos drainage have tested positive for *Myxobolus cerebralis* (whirling disease causal agent) (Hansen 2002). Very little is known regarding whether the disease exists in cutthroat trout populations. However, the species produces young fish from March through June when temperatures are conducive for optimum triactinomyxon production. Thus, it is likely that if *M. cerebralis* were to spread to Core Conservation Areas for Rio Grande cutthroat trout, the species would be at risk of infection. Core Conservation Areas contain isolated populations of Rio Grande cutthroat trout and are specifically managed for their genetic purity and potential use in restoration of the species.

Chronic wasting disease is also a concern in New Mexico. A total of 12 cases of chronic wasting disease have been confirmed in New Mexico as of September 2005. All were mule deer (*Odocoileus hemionus*) located in the Organ Mountains east of Las Cruces. Two mule deer subjected to tonsillar biopsies and released in December of 2004 in southern New Mexico as part of a research project were later found to be positive for chronic wasting disease. In 2001, a New Mexico game park imported 21 elk from a southern Colorado game ranch at which animals tested positive for chronic wasting disease. Investigation revealed that, subsequent to the initial importation, the New Mexico facility transferred animals to four other game parks in New Mexico. All five New Mexico game parks are precluded from transferring ungulates until the imported animals are shown to be disease free for not less than 60 months. No New Mexico game parks have as yet tested positive for chronic wasting disease.

Phytophagous (plant-eating) insect outbreaks cause tree mortality and reduced growth in New Mexico's forests and woodlands (Haack and Byler 1993). Bark beetles and inner bark borers are primary tree killers (Haack and Byler 1993). Phytophagous insects have traditionally been considered detrimental to forest health and commercial timber harvest (Schowalter 1994). However, most phytophagous insects that affect forest trees in New Mexico are native organisms (Wilson and Tkacz 1994) and, from an ecosystem perspective, perform functions that are instrumental in sustaining forest health and function through succession, decomposition, nutrient cycling and soil fertility (Haack and Byler 1993).

Altered forest conditions have likely increased the frequency, intensity, and extent of insect outbreaks and diseases (Haack and Byler 1993, Wilson and Tkacz 1994, New Mexico Energy, Minerals, and Natural Resources Department 2004). Changes in forest tree age, size, density, species composition, and vertical stratification across temporal and spatial scales influence patterns of forest insect herbivory at the ecosystem and landscape levels (Schowalter *et al.* 1986, New Mexico Energy, Minerals, and Natural Resources Department 2004). Environmental stresses such as drought, late spring frosts, wind throw, and air pollution can encourage insect outbreaks (Haack and Byler 1993). Although insect outbreaks in forest ecosystems occur naturally, they can cause shifts in vegetative species composition and structure (Haack and Byler 1993). Further, certain phytophagous insects are attracted to fire-damaged or fire-killed trees and their build-up in weakened host trees can threaten adjacent, unburned stands (US Forest Service 1999).

The magnitude of disturbance from an outbreak depends upon the particular insect or pathogen, and on the condition of the forest ecosystem affected (Wilson and Tkacz 1994). Closely spaced host trees are likely to trigger outbreaks of phytophagous insects and pathogens. In compositionally and structurally diverse forests, however, potential host trees can be harder for insects to locate among non-host trees, and vulnerable host trees may be relatively resistant to small numbers of insects that find their way through the surrounding non-host vegetation (Hunter and Aarssen 1988, Waring and Pitman 1983). Outbreaks are typically worse in single-species, monocultural tree stands especially during vulnerable periods such as drought (Mattson and Haack 1987, Schowalter and Turchin 1993, Waring and Pitman 1983). Populations of most foliar and sap-feeding insects peak during particular stages of host-tree development (Schowalter *et al.* 1986), which make monoculture stands of single-aged trees more susceptible to outbreaks.

Drought provides a more favorable environment for phytophagous insect growth, survival, and reproduction, and may reduce the effectiveness of the biochemical defense system that some plant species have evolved (Mattson and Haack 1987).

Modification of Natural Processes and Ecological Drivers

Changes in natural processes and ecological drivers (e.g., drought, fire management, ecological sustainability and integrity, or loss of keystone species) have influenced all habitats in New Mexico and the Southwest. However, some habitats are more resilient or resistant to these modifications. Aquatic systems, especially ephemeral habitats, may be considerably altered by drought conditions. Other ecosystems may have the ability to maintain or rebound to conditions of diversity, integrity, and sustainable ecological processes following such disturbances.

Climate Change and Drought

Climate change may occur in the Southwest from increased atmospheric concentrations of CO_2 and other "greenhouse" gases. Effects may include increased surface temperatures, changes in the amount, seasonality, and distribution of precipitation, more frequent climatic extremes, and a greater variability in climate patterns. Such changes may affect vegetation at the individual, population, or community level and precipitate changes in ecosystem function and structure (Weltzin and McPherson 1995). They will likely affect competitive interactions between plant and animal species currently coexisting under equilibrium conditions (Ehleringer *et al.* 1991).

