# New Mexico Statewide Assessment and Strategy for Forest Resources

## Data Atlas
## July 8, 2009

**Fish and Wildlife Habitat**: This data layer identifies areas that provide habitat for fish and wildlife species, including, but not limited to, threatened and endangered species. This layer will be used in the State Strategy and Response plan to help emphasize areas which will enhance public benefit from forested areas.

**Proposed Model:** Combine threatened and endangered species habitat, important forested species habitat, TNC fish atlas, forest patch size, TNC conservation areas, and Comprehensive Wildlife Conservation Strategy key areas using an additive Boolean overlay.

**Description of Factors**:

***1. Threatened and Endangered Species Habitat***

*Function:* Gives value to land that provides potential habitat for threatened and endangered species.

*Criteria:* Pixels that are modeled as potential T&E habitat are given value of 1; otherwise 0.

*Justification:* All land with potential to provide habitat for T&E species is considered valuable for T&E species conservation and recovery because it is needed for population growth and range expansion. Habitat destruction or degradation of potential habitat would likely impede range expansion and could negatively impact existing populations.

*Data Description:* The Comprehensive Wildlife Conservation Strategy (CWCS) for New Mexico (NMDG&F, 2006) developed potential habitat models for a majority of T&E species in New Mexico. For terrestrial wildlife species, the potential habitat is based on the concept of wildlife habitat relationships developed for GAP analysis and represents areas where a species could potentially persist, reproduce, or otherwise occur. For the aquatic species, the potential habitat is based on a deductive model and highlights the stream order where fish species might occur. Modeling of all predicted species habitat was completed for the CWCS See Table 1 for which T&E species were included (and excluded) in this layer

*Data Source:* The T& E potential habitat models were obtained from Ken Boykin of the Center for Applied Spatial Ecology with the New Mexico Cooperative Fish and Wildlife Research Unit who developed the potential habitat models. Details of the methodology are described in the CWCS. The Nature Conservancy in New Mexico combined the potential habitat layers into one layer. A number of T&E species were not modeled for the CWCS. For species included and excluded in the T&E habitat layer see Table 1.

***2. Forested Species Habitat***

*Function:* Gives value to land that provides potential habitat for key forested species.

*Criteria:* Pixels that are modeled as forested habitat for selected key forested species are given value of 1; otherwise 0.

*Justification:* All land with potential to provide habitat for key species will serve as a proxy for valuable wildlife habitat for forested species conservation. Habitat

destruction or degradation of potential habitat would likely impede range expansion and could negatively impact existing populations.

*Data Description:* The forested potential habitat is based on the concept of wildlife habitat relationships developed for GAP analysis and represents areas where a species persists, reproduces, or otherwise occurs. Modeling of each predicted species habitat was completed for the CWCS. The technical advisory committee will identify important species to include in this layer.

*Data Source:* The forested species habitat is taken from the CWCS. The modeling approach is described in the plan.

***3. TNC Fish Atlas***

*Function:* Gives value to riparian areas where sensitive fish species occur.

*Criteria:* Pixels of reaches with current or historical (up to 1970s) occurrences are given value of 1; otherwise 0.

*Justification:* Riparian areas foster high species richness and abundance of wildlife, and particularly in the southwest they serve as important habitat corridors between larger areas of habitat facilitating dispersal, recruitment, and migration of wildlife.

*Data Description:* The TNC Atlas is based on information from Natural Heritage New Mexico occurrence records and literature searches. Perennial and intermittent reaches were defined using National Hydrography Dataset at a 100,000 scale. The Atlas represent fish occurrence from 1975 to 2005 for 26 native fish species including: Reaches with fish occurrences were buffered 100 feet and converted to a raster layer.

*Data Source:* The TNC Fish Atlas was developed by The Nature Conservancy in New Mexico and completed in 2007. The Fish occurrence raster layer was created by The Nature Conservancy in New Mexico in 2009.

***4. Forest Patch Size***

*Function:* Gives value to large, unfragmented areas of forest habitat

*Criteria:* Patches were classified into 5 categories based on patch size. Pixels were assigned values ranging from 0 to 10 with 0 for the lowest patch size and 50 for the largest patch size.

*Justification:* Large, unfragmented areas of forest support viable populations of fish and wildlife species, particularly wide-ranging and interior species, by allowing access to feeding habitat, reproduction, and genetic exchange.

*Data Description:* Forest Patch Size layer was created with SWReGAP (2004) vegetation data using methodology described in the Texas Statewide Assessment of Forest Resources.

*Data Source:* The Forest Patch Size layer was created by The Nature Conservancy in New Mexico in 2009.

***5. TNC conservation areas***

*Function:* Gives value to land identified as critical to the conservation of biodiversity in New Mexico.

*Criteria:* Pixels that are modeled as conservation areas are given value of 1; otherwise 0.

*Justification:* Ecoregional assessments are comprehensive and systematic efforts to identify conservation priorities. TNC conservation areas identify areas containing the full distribution and diversity of native species and natural communities.

*Data Description:* TNC conservation areas are a product of a priority setting process described in Designing a Geography of Hope (The Nature Conservancy, 2000). They represent the best remaining areas to conserve. Over 200 terrestrial and aquatic conservation areas were identified in New Mexico.

*Data Source:* Seven ecoregional assessments that identified the portfolio of conservation areas were completed from 1999 to 2007. TNC ecoregional assessments can be found on the New Mexico Conservation Science website (http://nmconservation.org/projects/ecoregions/).

***6. CWCS key areas***

*Function:* Gives value to land considered to be priority for conservation by the CWCS.

*Criteria:* The key areas layer developed for the CWCS was categorized into four priority groupings to represent low (1), medium (2), high (3), and very high (4).

*Justification:* Key areas for conservation are important for conservation because they provide valuable fish and wildlife habitat, contain high species diversity, and are the least protected lands within New Mexico.

*Data Description:* The layer represents potential key areas for conservation efforts. THE CWCS key areas are those areas that are within key habitats, have a high number of terrestrial and aquatic Species of Greatest Conservation Need, may be potentially altered by synergistic effects that influence habitats, and lack long-term legally-binding management plans protecting them from degradation.

*Data Source:* The approach for developing the key areas for conservation layer is described in the Comprehensive Wildlife Conservation Strategy for New Mexico (NMDG&F, 2006).

**Citations**:

Dodd, N. L., R. E. Schweinsburg, and S. Boe. 2006. Landscape-scale forest habitat relationships to tassel-eared squirrel populations: implications for ponderosa pine forest restoration. Restoration Ecology 14, Issue 4, pages 537 – 547.

Davis, 1996. Summary of the Sierra Nevada Ecosystem Project Report, Volume 1, Chapter 6 (Davis: University of California, Centers for Water and Wildland Resources, 1996).

