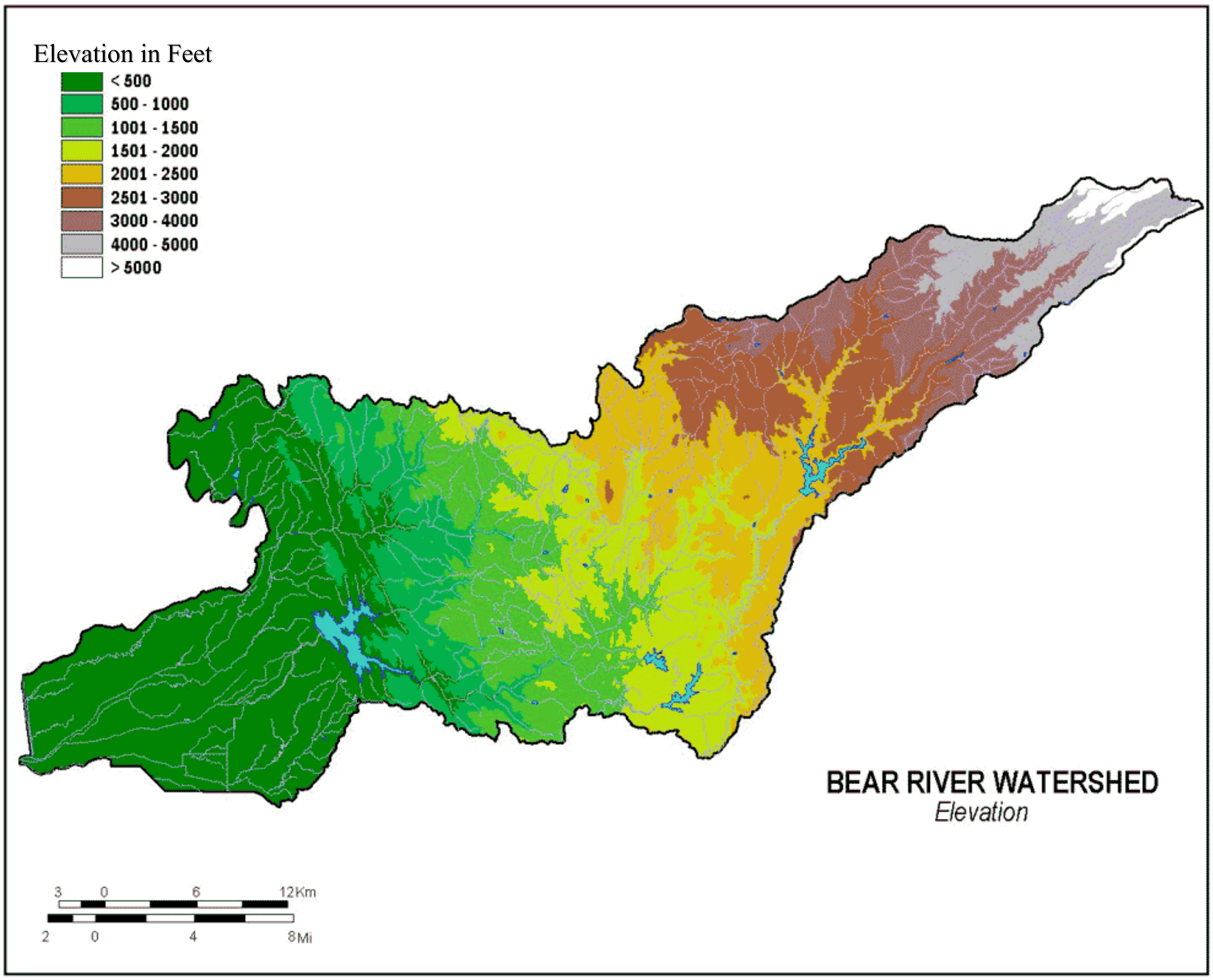
Bear River Watershed

Disturbance Inventory & Spatial Data Encyclopedia



A Report for
The Bear River CRMP Group and the Nevada County Resource Conservation District

by
Fraser Shilling, Ph.D. and Evan Girvetz
Department of Environmental Science and Policy
University of California, Davis 95616

Final Draft August 22, 2003

Contents

Figures

Tables

The authors: Fraser Shilling is a research scientist at the University of California, Davis. He has experience in aquatic ecology, geographic information system (GIS)-based decision-support in landscape evaluation and conservation planning, and technical support of watershed groups. Evan Girvetz is a post-graduate researcher with experience in GIS and its application in conservation planning. Reach the authors at: sierranetwork@ucdavis.edu.

Disturbance Inventory

I. Summary

The Bear River is located on the west-side of the "North/Central" Sierra Nevada and is a tributary to the Feather River. It is contained within the borders of Nevada, Placer, Sutter, and Yuba counties. The Bear River watershed drains from high-elevation conifer forests to Sacramento Valley agricultural areas. The water flows are heavily regulated for a combination of urban consumptive, agricultural irrigation, and hydropower uses. The River is listed under section 303(d) of the Clean Water Act for mercury and diazinon. The watershed itself is one of the most developed in the Sierra Nevada.

The Bear River Coordinated Resources Management Plan group, with the guidance of the Nevada County Resource Conservation District, has a contract under Proposition 204 to develop a "disturbance inventory" for the Bear River watershed. This report is intended to complement the CD-ROM and web site developed for the Bear River CRMP group by describing the resources and conditions of the watershed.

This inventory can be used to understand the general character of the watershed in terms of natural and human setting and large-scale changes. It would be useful in public education, developing land management proposals, and a base for more detailed studies of the biological, hydrological, geological, and sociological dimensions of the watershed. It should not be used as the basis for conclusive statements about specific parcels within the watershed, or specific resource extraction activities, since it only describes the watershed settings for these parcels and activities.

II. Inventory

Spatial and other data were collected for the Bear River watershed to represent the condition and extent of the natural resources and potential human impacts. Statewide, regional, and county level data were collected and "clipped" to the watershed boundary. The "metadata" for these data, or descriptions of the data, are contained with the "encyclopedia" that makes up the second half of this report. Data from individual monitoring stations within the watershed (e.g., precipitation) are expressed in tables or graphs.

A. Natural Setting

1. Plant Community Distribution

The distribution of plant species and communities is shown for the watershed in Figure 1. These plant distributions are determined by remote sensing and have not necessarily been ground-truthed for accuracy of plant community identification, or disturbance of the plant community by human activity. It therefore should be considered a map of "most likely" vegetation type for a particular area. Local-scale needs (e.g., for a particular parcel or section) should be met by on-the-ground surveys. The lower watershed (below Camp Far West Reservoir) is dominated by grasslands and agricultural production (row crops and orchards). The mid-watershed (below Rollins Reservoir/Chicago Park) is dominated by Blue Oak Woodlands, Blue Oak-Foothill Pine, and Mixed Hardwood/Conifer forests. The upper watershed (above Rollins Reservoir) is dominated by Montane Hardwood, Mixed Hardwood/Conifer, Sierran Mixed Conifer, and Pine forests. The data comes from the Gap Analysis Project (Davis and Stoms, 1996), which analyzed the vegetation cover on the ground.

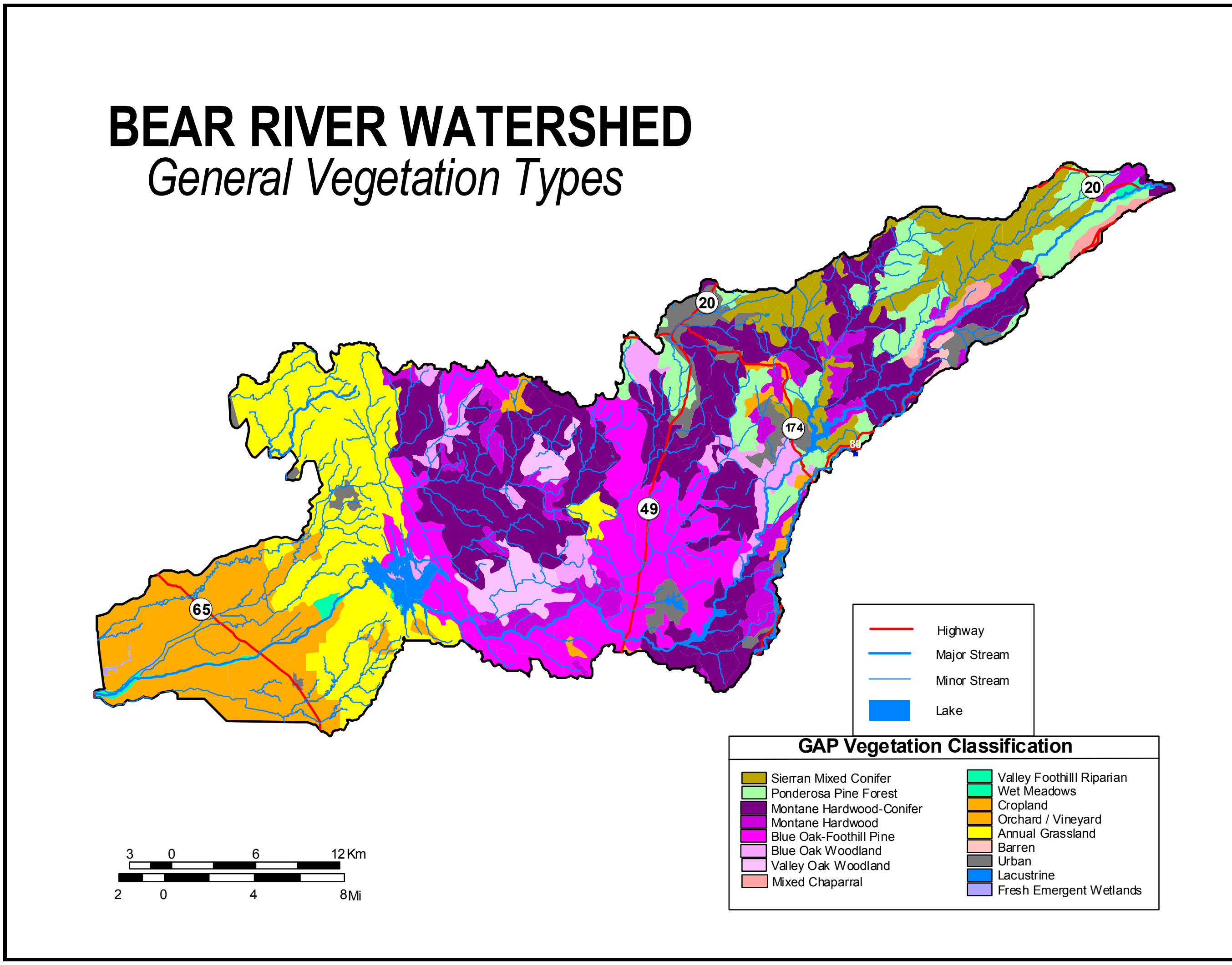


Figure 1

The table below shows examples of the dominant and associated plant species for each major plant community type found in the Bear River watershed. This is not an exhaustive list of all the plant species that could be present but rather the species that tend to be dominate the community composition.

Table 1 The plant communities and dominant species found in the Bear River watershed. The dominant species listed are from Gap Analysis Project (Davis and Stoms, 1996).

HABITAT TYPE	DOMINANT/ ASSOCIATE SPECIES
Annual Grass (AGS)	**Wild Oats, Soft Chess, Brome**
Barren (BAR)	**Rock, Pavement, Sand**
Blue Oak Woodland (BOW)	**Live Oak, Valley Oak,**
Blue Oak-Foothill Pine (BOP)	**Pine, Live Oak, Valley Oak, California Buckeye**
Closed Cone Pine-Cypress (CPC)	**, Foothill Pine**

Douglas Fir (DFR)	**Live oak, Tanoak, Ponderosa Pine**
Fresh Emergent Wetland (FEW)	**Big Leaf Sedge, Bulrush, Redroot NutGrass**
Potential Row Crops	**Corn, Dry Beans, Safflower, Alfalfa, Hay, Tomatoes, Cotton, Lettuce**
Juniper (JUN)	**White Fir, Jeffrey Pine, Ponderosa Pine**
Lacustrine (LAC)	**Plankton, Duckweed, Water Lillies**
Lodgepole Pine (LPN)	**Aspen, Mountain Hemlock, Red Fir**
Mixed Chaparral (MCH)	**Oaks, Ceanothus, Manzanita**
Montane Chaparral ((MCP)	**Ceanothus, Manzanita, Bitter Cherry**
Montane Hardwood (MHW)	**Canyon Live Oak, Douglas Fir, Knobcone Pine**
Montane Hardwood-Conifer (MHC)	**Ponderosa Pine, Douglas Fir, Incense Cedar**
Montane Riparian (MRI)	**Black Cottonwood, White Alder, Bigleaf Maple**
Ponderosa Pine (PPN)	**White Fir, Incense Cedar, Coulter Pine**
Red Fir (RFR)	**Noble Fir, White Fir, Lodgepole Pine**
Sagebrush (SGB)	**Rabbitbrush, Sagebrush, Gooseberry**
Sierran Mixed Conifer (SMC)	**White Fir, Douglas Fir, Ponderosa Pine**
Subalpine Conifer (SCN)	**Engelmann Spruce, Subalpine Fir, Mountain Hemlock**
Urban (URB)	**Grass Lawns, Trees, Hedges**
Valley Foothill Riparian (VRI)	**Cottonwood, Sycamore, Valley Oak**
Valley Oak Woodland (VOW)	**Sycamore, Black Walnut, Foothill Pine**
Vineyard (VIN)	**Grapes, Kiwi Fruit, Boysenberries**
Wet Meadow (WTM)	**Thingrass, Sedge, Spikerush**
White Fir (WFR)	**Live Oak, Jeffrey Pine, Sugar Pine**

2. *Major Animal Distribution*

Descriptions and distributions of plant community types (as above) can be used to infer the distribution of wildlife (amphibians, reptiles, birds, and mammals) within each plant community based on “wildlife habitat relations”. Particular plant communities are often home to certain wildlife species. Knowing the distribution of the plant communities is a clue for determining wildlife distribution. In the absence of surveys for wildlife, “guesses” at where wildlife are occurring should be used with caution and should not be used as the basis for any management or mitigation action. There are also databases maintained by the California Department of Fish and Game and the USDA Forest Service (among others) which list the species found through formal surveys, or casually observed by experts in the field. These databases can be accessed by formally requesting them from the relevant agencies. This is one of the weakest areas of data for watershed assessments; there are very few comprehensive surveys for wildlife, or plants, in the U.S.

a. Terrestrial vertebrate species

The following table shows the terrestrial/amphibious vertebrate wildlife species that *may* occur in the watershed according to the California Wildlife Habitat Relations model (CWHR). This model was developed by the California Department of Fish and Game and others and uses the plant community types in the area, habitat characteristics of the individual communities, and habitat needs of the individual species to determine the potential occupation of an area by particular species. The potential occupation ranks of 4 and 5 in the model refers to the higher quality habitat for particular species, or habitat they are more likely to occur in. Again, these are potential occurrences, not actual occurrences.

Table 2 The terrestrial wildlife that may occur in the Bear River watershed. This list is necessarily incomplete as the habitat needs for all vertebrate species have not been described sufficiently well. In addition, not all species will be necessarily found in the watershed, nor will the habitat quality necessarily be high.

Vertebrate Species with CWHR Ranks 4 and 5 in the Bear River Watershed

CWHR ID	Common Name (Scientific Name)
Amphibians	
A003	LONG-TOED SALAMANDER (AMBYSTOMA MACRODACTYLUM)
A007	CALIFORNIA NEWT (TARICHA TOROSA)
A012	ENSATINA (ENSATINA ESCHSCHOLTZII)
A014	CALIFORNIA SLENDER SALAMANDER (BATRACHOSEPS ATTENUATUS)
A023	MOUNT LYELL SALAMANDER (HYDROMANTES PLATYCEPHALUS)
A028	WESTERN SPADEFOOT (SCAPHIOPUS HAMMONDII)
A032	WESTERN TOAD (BUFO BOREAS)
A039	PACIFIC CHORUS FROG (PSEUDACRIS REGILLA)
A040	RED-LEGGED FROG (RANA AURORA)
A043	FOOTHILL YELLOW-LEGGED FROG (RANA BOYLII)
A044	MOUNTAIN YELLOW-LEGGED FROG (RANA MUSCOSA)
Birds	
B108	TURKEY VULTURE (CATHARTES AURA)
B110	OSPREY (PANDION HALIAETUS)
B111	WHITE-TAILED KITE (ELANUS LEUCURUS)
B114	NORTHERN HARRIER (CIRCUS CYANEUS)
B115	SHARP-SHINNED HAWK (ACCIPITER STRIATUS)
B116	COOPER'S HAWK (ACCIPITER COOPERII)
B117	NORTHERN GOSHAWK (ACCIPITER GENTILIS)
B119	RED-SHOULDERED HAWK (BUTEO LINEATUS)
B121	SWAINSON'S HAWK (BUTEO SWAINSONI)
B123	RED-TAILED HAWK (BUTEO JAMAICENSIS)
B126	GOLDEN EAGLE (AQUILA CHRYSAETOS)
B127	AMERICAN KESTREL (FALCO SPARVERIUS)
B129	PEREGRINE FALCON (FALCO PEREGRINUS)
B131	PRAIRIE FALCON (FALCO MEXICANUS)
B134	BLUE GROUSE (DENDRAGAPUS OBSCURUS)
B140	CALIFORNIA QUAIL (CALLIPEPLA CALIFORNICA)
B141	MOUNTAIN QUAIL (OREORTYX PICTUS)
B251	BAND-TAILED PIGEON (COLUMBA FASCIATA)
B255	MOURNING DOVE (ZENAIDA MACROURA)
B259	YELLOW-BILLED CUCKOO (COCCYZUS AMERICANUS)
B260	GREATER ROADRUNNER (GEOCOCCYX CALIFORNIANUS)
B262	BARN OWL (TYTO ALBA)
B263	FLAMMULATED OWL (OTUS FLAMMEOLUS)
B264	WESTERN SCREECH-OWL (OTUS KENNICOTTII)
B265	GREAT HORNED OWL (BUBO VIRGINIANUS)
B267	NORTHERN PYGMY-OWL (GLAUCIDIUM GNOMA)
B269	BURROWING OWL (SPEOTYTO CUNICULARIA)
B270	SPOTTED OWL (STRIX OCCIDENTALIS)
B272	LONG-EARED OWL (ASIO OTUS)
B274	NORTHERN SAW-WHET OWL (AEGOLIUS ACADICUS)
B275	LESSER NIGHTHAWK (CHORDEILES ACUTIPENNIS)
B276	COMMON NIGHTHAWK (CHORDEILES MINOR)
B277	COMMON POORWILL (PHALAENOPTILUS NUTTALLII)

B279 BLACK SWIFT (CYPSELOIDES NIGER)
B282 WHITE-THROATED SWIFT (AERONAUTES SAXATALIS)
B286 BLACK-CHINNED HUMMINGBIRD (ARCHILOCHUS ALEXANDRI)
B287 ANNA'S HUMMINGBIRD (CALYPTE ANNA)
B289 CALLIOPE HUMMINGBIRD (STELLULA CALLIOPE)
B293 BELTED KINGFISHER (CERYLE ALCYON)
B294 LEWIS' WOODPECKER (MELANERPES LEWIS)
B296 ACORN WOODPECKER (MELANERPES FORMICIVORUS)
B299 RED-BREASTED SAPSUCKER (SPHYRAPICUS RUBER)
B302 NUTTALL'S WOODPECKER (PICOIDES NUTTALLII)
B303 DOWNY WOODPECKER (PICOIDES PUBESCENS)
B304 HAIRY WOODPECKER (PICOIDES VILLOSUS)
B305 WHITE-HEADED WOODPECKER (PICOIDES ALBOLARVATUS)
B307 NORTHERN FLICKER (COLAPTES AURATUS)
B308 PILEATED WOODPECKER (DRYOCOPUS PILEATUS)
B309 OLIVE-SIDED FLYCATCHER (CONTOPUS BOREALIS)
B311 WESTERN WOOD-PEWEE (CONTOPUS SORDIDULUS)
B317 HAMMOND'S FLYCATCHER (EMPIDONAX HAMMONDII)
B318 DUSKY FLYCATCHER (EMPIDONAX OBERHOLSERI)
B320 PACIFIC-SLOPE FLYCATCHER (EMPIDONAX DIFFICILIS)
B321 BLACK PHOEBE (SAYORNIS NIGRICANS)
B326 ASH-THROATED FLYCATCHER (MYIARCHUS CINERASCENS)
B333 WESTERN KINGBIRD (TYRANNUS VERTICALIS)
B337 HORNED LARK (EREMOPHILA ALPESTRIS)
B338 PURPLE MARTIN (PROGNE SUBIS)
B339 TREE SWALLOW (TACHYCINETA BICOLOR)
B340 VIOLET-GREEN SWALLOW (TACHYCINETA THALASSINA)
B341 NORTHERN ROUGH-WINGED SWALLOW (STELGIDOPTERYX SERRIPENNIS)
B342 BANK SWALLOW (RIPARIA RIPARIA)
B343 CLIFF SWALLOW (HIRUNDO PYRRHONOTA)
B344 BARN SWALLOW (HIRUNDO RUSTICA)
B346 STELLER'S JAY (CYANOCITTA STELLERI)
B348 SCRUB JAY (APHELOCOMA COERULESCENS)
B352 YELLOW-BILLED MAGPIE (PICA NUTTALLI)
B353 AMERICAN CROW (CORVUS BRACHYRHYNCHOS)
B354 COMMON RAVEN (CORVUS CORAX)
B356 MOUNTAIN CHICKADEE (PARUS GAMBELI)
B357 CHESTNUT-BACKED CHICKADEE (PARUS RUFESCENS)
B358 PLAIN TITMOUSE (PARUS INORNATUS)
B360 BUSHTIT (PSALTRIPARUS MINIMUS)
B361 RED-BREASTED NUTHATCH (SITTA CANADENSIS)
B362 WHITE-BREASTED NUTHATCH (SITTA CAROLINENSIS)
B363 PYGMY NUTHATCH (SITTA PYGMAEA)
B364 BROWN CREEPER (CERTHIA AMERICANA)
B366 ROCK WREN (SALPINCTES OBSOLETUS)
B367 CANYON WREN (CATHERPES MEXICANUS)
B368 BEWICK'S WREN (THRYOMANES BEWICKII)
B369 HOUSE WREN (TROGLODYTES AEDON)
B370 WINTER WREN (TROGLODYTES TROGLODYTES)
B372 MARSH WREN (CISTOTHORUS PALUSTRIS)
B373 AMERICAN DIPPER (CINCLUS MEXICANUS)
B375 GOLDEN-CROWNED KINGLET (REGULUS SATRAPA)
B376 RUBY-CROWNED KINGLET (REGULUS CALENDULA)
B377 BLUE-GRAY GNATCATCHER (POLIOPTILA CAERULEA)