Plants respond differently to changes in atmospheric gases, temperature and soil moisture, in part based on their C_3 or C_4 photosynthetic pathways (Bazzaz and Carlson 1984, Patterson and Flint 1990, Johnson *et al*. 1993). For example, increases in winter precipitation favor tree establishment and growth at the expense of grasses. Increases in temperature and summer precipitation favor grasslands expanding into woodlands (Bolin *et al*. 1986).

Drought (an extended period of abnormally dry weather) is one of the principal factors limiting seedling establishment and productivity (Schulze *et al*. 1987, Osmond *et al*. 1987). Soil moisture gradients are directly altered by drought conditions. The distribution and vigor of some plant communities may be controlled primarily by soil moisture gradients (Griffin 1977, Pigott and Pigott 1993). Drought and climate change can potentially have a substantial effect on New Mexico's habitats.

Fire Management
For thousands of years, wildfires have been an integral process in New Mexico and southwestern forest and grassland ecosystems. Prior to 1900, naturally occurring wildfires were widespread in all western forests at all elevations (Swetnam 1990). From an ecological perspective, fire may be the most important disturbance process for many western forests (Hessburg and Agee 2003). Ecosystem processes and patterns are influenced and shaped by fire. These include soil productivity and nutrient cycling, seedling germination and establishment, plant growth patterns, vegetative plant community composition and structure, and plant mortality rates (Beschta *et al.* 2004).

Tree-ring and fire-scar data for the Southwest indicate that past fires were frequent and widespread (with an elevation range of variability) at least since AD 1700 (Swetnam and Baisan 1996). Within ponderosa pine and lower mixed-conifer forests and woodlands in New Mexico, naturally-occurring wildfires were frequently of low-intensity and helped maintain stands of older trees with an open, park-like structure (Moir and Dieterich 1988). Higher elevation, mixed conifer and spruce-fir forests (wetter forest types) exhibited less frequent fire return intervals and fires were generally stand-replacing fires of higher intensity, (Pyne 1984, Walstad *et al.* 1990, Agee 1993).

The extent to which fire occurred in southwestern grasslands varied geographically and is related to climatic variables such as seasonal and annual rainfall and physiographic variables such as elevation, slope and aspect (Archer 1994). Fire may have been rare in desert grasslands and limited in extent due to low biomass and a lack of continuity in fine fuels (Hastings and Turner 1965, York and Dick-Peddie 1969). In more mesic grassland and savanna systems where fire was a prevalent and recurring force, pre-historic frequency and intensity appear to have been regionally synchronized by climatic conditions (Swetnam and Betancourt 1990).

The elimination of high-frequency, low-intensity wildfires across New Mexico and the Southwest coincided with the reduction and/or elimination of fine herbaceous fuels caused by improper grazing practices (Savage and Swetnam 1990, Swetnam 1990, Swetnam and Baisan 1996). These grazing practices further reduced grass competition, thereby increasing tree and shrub establishment (Archer 1994, Gottfried *et al.* 1995), which further altered natural fire cycles. Since the early 1900s, systematic fire suppression efforts have further curtailed the natural fire regimes that historically kept ponderosa pine, mixed conifer and spruce-fir stand densities and fuel loads relatively low. Fire suppression allowed the development of ladder fuels and the accumulation of heavy fuel loads. Catastrophic, stand replacing crown fires are now the standard, rather than the exception as a result of these changes (Covington and Moore 1994).

> Fire suppression activities have had adverse effects on many New Mexico habitats by fragmenting, simplifying, or destroying habitats, and greatly modifying disturbance regimes.

Land management practices and fire suppression have had adverse effects on many New Mexico habitats through fragmenting, simplifying, or destroying habitats, and greatly modifying disturbance regimes (McIntosh *et al.* 1994, Hessburg and Agee 2003). These human-caused changes have created conditions that are outside of the evolutionary and ecological tolerance limits of native species (Beschta *et al.* 2004). Cumulatively, these practices have altered ecosystems to the point where local and regional extirpation of sensitive species is increasingly common (Rieman *et al.* 1997, Thurow *et al.* 1997). As a result, the integrity of many terrestrial and aquatic ecosystems has been severely degraded at the population, community, and species levels of biological organization (Nehlsen *et al.* 1991, Frissell 1993).

Ecological Sustainability and Integrity
When biotic and abiotic disturbances are modified or removed from New Mexico's ecosystems, plant and animal diversity and ecological sustainability are lost (Benedict *et al.* 1996). Ecological sustainability is essentially the maintenance (or restoration) of the composition, structure, and processes of the ecosystem over time and space (US Forest Service 2000). Likewise, ecosystem integrity incorporates the concept of functioning and resilience. It includes: 1) maintaining viable populations, 2) preserving ecosystem representation, 3) maintaining ecological processes, 4) protecting evolutionary potential, and 5) accommodating human use (Grumbine 1994). The loss of ecological sustainability and integrity will thus affect species that are closely tied to specific habitats or ecosystems.