Hackett, Jan and Jacob Frost, 2005. Forest Stewardship Spatial Analysis Project Methodology Report for Colorado. 20 pages.

New Mexico Department of Game and Fish. 2006. Comprehensive Wildlife Conservation Strategy for New Mexico. New Mexico Department of Game and Fish. Santa Fe, New Mexico. 526 pp + appendices.

The Nature Conservancy. 2000. Designing a Geography of Hope, Second Edition. The Nature Conservancy, Arlington, Virginia.

USGS National Gap Analysis Program. 2004. Digital Land Cover Map for the Southwestern United States. Version 1.0. RS/GIS Laboratory, College of Natural Resources, Utah State University.

*Table 1: Threatened & Endangered Species – All T&E species modeled for the CWCS were included. Excluded species are only those not modeled.*

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| **Fish** | | | | | |
| Chub, Chihuahua | Gila nigrescens | Federal: Threatened State NM: Endangered | Catfish, Yaqui | Ictalurus pricei | Federal: Threatened |
| Chub, Gila | Gila intermedia | Federal: Endangered State NM: Endangered | Chub, Humpback | Gila cypha | Federal: Endangered |
| Chub, Roundtail | Gila robusta | State NM: Endangered | Chub, Bonytail | Gila elegans | Federal: Endangered |
| Chub, Headwater | Gila nigra | Federal: Candidate State NM: Endangered | Chub, Sonora | Gila ditaenia | Federal: Threatened |
| Chub, Peppered | Macrhybopsis tetranema | State NM: Threatened | Chub, Yaqui | Gila purpurea | Federal: Endangered |
| Dace, Redbelly, Southern | Phoxinus erythrogaster | State NM: Endangered | Chub, River, Virgin | Gila seminuda | Federal: Endangered |
| Darter, Greenthroat | Etheostoma lepidum | State NM: Threatened | Spinedace, Colorado, Little | Lepidomeda vittata | Federal: Threatened |
| Gambusia, Pecos | Gambusia nobilis | Federal: Endangered State NM: Endangered | Woundfin | Plagopterus argentissimus | Federal: Endangered |
| Logperch, Bigscale | Percina macrolepida (Native pop.) | State NM: Threatened | Pupfish, Desert | Cyprinodon macularius eremus (AZ);macularius (AZ) | Federal: Endangered |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| Minnow, Loach | Tiaroga cobitis | Federal: Threatened<br>State NM: Threatened | Shiner, Arkansas River | Notropis girardi (Native pop.) | Federal: Threatened<br>State NM: Endangered |
| Minnow, Silvery, Rio Grande | Hybognathus amarus | Federal: Endangered<br>State NM: Endangered | Shiner, Beautiful | Cyprinella formosa mearnsi (NM,AZ) | Federal: Threatened |
| Minnow, Suckermouth | Phenacobius mirabilis | State NM: Threatened | Topminnow, Yaqui | Poeciliopsis occidentalis sonorensis (AZ) | Federal: Endangered |
| Pupfish, Pecos | Cyprinodon pecosensis | State NM: Threatened | Trout, Apache | Oncorhynchus apache | Federal: Threatened |
| Pupfish, White Sands | Cyprinodon tularosa | State NM: Threatened | | | |
| Redhorse, Gray | Moxostoma congestum | State NM: Threatened | | | |
| Shiner, Bluntnose, Pecos | Notropis simus pecosensis (NM) | Federal: Threatened<br>State NM: Endangered | | | |
| Spikedace | Meda fulgida | Federal: Threatened<br>State NM: Endangered | | | |
| Pikeminnow, Colorado | Ptychocheilus lucius | Federal: Endangered<br>State NM: Endangered | | | |
| Sucker, Blue | Cycleptus elongatus | State NM: Endangered | | | |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| Sucker, Bluehead, Zuni | Catostomus discobolus yarrowi (NM) | Federal: Candidate<br>State NM: Endangered | | | |
| Sucker, Razorback | Xyrauchen texanus | Federal: Endangered | | | |
| Tetra, Mexican | Astyanax mexicanus | State NM: Threatened | | | |
| Topminnow, Gila | Poeciliopsis occidentalis occidentalis (NM,AZ) | Federal: Endangered<br>State NM: Threatened | | | |
| Trout, Cutthroat, Rio Grande | Oncorhynchus clarki virginalis (NM) | Federal: Candidate | | | |
| Trout, Gila | Oncorhynchus gilae | Federal: Threatened<br>State NM: Threatened | | | |
| **Reptiles & Amphibians** | | | | | |
| Frog, Leopard, Chiricahua | Rana chiricahuensis | Federal: Threatened | Frog, Leopard, Ramsey Canyon | Rana subaquavocalis | Federal: Candidate |
| Frog, Leopard, Lowland | Rana yavapaiensis | State NM: Endangered | Lizard, Bunchgrass, Slevin's | Sceloporus slevini | State NM: Threatened |
| Salamander, Jemez Mtns. | Plethodon neomexicanus | State NM: Endangered | Lizard, Horned, Flat-tail | Phrynosoma mcallii | Federal: Proposed |
| Salamander, Sacramento Mtn. | Aneides hardii | State NM: Threatened | Rattlesnake, Rock, Mottled | Crotalus lepidus lepidus (NM) | State NM: Threatened |
| Salamander, Tiger, Sonora | Ambystoma tigrinum stebbinsi (AZ) | Federal: Endangered | Skink, Mountain | Eumeces callicephalus | State NM: Threatened |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| Toad, Mountain | Bufo boreas complex (NM) | Federal: Warranted/Precluded<br>State NM: Endangered | Snake, Rat, Green | Senticolis triaspis intermedia (NM,AZ) | State NM: Threatened |
| Toad, Desert, Sonoran | Bufo alvarius | State NM: Threatened | Tortoise, Desert, Mohave | Gopherus agassizi (Mohave pop.) | Federal: Threatened |
| Toad, Narrowmouth, Great Plains | Gastrophryne olivacea | State NM: Endangered | Tyrannulet, Beardless, N. | Camptostoma imberbe ridgwayi (NM) | State NM: Endangered |
| Cooter, River, Western | Pseudemys gorzugi | State NM: Threatened | | | |
| Lizard, Sand Dune | Sceloporus arenicolus | Federal: Candidate<br>State NM: Endangered | | | |
| Monster, Gila, Reticulate | Heloderma suspectum suspectum (NM,AZ) | State NM: Endangered | | | |
| Rattlesnake, Ridgenose, NM | Crotalus willardi obscurus (NM) | Federal: Threatened<br>State NM: Endangered | | | |
| Snake, Garter, Mexican | Thamnophis eques megalops (NM) | Federal: Candidate<br>State NM: Endangered | | | |
| Snake, Garter, Narrowhead | Thamnophis rufipunctatus rufipunctatus (NM) | State NM: Threatened | | | |
| Kingsnake, Gray-banded | Lampropeltis alterna | State NM: Endangered | | | |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
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| ***Included*** | | | ***Excluded*** | | |
| Snake, Ribbon, Western | Thamnophis proximus diabolicus (NM) | State NM: Threatened | | | |
| Snake, Water, Plainbelly | Nerodia erythrogaster transversa (NM) | State NM: Endangered | | | |
| Whiptail, Gray-checkered | Aspidoscelis dixoni | State NM: Endangered | | | |
| Whiptail, Spotted, Canyon | Aspidoscelis burti stictogrammus (NM,AZ);xanthonotus (AZ) | State NM: Threatened | | | |
| **Birds** | | | | | |
| Black-Hawk, Common | Buteogallus anthracinus anthracinus (NM) | State NM: Threatened | Crane, Whooping | Grus americana | Federal: Endangered State NM: Endangered |
| Bunting, Varied | Passerina versicolor versicolor (NM);dickeyae (NM) | State NM: Threatened | Hummingbird, White-eared | Hylocharis leucotis borealis (NM) | State NM: Threatened |
| Cormorant, Neotropic | Phalacrocorax brasilianus | State NM: Threatened | Nightjar, Buff-collared | Caprimulgus ridgwayi ridgwayi (NM) | State NM: Endangered |
| Cuckoo, Yellow-billed | Coccyzus americanus occidentalis (western pop) | Federal: Candidate | Owl, Pygmy, Ferruginous | Glaucidium brasilianum cactorum (AZ) | Federal: Proposed |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
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| ***Included*** | | | ***Excluded*** | | |
| Eagle, Bald | Haliaeetus leucocephalus alascanus (NM) | State NM: Threatened | Parrot, Thick-billed | Rhynchopsitta pachyrhyncha | Federal: Endangered |
| Falcon, Aplomado | Falco femoralis septentrionalis (NM) | Federal: Endangered<br>State NM: Endangered | Pelican, Brown | Pelecanus occidentalis carolinensis (NM) | State NM: Endangered |
| Falcon, Peregrine | Falco peregrinus anatum | State NM: Threatened | Plover, Piping | Charadrius melodus circumcinctus (NM) | Federal: Threatened<br>State NM: Threatened |