B380 WESTERN BLUEBIRD (SIALIA MEXICANA)
B381 MOUNTAIN BLUEBIRD (SIALIA CURRUCOIDES)
B382 TOWNSEND'S SOLITAIRE (MYADESTES TOWNSENDI)
B385 SWAINSON'S THRUSH (CATHARUS USTULATUS)
B386 HERMIT THRUSH (CATHARUS GUTTATUS)
B389 AMERICAN ROBIN (TURDUS MIGRATORIUS)
B391 WRENTIT (CHAMAEA FASCIATA)
B393 NORTHERN MOCKINGBIRD (MIMUS POLYGLOTTOS)
B398 CALIFORNIA THRASHER (TOXOSTOMA REDIVIVUM)
B408 PHAINOPEPLA (PHAINOPEPLA NITENS)
B410 LOGGERHEAD SHRIKE (LANIUS LUDOVICIANUS)
B415 SOLITARY VIREO (VIREO SOLITARIUS)
B417 HUTTON'S VIREO (VIREO HUTTONI)
B418 WARBLING VIREO (VIREO GILVUS)
B425 ORANGE-CROWNED WARBLER (VERMIVORA CELATA)
B426 NASHVILLE WARBLER (VERMIVORA RUFICAPILLA)
B430 YELLOW WARBLER (DENDROICA PETECHIA)
B435 YELLOW-RUMPED WARBLER (DENDROICA CORONATA)
B436 BLACK-THROATED GRAY WARBLER (DENDROICA NIGRESCENS)
B438 HERMIT WARBLER (DENDROICA OCCIDENTALIS)
B460 MACGILLIVRAY'S WARBLER (OPORORNIS TOLMIEI)
B461 COMMON YELLOWTHROAT (GEOTHLYPIS TRICHAS)
B463 WILSON'S WARBLER (WILSONIA PUSILLA)
B467 YELLOW-BREASTED CHAT (ICTERIA VIRENS)
B471 WESTERN TANAGER (PIRANGA LUDOVICIANA)
B475 BLACK-HEADED GROSBEAK (PHEUCTICUS MELANOCEPHALUS)
B476 BLUE GROSBEAK (GUIRACA CAERULEA)
B477 LAZULI BUNTING (PASSERINA AMOENA)
B482 GREEN-TAILED TOWHEE (PIPILO CHLORURUS)
B483 RUFOUS-SIDED TOWHEE (PIPILO ERYTHROPHTHALMUS)
B484 CALIFORNIA TOWHEE (PIPILO CRISSALIS)
B487 RUFOUS-CROWNED SPARROW (AIMOPHILA RUFICEPS)
B489 CHIPPING SPARROW (SPIZELLA PASSERINA)
B495 LARK SPARROW (CHONDESTES GRAMMACUS)
B504 FOX SPARROW (PASSERELLA ILIACA)
B505 SONG SPARROW (MELOSPIZA MELODIA)
B506 LINCOLN'S SPARROW (MELOSPIZA LINCOLNII)
B510 WHITE-CROWNED SPARROW (ZONOTRICHIA LEUCOPHRYS)
B512 DARK-EYED JUNCO (JUNCO HYEMALIS)
B519 RED-WINGED BLACKBIRD (AGELAIUS PHOENICEUS)
B520 TRICOLORED BLACKBIRD (AGELAIUS TRICOLOR)
B521 WESTERN MEADOWLARK (STURNELLA NEGLECTA)
B522 YELLOW-HEADED BLACKBIRD (XANTHOCEPHALUS XANTHOCEPHALUS)
B524 BREWER'S BLACKBIRD (EUPHAGUS CYANOCEPHALUS)
B528 BROWN-HEADED COWBIRD (MOLOTHRUS ATER)
B530 HOODED ORIOLE (ICTERUS CUCULLATUS)
B532 NORTHERN ORIOLE (ICTERUS GALBULA)
B536 PURPLE FINCH (CARPODACUS PURPUREUS)
B537 CASSIN'S FINCH (CARPODACUS CASSINII)
B538 HOUSE FINCH (CARPODACUS MEXICANUS)
B539 RED CROSSBILL (LOXIA CURVIROSTRA)
B542 PINE SISKIN (CARDUELIS PINUS)
B543 LESSER GOLDFINCH (CARDUELIS PSALTRIA)
B544 LAWRENCE'S GOLDFINCH (CARDUELIS LAWRENCEI)

B545 AMERICAN GOLDFINCH (CARDUELIS TRISTIS)
B546 EVENING GROSBEAK (COCCOTHRAUSTES VESPERTINUS)

Mammals

M006 ORNATE SHREW (SOREX ORNATUS)
M010 WATER SHREW (SOREX PALUSTRIS)
M012 TROWBRIDGE'S SHREW (SOREX TROWBRIDGII)
M018 BROAD-FOOTED MOLE (SCAPANUS LATIMANUS)
M045 BRUSH RABBIT (SYLVILAGUS BACHMANI)
M047 DESERT COTTONTAIL (SYLVILAGUS AUDUBONII)
M049 SNOWSHOE HARE (LEPUS AMERICANUS)
M051 BLACK-TAILED JACK RABBIT (HARE) (LEPUS CALIFORNICUS)
M052 MOUNTAIN BEAVER (APLODONTIA RUFA)
M055 YELLOW-PINE CHIPMUNK (TAMIAS AMOENUS)
M057 ALLEN'S CHIPMUNK (TAMIAS SENEX)
M062 LONG-EARED CHIPMUNK (TAMIAS QUADRIMACULATUS)
M063 LODGEPOLE CHIPMUNK (TAMIAS SPECIOSUS)
M066 YELLOW-BELLIED MARMOT (MARMOTA FLAVIVENTRIS)
M072 CALIFORNIA GROUND SQUIRREL (SPERMOPHILUS BEECHEYI)
M075 GOLDEN-MANTLED GROUND SQUIRREL (SPERMOPHILUS LATERALIS)
M077 WESTERN GRAY SQUIRREL (SCIURUS GRISEUS)
M079 DOUGLAS' SQUIRREL (TAMIASCIURUS DOUGLASII)
M080 NORTHERN FLYING SQUIRREL (GLAUCOMYS SABRINUS)
M081 BOTTA'S POCKET GOPHER (THOMOMYS BOTTAE)
M085 MOUNTAIN POCKET GOPHER (THOMOMYS MONTICOLA)
M087 SAN JOAQUIN POCKET MOUSE (PEROGNATHUS INORNATUS)
M095 CALIFORNIA POCKET MOUSE (CHAETODIPUS CALIFORNICUS)
M105 CALIFORNIA KANGAROO RAT (DIPODOMYS CALIFORNICUS)
M112 AMERICAN BEAVER (CASTOR CANADENSIS)
M113 WESTERN HARVEST MOUSE (REITHRODONTOMYS MEGALOTIS)
M117 DEER MOUSE (PEROMYSCUS MANICULATUS)
M119 BRUSH MOUSE (PEROMYSCUS BOYLII)
M120 PINON MOUSE (PEROMYSCUS TRUEI)
M127 DUSKY-FOOTED WOODRAT (NEOTOMA FUSCIPES)
M128 BUSHY-TAILED WOODRAT (NEOTOMA CINEREA)
M133 MONTANE VOLE (MICROTUS MONTANUS)
M134 CALIFORNIA VOLE (MICROTUS CALIFORNICUS)
M136 LONG-TAILED VOLE (MICROTUS LONGICAUDUS)
M139 MUSKRAT (ONDATRA ZIBETHICUS)
M143 WESTERN JUMPING MOUSE (ZAPUS PRINCEPS)
M145 COMMON PORCUPINE (ERETHIZON DORSATUM)
M146 COYOTE (CANIS LATRANS)
M149 COMMON GRAY FOX (UROCYON CINEREOARGENTEUS)
M151 BLACK BEAR (URSUS AMERICANUS)
M152 RINGTAIL (BASSARISCUS ASTUTUS)
M153 COMMON RACCOON (PROCYON LOTOR)
M154 AMERICAN MARTEN (MARTES AMERICANA)
M155 FISHER (MARTES PENNANTI)
M156 ERMINE (MUSTELA ERMINEA)
M157 LONG-TAILED WEASEL (MUSTELA FRENATA)
M158 MINK (MUSTELA VISON)
M160 AMERICAN BADGER (TAXIDEA TAXUS)
M161 WESTERN SPOTTED SKUNK (SPILOGALE GRACILIS)
M162 STRIPED SKUNK (MEPHITIS MEPHITIS)
M163 NORTHERN RIVER OTTER (LUTRA CANADENSIS)

M165 MOUNTAIN LION (FELIS CONCOLOR)
M166 BOBCAT (LYNX RUFUS)
M181 MULE DEER (ODOCOILEUS HEMIONUS)

Reptiles

R004 WESTERN POND TURTLE (CLEMMYS MARMORATA)
R022 WESTERN FENCE LIZARD (SCELOPORUS OCCIDENTALIS)
R023 SAGEBRUSH LIZARD (SCELOPORUS GRACIOSUS)
R029 COAST HORNED LIZARD (PHRYNOSOMA CORONATUM)
R036 WESTERN SKINK (EUMECES SKILTONIANUS)
R037 GILBERT'S SKINK (EUMECES GILBERTI)
R039 WESTERN WHIPTAIL (CNEMIDOPHORUS TIGRIS)
R040 SOUTHERN ALLIGATOR LIZARD (ELGARIA MULTICARINATA)
R042 NORTHERN ALLIGATOR LIZARD (ELGARIA COERULEA)
R046 RUBBER BOA (CHARINA BOTTAE)
R048 RINGNECK SNAKE (DIADOPHIS PUNCTATUS)
R049 SHARPTAIL SNAKE (CONTIA TENUIS)
R051 RACER (COLUBER CONSTRICTOR)
R053 CALIFORNIA WHIPSNAKE (MASTICOPHIS LATERALIS)
R057 GOPHER SNAKE (PITUOPHIS MELANOLEUCUS)
R058 COMMON KINGSNAKE (LAMPROPELTIS GETULA)
R059 CALIFORNIA MOUNTAIN KINGSNAKE (LAMPROPELTIS ZONATA)
R060 LONGNOSE SNAKE (RHINOCHEILUS LECONTEI)
R061 COMMON GARTER SNAKE (THAMNOPHIS SIRTALIS)
R062 WESTERN TERRESTRIAL GARTER SNAKE (THAMNOPHIS ELEGANS)
R063 WESTERN AQUATIC GARTER SNAKE (THAMNOPHIS COUCHII)
R071 NIGHT SNAKE (HYPSIGLENA TORQUATA)
R076 WESTERN RATTLESNAKE (CROTALUS VIRIDIS)

b. Fish species

The following native fish species (Table 3) are known to occur in the watershed (Moyle *personal communication* and Moyle et al., 1996), with the highest richness of species being in the lower watershed (Moyle *personal communication* and Moyle et al., 1996). This is not an exhaustive list of species, the descriptions in parentheses refers to the population status of each species in the Sierra Nevada (Moyle et al., 1996). There are currently only very general distribution maps for these species.

Table 3 Native fish potentially occurring in the watershed.

Common Name	**Latin Name**	**Status**
Black Crappie	*Pomoxis nigromaculatus*	stable
Chinook Salmon	*Oncorynchus tshawytscha*	Declining, special concern
Hardhead	*Mylopharodon conocephalus*	special concern
Pacific Lamprey	*Lampetra tridentate*	declining
California Roach	*Lavinia symmetricus*	stable
Riffle Sculpin	*Cottus gulosus*	stable
native trout	*Oncorynchus mykiss* ssp.),	stable
speckled dace	*Rhinichtys osculus* ssp	stable
Sacramento squawfish	*Ptychocheilus grandis*	stable or expanding
Sacramento sucker	*Catostomus o. occidentalis*	stable or expanding

3. Rare, Sensitive, Threatened, and Endangered Species Occurrences (California Natural Diversity Database, CNDDB)

The following plant and animal species listed in the CNDDB are found in the watershed: (animals) Giant garter snake, Chinook salmon, Northwestern pond turtle, California horned lizard (plants) Stebbin's morning glory, Pine Hill flannelbush, Follett's monardella, Red-anthered rush, Wooly violet, and Monadenia Mormonum buttoni (Figure 2). This should not be interpreted as meaning the only rare or endangered species present in the watershed are on this list as this database is not the result of intensive surveys of wildlife and plants. The records in this database come from a combination of casual observations and local surveys by experts. The database records occurrences and may indicate the suitability of a place for particular wildlife, but certainly does not show all of the places the species actually occur. For example, both the author and CDF&G staff have observed salmon in the lower Bear River, in contrast to what is shown on the map (no occurrence).

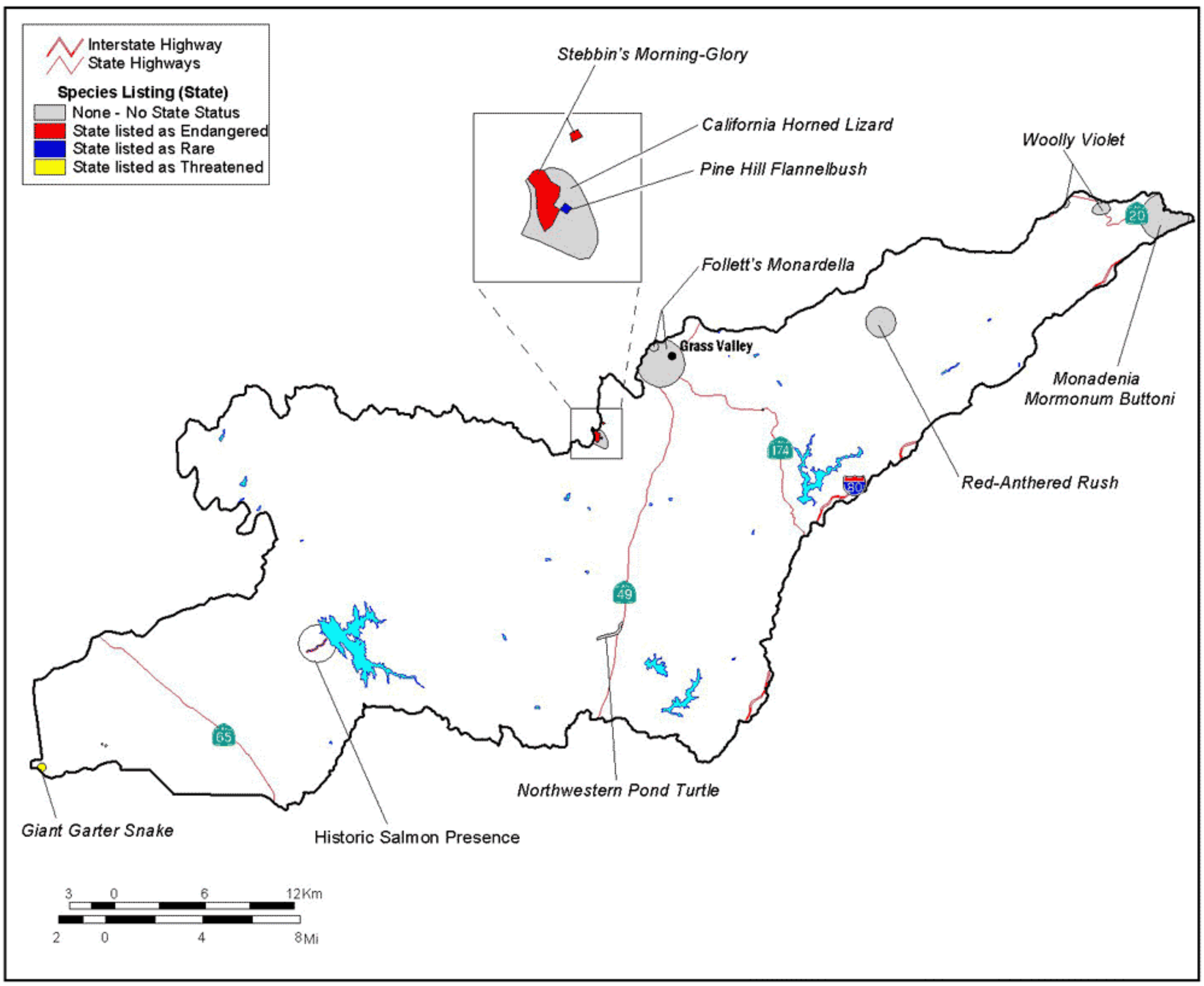


Figure 2

4. Invasive Plant Species: Identification and range

Invasive weeds can replace native plant and animal species and fundamentally alter ecological processes (such as fire ecology and plant community succession). The presence of weeds does not, however, mean that there are no native plant species present, or that restoration is not possible. The presence of weed seed banks in the soil and adjacent areas can make restoration a difficult and continuing issue.

The following weeds occur in Nevada, Placer, Sutter, and Yuba Counties: Dalmation toadflax (*Linaria genistifolia ssp. dalmatica*), Italian thistle (*Carduus pycnocephalus*), Klamathweed (*Hypericum perforatum*), Musk thistle (*Carduus nutans*), Puncturevine (*Tribulus terrestris*), Scotch thistle (*Onopardium acanthium*), Spotted knapweed (*Centaurea maculosa*), Diffuse knapweed (*Centaurea diffusa*), Yellow starthistle (*Centaurea solstitialis*), Himalayan blackberry (*Rubus discolor*), Scotch broom (*Cytisus scoparius*), gorse (*Ulex europaeus*), Skeletonweed (*Chondrella juncea*), Coontail (*Ceratophyllum demersum*), and Hydrilla (*Hydrilla verticillata*). (http://endeavor.des.ucdavis.edu/weeds/countylist.asp)

There are currently no maps of the distribution of these invasive plants, or the change in distribution over time. Both types of information are important in determining threat of invasion, spread, and occupancy by existing native vegetation. The USFS and other agencies and organizations are collecting this information for limited areas, but definitely need additional resources/assistance. The list above does not reflect the replacement of native grassland species at lower elevations by introduced European grass species for grazing purposes.