Loss of Keystone Species
Keystone species, such as beavers (*Castor canadensis*), bison (*Bison bison*), and prairie dogs (*Cynomys* sp.), are species that have a large overall effect, disproportionate to their abundance, on the structure or function of habitat types or ecosystems. If a keystone species is extirpated from a system, other species that are closely associated with the keystone species will also disappear. In New Mexico, several keystone species have either been completely removed or have experienced significant population reductions in their historic range. With their removal or reduction in population levels, other species population levels variously decline or benefit.

Transportation Infrastructure

Roads, highways, railroad, and utility corridors have the potential to be detrimental to some wildlife. They fragment habitats and landscapes (Reed *et al.* 1996, Saunders *et al.* 1991) dividing large landscapes into smaller patches and converting interior habitat into edge habitat. Studies in other states have demonstrated negative correlations between increasing road densities and wildlife populations (Lee *et al.* 1997, Wisdom *et al.* 2000).

New Mexico has over 206,000 miles (33,152 km) of major and minor roads, including US Forest Service classified roads (Earth Data Analysis Center, RGIS Tiger Data: http://edac.unm.edu/). A 16 foot-wide road removes approximately two acres of habitat per mile of road. Accident report data compiled by the University of New Mexico documented 914 large game animal/vehicle collisions in 2002 in New Mexico. An annual average of 828 large game animal/vehicle collisions has occurred since 1998 (Forman *et al.* 2003). Since many incidents go unreported, this number represents only a fraction of the total large animal/vehicle collisions that actually occur annually. In addition to collisions with vehicles, roads facilitate legal and illegal killing and collection of many large and valuable animals. In the US Forest Service's Southwestern Region, 57% of threatened, endangered and proposed species under the federal Endangered Species Act, and 54% of US Forest Service's Sensitive Species are dependent on habitat within or affected by Inventoried Roadless Areas (IRAs) (US Forest Service 2000).

Roads and similar structures influence stream characteristics, such as channel and floodplain configuration, substrate embeddedness, riparian condition, amount of woody debris, stream flow, and temperature regime (Furniss *et al.* 1991). Timing of water runoff can change as roads and related drainage structures intercept, collect, and divert water. These factors can accelerate water delivery, resulting in an increase in the potential for greater magnitude of runoff peaks than in watersheds without roads (Wemple *et al.* 1996). Roads, highways, railroad, and utility corridors serve as a means of dispersal for many non-native and invasive plant species. Ground disturbance associated with the creation and maintenance of these facilities provides additional opportunities for establishment of non-native species (Parendes and Jones 2000).

Synergistic Effects of Factors Influencing Species and Habitats

It is difficult, and perhaps impossible, to separate individual causal factors that influence habitats or SGCN. Multiple factors are closely linked in cause and effect relationships across spatial and temporal scales. Adverse effects from multiple ecosystem stressors can have cumulative effects that are much more significant than the additive effects alone, with one or more stressors predisposing biotic organisms to additional stressors (Paine *et al.* 1998). For example, reduced fire frequency from a century of fire suppression is partly responsible for conditions that have allowed major outbreaks of several phytophagous insects (Peet 1988). Further, unusually dry periods and/or climate changes reduce available soil moisture causing water associated stress, reduced xylem pressure and pitch production in trees. These conditions allow insects to bore into and infect and kill trees. Affected stands with high tree mortality quickly accumulate dead standing and downed woody fuels. In turn, these conditions greatly increase the risk of catastrophic, stand-replacing wildfire and subsequent insect attack on trees injured or weakened by the fire (Gara *et al.* 1985).

Many of the factors discussed are closely linked in cause and effect relationships across spatial and temporal scales. It is difficult, and perhaps impossible, to separate individual causal factors that influence habitats or SGCN.

To further illustrate the interactive and synergistic effects of these factors, consider historic grazing practices that reduced fine fuels and affected natural fire cycles. This condition, in combination with a century of fire suppression and multiple years of drought has created un-natural stand and fuel conditions, making forest and woodland habitat types increasingly susceptible to stand-replacing catastrophic wildfires. Add to this mix, insects and diseases linked with decreased forest health. The overall impact converts late-successional mixed conifer forests to early-successional grasslands, shrublands and recovering forests. Roads contribute to habitat fragmentation and are linked as well to other major habitat altering factors such as timber removal, fire ignition and suppression, fuel wood collection, and recreation.

The effects of climate change on ecosystems and species are likely to be exacerbated in areas that have already been substantially affected by human activities such as habitat loss and fragmentation, air and water pollution, and the establishment of invasive species. Habitat fragmentation decreases the ability of plant and animal species to migrate in response to changing conditions or species requirements. Invasive species are most successful in ecosystems already disturbed by anthropogenic activities (Elton 1958). Climate change may act as a form of disturbance creating opportunities for invasive species to colonize and displace native species

(Malcolm and Pitelka 2000). When suitable habitat conditions disappear or shift faster than populations can adjust, the likelihood of species extirpation or extinction increases (Malcolm *et al.* 1998).