| Falcon, Peregrine, Arctic | Falco peregrinus tundrius | State NM: Threatened | Rail, Clapper | Rallus longirostris yumanensis (AZ) | Federal: Endangered |
| Flycatcher, Willow, SW. | Empidonax traillii extimus | Federal: Endangered<br>State NM: Endangered | Condor, California | Gymnogyps californicus | Federal: Endangered |
| Ground-dove, Common | Columbina passerina pallescens (NM) | State NM: Endangered | | | |
| Hummingbird, Broad-billed | Cynanthus latirostris magicus (NM) | State NM: Threatened | | | |
| Hummingbird, Costa's | Calypte costae | State NM: Threatened | | | |
| Hummingbird, Lucifer | Calothorax lucifer | State NM: Threatened | | | |
| Hummingbird, Violet-crowned | Amazilia violiceps ellioti (NM) | State NM: Threatened | | | |
| Junco, Yellow-eyed | Junco phaeonotus palliatus (NM) | State NM: Threatened | | | |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
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| ***Included*** | | | ***Excluded*** | | |
| Kingbird, Thick-billed | Tyrannus crassirostris | State NM: Endangered | | | |
| Owl, Boreal | Aegolius funereus | State NM: Threatened | | | |
| Screech-Owl, Whiskered | Megascops trichopsis asperus (NM) | State NM: Threatened | | | |
| Owl, Spotted, Mexican | Strix occidentalis lucida (NM,AZ) | Federal: Threatened | | | |
| Prairie-Chicken, Lesser | Tympanuchus pallidicinctus | Federal: Candidate | | | |
| Ptarmigan, White-tailed | Lagopus leucura altipetens (NM) | State NM: Endangered | | | |
| Sparrow, Baird's | Ammodramus bairdii | State NM: Threatened | | | |
| Sparrow, Grasshopper, AZ | Ammodramus savannarum ammolegus (NM,AZ) | State NM: Endangered | | | |
| Tern, Least | Sterna antillarum athalassos (NM) | Federal: Endangered<br>State NM: Endangered | | | |
| Towhee, Abert's | Pipilo aberti aberti (NM) | State NM: Threatened | | | |
| Trogon, Elegant | Trogon elegans canescens (NM) | State NM: Endangered | | | |
| Turkey, Wild, Gould's | Meleagris gallopavo mexicana (NM,AZ) | State NM: Threatened | | | |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
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| ***Included*** | | | ***Excluded*** | | |
| Vireo, Bell's | Vireo bellii arizonae (NM,AZ);medius (NM) | State NM: Threatened | | | |
| Vireo, Black-capped | Vireo atricapillus | Federal: Endangered | | | |
| Vireo, Gray | Vireo vicinior | State NM: Threatened | | | |
| Woodpecker, Gila | Melanerpes uropygialis uropygialis (NM) | State NM: Threatened | | | |
| **Mammals** | | | | | |
| Bat, Long-nosed, Mexican | Leptonycteris nivalis | Federal: Endangered<br>State NM: Endangered | Bat, Long-nosed, Southern | Leptonycteris curasoae yerbabuenae (NM,AZ) | Federal: Endangered<br>State NM: Threatened |
| Bat, Spotted | Euderma maculatum | State NM: Threatened | Bat, Yellow, Western | Lasiurus xanthinus | State NM: Threatened |
| Chipmunk, Colorado, Organ Mtns. | Neotamias quadrivittatus australis (NM) | State NM: Threatened | Bear, Grizzly | Ursus arctos horriaeus (NM);perturbans (NM) | Federal: Threatened |
| Chipmunk, Colorado, Oscura Mtns. | Neotamias quadrivittatus oscuraensis (NM) | State NM: Threatened | Ferret, Black-footed | Mustela nigripes | Federal: Endangered |
| Chipmunk, Least, Penasco | Neotamias minimus atristriatus (NM) | State NM: Endangered | Ocelot | Leopardus pardalis sonoriensis (AZ) | Federal: Endangered |
| Gopher, Pocket, Southern | Thomomys umbrinus emotus (NM) | State NM: Threatened | Jaguarundi | Herpailurus yaguarondi tolteca (AZ) | Federal: Endangered |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| Jaguar | Panthera onca arizonensis (NM,AZ) | Federal: Endangered | Canadian Lynx | Lynx canadensis | Federal: Threatened |
| Mouse, Jumping, Meadow | Zapus hudsonius luteus (NM,AZ) | Federal: Candidate State NM: Endangered | Marten, American | Martes americana origenes (NM) | State NM: Threatened |
| | | | Pronghorn, Sonoran | Antilocapra americana sonoriensis (AZ) | Federal: Endangered |
| Rabbit, Jack, White-sided | Lepus callotis gaillardi (NM) | State NM: Threatened | Shrew, Arizona | Sorex arizonae | State NM: Endangered |
| Sheep, Bighorn, Desert | Ovis canadensis mexicana (endangered pops) | State NM: Endangered | Shrew, Least | Cryptotis parva parva (NM);berlandieri (NM) | State NM: Threatened |
| Vole, Montane, Arizona | Microtus montanus arizonensis (NM,AZ) | State NM: Endangered | Squirrel, Red, Mt. Graham | Tamiasciurus hudsonicus grahamensis (AZ) | Federal: Endangered |
| Wolf, Gray | Canis lupus nubilus (NM);youngi (NM,AZ) | Federal: Endangered | Vole, Mexican, Hualapai | Microtus mogollonensis hualpaiensis (AZ) | Federal: Endangered |
| Wolf, Gray, Mexican | Canis lupus baileyi (NM,AZ) | Federal: Endangered State NM: Endangered | | | |
| **Invertebrates** | | | | | |
| | | | Woodlandsnail, Hacheta Grande | Ashmunella hebardi | State NM: Threatened |
| | | | Woodlandsnail, Cooke's Peak | Ashmunella macromphala | State NM: Threatened |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
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| ***Included*** | | | ***Excluded*** | | |
| | | | Snail, Assiminea, Pecos | Assiminea pecos | Federal: Endangered State NM: Endangered |
| | | | Snail, Snaggletooth, Shortneck | Gastrocopta dalliana dalliana (NM) | State NM: Threatened |
| | | | Paper Pondshell | Utterbackia imbecillis | State NM: Endangered |
| | | | Hornshell, Texas | Popenaias popeii | Federal: Candidate State NM: Endangered |
| | | | Mountainsnail, Mineral Creek | Oreohelix pilsbryi | State NM: Threatened |
| | | | Mountainsnail, Florida | Oreohelix florida | State NM: Endangered |
| | | | Fingernailclam, Swamp | Musculium partumeium | State NM: Threatened |
| | | | Peaclam, Lilljeborg's | Pisidium lilljeborgi | State NM: Threatened |
| | | | Fingernailclam, Lake | Musculium lacustre | State NM: Threatened |
| | | | Peaclam, Sangre De Cristo | Pisidium sanguinichristi | State NM: Threatened |
| | | | Fingernailclam, Long | Musculium transversum | State NM: Threatened |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
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| ***Included*** | | | ***Excluded*** | | |
| | | | Springsnail, Hot, New Mexico | Pyrgulopsis thermalis | Federal: Candidate<br>Federal: Warranted/Precluded<br>State NM: Threatened |
| | | | Marshsnail, Wrinkled | Stagnicola caperata | State NM: Endangered |
| | | | Snail, Star Gyro | Gyraulus crista | State NM: Threatened |
| | | | Springsnail, Alamosa | Pseudotryonia alamosae | Federal: Endangered<br>State NM: Endangered |
| | | | Springsnail, Chupadera | Pyrgulopsis chupaderae | Federal: Candidate<br>Federal: Warranted/Precluded<br>State NM: Endangered |
| | | | Springsnail, Gila | Pyrgulopsis gilae | Federal: Candidate<br>Federal: Warranted/Precluded<br>State NM: Threatened |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| | | | Springsnail, Koster's | Juturnia kosteri | Federal: Endangered State NM: Endangered |
| | | | Springsnail, Pecos | Pyrgulopsis pecosensis | Federal: Warranted/Precluded State NM: Threatened |
| | | | Springsnail, Roswell | Pyrgulopsis roswellensis | Federal: Endangered State NM: Endangered |
| | | | Springsnail, Page | Pyrgulopsis morrisoni | Federal: Candidate |
| | | | Springsnail, Socorro | Pyrgulopsis neomexicana | Federal: Endangered State NM: Endangered |
| | | | Springsnail, Huachuca | Pyrgulopsis thompsoni | Federal: Candidate |
| | | | Talussnail, Dona Ana | Sonorella todseni | State NM: Threatened |
| | | | Talussnail, San Xavier | Sonorella eremita | Federal: Proposed |
| | | | Talussnail, Wet Canyon | Sonorella macrophallus | Federal: Candidate |
| | | | Snail, Vertigo, Ovate | Vertigo ovata | State NM: Threatened |