5. Soils of Western Nevada County, Placer County, Yuba County, and Sutter County

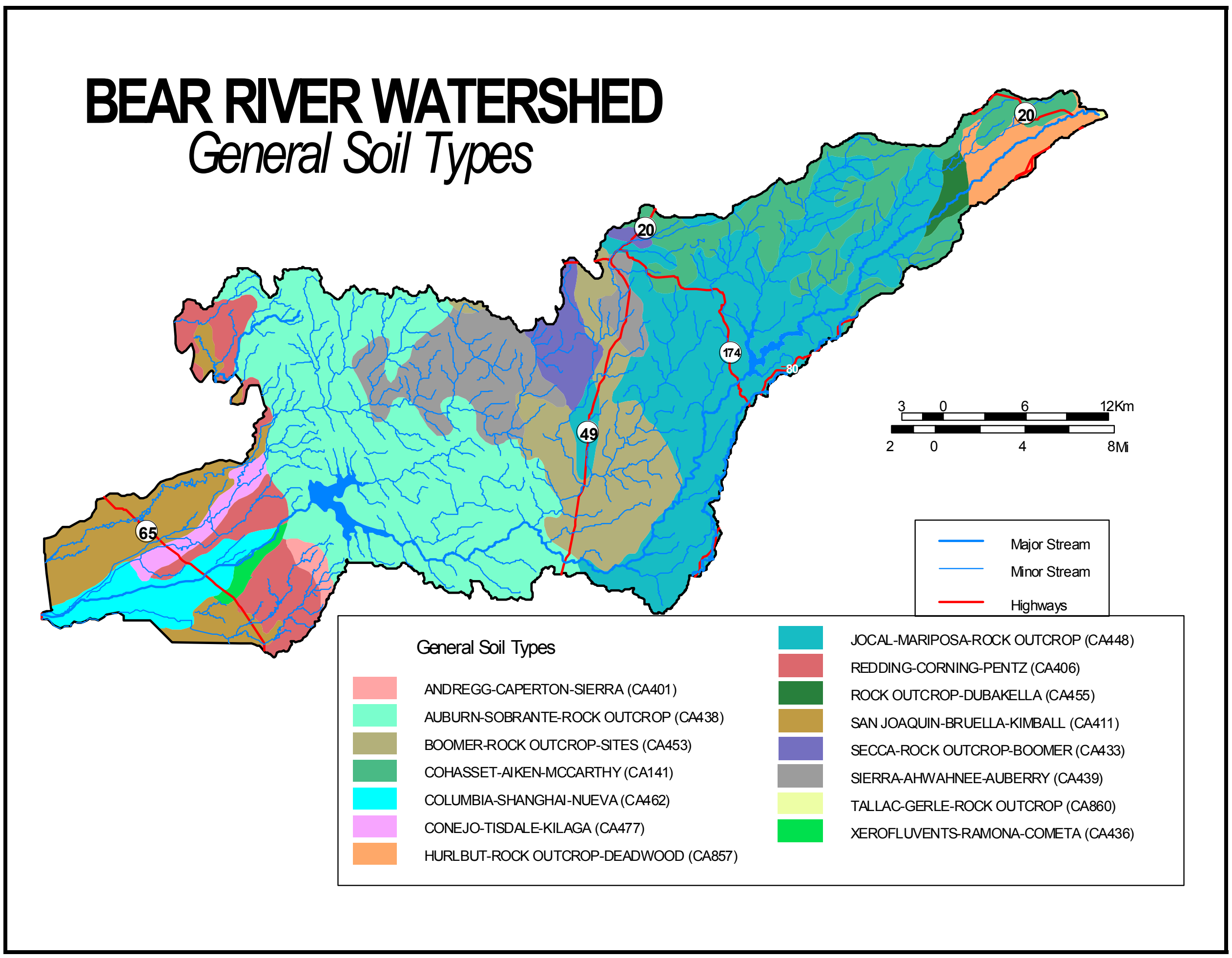


Figure 3

The soil map, Figure 3, is a relatively low-resolution representation of soil series distribution 1:250,000), which will be replaced by a 1:24,000 resolution map from the Natural Resources Conservation Services in the relatively near future. Soil types have different rates of erosion, percolation, and other processes. A high resolution map will be critical to long-term planning for soil conservation in sub-watersheds.

6. Geo-morphology and Hydrology

a. Area and delineation of watersheds

The Bear River watershed begins at over 5,000 feet elevation (Figure 4) and ends at the point the Bear River joins the Feather River (<100 feet elevation). The watershed is 296,452 acres, or 463 square miles. It is one of the smallest "river" basins in the Sierra Nevada; in comparison, the Yuba basin is over 800,000 acres (CALWATER 2.2). The watershed called "Bear River" in CALWATER 2.2 includes waterways that do not join the Bear River before their confluence with the Feather River primarily for administrative convenience. In other words, the lack of hydrologic connection with the Bear River means that these other waterways (in the lower watershed) should probably not be included in the Bear River watershed boundary.

b. Stream Mileage

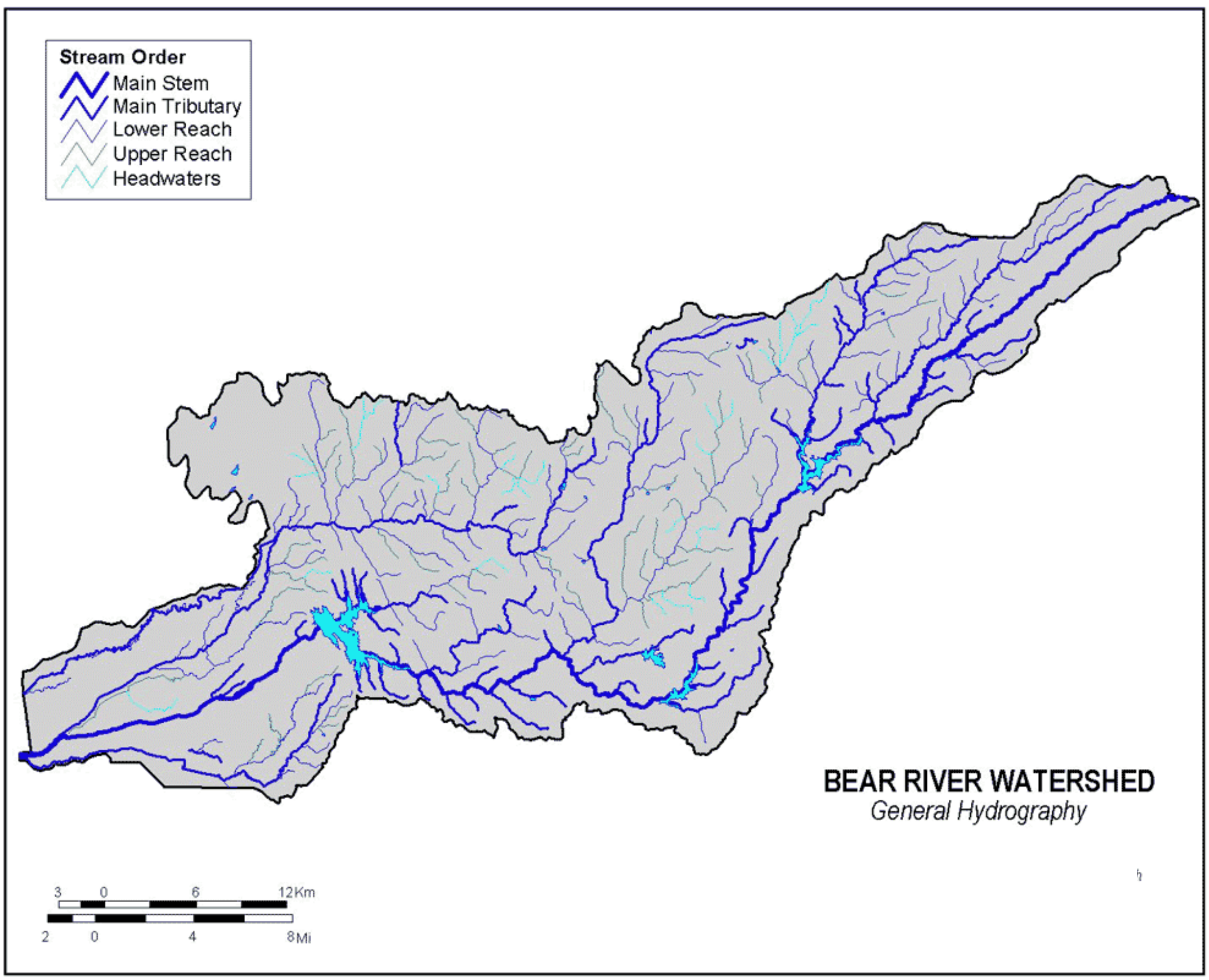


Figure 4

There are over 990 miles of streams, creeks, and rivers within the Bear River watershed (Figure 4, National Hydrography Dataset 1999). These range from small creeks running most of the year to the mainstem of the Bear River itself. The ephemeral, or seasonal streams are not included in the mileage figure because they have not been well mapped. If included they would increase the total mileage by several-fold. Each creek or stream has its own watershed (drainage area), which are called "sub-watersheds" here to indicate that they are within the larger Bear River watershed.

c. Topography

The majority of the basin consists of steep-sided creek and river canyons, like its larger neighboring watershed the Yuba River (Figure 5). A large portion of the watershed is in the lower foothills and the Valley, characterized by gentler slopes (<30 degrees). Slope steepness is a critical piece of information when assessing risk of erosion, slope failure, or risk to and from infrastructure (e.g., roads). Similarly, slope steepness should be an important factor in determining the management or development practices carried out on the landscape. This is primarily due to the potential for these activities to contribute to soil erosion and slope failure. Currently, data about steepness comes from a "digital elevation model" (DEM) based on 30 m X 30 m "pixels".

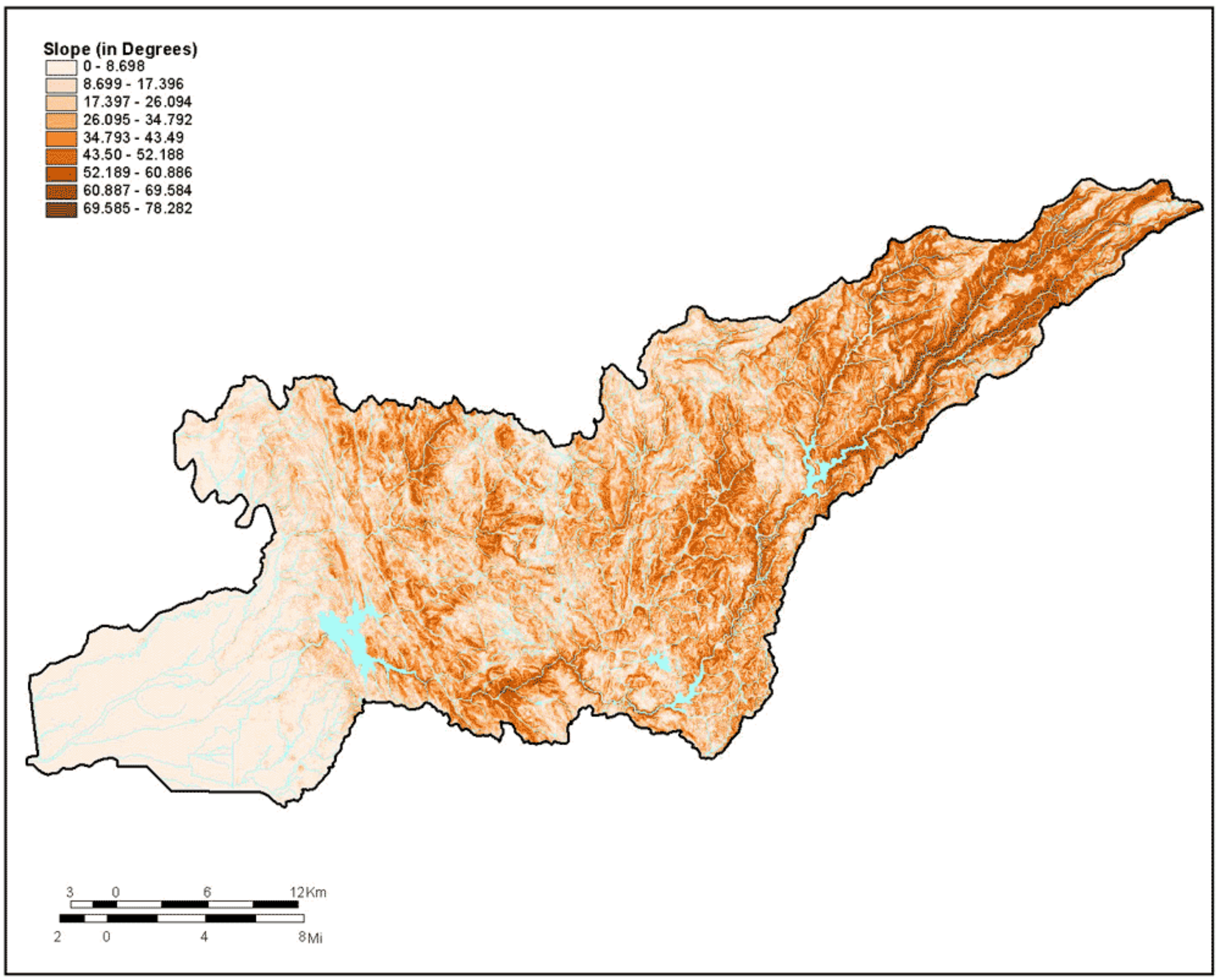


Figure 5

d. Hydrologic Cycle

The hydrologic cycle consists of the interactions among water "compartments" (e.g., water vapor in the atmosphere), which are driven by weather patterns, geomorphology of the watershed, plant cover, and other conditions. The rate of water movement among the main compartments can be measured (e.g., precipitation), allowing for assessment of the amount and distribution of water and planning for water movement, conservation, and consumption. These data are critical for understanding the natural processes, as well as the impacts of human activities on these processes.

i. Location of Stations

Various agencies and Pacific Gas & Electric maintain measuring devices at particular locations in the watershed for in-stream flow, climatic conditions, precipitation, and storage (Figure 6). In general, there are very few such stations. There are three long-term stations for measuring precipitation and flow measurements are primarily on the mainstem of the Bear River. Large areas of the watershed have no effective measurements of the hydrologic cycle. This situation would be best remedied by installing stations on tributaries such as Wolf Creek and making the data publicly available, as is the case for most hydrologic data in the watershed. The data should also be confirmed buy the local agency as soon as possible after collection.

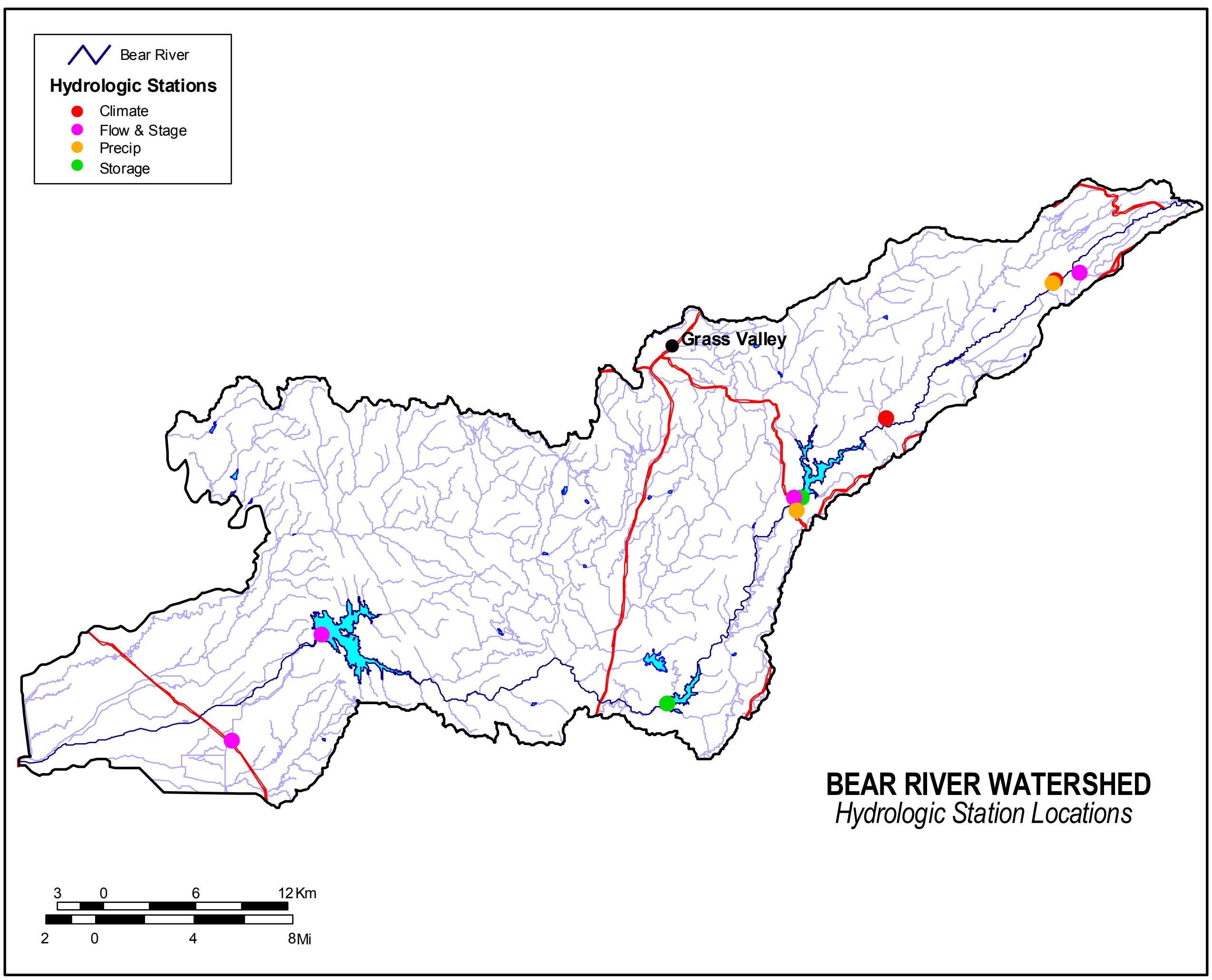


Figure 6

Table 4 Locations, operators, and descriptions of climate, flow, and reservoir monitoring stations.

LABEL	TYPE	NAME	COUNTY	ELEV.	OPERATOR	INFO UPDATE
C3	Climate	Secret Town	Nevada	2720	CDF	Hourly
C1	Climate	Drum Power House	Placer	3400	PG&E	Daily
S1	Storage	Rollins Reservoir	Placer	2176	NID	Monthly
F2	Flow	Bear River Canal	Placer	1980	PG&E	Daily / Monthly
F5	Flow	Bear River near Wheatland	Placer	72	USGS & DWR	Event / Hourly
F4	Flow	Camp Far West Dam	Yuba	260	DWR	Event / Hourly
S2	Storage	Combie Reservoir	Nevada	1610	NID	Monthly
C5	Climate	Colfax	Placer	2400	NWS	Daily
C2	Climate	Drum Powerhouse Forebay	Placer	3400	PG&E	Daily
F1	Flow	Drum Canal	Placer	4750	PG&E	Monthly
F3	Flow	Bear River below Wolf Creek	Pla/Nev	350	S. Sutter Water District	
C4	Climate	Grass Valley	Nevada	2400	NWS	Monthly

CDF California Department of Forestry
PG&E Pacific Gas & Electric
USGS United States Geological Survey
DWR California Department of Water Resources
NWS National Weather Service
NID Nevada Irrigation District

Table 5 Location on the internet of data for each of the monitoring stations.

LABEL	NAME	WEB LOCATION OF DATA
C3	Secret Town	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=SRT
C1	Drum Power House	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=DPH
S1	Rollins	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=RLL
F2	Bear River Canal	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=BEV
F5	Bear River near Wheatland	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=BRW
F4	Camp Far West Dam	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CFW
S2	Combie Lake	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CMB
C5	Colfax	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CLF
C2	Drum Powerhouse Forebay	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=DMF
F1	Drum Canal	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=DRM
F3	Wolf Creek	NID
C4	Grass Valley	http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=GSV

ii. Precipitation

Knowing where, when, and how much rain falls is a critical part of watershed assessment and planning. There are several stations for collecting these data in the watershed (see above), as well as models that map likely precipitation distribution (see below). The amount of precipitation determines water management regimes, flood potential, natural flows, erosion processes, and health of the plant communities. On a short-term basis, keeping track of precipitation is important in determining when to go and monitor water quality and other rain-sensitive parameters. Long-term changes in precipitation impact ecological processes and the predictability of water diversions and storage. Tracking and understanding these changes is a critical part of water management. There are data for actual precipitation in the watershed. The graph below (Figure 7) shows precipitation data for one monitoring station within the watershed over a 10-year period. The highest peak in the graph represents the series of storms around New Year's Day, 1997.

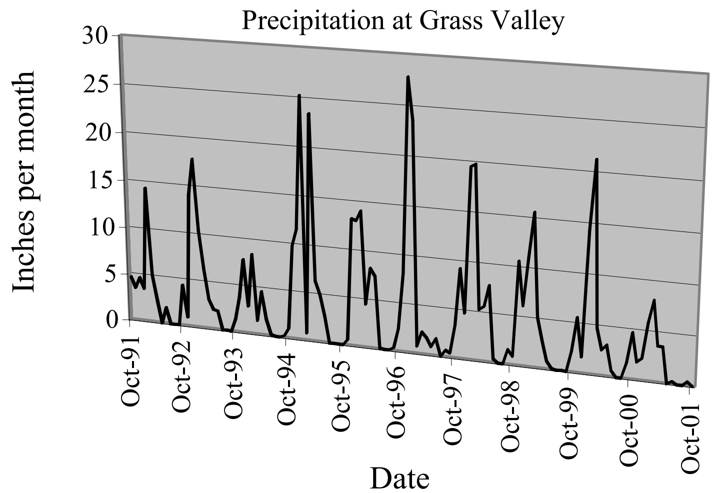


Figure 7

7. *Fire history and extent*

There have been 64 major fires in the Bear River basin recorded since 1910 (Figure 8 and Table 5). These range in size from an unnamed 6-acre fire in 1951 to the 36,342 acre 49'er fire of 1988. The total burned area in the last 91 years is 90,796 acres. However, several areas have burned twice or more (e.g., the series of fires in upper Greenhorn Creek). A total of about 80,000 acres (27%) of the 296,452-acre watershed has burned in the last century. This is roughly equivalent to a *fire rotation* of 337 years, which is higher than has been found for the Sierra Nevada in general. The range of fire rotations found between 1908 and 1992 in the Sierra Nevada by plant community type is from 57 years for interior live oak to 192 years for Ponderosa pine (McKelvey and Busse, 1996). The *fire-return interval* is less than 100 years for those areas that have burned twice or more in the last 91 years, but the majority of burned areas have only burned once in the last 91years, thus they have a fire-return interval of >100 years. A "normal" fire return interval for Sierra Nevada foothill forests was 28.5 years (median interval) before 1848 and 7-8 years after 1848 (Skinner and Chang, 1996). In grazed areas, these intervals are significantly longer (>60 years) due to the introduction of grazing (Mensing, 1988). Fire return intervals for mixed conifer forests range from 8 to 18 years (Skinner and Chang, 1996) for intact forests and are longer where fire suppression and logging have changed the landscape. The conclusion from these numbers is that the Bear River watershed is experiencing few of the small low-intensity fires that are expected for the plant community types. This results in an increase in fuel loading in certain forest types and a concomitant increase in risk of larger fires. National Park Service scientists have used prescribed fire in the Central and Northern Sierra to reduce fuel loadings and thus fire risk, with the added benefit that prescribed fire costs per acre are about 1/50 of the costs of fighting wildfires in the same area (Husari and McKelvey, 1996). The authors of the cited study found that the main limitation on the success of the program was concern about smoke and to a lesser extent the availability of funding. Even though this management approach has not been used much outside of National Parks, does not mean it is not a viable way to maintain natural disturbance processes in forested ecosystems where people live, such as the Bear River watershed.