Magnitude scores of each of the 43 generic factors within each key habitat were summed to provide a better understanding of their possible synergistic effects.

Many of the factors discussed above coincide in the same geographic area. Given the synergistic effects of multiple factors, it is difficult to understand the overall impact these factors will have on New Mexico landscapes, habitats, or Species of Greatest Conservation Need. In addition, it is difficult to understand which habitats may have higher risk of being altered by multiple factors. However, we conducted a simple analysis by summing magnitude scores of each of the 43 generic factors within each key habitat (See Approach chapter for details). This approach, while is not perfect, gives us a basis for understanding the possible synergistic effects, and where we might need further clarification on the outcomes of these factors.

Ephemeral natural catchments, perennial marsh/cienega/ spring/seeps, and riparian habitats may be at a higher risk of alteration by multiple factors than other habitat types in New Mexico.

The highest possible cumulative magnitude score for any habitat is 344 (see Approach Chapter). However, the top score of any key habitat was 165 (ephemeral natural catchments). Perennial marsh/cienega/spring/seeps and riparian habitats also yielded high cumulative magnitude scores (158 and 156, respectively) (Fig 4-6). Magnitude scores for each key habitat within category of factors that influence habitats are provided in Appendix L. Using cumulative magnitude scores as an indicator of the potential synergistic effects of all factors, these 3 key habitats may be at a higher risk of alteration by multiple factors than other habitat types in New Mexico. Likewise, aquatic habitats may be more likely to be altered than terrestrial habitats, with the exception of riparian habitats.

This information may be displayed spatially, allowing us to enhance our understanding of geographic areas where synergistic effects of potential factors may influence some habitats greater than other habitats (Fig. 4-7). Given this spatial representation, aquatic and riparian habitats statewide, areas in the shortgrass prairie in eastern New Mexico, and Madrean systems in the Gila National Forest may have several factors, that when placed together, influence the integrity of these habitats. These are key areas to investigate and enhance our understanding of factors that influence habitats.

Key areas to enhance our understanding of factors that influence habitats include:

- Aquatic and riparian habitats located throughout the state,
- Areas within the shortgrass prairie, and
- Madrean habitats.

These areas may have several factors, that when placed together, greatly influence the integrity of these habitats.