| Common Name | Scientific Name | Status | Common Name | Scientific Name | Status |
|---|---|---|---|---|---|
| ***Included*** | | | ***Excluded*** | | |
| | | | Ambersnail, Kanab | Oxyloma haydeni kanabensis (AZ) | Federal: Endangered |
| | | | Amphipod, Noel's | Gammarus desperatus | Federal: Endangered<br>State NM: Endangered |
| | | | Isopod, Socorro | Thermosphaeroma thermophilum | Federal: Endangered<br>State NM: Endangered |

**Water Quality and Supply**: This data layer identifies watersheds important for supplying clean and adequate water supply along with potential risks to supplying clean water. The intent of this layer is to emphasize areas the areas of greatest need with respect to water quality and quantity and where forests can have the greatest benefit. This layer will be used in the State Strategy and Response plan to help prioritize areas which will enhance public benefit from forested areas.

**Proposed Model:** Combine public drinking supply, impervious surfaces, erosion risk, and impaired waters using an additive Boolean overlay.

**Description of Factors**:

***1. Public Drinking Supply Sources***

*Function:* Identifies watersheds with public drinking supply source as a priority watershed.

*Criteria:* HUC 10 watersheds containing public drinking supply sources are given value of the number of intakes within that watershed; otherwise 0.

*Justification:* Protection of public drinking supply sources.

*Data Description:* The New Mexico Environment Department developed a public drinking supply layer that identifies surface water intake points for the state. Please refer to metadata of the NM drinking supply layer, for additional information on the process of delineating the intake points. The surface water intake points were summarized by HUC 10 watersheds. If a watershed contained a public drinking supply source it was given the value of the number of sources in the watershed. If not, the watershed was given a value of 0 indicating it does not contain a public drinking supply source.

*Data Source:* The public drinking supply layer was supplied by the New Mexico Environment Department with permission and is not available for release. The summarized layer was created by The Nature Conservancy in New Mexico in 2009.

***2. Impervious Surfaces***

*Function:* Identifies areas with impervious surfaces.

*Criteria:* Areas with impervious surface greater than 18% is given value of 1; otherwise 0 (Figure 1).

*Justification:* Percentage of impervious surfaces is a good indicator of potential water quality impacts. Impervious surfaces increase stream sedimentation, increase stormflows, concentrate nutrients and pollutants in streams, and decrease infiltration impacting groundwater recharge.