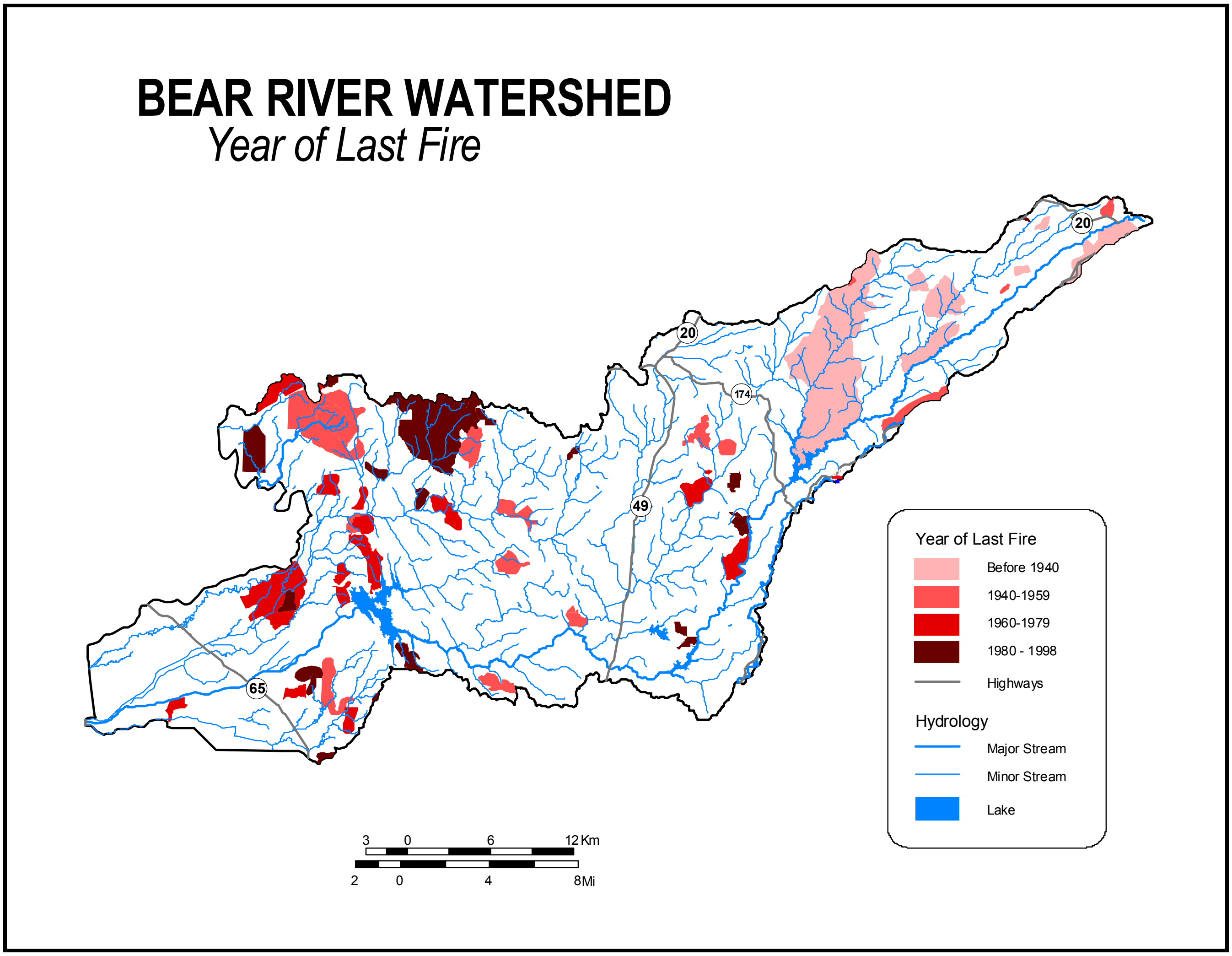


Figure 8

Table 6 Fire history of the Bear River watershed since 1910. Not all fires occurred only in the Bear River watershed (e.g., 49'er)

Year	Fire Name	Acres Burned	Cause	Watershed
1910		2852	Unknown	Greenhorn Creek
1911		425	Unknown	Greenhorn Creek
1916		1506	Unknown	Steephollow Creek
1916		3924	Unknown	Greenhorn Creek/Clipper Creek
1917		6270	Unknown	Greenhorn Creek/Rollins Reservoir
1919		177	Unknown	Steephollow Creek/Upper Bear above Rollins Res.
1919		611	Unknown	Upper Bear above Rollins Reservoir
1923		445	Unknown	Greenhorn Creek
1924		1401	Unknown	Steephollow Creek/Upper Bear above Rollins Res.
1924		1770	Unknown	Upper Bear above Rollins Reservoir
1931		172	Unknown	Steephollow Creek
1943		323	Unknown	Upper Bear above Rollins Reservoir
1944		60	Human	Greenhorn Creek
1949		67	Lightning	Upper Bear above Rollins Reservoir
1950	BOBO	264	Unknown	Wolf Creek/Bear River
1950	CAMP BEALE	669	Unknown	Dry Creek

1950	CAMP BEALE #2	4885	Unknown	Reeds Creek/Dry Creek
1951		6	Human	Greenhorn Creek
1951	CAMP BEALE #1	585	Unknown	Rock Creek
1951	RATTLESNAKE	585	Unknown	Wolf Creek
1951	WIZWELL	1049	Unknown	Lower Bear
1952	DENIZ	297	Unknown	Wolf Creek/Bear River
1952	CAMP BEALE #2	799	Unknown	Reeds Creek/Dry Creek
1953	SUNSHINE VALLEY	336	Unknown	Wolf Creek
1953	CAMP BEALE #5	881	Unknown	Dry Creek
1954	CAMP BEALE #1	509	Unknown	Dry Creek
1955	CAMP BEALE #7	445	Unknown	Dry Creek
1955	CAMP BEALE #3	1115	Unknown	Reeds Creek and Dry Creek
1958	LIGHTNING #6	551	Unknown	Bald Rock Mountain
1959	MADONNA #2	3164	Unknown	Upper Bear below Rollins Reservoir
1960	NEWNAN LIGHTNING #9	739	Unknown	Wolf Creek
1961	MAYS	710	Unknown	Dry Creek
1961	BILDERBACK	925	Unknown	Upper Bear below Rollins Reservoir
1961	CAPEHART	3302	Unknown	Lower Bear
1963	CAMP BEALE #29	501	Unknown	Reeds Creek/Dry Creek
1964	BREWER	293	Unknown	Lower Bear
1964	BEALE #4	426	Unknown	Dry Creek
1967	CAPEHART	1063	Unknown	Dry Creek/Camp Far West
1970	SHOCKLEY	285	Unknown	Lower Bear
1970	JACINTO	385	Unknown	Lower Bear
1970	CAMP FAR WEST	588	Unknown	Grasshopper Slough
1973	FISH & GAME #4	242	Unknown	Dry Creek
1979	ROADSIDE #88	299	Unknown	Reeds Creek
1979	ROADSIDE #70	2400	Unknown	Reeds Creek
1980	ROADSIDE #117	264	Unknown	Dry Creek
1980	R.S.#31	281	Unknown	Dry Creek
1980	LIGHTNING 1	336	Unknown	Lower Bear
1980	DOG BAR	347	Unknown	Upper Bear below Rollins Reservoir
1981	BROWN	100+	Prescribed	Dry Creek Spenceville area
1981	NADEIC	425	Miscellaneous	Lower Bear
1981	PG&E #5	812	Use of Equipment	Camp Far West
1982	BROWNING RANCH	121	Prescribed	Dry Creek
1982	NEIL ROBINSON	271	Prescribed	Dry Creek
1982	ANDRESSEN	439	Use of Equipment	Lower Bear
1983	RONDONI	258	Prescribed	Wolf Creek/Upper Bear below Rollins
1985	BALDWIN RANCH	171	Prescribed	Wooley Creek/Lake of the Pines
1985	DOG BAR	186	Smoking	Upper Bear below Rollins Reservoir
1986	ROADSIDE 82	143	Unknown	Yankee Slough/Coon Creek
1986	BALDWIN RANCH	157	Prescribed	Lake of the Pines
1987	CONOUCK	183	Use of Equipment	Lower Bear
1988	49'ER		Debris or Human	Dry Creek
1989		25	Prescribed	Steephollow Creek
1998	READER RANCH	115	Prescribed	Dry Creek
1998	SMART	343	Arson	Reeds Creek
1998	BEALE ASSIST	1276	Smoking	Reeds Creek

B. Human Setting

The Bear River watershed crosses the borders of 4 counties (Nevada, Placer, Sutter, and Yuba) and is therefore affected by the land-use practices in each of these counties. There are also various cities, water districts, sanitation districts, school districts, public lands, and private lands devoted to various resource extraction and other uses. The particular kinds of human activities and structures and the kinds of activities permitted in the future can have impacts on the water quantity and quality, health of aquatic and terrestrial ecosystems, and the solutions available to public and private parties interested or legally obligated to protect watershed functioning. .

1. Important Political Boundaries

a. Counties

Most of the Bear River watershed is in Nevada County (Figure 9), which is one of the fastest growing counties in the Sierra Nevada. Actually, all four counties that make up the Bear River basin are at the forefront of changing land-uses from extractive industries and agriculture to rural and urban development (SNEP Science Team, 1996; McBride et al., 1996). The policies, allowable land-uses, and ordinances in these counties will have the most impact of the potential stressors on health and condition of the watershed, especially given that most of the watershed is owned privately (Menning et al., 1996; Figure 9).

b. Water Providers

Water volumes (flow) in the Bear River drainage are largely controlled by Nevada Irrigation District, PG&E and South Sutter Irrigation District. Water conveyed through the Bear River system is used for urban consumptive use, agriculture, recreation and hydropower generation. Data on water use and limited data on threats to water for the Bear River watershed are available from the US Geological Survey and the US Environmental Protection Agency at http://water.usgs.gov/watuse/ and http://cfpub.epa.gov/surf/huc.cfm?huc_code=18020126, respectively. A summary of water consumption data (1985-1995) for residential, agricultural, commercial, industrial, and hydroelectric users is available on the Bear River website at http://snepmaps.des.ucdavis.edu/snner/bear/data/epa-hydro1.htm. However, without an assessment of river discharge it is not possible to put these data into perspective, in terms of proportion of natural surface water withdrawn for human use.

c. Cities

There is one major city in the Bear River watershed, Grass Valley (Figure 9). There are also several rapidly urbanizing areas along the highway 49 corridor (e.g., Lake of the Pines). At some point it is likely that new towns and cities will become incorporated in the basin as population pressure mounts. The watershed is currently more affected by human populations outside of the limited urban areas. There are many areas in the watershed where low (>1 acre parcel) to moderate (<1 acre parcel) density development is occurring outside of towns. This development results in a conversion of native vegetation and may have consequences for waterway conditions (McBride et al., 1996).

d. Land Ownership

The information presented here on land ownership comes from the Gap Analysis Project (e.g., Davis and Stoms, 1996). Because the data for this project was collected in the early to mid 1990s, it is not completely up to date and there may be local errors in terms of current size of holdings.

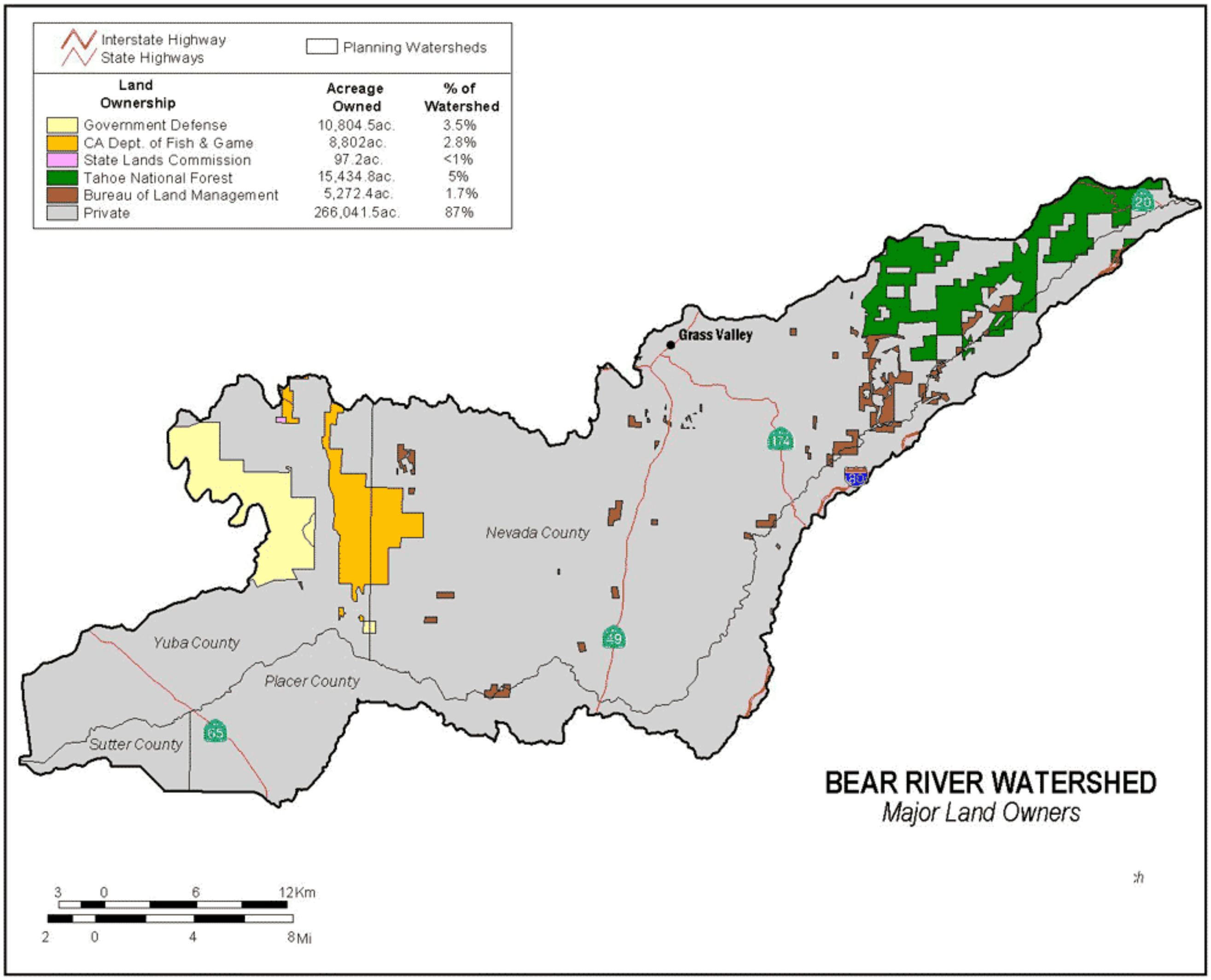


Figure 9

i. Tahoe National Forest

Only 5% (15,434 acres) of the watershed consists of National Forest system lands managed by the USDA Forest Service (Figure 9). This public land ownership in the upper watershed is broken up in a "checkerboard" fashion by private in-holdings, such as PG&E lands. This fragmented ownership makes analysis of logging and other operations and carrying out restoration actions difficult because of the unpredictable nature of use of private lands. National Forest system lands are managed by the USDA Forest Service for "multiple uses". These uses include water production, mining, grazing, logging, recreation, biodiversity protection, resource extraction, wildlife and other habitats.

ii. Bureau of Land Management

The BLM manages 1.7% (5,272 acres) of the watershed, primarily in lands in the upper watershed (Figure 9). These lands are scattered among many small parcels making integrated management difficult for the agency.

iii. State Lands

The state manages about 3% of the watershed, the vast majority of which is the California Department of Fish and Game's Spenceville Wildlife Refuge in the lower watershed (Figure 9). This refuge is one of the few low-elevation Sierra Nevada foothills protected areas (Davis and Stoms, 1996). It contains native plant and wildlife communities and is used primarily for recreation and wildlife protection.

iv. Private Lands

The vast majority (87%, 266,052 acres) of the watershed is owned by private individuals or corporations (Figure 9). There are a huge number of uses that these lands are put to, from logging to vineyards, to large backyards. The activities on these lands are regulated by the counties, the state, and to a limited degree by the federal government. There is no watershed basis for the regulations, making consistency among regulatory requirements for watershed protection challenging. However, not all processes are at the watershed scale, so should not necessarily be dealt with at that scale (e.g., protection of the California spotted owl).

2. Existing Land Uses

a. County General Plans

The county general plans displayed above make it clear that the majority of the watershed is intended for agricultural or housing development uses (Figure 10). General plans can be modified, but give a sense for how development may proceed across a region. Low and medium density residential development is planned for areas of the watershed near major highways (80, 49, and 174). There are also areas of "planned development" which tends to mean slightly higher densities of houses (~1 per acre) than found in low-density residential areas (~1 per 5 acres). The "open space" designation includes a variety of land use types, from USDA Forest Service thinning practices, to private timberland clearcutting, to ranching in the lower foothills. Thus the actual condition of the lands will vary depending on the ownership and actual land use. What is very clear from this map is that very little of the watershed has been specifically designated as requiring some special protection by the counties. Only the public lands in the upper watershed and lightly grazed ranches at lower elevations will provide any assurance of protection for the natural communities and processes present in the watershed.

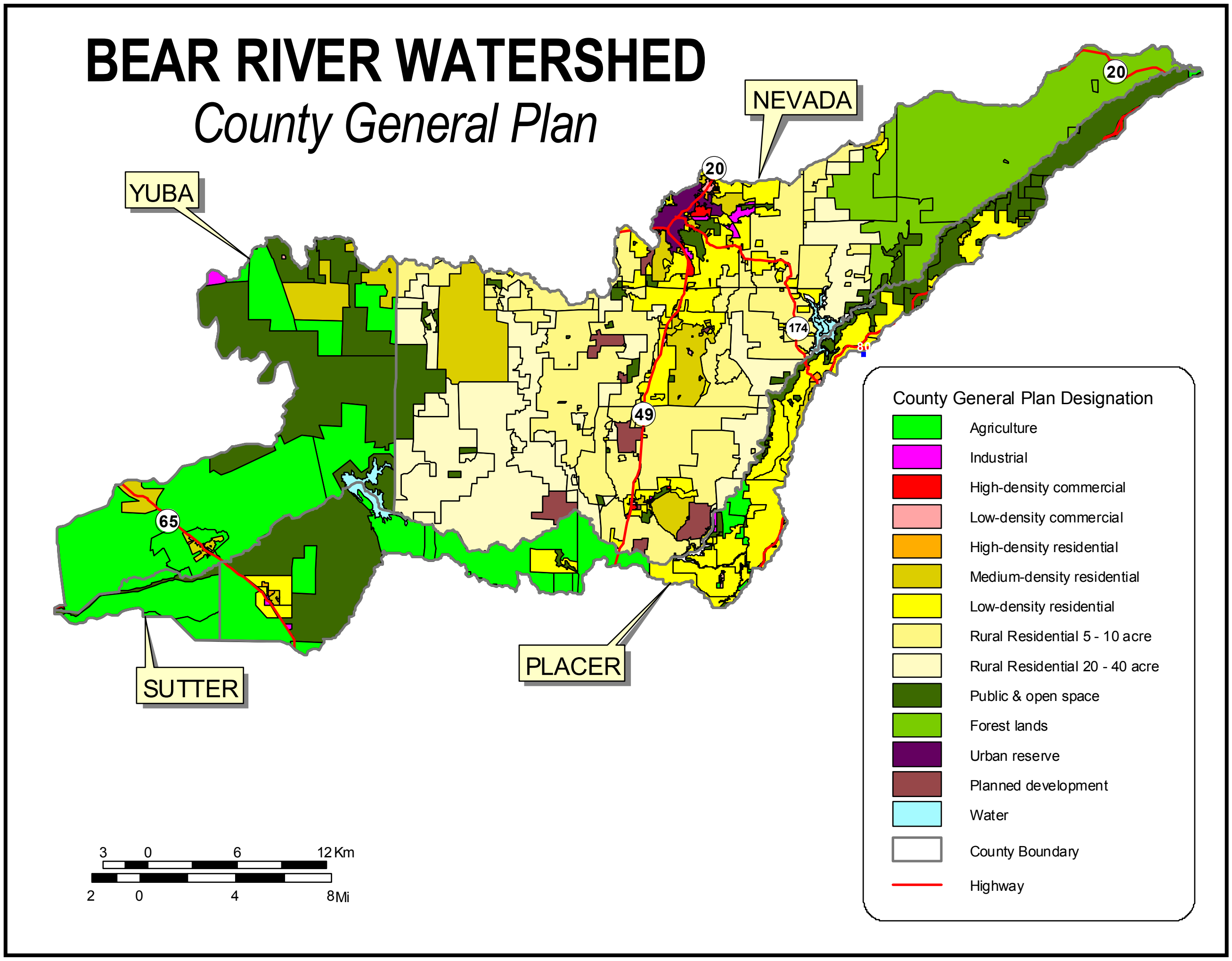


Figure 10

The rate of parcel subdivision (Figures 11 & 12) that is occurring in the central part of the watershed adjacent to highways 49 and 174 suggests that the general plan map is an underestimate of the development pressure that the watershed will experience once the Nevada County general plan is updated. Once subdivision has occurred and the county is subsequently pressured to plan for residential development, it will become much harder to plan and implement conservation actions (e.g., purchase of conservation easements on agricultural lands) because of fragmented ownership and higher prices per acre. Only improving zoning (e.g., putting more areas into agricultural or open space designation) and limiting rates of subdivision will abate this process. El Dorado County has begun to address this issue and is limiting new subdivision of parcels.