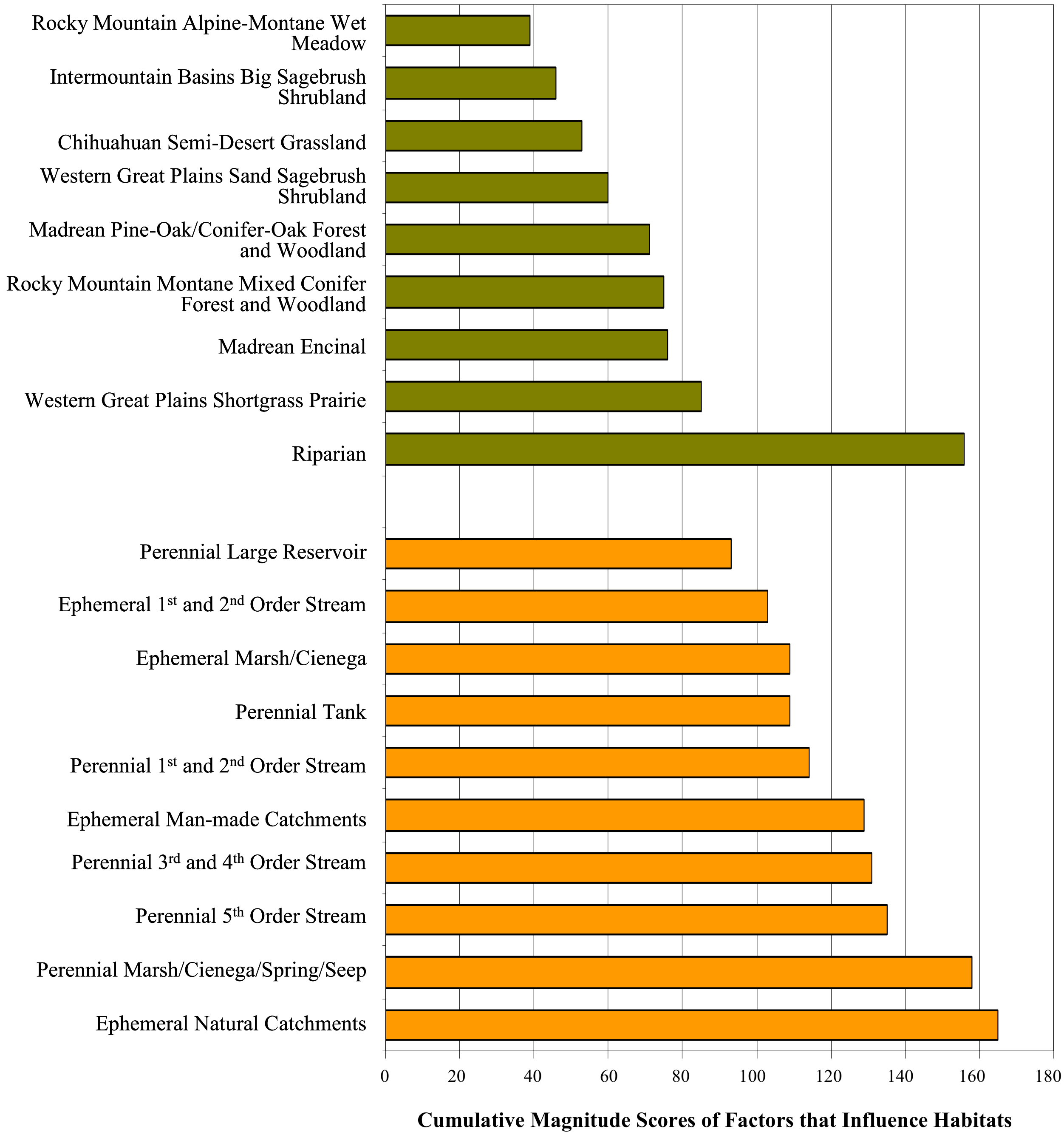

Figure 4-6. Cumulative magnitude scores of 43 factors that influence key habitats in New Mexico. This analysis assists in the identification of key habitats which may have the highest risk of being altered by synergistic effects of factors that influence habitats. Methods of calculating magnitude scores are presented in the Approach chapter. Magnitude scores for each key habitat by category of factors that influence habitats are provided in Appendix L.