*Data Description:* Impervious surfaces were derived from the National Land Cover Dataset (NLCD) 2001 impervious layer. The NLCD layer was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium (www.mrlc.gov). The NLCD impervious layer was classified into two groups: 1) areas with >18% impervious surfaces were given a value of 1 and 2) areas with < 18% impervious surface were given a value of 0. The 18% threshold value was chosen since it is a metric used by the Environmental Protection Agency to distinguish between rural and exurban/suburban development (Jennings et al, 2004). The Idaho State

Assessment of Forest Resources also used the 18% threshold to identify areas with potential to impact water quality.

*Data Source:* For a detailed description of the MRLC impervious layer and other landcover products, see http://ww.mlrc.gov/mrlc2k.asp. The NLCD reclassed impervious surfaces layer data layer was created by The Nature Conservancy in New Mexico in 2009.

***3. Erosion Risk***

*Function:* Identifies areas with high erosion potential.

*Criteria:* Erosion potential of area is given a scaled value from 1 to 10; 1 indicates low risk and 10 indicates high risk.

*Justification:* Water erosion is a serious and continuous environmental problem. Excessive sedimentation clogs stream channels and is a source of contamination. The Revised Universal Soil Loss Equation (RUSLE) was used to assess mean erosion potential at the watershed scale.

*Data Description:* Erosion potential was modeled using the Revised Universal Soil Loss Equation: A = R*K*L*S*C*P where

R = Rainfall-Runoff Erosivity Factor
K = Soil Erodibility Factor
L = Slope-Length Factor
S = Slope Steepness Factor
C = Cover Management Factor
P = Support Practice Factor

The Erosion potential values were scaled from 1 to 10 where 1 indicates low risk and 10 indicates high risk. The Rainfall-Runoff Erosivity Factor was derived using methodology developed by Renard and Friedmund (1994) who modeled erosivity equations based on the amount of precipitation. The Soil Erodibility Factors were developed by the NRCS as a part of the STATSGO statewide soils layer. The Slope Length and Slope Steepness factors were derived using ArcGIS 9.2 hydrology tools. The Cover Management Factor was development through a reclassification of the NLCD 2001 landcover dataset.

*Data Source:* This data layer was created by The Nature Conservancy in New Mexico in 2009. The base layers used to derive the RUSLE factors included PRISM precipitation, STATSGO soils, New Mexico Digital Elevation Model (DEM) maintained by RGIS, and the NLCD 2001 landcover dataset.

***4. Impaired Waters***

*Function:* Identifies watersheds with impaired reaches as priorities

*Criteria:* Watersheds containing category 4 or category 5 impaired reaches are given a value of 1; otherwise 0.

*Justification:* Impaired watersheds indicate areas in need of restoration and management.

*Data Description:* The New Mexico Environment Department maintains an impaired reaches layer that identifies all impaired water in the state, per section 303(d) of the Clean Water Act (see metadata for additional information on the impaired waters data). The impaired waters reaches were summarized by HUC 10 watersheds. If a watershed contained an impaired reach it was given the value of the number of reaches in

the watershed. If not, the watershed was given a value of 0 indicating it does not contain an impaired reach.

*Data Source:* The impaired waters reach layer was supplied by the New Mexico Environment Department in 2009. The summarized layer was created by The Nature Conservancy in New Mexico in 2009

**Citations**

Jennings, David B., S.T. Jarnagin and D.W. Ebert. 2004. A Modeling Approach for Estimating Watershed Impervious Surface Area from National Land Cover Data 92. Photogrammetric Engineering & Remote Sensing. 70(11): 1295-1307.

Reinard K.G., and J. Freimund (1994). Using monthly precipitation data to estimate the R-factor in the revised USLE. Journal of Hydrology 157, pp. 287-306.

**Forest Fragmentation**: This data layer is intended to identify the extent of fragmentation of forest and woodlands. This layer will be used in the State Strategy and Response plan to help prioritize areas where management of threats to forest health is most needed.

**Proposed Model:** Create a forest fragmentation layer by combining forest patch size and distance to roads.

**Description of Factors**:

***1. Patch Size***

*Function:* Gives higher value to larger more ecologically and economically viable forest patches.

*Criteria:* Pixels are assigned values based on acreage of patches, where larger values mean greater areas of continuous forest, smaller values signify smaller areas with more fragmentation.

*Justification:* Smaller patches of forest have larger percentage of edge habitat. Edge habitat favors invasive species, increases parasitism and predation, reduces forest and woodland system ability to recover from disturbance events such as wind-throw, fires, or insect and disease infestations, and reduces viability of interior and wide-ranging forest species.

*Data Description:* SWReGAP landcover (2004) was reclassified to NLCD forest/non-forest classes. Road pixels were used to reclassify forested areas to non – forested, using all roads. The resulting forested region layer had 1 = forested , 0=non-forested. Region Group was used to assign a unique number to each continuous forested region (four adjacent cells used for grouping). Zonal geometry was used to calculate the area of each region, and Hawths tools used to calculate acreages.

*Data Source:* The Tiger (2006) roads layer combined with the SWReGAP landcover data (2004) was used to create patches. Patch size layer was created by The Nature Conservancy in New Mexico in 2009.

***2. Distance to Roads***

*Function:* Gives a scaled value between 1 and 10 to forest land based on distance to a road.

*Criteria:* The distance from each pixel to the nearest road is measured. The distance measure is then scaled so that the pixels closest to a road are classified as 1 and those farthest from the road are classified as 10.

*Justification:* Edge habitat favors invasive species and increases parasitism and predation.

*Data Description:* The Tiger Roads layer was used to calculate the distance of each pixel in the Patch Size layer. The calculated distances were then scaled from 1 to 10 with 1 representing closest pixels to a road and 10 representing edge habitat.

*Data Source:* The Tiger (2006) roads layer was used to distance measure. Scaled distance layer was created by The Nature Conservancy in New Mexico in 2009.

**Citations**

U.S. Department of Commerce, U.S. Census Bureau, Geography Division, 2006, TIGER/Line Files, 2006 Second Edition, http://www.census.gov/geo/www/tiger

USGS National Gap Analysis Program. 2004. Digital Land Cover Map for the Southwestern United States. Version 1.0. RS/GIS Laboratory, College of Natural Resources, Utah State University.

**Wildfire Risk**: This data layer identifies areas with a relatively high risk of wildfire. The intent of this layer is to emphasize areas where forests management is likely to reduce the risk of wildfire. This layer will be used in the State Strategy and Response plan to help prioritize areas which will minimize potential and reduce impact of wildfire.

**Proposed Model:** Combine rate of spread, flame length, crown fire potential, wildland urban interface, community capacity, fire occurrence, fire regime condition class in an additive Boolean overlay.