In the map in Figure 11, the largest parcels are about 640 acres. Although these remain primarily in the western and eastern parts of Nevada and Placer counties, there are a few such large parcels remaining in the subdividing core (e.g., along Bear River east of highway 49). The Bear River canyon from highway 174 to the west of highway 49 may provide the last best link between the upland conifer forests and lowland oak forests, critical for wintering deer herds and other migrating wildlife.

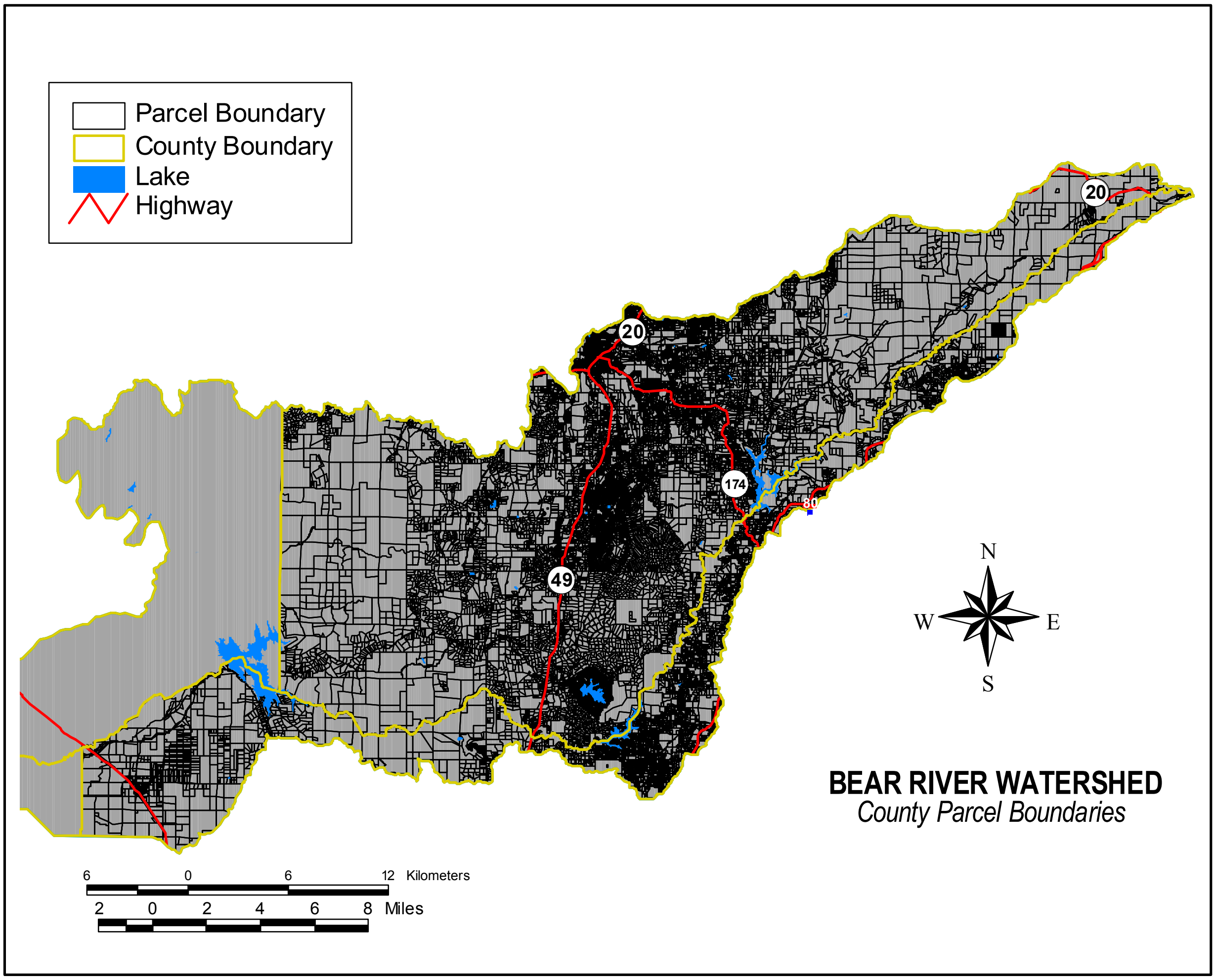


Figure 11

The map of parcel densities (Figure 12) also reveals another east-west open space corridor crossing highway 49 north of Lake of the Pines near Cottage Hill. Parcel densities indicate the extent to which areas have been subdivided into different ownerships. Because development in the foothills of the Sierra Nevada is considered to be one of the primary threats to wildlife and lower elevation ecosystems (SNEP report, 1996), such maps are critical for planning where subdividing has gone too far and where future county planning can alleviate already intense pressure on these fragmenting ecosystems.

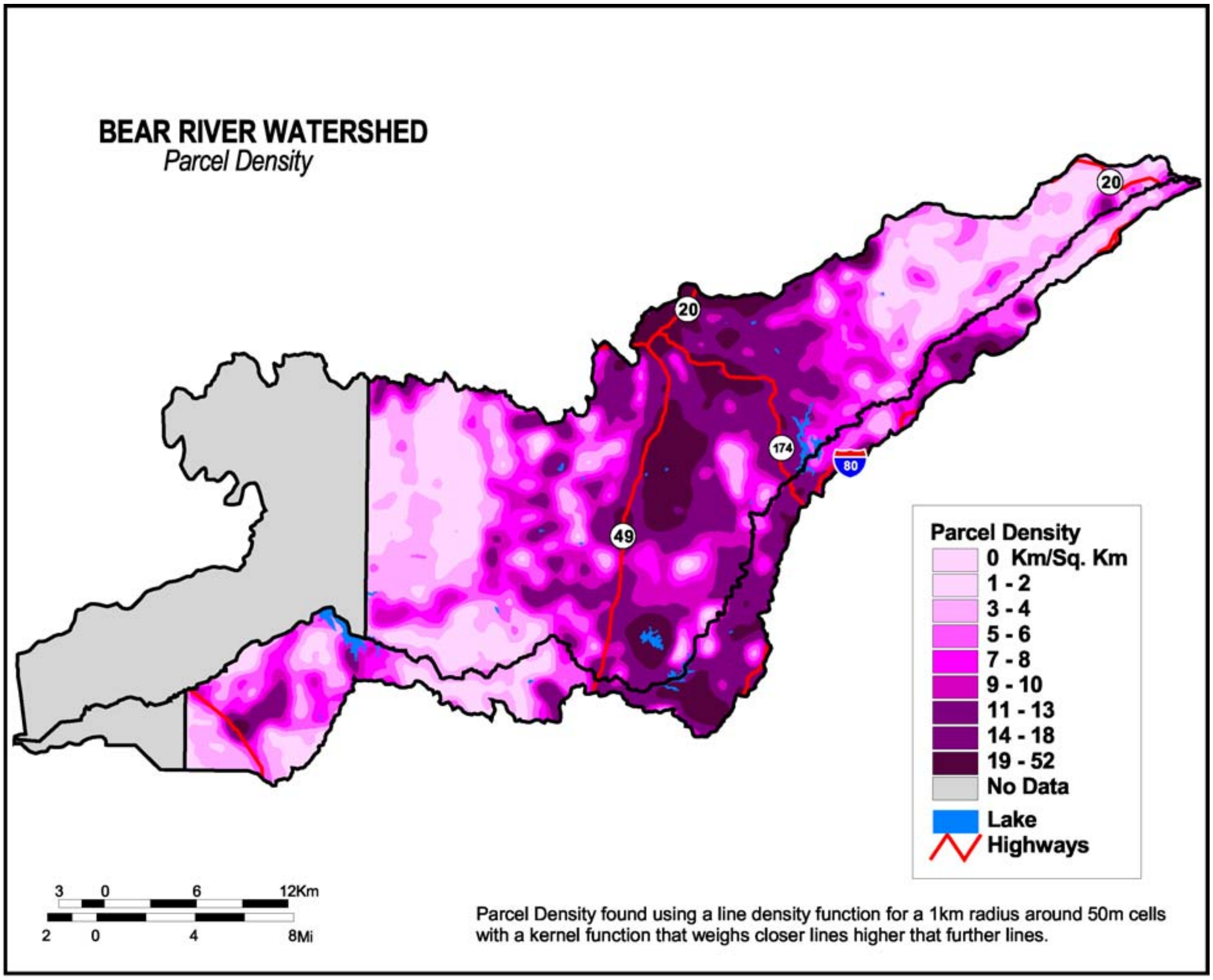


Figure 12

b. Population Pressure

According to data from the Census Bureau (2000) the population density in census blocks ("neighborhoods") within the watershed ranges from 0 to >2,000 people per square mile (Figure 13). The highest densities are in the highway corridors, Lake of the Pines, and Beale Air Force Base. Alignment of the parcel map with population density shows that there are places in the watershed where populations are low, but the number of parcels is high (e.g., Lime Kiln Rd.), indicating threat of new development. If parcels have been subdivided, it is likely that the owner will want to sell them for development, which is the most profitable land use in the area.

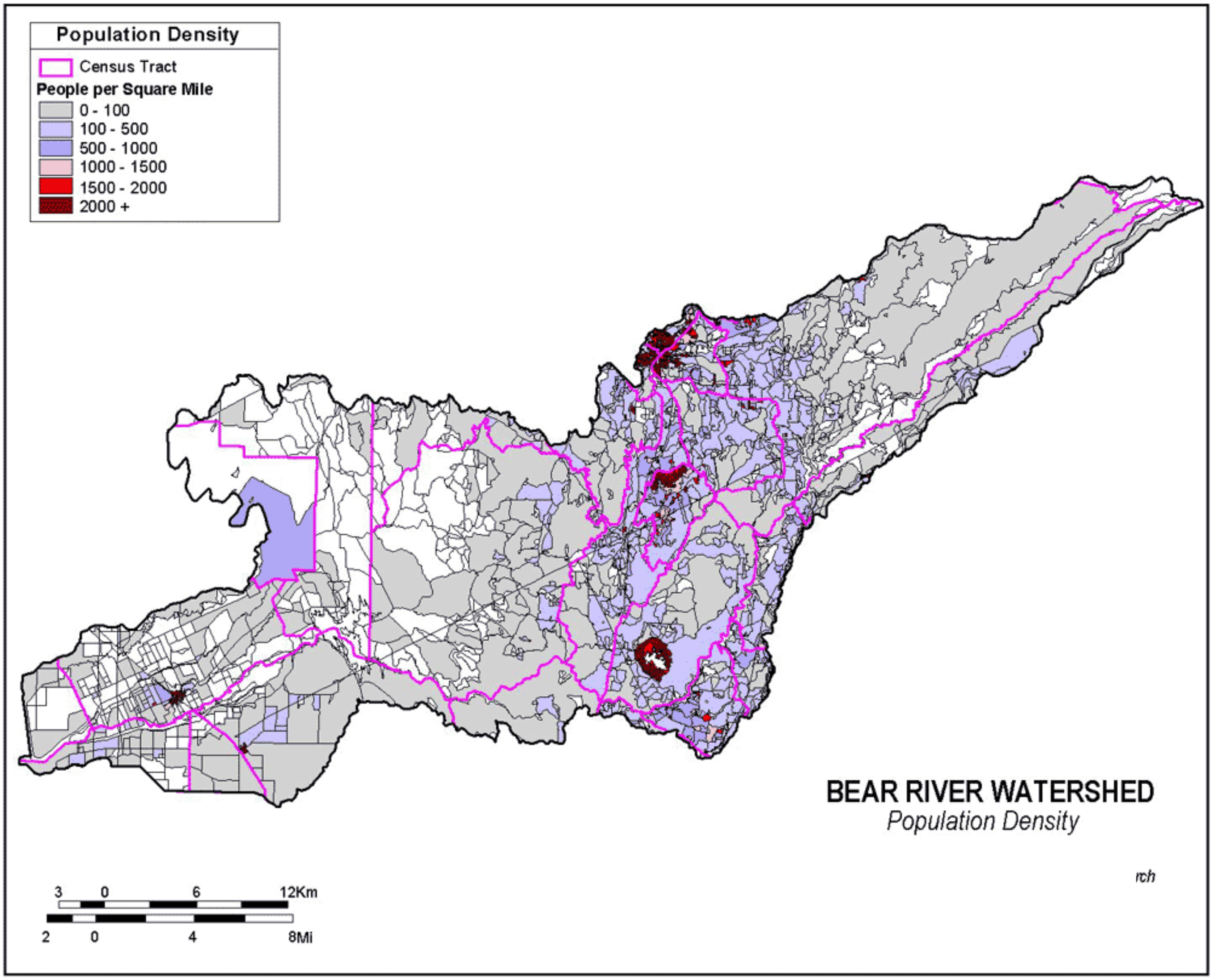


Figure 13

By allocating population increases from 1990 to 2000 in census blocks (Figure 14) to sub-watersheds (e.g., Little Wolf Creek) it is possible to ascertain which creek watersheds are most likely to be impacted to by changes in human population. For two sub-watersheds in the upper watershed there was actually a decrease in population, though the larger change was only 19 people. The biggest changes were near Grass Valley with over 2000 people entering the 26,000-acre Wolf Creek drainage over the last decade.

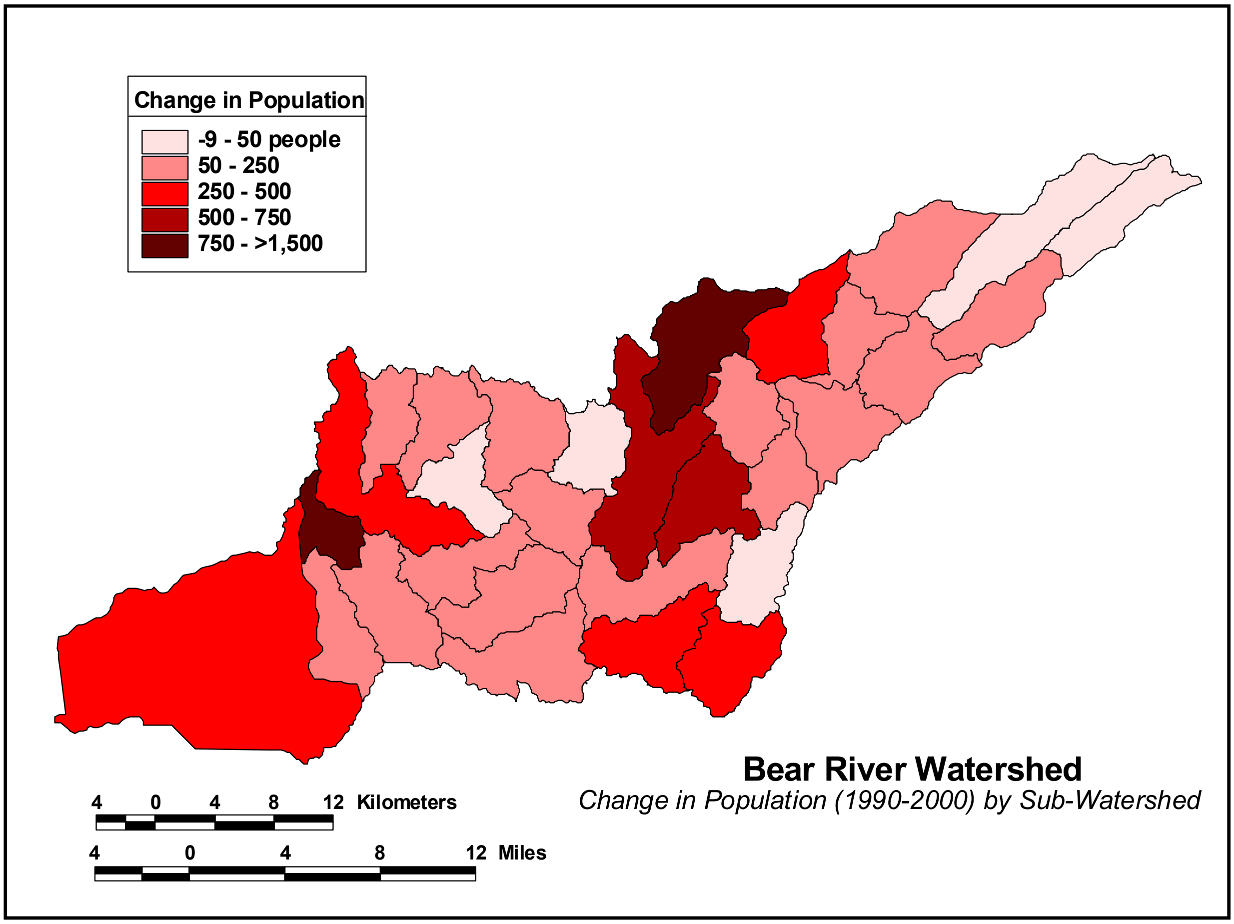


Figure 14

c. Roads

Roads have a variety of potential and actual effects on natural environments (Trombulak and Frissell, 2000). Road placement can affect surface water flows and stream channel morphology. Runoff from roads may contain dust, salt, and various metals and hydrocarbons. Roads fragment wildlife habitat and provide corridors for invading species. This valuation has contributed to development of the >6.2 million kilometers of roads in the U.S. and the potential impact by roads of 20% of the U.S. landscape (Forman, 2000).

The fragmentation effects of roads on natural habitats has been studied primarily in terms of the creation of new edges when a road is built. Roads pose a barrier to species dispersal and migration through aversion effects ("habitat alienation", e.g., Mac et al., 1996), direct mortality from traffic (Madsen, 1996; Putman, 1997; Rubin et al., 1998), and traffic noise-induced effects (Reijnen et al., 1997; Gill et al., 1996). The combination of edge and barrier can reduce the effective area for species that depend on intact habitat in the interior of patches. Because roads are often accompanied by other development activities, there may be additional fragmentation effects beyond just the linear extent of the road (Theobald et al., 1997). Mitigation efforts for these fragmentation effects have been made in particular geographic locations by installing underpasses and overpasses intended for use by large mammals (e.g., Clevenger and Waltho, 2000) and by promoting post-harvest logging road closures to protect large mammals.

i. Road system and density

There are 2003 miles of roads in the Bear River watershed. This watershed has one of the highest road densities in the Sierra Nevada (4.3 miles/mile^2, Figure 17), By comparing figures 14, 15, and 17 the high road densities seem to be primarily associated with housing development for population increases. This density is an underestimate because of the unknown extent of private roads in the watershed. Densities range from 0 miles/mile^2 in unroaded areas to >8miles/mile^2 in urban areas (Figure 17). Because population growth has tended to take place on large parcels, the miles of road needed per person is very high when compared to more urban settings.