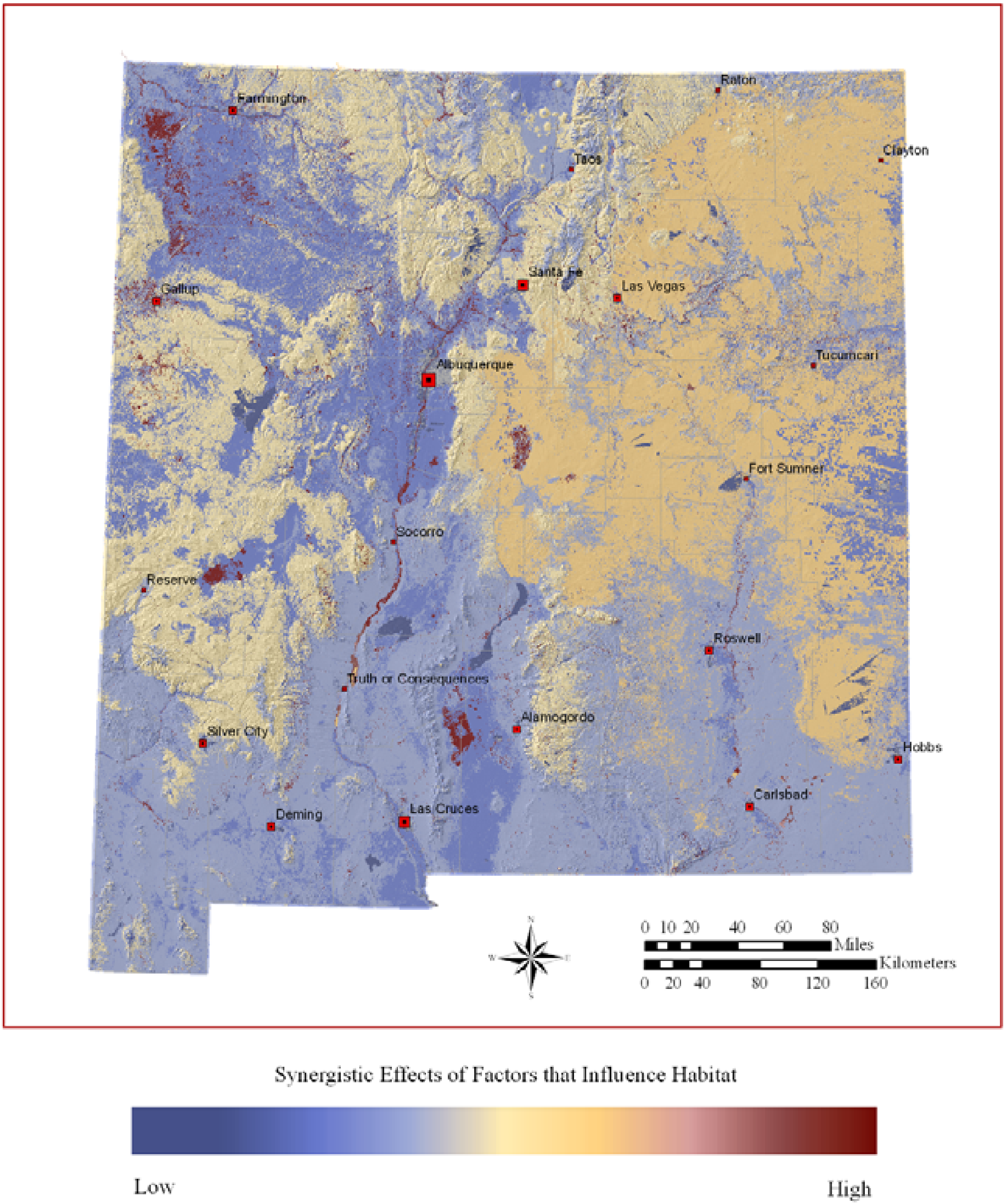

Figure 4-7. Magnitude scores of factors that influence habitats associated with terrestrial and aquatic land cover types. This spatial representation is designed to enhance our understanding of geographic areas where synergistic effects of potential factors may influence some habitats more than others. This analysis should not be used to locate small parcels of land.

Information Gaps

There are numerous information gaps that limit our ability to make informed conservation decisions in New Mexico. Appendices M and N summarize information gaps identified in each ecological framework (terrestrial and aquatic, respectively) and key habitat. Information gaps that, if filled, would enhance our ability to make informed conservation decisions in New Mexico are outlined below.

- The extent to which land use activities (e.g., grazing, human development, road-building, and energy exploration and development, etc...) fragment and alter habitats in relation to size, edge effect, and use by SGCN is unknown.

- Life history of most of the SGCN, including distribution, abundance, status and trends, habitat requirements, and movement information is poorly understood.

- Effects and extent of habitat fragmentation on SGCN are unknown.

- Extent to which invasive and non-native species may alter habitat community structure and preclude populations of SGCN is unknown.

- The role of natural fire and differing intensities of fire within key habitats and the long-term affect of altered fire regimes on SGCN are poorly understood.

- More information is needed on the existing conditions that limit populations of SGCN or otherwise inhibit their resiliency for adapting to human disturbances.

- The affects of altered hydrological patterns on aquatic habitats and their SGCN, including modifications to current hydrological patterns that may benefit native SGCN are unknown.

- Little is known about water quality and its affects upon associated SGCN or sources of pollution and the extent to which pollution alters habitats.

- Our information base on the factors causing pathogen outbreaks and the potential for diseases needs to be expanded.

- We have an inadequate understanding of the overall impact of the synergistic effects of the multiple factors influencing key habitats or SGCN.

- Additional information is needed on the suitability of selected key habitats and SGCN for restoration.

- More information is needed on methods for detecting landscape degradation, especially the identification of attributes for early detection.

- There are no accurate data for creating spatial depictions of suitable habitats for molluscs, crustaceans, and other arthropods in New Mexico, including the locations and quality of ephemeral habitats, marsh, springs, seeps, cienegas, or perennial ponds.

- Comprehensive evaluative information is lacking regarding the status and trends pertaining to the occupation of New Mexico by non-native plant and animal species.

- We lack information needed to evaluate the collective effectiveness of multi-agency conservation actions such as riparian and terrestrial habitat restoration projects on a statewide basis.

- We lack the information necessary to detect changes in key habitats at a landscape level within ecoregions.

Research, Survey, and Monitoring Needs

Summaries of specific research, survey, and monitoring needs identified for each ecological framework and key habitat are provided in Appendices O and P (terrestrial and aquatic, respectively). Research, survey, and monitoring initiatives found to be needed across ecological framework and key habitat boundaries and that would assist in filling information gaps and informing conservation efforts on a statewide scale are aggregated below.

- Conduct research to enhance knowledge of the natural history, population biology, and community ecology of SGCN within key habitats, including SGCN distribution, abundance, habitat use, and population trend information.

- Research is needed to quantify the extent to which land use activities (e.g., grazing, human development, road-building, and energy exploration and development, etc...) fragment and alter habitats in relation to size, edge effect, composition and structure, and use by SGCN.

- Investigate hydrologic relationships and their effects on SGCN to provide a better understanding of the physicochemical and hydrologic processes that will allow for sustainable watershed conservation and management practices.

- Determine conditions that limit populations of SGCN and their resiliency in adapting to human disturbances.

- Conduct research to anticipate how climate change or drought will affect vegetation patterns and community and ecosystem-level dynamics.

- Determine the extent to which invasive and non-native species may alter community structure and preclude populations of SGCN and identify methods to minimize impacts from non-native species.