**Description of Factors**:

***1. Rate of Spread (feet per minute)***

*Function:* Gives value to areas with potential for high rate of spread (ROS).

*Criteria:* Areas are classified into four groups low (0 to 5 ft/min), medium (5 to 15 ft/min), high (15 to 30 ft/min), and extreme (>15ft/min). Areas with low ROS are given a value of 1, medium a value of 2, high a value of 3 and extreme a value of 4. (Figure 1).

*Justification:* Rate of spread is the horizontal distance that the flame zone moves per unit of time (feet per minute) and is influenced strongly by type of fuels, wind, and topography of an area. Rate of spread is important in indicating how fast a fire will travel and reach a point of concern, and impacts the type and number of suppression resources needed to contain a fire.

*Data Description:* ROS was modeled using a ArcGIS tool developed by the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFFT) project. The tool uses eight GIS data layers created by Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) including elevation, slope, aspect, canopy closure, fuel model, canopy base height, and canopy bulk density. It also uses weather parameters to simulate wind and fuel moisture conditions. This data was collected from all New Mexico's RAWS data stations and represents the average summer (June through August) conditions.

*Data Source:* The ROS layer was created by The Nature Conservancy in New Mexico in 2009.

***2. Flame Length (Feet)***

*Function:* Gives value to areas with the potential for high and extreme flame lengths.

*Criteria:* Watersheds containing public drinking supply sources are given value of 1; otherwise 0 (Figure 1).

*Justification:* Flame length is the distance from the base of the flame to the tip of the flame in a fire burning in surface fuels. Flame length is an indicator of fire intensity at the active, flaming front and is a good measure of what suppression resources can be used on a fire. The intensity of a surface fire is also an important measure of the likelihood of a fire moving into the forest canopy. As a general rule, flame lengths less than four feet can be managed by ground crews, between four and twelve feet requires aerial equipment, greater than twelve feet are unmanageable even with aerial equipment.

*Data Description:* Flame length was modeled using a ArcGIS tool developed by the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFFT)

project. The tool uses eight GIS data layers created by Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) including elevation, slope, aspect, canopy closure, fuel model, canopy base height, and canopy bulk density. It also uses weather parameters to simulate wind and fuel moisture conditions. This data was collected from all New Mexico's RAWS data stations and represents the average summer (June through August) conditions.

*Data Source:* The Flame Length layer was created by The Nature Conservancy in New Mexico in 2009.

***3. Crown Fire Potential***

*Function:* Gives value to areas with potential for high to extreme crown fire.

*Criteria:* Areas with potential for passive crown fire are given value of 1, active crown fire a value of; otherwise 0, indicating surface fire or no data (Figure 2).

*Justification:* Crown fire is the movement of fire into and through the tree canopy. Crown fires typically move rapidly, and are very intense. Passive crown fire does not carry continuously through the canopy, but burns crown fuels intermittently (eg when individual trees or groups of trees burn). Active crown fire carries continuously through the canopy. Crown fires are the most difficult and dangerous types of fire to fight.

*Data Description:* Crown fire potential was modeled using a ArcGIS tool developed by the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFFT) project. The tool uses eight GIS data layers created by Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) including elevation, slope, aspect, canopy closure, fuel model, canopy base height, and canopy bulk density. It also uses weather parameters to simulate wind and fuel moisture conditions. This data was collected from all New Mexico's RAWS data stations and represents the average summer (June through August) conditions.

*Data Source:* The Crown Fire Potential layer was created by The Nature Conservancy in New Mexico in 2009.

***4. Fire Occurrence (# fires per square kilometer)***

*Function:* Gives value to areas where fires are likely to occur.

*Criteria:* Pixels are given value of the number of fires that have occurred per square kilometer.

*Justification:* There will be an increase in probability of a fire occurring in areas where they have occurred in the past.

*Data Description:* USFS and State Forest fire occurrence point locations were combined and converted into a fire occurrence probability or density grid using ArcGIS spatial analyst tools.

*Data Source:* The fire occurrence point data was supllied by NM State Forestry and USFS. The fire occurrence density layer was created by The Nature Conservancy in New Mexico in 2009.

***5. Community Capacity***

*Function:* Identifies and prioritizes areas without capacity to control fires and thus with a greater likelihood of losing infrastructure.

*Criteria:* Nine indicators were used to create an Index of Community Capacity for Protection from wildfires (ICCPW). Each of the 9 indicators is rescaled to a 1 to 10 scale, where 10 indicates high capacity and 1 indicates the most need for assistance (Figure ).

*Justification:* Communities have varying capacity to respond to wildfire. Those communities with capacity to respond have greater likelihood of responding to and recovering from wildfire. Community capacity to recover from wildfire includes the ability to rebuild houses, restore community services, and resume regular activities.

*Data Description:* The ICCPW is designed to integrate social, human, financial, and political capital into a single measure. Nine indicators, including age dependency ratio, percent without disabilities, female only headed households, education, percent employed, English proficiency, median income, percent of community below poverty line, were used to the ICCPW.

*Data Source:* The community capacity data layer was created by the Forest Guild in 2007. Details of the methodology can be found in Evans et al. (2007).

***6. Fire Regime Condition Class (FRCC)***

*Function:* Gives value to areas considered in departure from historic range of variability.

*Criteria:* Pixels are given the value of the FRCC departure class (1, 2, or 3).

*Justification:* FRCC is a tool for determining how similar a landscape's fire regime is to its natural or historical state. FRCC 1 indicates low departure or areas that contain vegetation, fuels, and disturbances characteristic of the natural regime; FRCC 2 indicates moderate departure from the natural regime; and FRCC 3 indicates high departure. A watershed in FRCC 1 reflects a landscape with key ecosystem components intact; whereas a watershed predominantly in FRCC 3 reflects a landscape that has lost key ecosystem components. For example, the departure could be a dominance of dense stands within forested systems which historically were more open or the loss of characteristic large trees due to unusually large wildfires.

*Data Description:* FRCC was modeled using a ArcGIS tool developed by the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFFT) project. The tool uses eight GIS data layers created by Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) including biophysical setting and succession class. It also database of historic conditions to evaluate relative departure of vegetation and structure. All data layers were downloaded from landfire.gov in 2009.

*Data Source:* The FRCC layer was created by The Nature Conservancy in New Mexico in 2009.

### *7. Wildland Urban Interface (WUI)*

*Function:* Gives value to areas considered to be Wildland Urban Interface (WUI).

*Criteria:* Pixels considered to be WUI given value of 1; otherwise 0.

*Justification:* WUI is the area where structures and other human development meet or intermingle with undeveloped wildland.

*Data Description:* The USFS, Silvis Lab developed a statewide WUI layer (see metadata for more information. New Mexico State Forestry has developed Community Wildfire Protection Plans, in which individual counties developed WUI layers. CWPPs for 26 of 33 counties have been completed and are available. The Silvis WUI and CWPP WUI layers were combined and converted to raster. WUI areas were assigned a value of 1, otherwise 0.