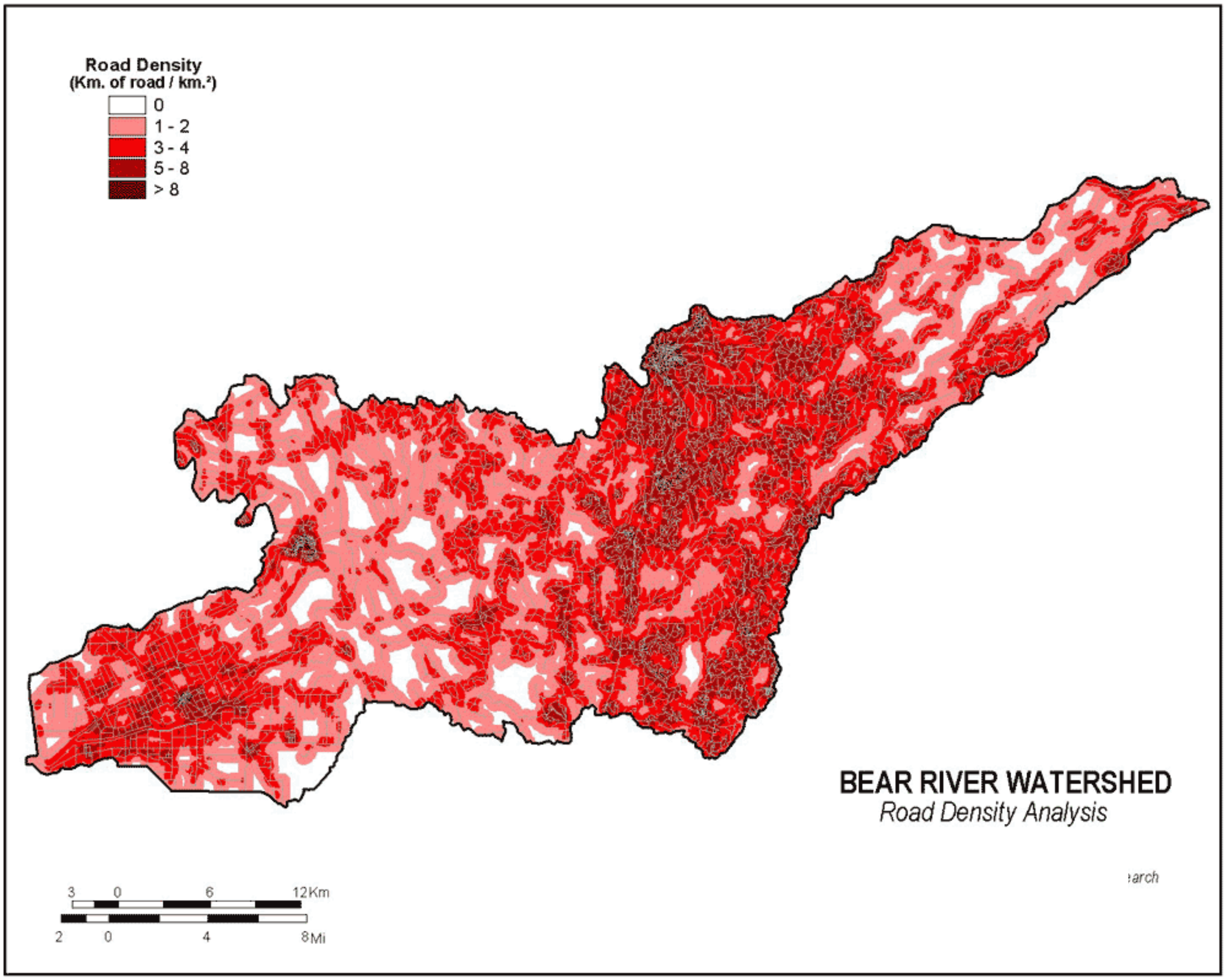


Figure 17

There are very few areas with zero or low road densities in the watershed, clumped in the lower foothills and in the upper watershed below highway 20 (Figure 17). These areas would be the primary refuges in the watershed for terrestrial and aquatic wildlife and natural processes sensitive to the presence of roads and traffic, for example, deer fawning areas and forest carnivores that avoid humans. Deer migration and wintering are sensitive to road densities greater than 2 miles/mile^2 (Department of Fish and Game, personal communication)

ii. Roads near streams

Road effects on aquatic ecosystems have been measured primarily in terms of the deposition of contaminants from the traffic or road surface to waterways. Failure of roads above streams, contributing sediment to the stream itself, is probably the most obvious potential impact. Stream crossings by roads can contribute sediment to the streams and become weak points in the stream/road interface. Metals, hydrocarbons, and de-icing salts originating from roadways have all been found in nearby streams (Gjessing et al., 1984; Hoffman, et al., 1981) and can alter aquatic community processes (Wilcox, 1986; Maltby et al., 1995). Airborne pollutants (e.g., dust or metals) originating from road surfaces or automobile traffic are detectable and may be deposited near roads (Bell and Ashenden, 1997). Roadbeds and road-related infrastructure can also impinge upon the physical characteristics and processes of fluvial systems. Roads can also limit recovery of stream channels from grazing impacts (Myers and Swanson, 1995), species richness in wetlands up to 2 km from roaded forests (Findlay and Houlahan, 1997), and disrupt riparian vegetation leading to reduced bird species richness and density. Unpaved road surfaces have limited infiltration, resulting in runoff of excess rainfall (Ziegler and Giambelluca, 1997).

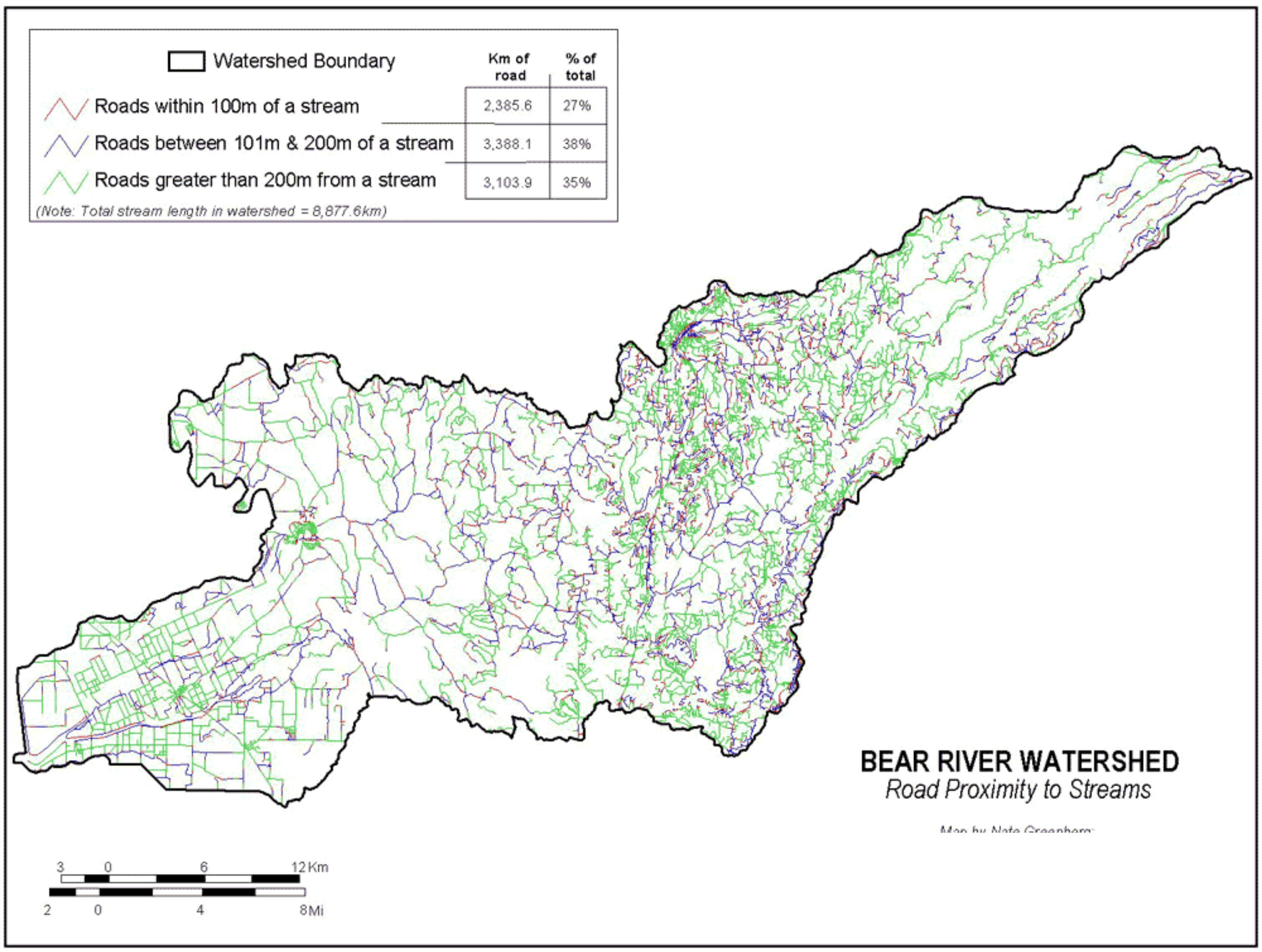


Figure 18

A majority of the stream system in the watershed (68%) is within 200 meters of a road (Figure 18). Almost half (45%) of the stream system is within 100 meters, most of which is due to the many stream crossings and places where roads run alongside streams. Because of the extent of the road system interactions with the stream system in the Bear River watershed, it is very likely that there are significant impacts on fluvial and riparian functions. Although it is conceivable that these impacts have been mitigated somehow by “best-management practices” and other measures, it is unlikely for “legacy roads” (i.e., roads inherited from many decades ago) and unknown for roads whose management has not been monitored. A solution to this question would be to begin assessing impacts in specific areas representative of the watershed as a whole and prioritize road/stream interactions for remediation. Remedial actions could take the form of increasing culvert sizes, out-sloping roads, removing excess roads, and installing bridges. Monitoring of the effectiveness of past actions as well as the effectiveness of mitigation and remediation actions is critical to understanding the actual impacts of roads in the watershed.

d. Canals, Ditches, and Water Storage Facilities

There are 172 “jurisdictional” dams or diversions in the watershed (Figure 19; CA Departments of Fish and Game and Water Resources data). Jurisdictional dams are over 25’ tall or hold more than 50 acre-feet of water. The diversions convey water within the watershed to users who are remote from the waterway of origin as well as to convey water to the North Fork American River.

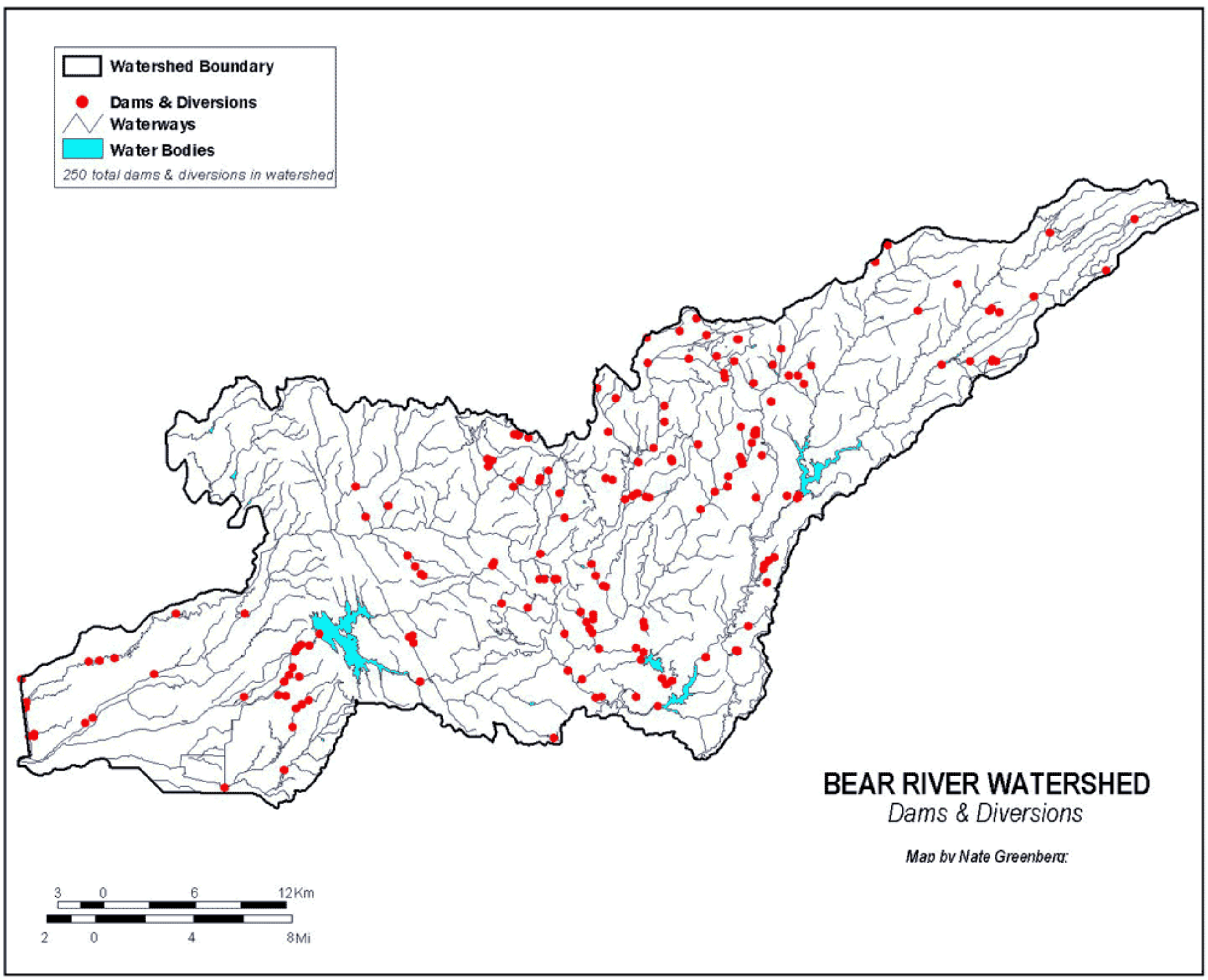


Figure 19

Along with the Yuba River basin, this watershed is one of the most heavily managed for water conveyance in California. Besides providing hydroelectric power, water storage, and limited flood control, the dams block fish passage (unless fitted with efficient fish ladders) and can change temperature, pH, and nutrient conditions and create methylation sites for mercury. Water diversions decrease the flows available for in-stream natural processes. This results in sediment aggradation in stream channels, higher water temperatures, a lack of flushing, and other negative impacts.

e. Mine Lands and Mercury

There is no single database for active and abandoned mines in the watershed. Three databases (available from Department of Conservation, Office of Mine Reclamation and the U.S. Geological Survey) that have data are the Principal Areas of Mine Pollution system (PAMP), the Mineral Resource Data System (MRDS), and Minerals Availability System/Minerals Industry Location System (MAS/MILS). There are 75 PAMP, 397 MRDS, and 477 MAS/MILS points in the watershed (Figure 20). There may be multiple locations indicated for a single “mine”.

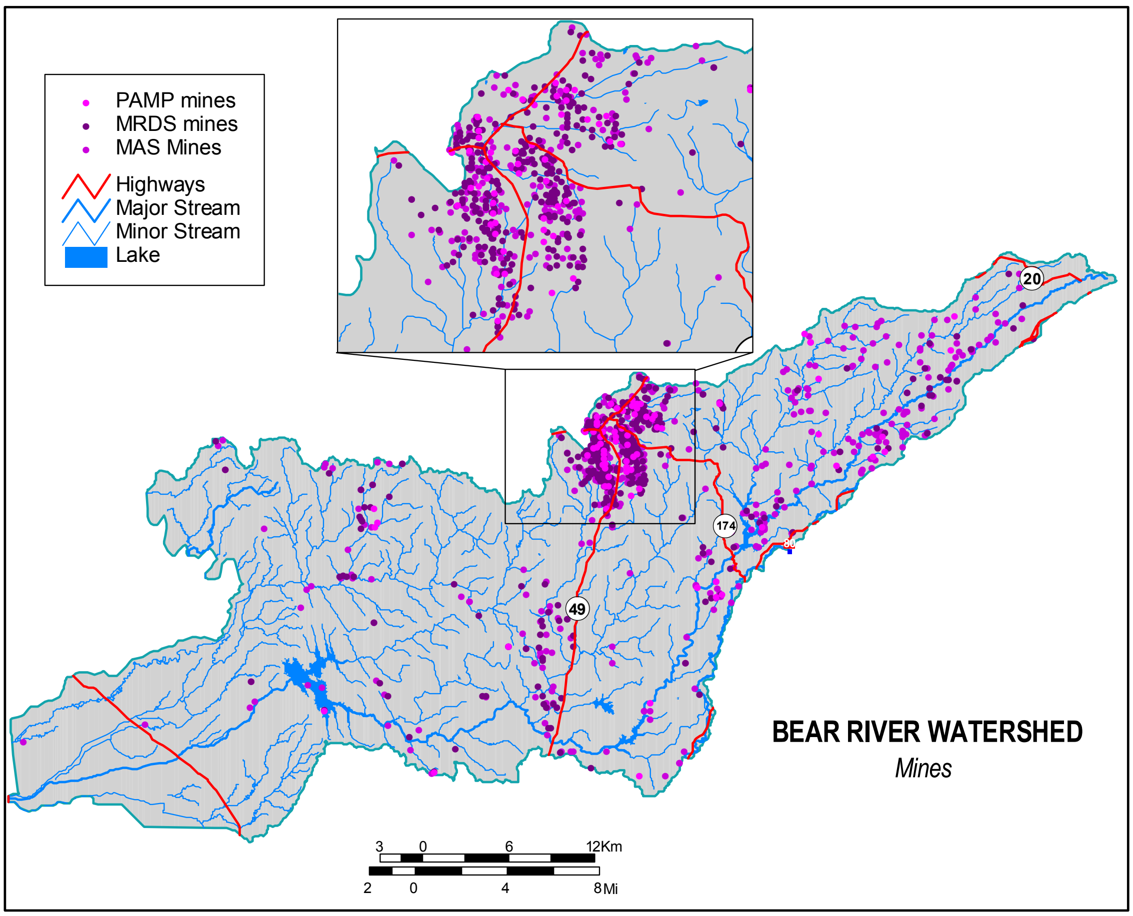


Figure 20

The MAS/MILS database provides information on locations of mines, their operational status, and information about the minerals at those locations. The data includes name of deposit, deposit type, current status, location, and point of reference for all sites. The MRDS data originates not only from USGS studies but also from other federal and state agencies and primarily pertains to mineral commodities. The data included contains mine name, location, deposit type, mineral age, commodities, products, and tectonics information. The PAMP data set is a compilation of 2,422 mining operations and their potential water-quality problems. The Division of Mines and Geology originally compiled this information in 1972 for the State Water Resources Control Board. It was published in a series of volumes of tabular data. The data set includes operations where production exceeded $100,000 or where other factors indicated a high potential for pollution.

Historic hydraulic mining and the use of mercury to remove gold through amalgamation has left Sierra Nevada rivers and watersheds with a legacy of eroding hillsides, mercury, and excess sediment. Mercury originates from abandoned mines in the Sierra Nevada because miners would pour mercury directly into sluices in order to recover fine gold particles. The excess mercury would end up in the soil on the mine lands, in pits, sluices, and tunnels remaining on abandoned mine lands (AMLs), in the creek beds, and in the sediments behind any retention structures (dams) downstream. There are no measurements of the actual amount of mercury on the land or in the water in the hydraulically-mined areas of the Sierra Nevada. The United States Geological Survey (USGS) estimates that up to 8,000,000 of the 26,000,000 lbs used in the Sierra Nevada may have been "lost" during gold recovery (Alpers and Hunnerlach, 2000). The mercury is transported by erosion and runoff in dissolved ionic form (e.g., Hg^{2+}), adsorbed to particles, and as droplets of the metal and as particles of gold-mercury amalgam. This pool of mercury can be converted by microbial action into methylmercury, which can then be absorbed by microbes, plants, and animals. As methylmercury makes its way up the food chain (bioaccumulation) it is concentrated (biomagnification) in larger predatory fish (e.g., trout and bass). Concentrations can exceed levels of concern for human consumption (>0.3 parts per million in fish tissue, ppm). There are very few areas (primarily within AMLs) where mercury concentrations in surface water are high enough to warrant concern for public health from consuming the water itself.

The recent report by Charlie Alpers and co-workers (US Geological Survey) of mercury contamination in fish provided the most detail to date of the extent of the problem in Bear River waterbodies (http://ca.water.usgs.gov/rep/ofr00367/ofr00367.pdf). Concentrations of mercury in fish tissue ranged from barely detectable to over 1 ppm mercury. Certain reservoirs stood out as having a greater problem, with lower, warmer reservoirs seeming to predominate. In Rollins Reservoir, most channel catfish and most largemouth bass >1 foot in length and >400 grams in weight had levels >0.3 ppm mercury. In Lake Combie, all largemouth bass >1 foot and >400 grams had levels >0.7 ppm. In Camp Far West Reservoir, all spotted and largemouth bass and channel catfish >1 foot and >300 grams had levels >0.5 ppm, half of the spotted bass sampled exceeded the Food and Drug Administration's (FDA) action level of 1.0 ppm. In the Bear River at Dog Bar Rd., half of brown trout sampled >10 inches and >200 grams had levels >0.3 ppm (May et al., 2000).

The Environmental Protection Agency and the Office of Environmental Health Hazard Assessment (OEHHA) standard for concentration needing greater attention ("screening value") currently stands at 0.3 ppm. Most of the game fish tested and the waterbodies sampled fall above this threshold, suggesting that although there may be hot-spots, most of the Bear system should be considered worthy of more extensive monitoring. The Food and Drug Administration's action level for regulating mercury in commercial fish is 1.0 mg/kg (1 ppm) wet weight of fish tissue.

The best conclusions to draw from this study are that a comprehensive understanding of fish consumption by humans and wildlife around these reservoirs is needed, that there should probably be monitoring of the mercury levels in people who eat a lot of fish from these waterbodies, and that continued surveying of mercury in fish and other biota is essential, especially in years where the precipitation and other environmental conditions are different from 1999, the year the samples were taken. For example, during high flow years, mercury mobilization will occur more frequently and methylation in the following summer may occur at a higher rate due to the increased availability of mercury.

The USGS has also measured methylmercury concentrations in aquatic and terrestrial invertebrates, amphibians, and cliff swallow eggs (U.S. Geological Survey preliminary findings released at DTMC meeting). This survey was conducted to see how well the measured concentrations correlated with the fish data. It was also intended that this approach would lead to a rapid and broad assessment technique, based on non-fish data, for prioritizing mine sites and streams for cleanup and monitoring action. The aquatic insects sampled (dragonflies, stoneflies, hellgrammites, diving beetles, and giant waterbugs) had concentrations of methylmercury ranging from 0.01 ppm to 1.6 ppm for dragonfly larvae in Buckeye Flats (South Greenhorn Creek). The areas with the highest concentrations found in the different organisms were Boston pit and mine tunnel, Buckeye Flats (Greenhorn Creek), and Missouri Canyon. The foothill yellow-legged frogs, Pacific tree frogs, and bullfrogs had concentrations ranging from 0.23 ppm to 0.39 ppm, with the areas rating the highest being Missouri Canyon, Diggins Pond (Malakoff Diggins, Yuba River watershed), and Polar Star mine tunnels.