- Investigate invasive species early detection protocols and identify potential vectors and pathways.
- Assess and continually monitor habitat condition and water quality.
- Investigate methods to reduce the spread of pathogens through aquatic and terrestrial environments.
- Investigate hydrologic relationships in key habitats.
- Identify or develop protocols and monitoring standards for consistently describing landscape health and condition.
- Investigate methodology that might be employed for early detection of transitions in habitat type and determining indicators of biological integrity.
- Develop collaborative survey and monitoring protocols for invertebrate SGCN that are not currently being monitored.
- Identify SGCN travel corridors and assess habitat connectivity.
- Investigate the role of natural fire and the effectiveness of prescribed fire in reducing the potential for catastrophic stand-replacing fires and maintaining habitats for SGCN.
- Determine and monitor the location and condition of ephemeral aquatic habitats, marshes, springs, seeps, cienegas, and perennial ponds and develop spatial depictions of habitats predicted as suitable for molluscs, crustaceans, and other arthropods in New Mexico.
- To our knowledge, no systematic, standardized monitoring of introduced, non-native plant and animal species is occurring in New Mexico. Introduced non-native species are a primary cause of the decline of native biological diversity globally, and should be addressed at a state, regional and national level, in part by instituting monitoring programs at these different scales. Monitoring and efforts to identify new invasions (both deliberate and accidental) are technically feasible, but lack sufficient funding and coordination (Simberloff *et al.* 2005). This information should be incorporated into a dynamic statewide Geographical Information System (GIS) database to allow tracking of these trends.
- A more efficient monitoring program needs to be developed to track the effectiveness of conservation actions such as riparian and terrestrial habitat restoration programs at a statewide level. This information should be incorporated into a dynamic statewide GIS database to allow the tracking and assessment of project performance at a landscape level.

- Other than the efforts of the USGS Southwest Regional Gap Analysis Project (SWReGAP) to map vegetation and wildlife species distribution of the southwestern United States, to our knowledge, no formal, systematic, standardized monitoring of key habitats at a landscape level within ecoregions is occurring in New Mexico. Development of the capacity to detect habitat changes and compare them directly with SGCN monitoring results is essential to evaluating the effectiveness of our conservation actions.

- There is a need to continue monitoring the incidence of whirling disease and chronic wasting disease on a statewide basis.

Desired Future Outcome

Since New Mexico is a diverse state with a variety of habitats, it is reasonable that there would be multiple desired future outcomes for its key habitats and SGCN. However, the overriding desired future outcome driving biodiversity conservation in New Mexico is that our key habitats persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land uses with reduced resource use conflicts. More spatially specific desired future outcomes are provided in Chapter 5 for the key habitats within each ecological framework.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific levels alone are inadequate for long-term conservation of SGCN. Rather, conservation strategies should be ecosystem-based and include broad public input and support (Galeano-Popp 1996). Prioritized conservation actions that we believe will assist in achieving desired future outcomes are aggregated below at a statewide scale. NMDGF will monitor species and habitats to evaluate the effectiveness of these conservation actions and those found to be ineffective will be modified and re-deployed in accordance with the principles of adaptive management.

Terrestrial Habitats

1. Work with federal and state agencies, tribes, private landowners, research institutions, and universities to design and implement research, survey, or monitoring projects to enhance our understanding of SGCN and key habitats. Research pertaining to SGCN distribution and abundance and the condition and connectivity of habitats is especially desirable as are studies that monitor SGCN status and identify factors limiting SGCN populations.

2. Work with land management agencies, private land managers, and the agriculture industry to identify and promote rangeland grazing methodologies that ensure long-term plant and animal productivity, ecological sustainability and integrity, and are cost effective for livestock interests.

3. Collaborate with state and federal agencies, tribes, private organizations, research institutions, universities, and private landowners to identify and protect riparian and other habitat corridors that are important for sustaining SGCN. This should include identifying areas that have historic or potential value as connecting habitat corridors and for which willing private landowners can obtain conservation easements.

4. Form partnerships with affected communities and federal land management agencies to facilitate and encourage the conservation, protection, maintenance, and restoration of key habitats and unique microhabitats within key habitats. Watershed management practices that reduce soil erosion, and maintain biodiversity are encouraged.

5. Collaborate with state and federal agencies and private landowners to develop measures to reduce habitat fragmentation within and adjacent to key habitats. Closures of unnecessary roads or minimizing new roads in key habitats are potential approaches.

6. Create public awareness and understanding of ecosystem function, values, and products and the scope and scale of human impacts important to SGCN. Promote community based support and involvement in decisions related to ecological sustainability and integrity of key habitats and SGCN viability.

7. Work with federal and state agencies, tribes, private agencies and institutions to maintain tracts of native vegetation and to identify additional sources of funding for long-term conservation of SGCN. Actions that create incentive based or voluntary partnerships with private landowners to conserve and manage properties to sustain SGCN are desirable.

8. Maintain awareness of the introduction and spread of invasive, non-native, and exotic plants and animals and encourage control or eradication where necessary to maintain or restore biodiversity.

9. Collaborate with affected interests to pursue enactment of state laws or policies to protect closed basins within key habitats from the impacts of dredge and fill activities and future development.

10. Work with public and private land managers to reduce woody vegetation encroachment in grassland and meadow habitats that are important to SGCN and to maintain grassland and meadow functionality.