*Data Source:* USFS, Silvis WUI layer was downloaded from in 2009. The CWPP WUI poylgons were obtained from NM State Forestry. The combined WUI layer was created by The Nature Conservancy in New Mexico in 2009

**Citations**

Evans, Alexander, Mike DeBonis, Eytan Krasilovsky, and Michelle Melton. 2007. Measuring Community Capacity for Protection from Wildfire. Technical report, The Forest Guild. 19 p. http://www.forestguild.org/publications/research/2007/community_capacity_wildfire.pdf.

**Forest Health Risk**: This data layer identifies areas that make a forest area more susceptible to insect and disease outbreaks. This layer will be used in the State Strategy and Response plan to help prioritize areas where management of threats to forest health is most needed

**Proposed Model:** Combine stand density index, drought stress, and insect and disease surveys using an additive Boolean overlay.

**Description of Factors**:

***1. Stand Density Index (SDI)***

*Function:* Gives scaled value to watersheds with higher density of trees.

*Criteria:* Maximum SDI ($SDI_{max}$) is categorized into four classes: 25% $SDI_{max}$ = 1, 35% $SDI_{max}$ = 2, 60% $SDI_{max}$ = 3, and 100% $SDI_{max}$ = 4.

*Justification*: Dense forests and woodlands are more susceptible to insect and disease outbreaks in dense stands. Stand Density Index (SDI) determines the relative density of a stand. SDI is a measure of the stocking of a stand of trees based on the number of trees per unit area and diameter at breast height of the tree of average basal area. It may also be defined as the degree of crowding within stocked areas, using various growing space ratios based on crown length or diameter, tree height or diameter, and spacing. Stand density index is usually well correlated with stand volume and growth.

*Data Description:* Forest Inventory Analysis (FIA) Data was used to calculate SDI. The FIA data, from 1987 and 1999, was spatially joined to a HUC 10 watershed layer and the average SDI was calculated for each species by HUC. The $SDI_{max}$ was categorized into the above classes then added. Maximum SDI values were determined by John Shaw, Research Ecologist from IWFIA, RMRS

*Data Source:* The SDI data layer was created by The Nature Conservancy in New Mexico in 2009.

***2. Drought Stress***

*Function:* Gives a scaled value between 7 and -7 based on a moisture stress calculation.

*Criteria:* Existing moisture stress from 1970 to 2007 was calculated for State of New Mexico using PRISM temperature and precipitation data. Higher values indicate greater moisture stress.

*Justification:* Drought or moisture stress increases susceptibility to insect and disease outbreak, wildfire, and mortality, eventually leading to shifts in vegetation type and distribution.

*Data Description:* The Nature Conservancy in New Mexico mapped recent trends using data from 1970-2006 in a combined temperature-precipitation variable, the climate water deficit. This variable indicates biological moisture stress, or drying of an area

*Data Source:* The Nature Conservancy in New Mexico produced this layer in 2007 as a part of its climate change project. Details of the methodology can be found in Enquist et al. (2008).

### *3. Insect and Disease Surveys*

*Function:* Gives value to watersheds with severe outbreaks of Ips and Dendroctonus outbreaks.

*Criteria:* Pixels with DCA codes representing Ips and Dendroctonus species were selected and given a value of 1; otherwise 0.

*Justification:* Insects and diseases play an important role in maintaining forest health. They are essential to the function of dynamic ecosystems: they serve to thin out some of the trees, recycle nutrients, create habitat and provide food to many wildlife species. However, stressful conditions (eg. drought stressed, dense forests) favor extensive outbreaks of forest pests, which can have serious negative effects on the structure and function of forested systems. The highest mortality rates and greatest threat to New Mexico forests and woodlands are caused by bark beetle activity, predominantly Ips species followed by Dendroctonus species.

*Data Description:* USFS Forest Health Aerial Survey data from 1987-2008 was used to classify threat to New Mexico's forests using the severity of infestations over that time period. Survey polygons from each year, 1987 to 2008, were combined into one layer. Polygons representing prominent Dendroctonus and Ips species (DCA1 codes 11000, 11002, 11006, 11007, 11009, 11029, 11030, 80004) were selected and converted to a grid.

*Data Source:* This data layer was created by The Nature Conservancy in New Mexico in 2009.

**Citations**

Enquist, C., Evan Girvetz, and D. Gori. 2008. Conservation Implications of Emerging Moisture Stress due to Recent Climate Changes in New Mexico. Technical report, The Nature Conservancy. 32 p. http://www.nmconservation.org.

**Development Risk**: This data layer emphasizes areas that are projected to experience increased housing development in the next 30 years.

**Proposed Model:** Combine 2030 development density projection to the 2000 development density data.

**Description of Factors**:

***1. 2030 and 2000 Development Data***

*Function:* Gives value to areas expected to experience increased housing density.

*Criteria:* Land expected to have housing development by 2030 are given value of 1 to 4 indicating type of development change; otherwise 0.

*Justification:* Watersheds containing public drinking supply sources or input are important to protect.

*Data Description:* The 2000 and 2030 development data was combined and grouped to show the types of anticipated development change

*Data Source:* The data is an updated version (v12) of the housing density data produced by Dr. Dave Theobald as a part of the USFS Forest on the Edge study (Stein et al., 2005). The data was created by subtracting public lands and water areas from the 2000 Census block data. Acres per house were calculated on this layer to create the 2000 development data and then projected forward using current development trends to create the 2030 development data.

**Citations**

Stein, Susan M.; McRoberts, Ronald E.; Alig, Ralph J.; Nelson, Mark D.; Theobald, David M.; Eley, Mike; Dechter, Mike; Carr, Mary. 2005. Forests on the edge:housing development on America's private forests. Gen. Tech. Rep. PNW-GTR-636. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 16 p.

**Green Infrastructure:**

"An interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife."

"Helps identify and prioritize conservation opportunities and plan development in ways that optimize the use of land to meet the needs of people and nature"

*Green Infrastructure: Linking landscapes and communities. Island Press. 2006*

**Statewide Scale** – Identify broad landscape linkages that connect unfragmented forests, prairies, and other natural areas.

The highest priority linkages will provide habitat for wildlife, maintain clean water supply, offer recreational opportunities and increase forest health.