The extent of current knowledge is that the mercury is at minimum leaking gradually from abandoned mine tunnels, sluice boxes, and pits. Dredge tailings are also thought to be potential hot-spots, as is sediment disturbance during secondary mining near abandoned mine features, or in contaminated sediments. Mercury is also assumed to be slowly migrating downstream in the creeks and rivers, temporarily lodging in the benthic sediments and pockets in the channel bedrock.

f. Locations of Potential Sources of Pollution

The EPA computer tool “Better Assessment Science Integrating point and Nonpoint Sources” (BASINS) provides a database of locations for “toxic release inventory sites”, “National Pollutant Discharge Elimination System” (NPDES) sites, and “industrial facilities discharge sites” (Figure 21). These are permitted or are known to release certain amounts of toxic chemicals, bacteria, nutrients, and sediment. The majority of the known sites are in the Wolf Creek and Greenhorn Creek watersheds, which drain the Grass Valley area. This is not surprising given the amount of industrial activity in this area compared to other parts of the watershed.

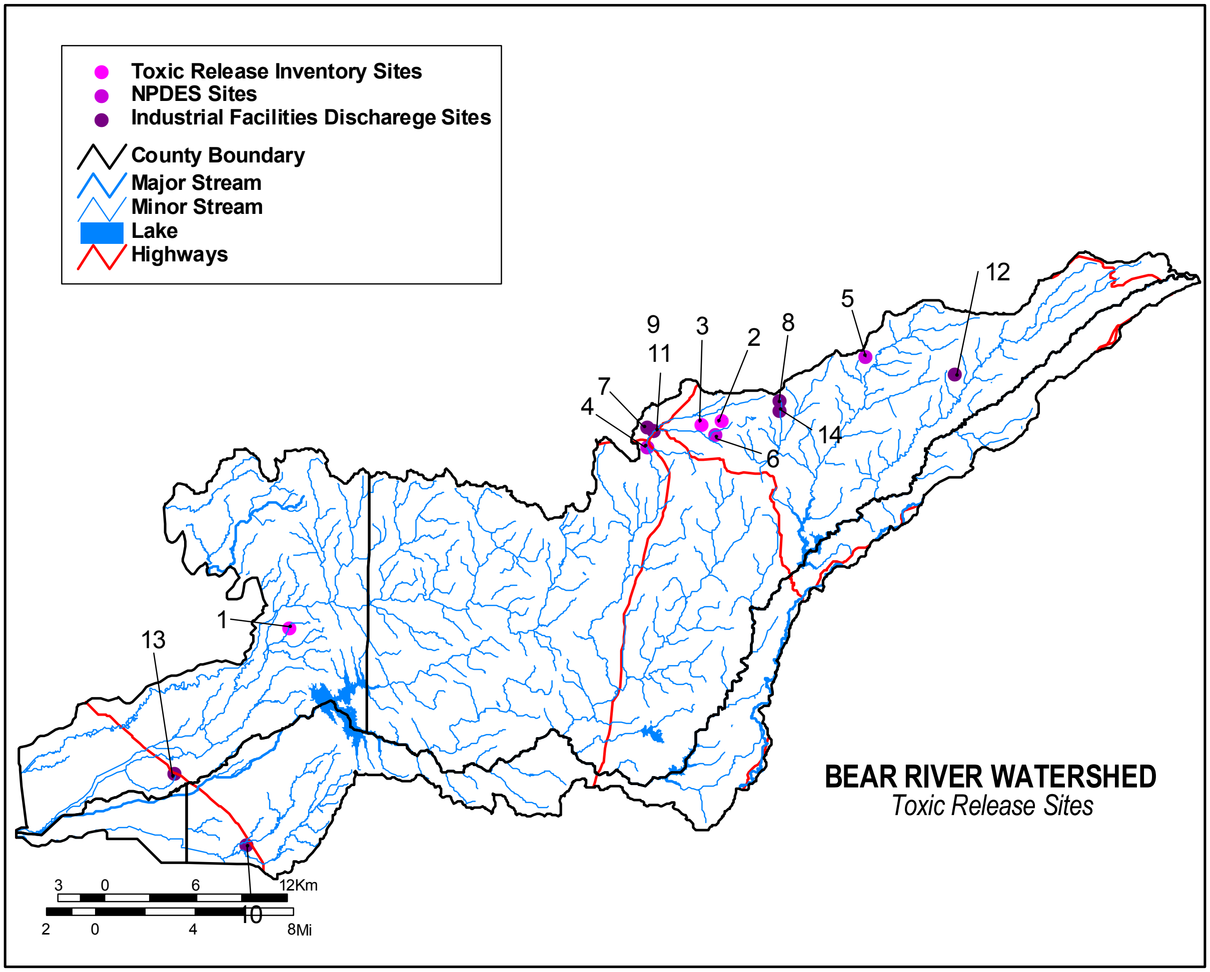


Figure 21

Table 7 Locations of potential and actual toxic release sites in the Bear River watershed (Figure 21). Pollutant data is for the time period 1987 – 1995 and includes only points from the federal database (BASINS model, US EPA).

Number on Map	ID	Name	Receiving Water	Pollutant
(Toxic Release Inventory)				
1	CA7570024508	Beale AF Base	Hutchinson Creek	Cl
2	CAD982497653	Grass Valley Group Inc.	Wolf Creek	Ni, Cu, Cr, Sulfuric Acid, Freon113, Nitric Acid
3	CAD983635046	JDK Controls Inc.	Wolf Creek	Trichloroethane
4	CA0079898	City of Grass Valley	Wolf Creek	
5	CA0083241	Nevada County Sanitation District Cascade Shores	Gas Canyon Creek	

6	CA0083747	Emperor Gold (US) Corp.	S. Fork Wolf Creek	
7	CA0077771	Grass Valley Ready-Mix	Trib. To Wolf Creek	
8	CA0077968	Gene West Inc.	Gold Flat Creek	
9	CA0079073	Hansen Bros. Enterprise	Wolf Creek	
10	CA0079341	Placer Co. Area #6 Hwy.	Trib. To Bear River	
11	CA0079421	Nevada Joint UHSD	Wolf Creek	
12	CA0080241	Red Hill Steephollow	Steephollow Mine	
13	CA0080624	City of Wheatland	Bear River	
14	CA0080993	J.T. Hudgins & R.T. Lava Cap Mine	Lower Clipper Creek	

III. Data Gaps

1) Almost all digital, spatial data available for the watershed is of lower resolution than would be optimal for site and parcel-specific protection, management and restoration decision-making. The solution is to communicate with private, state, academic, and federal enterprises that develop and collect digital, spatial data according to federal standards.

2) The most important data for understanding disturbance to support good management and restoration decisions are for human features like roads, mines, and resource extraction activities and natural features and processes, like soils, hydrologic flows, terrestrial and aquatic wildlife, changes in plant communities (these are not all-inclusive lists). The solution is to prioritize data types for particular types of decisions – restoration, regulatory, management – and procure these data either commercially or from a free data provider (e.g., a public agency).

3) The potential and actual impacts of human activities are rarely measured in the watershed, as is true for most places. Knowledge of beneficial or negative impacts of human activities is critical information for informing future restoration, management, and extraction activities. This knowledge allows adaptive management and decision-making for reducing disturbances from human activities and learning how to protect and restore watershed function.

IV. Conclusion

There are many natural and human disturbances present in the Bear River watershed. Although we know where many of these occur, there are very few instances where monitoring the effects of these disturbances on the ecosystem and human health transpire. A variety of local, state, and federal agencies are legally responsible for knowing and finding the impacts of human activities on natural processes. For a combination of reasons, this legally-prescribed knowledge is only rarely obtained. By conducting an inventory of the natural and human processes and features within the Bear River watershed, the Bear River CRMP group and the Nevada County Resource Conservation District have taken an important step in understanding the state of the watershed. The collection of data is a step in the assessment and planning process that leads to effective watershed management, protection, and restoration. Subsequent steps could include assembling the data into a form that supports prioritization of sub-watersheds for particular types of actions, using the data here to gain support for restoration and other types of projects, and designing watershed monitoring that supports the projects and increases our knowledge of the natural processes in the watershed and the impacts our activities have on these processes.

V. Bibliography

Alpers, C.N. and M.P. Hunnerlach (2000). Mercury contamination from historic gold mining in California. USGS Fact Sheet, FS-061-00.

Bell, S., and T.W. Ashenden. 1997. Spatial and temporal variation in nitrogen dioxide pollution adjacent to rural roads. Water Air and Soil Pollution, 95(1-4): 87-98.

California Natural Diversity Database (1999). California Department of Fish and Game, Natural Heritage Division.

Clevenger, A.P. and N. Waltho 2000. Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada. Conservation Biology, 14(1): 47-56.

Davis, F. W. and D.M. Stoms 1996. Sierran vegetation: a Gap analysis. Sierra Nevada Ecosystem Project, Final Report to Congress, vol. II: 671-690

Findlay, C.S. and J. Houlahan. 1997. Anthropogenic correlates of species richness in southeastern Ontario wetlands. Conservation Biology, 11(4): 1000-1009.

Forman, R.T.T. 2000. Estimate of the area affected ecologically by the road system in the United States. Conservation Biology, 14(1): 31-35.

Gill, J.A., W.J. Sutherland, A.R. Watkinson. 1996. A method to quantify the effects of human disturbance on animal populations. Journal of Applied Ecology, 33(4): 786-792.

Gjessing, E., E. Lygren, L. Berglind, T. Gulbrandsen, and R. Skanne 1984. Effect of highway runoff on lake water quality. Science of the Total Environment, 33: 247-257.

Hoffman, R.W., C.R. Goldman, S. Paulson, and G.R. Winters 1981. Aquatic impacts of deicing salts in the central Sierra Nevada Mountains, California. Water Resources Bulletin, 17: 280-285.

Husari, S.J. and K.S. McKelvey (1996). Fire-management policies and programs. Sierra Nevada Ecosystem Project, Final Report to Congress, vol. II: 1101-1114.

Mac, R.D., J.S. Waller, T.L. Manley, L.J. Lyon, and H. Zuuring. 1996. Relationships among grizzly bears, roads and habitat in the Swan Mountains, Montana. Journal of Applied Ecology, 33(6):1395-1404.

Madsen, A.B. 1996. Otter Lutra lutra mortality in relation to traffic, and experience with newly established fauna passages at existing road bridges. Lutra, 39(2): 76-88.

Maltby, L., A.B.A. Boxall, D.M. Farrow, P. Calow, and C.I. Betton 1995. The effects of motorway runoff on freshwater ecosystems. 2. Identifying major toxicants. Environmental Toxicology and Chemistry. 14: 1093-1101.

May, J.T., R.L. Hothem, C.N. Alpers, and M.A. Law (2000). Mercury bioaccumulation in fish in a region affected by historic gold mining: The South Yuba River, Deer Creek, and Bear River watersheds, California, 1999. USGS Open-File Report 00-367.

McBride, J.R., W. Russell, S. Kloss (1996). Impact of human settlement on forest composition and structure. In *Sierra Nevada Ecosystem Report: Final report to Congress*, vol II, chap. 46. Davis: University of California, Centers for Water and Wildland Resources.

McKelvey, K.S. and K.K Busse 1996. Twentieth-century fire patterns on Forest Service lands. In *Sierra Nevada Ecosystem Project: Final report to Congress*, vol. II, chap. 38. Davis: University of California, Centers for Water and Wildland Resources.

Menning, K.M., K.N. Johnson, and L. Ruth (1996). A review of current non-federal policies on non-federal lands in the Sierra Nevada that affect aquatic, riparian, upland, and late-successional biological diversity. In *Sierra Nevada Ecosystem Project: Final report to Congress*, Addendum, chap. 1. Davis: University of California, Centers for Water and Wildland Resources.

Mensing, S.A. 1988. Blue oak (*Quercus douglasii*) regeneration in the Tehachapi Mountains, Kern County, California. Master's thesis, University of California, Berkeley.

Moyle, P.B., R.M. Yoshiyama, and R.A. Knapp 1996. Status of fish and fisheries. In *Sierra Nevada Ecosystem Project: Final report to Congress*, vol. II, chap. 33. Davis: University of California, Centers for Water and Wildland Resources.

Myers, T. J., S. Swanson. 1995. Impact of deferred rotation grazing on stream characteristics in Central Nevada: A case study. North American Journal of Fisheries Management, 15(2): 428-439.

National Hydrography Dataset (1999). United States Geological Service and United States Environmental Protection Agency.

Putman, R. J. 1997 Deer and road traffic accidents: Options for management. Journal of Environmental Management, 51(1): 43-57.

Reijnen, R., Foppen, Ruud, Veenbaas, Geesje. 1997. Disturbance by traffic of breeding birds: Evaluation of the effect and considerations in planning and managing road corridors. Biodiversity and Conservation, 6(4): 567-581.

Rubin, E.S., W.M. Boyce, M.C. Jorgensen, S.G. Torres, C.L. Hayes, C.S. O'Brien, D.A. Jessup. 1998. Distribution and abundance of bighorn sheep in the Peninsular Ranges, California. Wildlife Society Bulletin, 26(3): 539-551.

Skinner, C.N. and C. Chang 1996. Fire regimes, past and present. In *Sierra Nevada Ecosystem Project: Final report to Congress*, vol. II, chap. 38. Davis: University of California, Centers for Water and Wildland Resources.

SNEP Science Team (1996). People and resource use. In: *Sierra Nevada Ecosystem Project: Final report to Congress*, vol. I, chap. 1. Davis: University of California, Centers for Water and Wildland Resources.

Theobald, D.M., J.R. Miller, N.T. Hobbs. 1997. Estimating the cumulative effects of development on wildlife habitat. Landscape and Urban Planning, 39(1): 25-36.

Trombulak, S.C. and C.A. Frissell 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology, 14(1): 18-30.

Wilcox, D.A. 1986. The effects of deicing salts on vegetation in Pinhook Bog, Indiana. Canadian Journal of Botany, 64: 865-874.

Ziegler, A.D. and T.W. Giambelluca. 1997. Importance of rural roads as source areas of runoff in mountainous areas of northern Thailand. Journal of Hydrology (Amsterdam), 196(1-4): 204-229.

VI. Data Dictionary

A. GENERAL POLITICAL AND HUMAN USE DATA:

Census Blocks & Tracts>>Based on 1990 housing density by census block information from the Sierra Nevada Ecosystem Project (SNEP) and 2000 data from the Census Bureau.

County Lines >>Data from the California Gap Analysis Project, 1996. This is a coverage of the county boundaries of California. The lines were originally extracted from U.S. Census TIGER/line files using the program ARCTIGER.AML at USGS. At UC Santa Barbara, the coverage was reprojected into Albers equal area projection and clipped by a 1:100,000-scale map of the coastline and state boundary derived from the statewide land ownership map.

General Plan>>The Data for Placer and Sutter Counties was obtained from the Sacramento Association of Governments (SACOG). Nevada and Yuba County data came from the counties directly.

Land Ownership >>Data from the California Gap Analysis Project, 1996. The coverage shows land ownership and management of California, distinguishes local, state, and federal jurisdictions from private lands and delineates areas managed for the long-term maintenance of natural ecological processes and biodiversity. This layer therefore contains attributes both for ownership and for the crude level of biodiversity protection. Base land ownership was originally derived from BLM 1:100,000 scale map sheets. Additional land ownership was updated from various sources on published or agency maps. Managed areas were added from paper and digital sources from the responsible agency. Set of managed areas were incorporated based on lists in Kreissman, B. 1991. *California: An Environmental Atlas and Guide*. Bear Klaw Press, Davis, CA. Additional managed areas were identified from more recent legislation and agency contacts. Managed areas smaller than 200 hectares for upland sites and 80 hectares for wetland sites were not included on the assumption that they contribute little to regional biodiversity conservation. However, where digital map boundaries were readily available, these smaller sites were incorporated as well, but were labeled as a special management level.
Some managed areas are nested within others. Because only one code is permitted per map unit, the one with the highest level of protection is encoded. This means that it may not be straightforward to extract or reselect all areas of a particular category. For instance, some Forest Service Research Natural Areas (RNA) are within Wilderness Areas. To extract all wilderness from the database, a user would have to know which specific RNA's, condor sanctuaries, etc. occur within wilderness.
The ownership data were originally digitized by the Forest and Rangeland Resources Assessment Program of the California Department of Forestry and Fire Protection. It was then registered to the Public Land Survey coverage at Teale Data Center so that coincident line-work was common. Land owner information was included as an attribute.
Managed areas were incorporated into this base coverage at UC Santa Barbara. Some boundaries were merged from existing digital coverages (see *Source Information* above). Others were transcribed from paper maps onto USGS 1:100,000 scale topographic maps and digitized. Attributes were added for the source of data, management status, and a 10 character Heritage Program ID-code for managed areas.

Mine Features >> These data were obtained from the Department of Conservation, Office of Mine Reclamation) and the U.S. Geological Survey from the Principal Areas of Mine Pollution system (PAMP), the Mineral Resource Data System (MRDS), and Minerals Availability System/Minerals Industry Location System (MAS/MILS). The MAS/MILS database provides information on locations of mines, their operational status, and information about the minerals at those locations. The data includes name of deposit, deposit type, current status, location, and point of reference for all sites. The MRDS data originates not only from USGS studies but also from other federal and state agencies and primarily pertains to mineral commodities. The data included contains mine name, location, deposit type, mineral age, commodities, products, and tectonics information. The PAMP data set is a compilation of 2,422 mining operations and their potential water-quality problems. The Division of Mines and Geology originally compiled this information in 1972 for the State Water Resources Control Board. It was published in a series of volumes of tabular data. The data set includes operations where production exceeded $100,000 or where other factors indicated a high potential for pollution.

Title: Principal Areas of Mine Pollution (PAMP)
Originator: Office of Mine Reclamation
Publication_Date: 2000
Geospatial_Data_Presentation_Form: tabular digital data
Publisher: Department of Conservation

Purpose:

The PAMP data set was converted to a digital format by the Office of Mine Reclamation to provide a digital data set describing abandoned mines that may have pollution problems. This data set is not intended to be a statement of fact that any of the listed sites do have such problems. Instead, it provides a starting point for locating and investigating abandoned mines in order to make such determinations. It is a known fact that the reported coordinates for the mines in this data set often have poor spatial accuracy. Because of this, additional information sources should be consulted in order to accurately locate the sites.

Available fields include: mine name, mine owner, latitude and longitude, county, commodity, mine history, type of mine operation, point of discharge, potential pollutants, and literature references.

Title: Mineral Resource Data System (MRDS) data in Arc View Shape File Format, for Spatial Data Delivery Project, 1999
Edition: Version 1.1
Geospatial_Data_Presentation_Form: map
Publication_Place: Spokane, Washington
Publisher: U.S. Geological Survey
Other_Citation_Details:
Arc View shape file containing all Mineral Resource Data System locations world-wide. Data from master database. This dataset contains 44 of the 226 possible fields from the master database.
Online_Linkage: <http://mrdata.usgs.gov>
Abstract:
MRDS contains variable-length records of metallic and nonmetallic mineral resources of the world. A record contains descriptive information about mineral deposits and mineral commodities. The types of information in the data base include deposit name, location, commodity, deposit description, geologic characteristics,production, reserves, potential resources, and references. The Mineral Resource Data System master database is not accessible via the WWW. The large number of multi-valued fields make it difficult to import all the fields into a

data format that can be utilized by the ArcView Internet Map Server Software. This dataset contains all MRDS locations, but only 44 of the possible 226 fields. A data structure was created in Access 97. Data was imported into the file structure and then processed into Arc View, where it was transformed into shape files that are used by the IMS software to serve the MRDS data and permit access via the www. Positional accuracy is variable among records in the database because the data came from multiple sources and no consistent program has been implemented to verify the accuracy of the positional information.

Available fields include: site name, county, land status, quad name, latitude and longitude, commodity, hydrologic unit, production size, owner, and operation type.

Title: MAS/MILS mineral location database information
Publication_Date: 1998
Geospatial_Data_Presentation_Form: map
Publisher: U. S. Geological Survey
Abstract:
This coverage and associated databases contain data from selected fields of five tables in the MAS/MILS database. This database was transferred to the U.S. Geological Survey from the U.S. Bureau of Mines upon its closure in 1996. The database is considered archival and will be incorporated into the U.S. Geological Survey mineral location database along with the MRDS database.

Completeness_Report: Contains all locations in MAS/MILS database as of time of download.