11. Work with public and private land managers and the energy industry to encourage conducting energy development in a manner that preserves the integrity and functionality of key habitats and to rehabilitate abandoned well pads and access roads.

12. Collaborate with federal and state agencies and private landowners to ensure the ecological sustainability and integrity of key habitats. Methods may include: establishing conservation agreements, inter-agency memoranda of understanding, or land acquisition projects.

13. Work with land management agencies and private landowners to develop a fire management regime that promotes restoration of vegetative communities more nearly approximating those that historically supported SGCN.

14. Work with federal and state agencies to liberalize burn policies in the wilderness areas surrounding meadow habitats to allow future fires to burn up to a meadow's edge rather than being suppressed.

15. Work with the US Forest Service to promote compliance with the principles of ecological forestry for any land management activities conducted within woodland or forested habitats.

16. Investigate opportunities to strengthen conditions of approval and reclamation standards for oil and gas development and develop partnership programs and funding mechanisms for implementing improved reclamation.

17. Work with public and private land managers and the energy industry to adopt adaptive management strategies that minimize disturbance to SGCN caused by industrial infrastructure, grazing, and recreation in key habitats.

18. Work with private landowners, counties, municipalities, federal land management agencies, and the State Land Office to mitigate and reduce impacts related to urbanization and develop consistent reclamation standards that ensure future key habitat integrity and functionality.

Aquatic Habitats

1. Work with federal and state agencies, tribes, private landowners, research institutions, and universities to design and implement research, survey, or monitoring projects to enhance our understanding of SGCN and key habitats. Research pertaining to SGCN distribution and abundance and the condition and connectivity of habitats is especially desirable as are studies that monitor SGCN status and identify factors limiting SGCN populations.

2. Coordinate with state and federal land managers, tribes, and private landowners to protect, restore, conserve, and create aquatic habitats and surrounding natural vegetation.

3. Collaborate with federal and state agencies and affected publics to create public awareness and understanding of aquatic habitats functions, services, and values. Emphasize educating anglers about the risks posed by undesirable non-native fishes.

4. Collaborate with federal and state agencies, private landowners, research institutions, and universities to develop strategies to prevent emigration of non-native species or invasive species (including plants) into surrounding areas; seek partnerships that encourage the removal of harmful non-native species and the prevention of further introductions; and monitor habitat communities to assess and eliminate potential adverse effects posed by introduced species.

5. Collaborate with involved government agencies to implement existing management plans, conservation agreements, and recovery plans.

6. Collaborate with federal and state agencies, tribes, and affected publics to adopt standardized monitoring and survey methods to track gains and losses of aquatic habitats.

7. Work with federal and state agencies and affected publics to develop techniques to maintain natural hydrologic flows in aquatic habitats that maintain minimum conservation pools sufficient to support sport fisheries, SGCN, and year-round recreational opportunities; minimize the effect of diversion structures and water withdrawals on native fish SGCN; and design and implement irrigation water withdrawal structures that balance needs of aquatic SGCN communities.

8. Seek acceptance of "instream flow" water rights for wildlife conservation needs.

9. Work with land management agencies, private land managers, and the agriculture industry to identify and promote grazing methodologies on rangelands that ensure long-term plant and animal productivity, ecological sustainability and integrity, and are cost effective for livestock interests.

10. Collaborate with federal and state agencies and affected publics to complete and implement the Draft State Aquatic Nuisance Species Management Plan.

11. Collaborate with federal and state agencies, tribes, private landowners, research institutions, and universities to complete an inventory and conduct a regional risk assessment of the distribution of the whirling disease parasite (*Myxobolus cerebralis*) and suppress yellow grub parasite in affected habitats.

12. Actively pursue the cooperation of private landowners in the protection and recovery of the SGCN.

13. Collaborate with agencies and affected publics to adopt and encourage compliance with baitfish regulations that preclude introduction of non-native species.

14. Work with federal and state agencies, tribes, NGOs, and universities to improve the use of existing data management systems for tracking information pertinent to aquatic habitats.

15. Work with federal and state agencies and affected publics to identify actions to prevent lowering of groundwater levels and promote water conservation activities.

16. Collaborate with federal and state agencies to reduce the amount of aquatic habitat altered by logging and road building.

17. Work with state, federal and private land managers to mitigate and reduce impacts on aquatic habitats from land and water use practices.

18. Work with the US Forest Service to develop strategies to reduce the effects of wildfire induced ash flows on native fish assemblages and ensure that SGCN in aquatic habitats are not adversely affected by fire management practices.

19. Establish partnerships with other federal, state, local agencies and potentially affected interests to encourage monitoring local aquifers for water quantity and quality as it relates to specific habitat locations, to identify potential threats to habitats important to SGCN, and to identify and pursue alternatives to the Clean Water Act for restoring protection to aquatic habitats.

20. Work with law enforcement agencies to increase compliance with regulations regarding transport and release of undesired non-native fishes.

More spatially explicit conservation actions are provided in Assessments and Strategies for SGCN and Key Habitats (Chapter 5).