**Process data dependant**

**Potential Hubs (5000+ acres) :**

| Feature | Data Used |
|---|---|
| Unfragmented Forest Blocks | Results of Forest Fragmentation Model |
| Other natural areas, grasslands, wetlands, etc | Landcover |
| Existing Public Land | Federal, State, Local, TNC |
| Working Lands | Ranch and Agricultural Land |
| Wildlife Habitat Priorities | CWCS , results of Habitat Model |
| Groundwater Recharge Areas | Zones of Contribution |

**Potential Connectors:**

| Feature | Data Used |
|---|---|
| Rivers, Streams | Hydrology |
| Wildlife Habitat Priorities | CWCS, results of Habitat Model, Fish Atlas |
| Floodplain | FEMA floodplain |
| Ridgelines | USGS Elevation |
| Trails | Trails |
| Historic Sites | Archeological Inventory |
| Utility Right of Way | ??? |

**Will use the results of the other aspects of the study to help create a range of priority (Final Methodology to be Determined by Technical Team):**

*Fish & Wildlife Habitat (Critical habitat prioritized higher)*
*Water Quality & Supply (High quality water and areas critical to water supply get highest priority)*
*Forest Fragmentation (Used as a Hub, prioritize buffers)*
*Wildfire Risk (High fire Risk areas increase priority for conservation)*
*Forest Health Risk (Healthy forests prioritized)*
*Development Risk (Steer connectors to areas with High Development Risk)*
*Economic Potential (Prioritize Hubs with High Economic Potential)*

**Proposed Model:** Identify best linkages between existing hubs using data described above using a Least Cost Path analysis.

**Economic Potential**: This data layer highlights areas where forests do or could potentially play a major role in local or state economic growth or contribute to the development of emerging markets, such as biomass energy, ecosystem services, and timber products. We have divided economic potential into two different categories one based on the availability of saw timber and the other based on the availability of lower value material such as fire wood or biomass for energy.

**Proposed Model:** Combine Distance to use, forest type, land tenure, accessibility, and forest attributes using an additive Boolean overlay.

**Description of Factors**:

***1. Distance to use***

*Function:* Gives a scaled value between 1 to 10 to forest land based on distance to a wood processor.

*Criteria:* The distance from each pixel to the nearest wood utilization facility is measured and then distances are scaled such that those pixels with the shortest distances to utilization are labeled 10 and the longest distances are label 1. Distance will be calculated along roads.

*Justification:* Forest land closer to utilization facilities are more likely to contribute to economic activity.

*Data Description:* New Mexico Highlands University maintains a geospatial data layer of wood processors in New Mexico in cooperation with the New Mexico Forest Industry Association. Each facility is labeled with the type of material it uses.

*Data Source:* The "wood_infrastructure" layer from New Mexico Highlands University and the "Transportation Geodatabase" from RGIS (see metadata for more information).

***2. Forest Type***

*Function:* Identifies forest land in New Mexico.

*Criteria:* Pixels that are forested are given value of 1; otherwise 0.

*Justification:*

The economic potential of forests needs to focus on existing forest land.

Forest types could be ranked according to economic potential. For example ponderosa pine forests would have greater economic potential for wood products than piñon-juniper savannas.

*Data Description:* The Office of State Engineer developed a statewide geodatabase with all the supporting layers sourced from RGIS..

*Data Source:* Forest types will use the "Geology / Land Cover Geodatabase" from RGIS (see metadata for more information).

***3. Working Forests***

*Function:* Identifies forest land in New Mexico that may be available for harvest of wood products.

*Criteria:* Pixels that are in a land tenure or status that may allow harvest of wood products are given value of 1; otherwise 0.

*Justification:* Not all forest land is available for harvest of wood products. For example wilderness areas should not be considered in the assessment of economic potential.

*Data Description:* The following land tenures were label as **not** available for harvest of wood products:

- National Parks, Monuments, and other NPS lands
- Wilderness Areas (including BLM, USFS, FWS and NPS)
- Wilderness Study Areas
- State Parks
- Inventoried Roadless Areas

*Data Source:* We used both the State Engineer's Office's" Administrative Geodatabase" (see metadata) "USDA FS Inventoried Roadless Areas in New Mexico, Sept. 2000" to map roadless areas (see metadata).

***4. Accessibility***

*Function:* Gives value to areas where slopes would permit harvest.

*Criteria:* Pixels with a slope less than 40% are given value of 1; otherwise 0 (Figure 1).

*Justification:* Steep slopes prohibit safe and ecological harvest of wood products.

*Data Description:* Slope was calculated from a digital elevation model for the state.

*Data Source:* The slope layer was created for the New Mexico Forest Stewardship project.

***5a. Availability of Sawtimber***

*Function:* The goal of this map is to identify areas in New Mexico's forests where sawtimber could be harvested.

*Criteria:* The each pixel has a value from 1 to 10 where 1 represents very little potential for saw timber and 10 represents the best potential to harvest sawtimber.

*Justification:* While some stands may have many trees that could be cut for saw timber other nearby stands of the same forest type may have no trees large enough to sell for saw timber.

*Data Description:* In order to rank areas based on the availability of sawtimber we use the FIA's Net cubic-foot volume on a per acre basis. FIA's Net cubic-foot volume is described as "For timber species (trees where the diameter is measured at breast height [DBH]), this is the net volume of wood in the central stem of a sample tree 5.0 inches diameter or larger, from a 1- foot stump to a minimum 4-inch top. For woodland species (trees where the diameter is measured at root collar [DRC]), this is the net volume of wood from the DRC measurement point(s) to a minimum 1-1/2-inch top. This is a per tree value and must be multiplied by TPA_UNADJ to obtain per acre information." From *The Forest Inventory and Analysis Database: Database Description and Users Manual Version 4.0 for Phase 2.*

We interpolated the FIA data point to form a data surface across the forested area of New Mexico.

Though FIA data provide the best available information on New Mexico's forest attributes, it is far from perfect. The FIA measurements date from 1987 (33%) and 1999 (66%) and so are at least 10 years out of date. Current FIA measurements only cover a portion of the forested area of New Mexico.

*Data Source:* Forest Inventory and Analysis Database

***5b. Availability of Other Forest Products***

*Function:* The goal of this map is to identify areas in New Mexico's forests where forest products besides saw timber, often small diameter and underutilized material, could be harvested.

*Criteria:* The each pixel has a value from 1 to 10 where 1 represents very little potential for wood products and 10 represents the best potential to harvest wood products other than saw timber.

*Justification:* Though sawtimber commands the best price, many other products can be harvested from New Mexico's forests including poles, fire wood, and wood for energy production.

*Data Description:* We are exploring the possibility of using the difference between FIA's measures of total biomass (DRYBIOT) and merchantable biomass (DRYBIOM). Areas with high total biomass but low merchantable biomass would be likely to have economic potential for harvest of non-sawtimber products. Both DRYBIOT and DRYBIOM are per tree values and must be multiplied by TPA_UNADJ to obtain per acre information.

We interpolated the FIA data point to form a data surface across the forested area of New Mexico.

As mentioned above there are a number of caveats and limitations to the use of the currently available FIA data to estimate harvestable material.

*Data Source:* Forest Inventory and Analysis Database