Available fields include: county, name of property, type of operation, current status, on-site point of reference, quad name, property ownership type, mineral and access rights, type of processing, commodity type, and bibliography

B. GEOMORPHOLOGY AND HYDROLOGY

Digital Elevation Model (DEM)>> 30 meter grid cells showing average elevation per cell in feet. Data were derived from USGS 3 arc-second (approximately 75 x 90 m at the latitude of California) DEM files. A Digital Elevation Model consists of a sampled array of elevations for ground positions that are normally at regularly spaced intervals. The basic elevation model was produced by or for the Defense Mapping Agency, but is distributed by the EROS Data Center, in the DEM data record format. The majority of the 1-degree Digital Elevation Models are produced by DMA from cartographic and photographic sources. The digital elevation models distributed within the Department of Defense cover 1- x 1-degree blocks and are called Digital Terrain Elevation Data Level 1 (DTED-1). In reformatting the DMA product to create the DEM's, the USGS restructured the header records and data but did not change the basic elevation information. The 1- x 1- degree DEM files were converted to image format at UCSB, mosaicked together to form a single coverage of the entire state, and projected into the standard California Gap Analysis Albers projection, using a nearest neighbor sampling with a 100m pixel size. No attempt was made to fix seam problems between 1- x 1- degree blocks.

Planning Watersheds >> Data from the Teale Data Center. The California Watershed Map (CALWATER version 2.0) is a set of standardized watershed boundaries meeting standardized delineation criteria. The hierarchy of watershed designations consists of four levels of increasing specificity: Hydrologic Region (HR), Hydrologic Unit (HU), Hydrologic Area (HA) , and Hydrologic Sub-Area (HSA). The primary purpose of CALWATER is the assignment of a single, unique code to a specific watershed polygon. While there are 987 polygons in the ARC/INFO coverage, there are actually fewer watershed codes. This is due to cases of multiple polygons bearing the same watershed code (Channel Islands, split polygons due to other boundary integration, e.g. ground water basins). Another confusing factor is that not all Hydrologic Units are subdivided into Hydrologic Areas, and not all Hydrologic Areas are subdivided into Hydrologic Sub-Areas. The following comments are subjective remarks: CALWATER boundaries were digitized on a 1:24,000-scale base and thus very accurately divide surface water features depicted on 1:100,000-scale Digital Line Graph hydrography. However, CALWATER delineations are primarily designed to be administrative reporting units, and the boundaries should not be used to define authoritative drainage area above a given point as a portion of their definition includes non-physical boundaries, particularly in valley floor and urbanized coastal regions. Attribute completeness is good. Compatibility with existing state and federal watershed delineations is good, except where explicitly different boundary configurations are applied.

Slope Analysis>> Slope analysis consists of a 30meter cell-size grid, which was derived from the DEM by the authors. Contact us directly for more information.

Dams & Diversions>> Data from the California Department of Water Resources and the Department of Fish and Game. The point coverage is from 1994 and the dams are the jurisdictional dams of California (Bulletin 17-93, California Department of Water Resources (DWR), Division of Safety of Dams, Sacramento). Jurisdictional Dams are defined as "artificial barriers, together with appurtenant works, which are 25 feet or more in height or have an impounding capacity of 50 acre-feet or more. Any artificial barrier not in excess of 6 feet in height, regardless of storage capacity, or that has a storage capacity not in excess of 15 acre-feet, regardless of height, is not considered jurisdictional." (DWR Bulletin 17-93). The coverage was prepared by the California Department of Fish and Game, Inland Fisheries Division GIS Staff from a database file provided by Floyd Brooks, DWR, containing latitude/longitude coordinates and descriptive data for each dam. Primary Purpose: reference - Determine management needs (research, regulations, etc.) - Project planning and management. - Assess effects of proposed projects or development on resources. - Emergency response planning

Hydrography>> Data from the National Hydrography Database (NHD). The NHD is a comprehensive set of digital spatial data that encodes information about naturally occurring and constructed bodies of water, paths through which water flows, and related entities. The information encoded about these features includes classification and other characteristics, delineation, geographic name, position and related measures, a "reach code" through which other information can be related to the NHD, and the direction of water flow. Features are classified by type. These feature types, such as "stream/river", "canal/ditch", and "lake/pond", provide the basic description of the features. Each type has a name and a definition. Characteristics, which are traits, qualities, or properties of features, are provided for many feature types. Each characteristic has a name, a definition, and a list of values and corresponding definitions. A five-digit feature code encodes the feature type and combinations of characteristics and values that can be assigned to a type. The first three digits encode the feature type, and the last two digits encode a set of characteristics and values. For example, the feature type "dam/weir" has the code "343". There are five combinations of characteristics and values that can be assigned to features of this type. These combinations are assigned the values of "00" through "04". A reach is a continuous, unbroken stretch or expanse of surface water. In the NHD, this idea has been expanded to define a reach as a significant segment of surface water that has similar hydrologic characteristics, such as a stretch of stream/river between two confluences, or a lake/pond. Reaches also are defined for unconnected (isolated) features, such as an isolated lake/pond. A transport reach represents the pathway for the movement of water through a drainage network. These reaches also are used to encode the direction in which water flows along the reach when the direction is known. They provide a basis on which locations of observations can be geocoded and linked to the drainage network. A waterbody is a hydrographic feature delineated using areas. Reaches assigned to waterbodies are termed waterbody reaches. These reaches provide a means to geocode observations for areas of water. (In contrast, transport reaches represent the path of a flow of water and provide a means of geocoding observations along the path.) Areal delineations of features provide the areas used to delineate waterbody reaches. A reach code is a numeric code that uniquely labels each reach. This 14-digit code has 2 parts: the first 8 digits are the hydrologic unit[4] code for the cataloging unit in which the reach exists; the last 6 digits are assigned in sequential order, and arbitrarily among the reaches.

Each reach code occurs only once throughout the Nation. Once assigned, a reach code is associated with its reach permanently. If a reach is deleted, its reach code is retired. A reach code should not be altered.

Reach codes can serve to geocode an observation to a reach or a position along a reach. Observations can be geocoded to an entire reach by associating the reach code with the observation data, or to sections of a transport, coastline, or (the planned) shoreline reach by using the reach and reach code as the basis of a linear referencing system.

Reach codes are stored in data elements named "RCH_CODE".

Sources of information used to construct the initial release of the NHD include:

- Digital line graph 3 (DLG-3) data. These data, captured from USGS topographic maps and unpublished source materials, provide the delineations and classification of features (except for artificial paths in areal features and connectors). The data were organized in the DLG optional format, were tiled in quadrangles, were edge-matched, were from the DLG "hydrography" data category, and were in the Universal Transverse Mercator coordinate system, North American Datum of 1927 (NAD27). The scales of the map source materials used for the initial release of the data are shown below:

Geographic Area	Map Scale of Source Information
Conterminous United States and Hawaii	1:100,000
Puerto Rico	1:20,000 and 1:30,000
Virgin Islands	1:24,000

Efforts are under way to improve the NHD; most of these involve the collecting data for the conterminous United States from 1:24,000-scale maps, and digital images with positional accuracies commensurate with 1:12,000 and larger scales. Currentness varies by individual maps; see digital update units for more information.

- Reach File Version 3 (RF3) data. These data, developed by the USEPA, provide the starting point for reach delineation, reach codes, direction of water flow information, and positions of geographic names for the feature type stream/river. These data were developed on 1:100,000-scale DLG data for the conterminous United States and Hawaii as part of a previous project.

- Cataloging unit boundaries. These data, developed by different agencies, are used to assign features and reaches to cataloging units.

Hydrologic Stations>> Manually digitized from web-based location points on California Data Exchange Center website. Metadata available for individual stations available on web site (http://cdec.water.ca.gov/cgi-progs/nearbymap?staid=CFW).

C. CLIMATE

Precipitation>> Data from Chris Daly & George Taylor (Oregon State University). There are many methods of interpolating precipitation from monitoring stations to grid points. Some provide estimates of acceptable accuracy in flat terrain, but few have been able to adequately explain the extreme, complex variations in precipitation that occur in mountainous regions. Significant progress in this area has been achieved through the development of PRISM (Parameter-elevation Regressions on Independent Slopes Model). PRISM is an analytical model that uses point data and a digital elevation model (DEM) to generate gridded estimates of monthly and annual precipitation (as well as other climatic parameters). PRISM is well suited to regions with mountainous terrain, because it incorporates a conceptual framework that addresses the spatial scale and pattern of orographic precipitation.

Point estimates of precipitation originated from the following sources: National Weather Service Cooperative (COOP) stations, 2) Natural Resources Conservation Service (NRCS) SNOTEL, 3) local networks. All COOP station data were subjected to quality control checks by the National Climatic Data Center (NCDC). This ftp site contains spatially gridded precipitation of average monthly and annual precipitation for the climatological period 1961-90. Distribution of the point measurements to a spatial grid was accomplished using the PRISM model, developed by Chris Daly of PRISM Services/Oregon State University. Care should be taken in estimating precipitation values at any single point on the map. Precipitation estimated for each grid cell is an average over the entire area of that cell; thus, point precipitation can be estimated at a spatial precision no better than half the resolution of a cell. For example, the Oregon precipitation data was distributed at a resolution of approximately 4km. Therefore, point precipitation can be estimated at a spatial precision no better than 2km. However, the overall distribution of precipitation features is thought to be accurate.

It is beyond the scope of this metadata to document the processes involved in generating spatially gridded precipitation using the PRISM model. However, the processes are documented in numerous conference proceedings and journal articles. The references can be found online at <URL:http://www.ocs.orst.edu/prism/prism_new.html>.

D. NATURAL SETTING

Fire History >> Data from Sierra Nevada Ecosystem Project (SNEP, 1996), updated by the California Department of Forestry – Fire and Resources Assessment Program (CDF-FRAP). This is a statewide coverage of fire history, constantly under development. It is a regions coverage to handle overlapping polygons. Fires contained in this coverage came from many sources, some better than others.

SOURCE: Various ranger units, forests, national parks, and counties
MINIMUM MAPPING UNIT: 10 ac for USFS, 300 ac for CDF

The attributes have been separated into five region subclasses, one for the statewide fires subclass attributes, one for the CDF attributes, one for the USFS attributes, one for the National Park attributes, and one for the LAC Fire attributes.

Hardwood Vegetation>> Data from California CDF-FRAP. Hardwood rangelands below 5000' elevation were originally mapped by Dr. Norm Pillsbury (Cal Poly SLO) under contract by California Department of Forestry and Fire Protection (CDF). Polygons were delineated on 1981 1:24,000 scale black and white air photos, transferred to 1:100,000 scale base maps, and digitized. The data were updated by Pacific Meridian Resources under contract from CDF using 1990 LANDSAT TM imagery. This GRID format data represent the base classification data used to update delineated polygons (polygons are provided as an additional layer). Each pixel is coded based on species group, tree size, and canopy closure class.

FIELD NAME: DESCRIPTION
DESCRIPTION

BOW Blue Oak Woodland
BODP Blue Oak \ Foothill Pine
VOW Valley Oak Woodland
COW Coastal Oak Woodland
MH Montane Hardwood
OTHER Non-Hardwood
POTENTIAL Vegetation classified as hardwood outside the original Pillsbury hardwood polygons
CONIFER Conifer vegetation type
SHRUB Shrub vegetation type
GRASS Grass vegetation type
URBAN Urban area
WATER Lake, stream, bay, etc.
OTHER Other area

FIELD NAME: SIZE_CLASS
SIZE_CLASS DESCRIPTION
---------- -----------
0 No data
1 Large
2 Small
3 Non-Hardwood

FIELD NAME: SIZE
SIZE DESCRIPTION
---- -----------
No data
S Small (dbh < 12")
L Large (dbh >= 12")
NH Non-hardwood

FIELD NAME: WHR_CC
WHR_CC DESCRIPTION
------ -----------

0	No data
1	10-24% crown closure
2	25-39% crown closure
3	40-59% crown closure
4	60-100% crown closure
5	OTHER

Late Succession / Old Growth (LSOG)>> Data derived from the Sierra Nevada Ecosystem Project's expert input sessions. This coverage contains the mapping and characterization of late-successional forest attributes for the National Forests, State Parks, National Parks, and Bureau of Land Management land in the Sierra Nevada Ecosystem Project Study area. The data do not include information about private land. The mapping was originally done by agency resource experts with guidance from the Sierra Nevada Ecosystem Project Late-Successional Work Group. This coverage contains ecological attributes for landscape map units including rank based on the polygon?s level of late-successional forest attributes. Each polygon is subdivided into no more than 7 subpolygons or patches. Each patch is classified as a percentage of the larger polygon and described by ecological attributes.

In some areas the intermix of private and public land was too complex for the resource experts to accurately exclude the private land in their hand drawn polygons. However, the data recorded for the polygon is only applicable to the public land. Therefore, to accurately use this layer the GIS analyst must use the administrative boundaries (i.e. the administrative boundary for the Plumas National Forest) to exclude any private land from area calculations or maps. Otherwise any acreage estimates or maps would be inaccurate because the database does not include information about private land within the polygon.

Subject: for each polygon, overall contribution to late-successional characteristics (rank) and dominant forest type, for each subpolygon or patch; subpolygon patch type, patch rank, and up to four patch disturbance codes, percentage of patch type for total polygon, density and size of large diameter trees per acre, code for estimated percentage of decadent trees, size of large trees for a given forest type and size class, presence of intermediate canopy, density of large snags per acre, site class, dominant tree species, and canopy closure .

Geographic Extent: The administrative boundary for each National Forest and National Park and various, but not all, State Parks in the study area. The BLM information is limited and occurs in small patches throughout the study area.

In the early part of the Sierra Nevada Ecosystem Projects efforts to assess late-successional forests a group of over 100 resource specialists was convened to identify, map and characterize forest landscape units that include functional late-successional forest elements across federal and state lands in the greater Sierra Nevada ecoregion. The resource specialists were provided with every available information source, including aerial photographs, satellite images, old-growth maps supplied by a variety of sources, and inventory data. Much of this information the resource specialists brought with them to the exercise from their individual districts, forests, and parks.

In the summer of 1994 the polygons were field checked by members of the Late-Successional Work Group. Corrections were made based on these reviews. In the spring of 1995 the resource mappers were given draft copies of the maps and the database and asked to review and make changes. Corrections and changes were made following these reviews. Polygons were updated due to natural occurrences such as fire. For further information regarding thematic accuracy see:

Franklin, J. F. and J.A. Fites-Kaufman. 1996 Analysis of late successional forests. In Sierra Nevada Ecosystem Project : Final Report to Congress, vol. II, chap. 21. Davis: University of California, Centers for Water and Wildland Resources.

Langley, P.G. 1996. Quality assessment of late seral old-growth forest mapping. In Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, chap. 22. Davis: University of California, Centers for Water and Wildland Resources.

Davis, F.W. 1996. Comparison of late seral/old growth maps from SNEP versus the Sierra Biodiversity Institute. In Sierra Nevada Ecosystem Project: Final report to Congress, vol. III. Davis: University of California, Centers for Water and Wildland Resources.

Positional Accuracy: These polygons were hand drawn by resource experts on various base maps. The base maps used included: National Forest maps 1:126,720 and USGS orthophotoquads and quadrangle maps 1:24,000; BLM 1:100,000 and USGS National Park maps 1:125,000. The base maps used met National Mapping Accuracy Standards.

Natural Diversity Database (NDDB)>> From California Department of Fish & Game showing point and polygon occurences of recognized species. The California Natural Diversity Database (CNDDB) is a statewide inventory of the locations and condition of the state's rarest species and natural communities. The CNDDB includes within its inventory all federally and state listed plants and animals, all species that are candidates for listing, all species of special concern, and those species that are considered “sensitive” by government agencies and the conservation community. This is a computerized inventory with over 36,000 location records for over 3,000 species and natural communities. These do not represent all locations of these species and communities, just the ones that are known.

Significant Natural Areas (SNAs)>> Cultural, Ecological & Geological areas - data derived from the Sierra Nevada Ecosystem Project's expert input sessions.

Purpose of Layer:

This layer was developed by the Sierra Nevada Ecosystem Project to describe, inventory and assess significant ecological, geological, and cultural areas of the Sierra Nevada. The mapping project did not attempt to be exhaustive, but rather contributory to the list of areas already known for the Sierra Nevada. Goals of the mapping project included: mapping areas on a fine scale, extending scope to include areas of cultural significance, collecting attribute data for each area, and utilizing resource experts from local areas as opposed to most previous efforts which queried academic scientists. These efforts were intended to compliment the SNEP late-successional forest effort. By inventorying these areas and their special attributes, we bring attention their existence and potential needs for management attention.

Layer Description:

This layer contains SNEP significant area polygons for National Parks and National Forests in the Sierra Nevada region. A small area of Bureau of Land Management land was also mapped. Areas mapped reflect three main types: (1) ecological (which combines genetic attributes, plant and animal species, and plant communities) and natural processes, (2) cultural, and (3) geological types. Within each category, areas were selected for rarity, richness, and representativeness. Each polygon is also described by narrative comments, management goals, and current impacts. The coverages can be linked to the database sigars_info by the join item poly_id.

Layer Subject:

Attributes for each map unit include category of significant area; ecological, geological, or cultural and criteria for selection as a significant area (rich, rare, and representative). Cultural and geological representative areas are also described by type. Other attributes include narrative comments regarding attributes that make the area significant, coding for primary, secondary, and long range management, past activities and current impacts to value of significant area. SNEP defines significant area as lands in the Sierra Nevada that contain special features of ecological, cultural or geological diversity; a feature is special if it is unusually rare, diverse, or representative of natural diversity.

GAP Vegetation >> Dominant Species landcover information from California GAP Analysis Project, UC Santa Barbara. The ownership data were based on the Managed Areas Database (MAD). MAD is a comprehensive GIS database for the conterminous United States which includes all types of managed areas. Examples include National and State Parks and Forests, Wilderness Areas, Indian and Military Reservations, and National Wildlife Refuges. Researchers at the Remote Sensing Research Unit at the University of California, Santa Barbara, compiled this database by integrating a number of data sources diverse in scale and map projection. The database has been compiled as a 1:2,000,000 scale product, and both the precision and accuracy of the database are in accord with that scale. MAD was based on the 1:2,000,000 scale Digital Line Graph files of boundaries produced by the U. S. Geological Survey.

The original Managed Areas Database was projected to the standard map projection used for the California Gap Analysis Project and unioned with the state boundary to enclose lands that are not categorized as managed areas. The arcs were then moved into a new layer.
The California Gap Analysis Project had concurrently compiled a map of managed areas for the state at a 1:100,000 scale. Managed areas boundaries digitized or incorporated from other sources into the GAP 1:100,000 scale layer were extracted and moved into the 1:2,000,000 scale version. Managed areas were incorporated into this base coverage at UCSB. In addition, boundaries of BLM lands not already in the coverage were extracted from the newest USGS 1:2,000,000 scale digital line graph layer and added to the Land Ownership/Management layer.
Polygon labels were transferred from the GAP 1:100,000 scale layer into the corresponding polygons on the 1:2,000,000 scale layer. Attributes for the polygons include the owner or steward, management status, and a 10 character Heritage Program ID-code for managed areas. For further details on attributes, see:
Beardsley, K. and D. M. Stoms. 1993. Compiling a digital map of areas managed for biodiversity in California. *Natural Areas Journal,* 13: 177-190.

E. TRANSPORTATION DATA

Highways>> State highways derived from Teale Roads Coverage (below).

Roads>> From Teale Data Center - derived from 1:100k Digital Raster Graphics. The 'ROADS' layer is based on the USGS DLG transportation linework derived from the DLG-3 digital series. The library layer contains DLG linework as it came from USGS, plus edited and new linework. Edits included corrections of coding and additions, deletions and alterations of linework. This layer contains a second-generation arc attribute table derived from the DLG major/minor pair scheme. The derived table is fully described here. The original coding can be made available upon request. DLG coding is documented in "Digital Line Graphs From 1:100000-Scale Maps, Data Users Guide 2, 1985" available from the U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia.

The roads layer contains several classes of transportation features including jeep trails, city streets, thoroughfares, unpaved roads, state highways, and interstates. Some of the data is 20 years old. All major highways were updated in 1993 through a joint project with CALTRANS. There were various types of updates, such as recoding former thoroughfares as highways, or vice-versa. We also added newly constructed highways and realignments. These roads were digitized at 1:24,000 scale. All post 1994 updates may by found by selecting the item "updinfo" not equal to zero. To find digitized roads, select for class equal to 90.

The attribute Route1 contains the 'legislative' route number. Route2 and Route3 may or may not contain the other route number assigned to that route. Due to inconsistency of classifications found among USGS 1:100,000 scale quads, some infrequently occurring classifications were not preserved in the attributes in the library, but can be retrieved through related files.

DATA QUALITY ASSESSMENT:

This layer is only as complete as USGS 1:100,000 quad maps, some of which date back to the mid 1970s. Recent areas of growth are not included; however, the information the layer does have is quite detailed and includes even jeep trails. The attribute coverage is fairly complete with 5 types and 22 classes of roads; however, not all classifications occur in each county, and classification of secondary roads can be somewhat inconsistent between 100k quads.

Road Density Analysis>> Road Density calculated as km/km^2. Calculated into 30meter grid cells using a function that calculates the relative proximity of a road to a 30m grid cell. The result of this function smoothes the transition between calculated road densities making the image more consistent and easier to interpret.

Road Proximity to Streams: This analysis was conducted in order to show the relative proximity of roads to stream courses throughout the watershed. This analysis was used to determine the total length of road (and percentage of total road length in the watershed) that existed within 100m, 200m and >200m of a stream course. The results were statistical and visual.

Stream Proximity to Roads: This analysis was conducted in order to show the relative proximity of stream courses to roads throughout the watershed. This analysis was used to determine the total length of stream (and percentage of total stream length in the watershed) that existed within 100m, 200m and >200m of a road. The results were statistical and visual.