prepared for The Trust for Public Land
by the Conservation Biology Institute

Conservation Assessment for The

Yuba River Watershed Foothills

The Trust *for* Public Land

Conserving Land for People

CONSERVATION ASSESSMENT for the YUBA RIVER WATERSHED FOOTHILLS

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CONSERVING LAND FOR PEOPLE

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INTRODUCTION

The foothills of the iconic Sierra Nevada—the California gold fields—are linked to California's way of life and sense of place, as well as tied to the history of our nation. To many Californians, the natural resources of the Sierran foothills are emblematic of our state—grasslands golden in the summer sun mingling with rolling oak woodlands. Nonetheless, this iconic California landscape is not well protected, but rather is severely threatened by residential sprawl that has the potential to permanently compromise its conservation values. Less than 10% of the oak woodlands and grasslands in the Sierra Nevada foothills are protected, and the value of these conservation investments relies on maintaining the lands' integrity and ecosystem functions by buffering them from development and maintaining connections to other intact areas. The current downturn in the real estate market provides a window of opportunity to protect some of the last uncompromised areas of the northern Sierra foothills using conservation tools such as fee title acquisitions, conservation easements, and land management agreements.

The Trust For Public Land (TPL), through its Sierra Nevada Program, has for years implemented conservation actions to protect the natural, scenic, and recreational resources of the Sierra. This report assesses the conservation values and opportunities in the foothills of the northern Sierra Nevada, generally within the Yuba River watershed, and is intended to inform TPL's conservation activities and assist other conservation organizations and public agencies in the region (Appendix A). These organizations and agencies include, but are not limited to, the California Department of Fish and Game (CDFG), California Department of Parks and Recreation, Sierra Nevada Conservancy, Nevada County, Yuba County, Placer County, and Butte County, Nevada County Land Trust, and Placer Land Trust. The Yuba River Watershed Foothills study area is contiguous with TPL's Sierra Nevada Checkerboard Initiative study area (White et al. 2005, 2008), which outlined a vision and proposed strategies for conserving natural resources and scenic and recreational values of a 1.5 million-acre area of the high Sierra. The current assessment provides a complementary conservation vision for a portion of the Sierran foothills. This vision is focused on maintaining the biodiversity of the region while realizing other associated benefits, such as improving public recreational opportunities, maintaining working landscapes, and contributing to the regional economy, by keeping the land uses of this area sustainable.

We conducted this assessment using publicly available information; as such, its scale is necessarily coarse, and assessment of parcel-level conservation values was not possible. In addition, the focus of this assessment is landscape-scale wildland conservation values. It does not attempt to address areas of open space that may support local-scale conservation values or that may be otherwise important to local communities. Appendix B provides details of information and methods used in the assessment.

PROJECT SETTING

The Yuba River Watershed Foothills study area (Yuba Foothills) lies largely within the Northern Sierra Nevada Foothills subregion of the Sierra Nevada region (Hickman 1996) (Figure 1). The Yuba Foothill's western border is approximately the boundary between the Great Central Valley and Sierra Nevada ecological regions, and the Sierra Checkerboard Initiative study area (White et al. 2005) is the boundary of the Yuba Foothill's eastern side. The approximately 660,000-acre study area for the Yuba Foothill conservation assessment is located primarily within portions of Yuba and Nevada counties, but includes small areas of Butte, Placer, and Sierra counties (Figure 2). The study area was generally derived from watershed units—Hydrographic Sub-Areas (HSAs)—within the Yuba, Bear, and American River watersheds (Figure 3).

The Yuba Foothills region is comprised of Mesozoic and Paleozoic Era marine sedimentary and metavolcanic rocks, with ultramafic rocks (e.g., serpentine) common along faults, and minor amounts of Cenozoic Era basalt and andesite (Miles and Goudey 1998). Varying in elevation from 130 to 4,000 ft, the terrain consists of moderately steep, northwest-trending ridges with major western-draining rivers cutting across them. The foothills of the Sierra Nevada are characterized by extensive oak woodlands and savannas.

Several major rivers traverse the Yuba Foothills study area, including Honcut Creek, Yuba River, North Yuba River, Middle Yuba River, South Yuba River, Bear River, and Coon Creek. With the exception of Coon Creek, which drains to the Sacramento River, all of the rivers in the study area drain to the Feather River. Snow plays a dominant role in the hydrology of Sierran river systems (Kattleman 1996), which are a significant component of California's water supply.

RESOURCE VALUES OF THE STUDY AREA

Wildlife Habitats

Twenty wildlife habitat types, defined by vegetation community characteristics per the California Wildlife Habitat Relationship System (Mayer and Laudenslayer 1988), have been mapped in the study area (Table 1).

The study area is dominated by four general vegetation associations: annual grasslands, blue oak woodlands, montane hardwoods, and conifer forests (Figure 4), which collectively comprise nearly 80% of the vegetative cover. For the purposes of this discussion, we grouped blue oak-foothill pine and blue oak woodlands, montane hardwoods-conifer and montane hardwoods, and ponderosa pine, Douglas fir, and mixed conifer forests. Riparian corridors (i.e., riverine aquatic and associated riparian and wetland habitats) account for less than 2% of the study area but provide valuable habitat and ecosystem services. Approximately 14.5 % of the study area has been mapped as urban and agricultural land cover types, and 3% of the study area has not been mapped. The following wildlife habitat discussion is summarized from Mayer and Laudenslayer (1988).

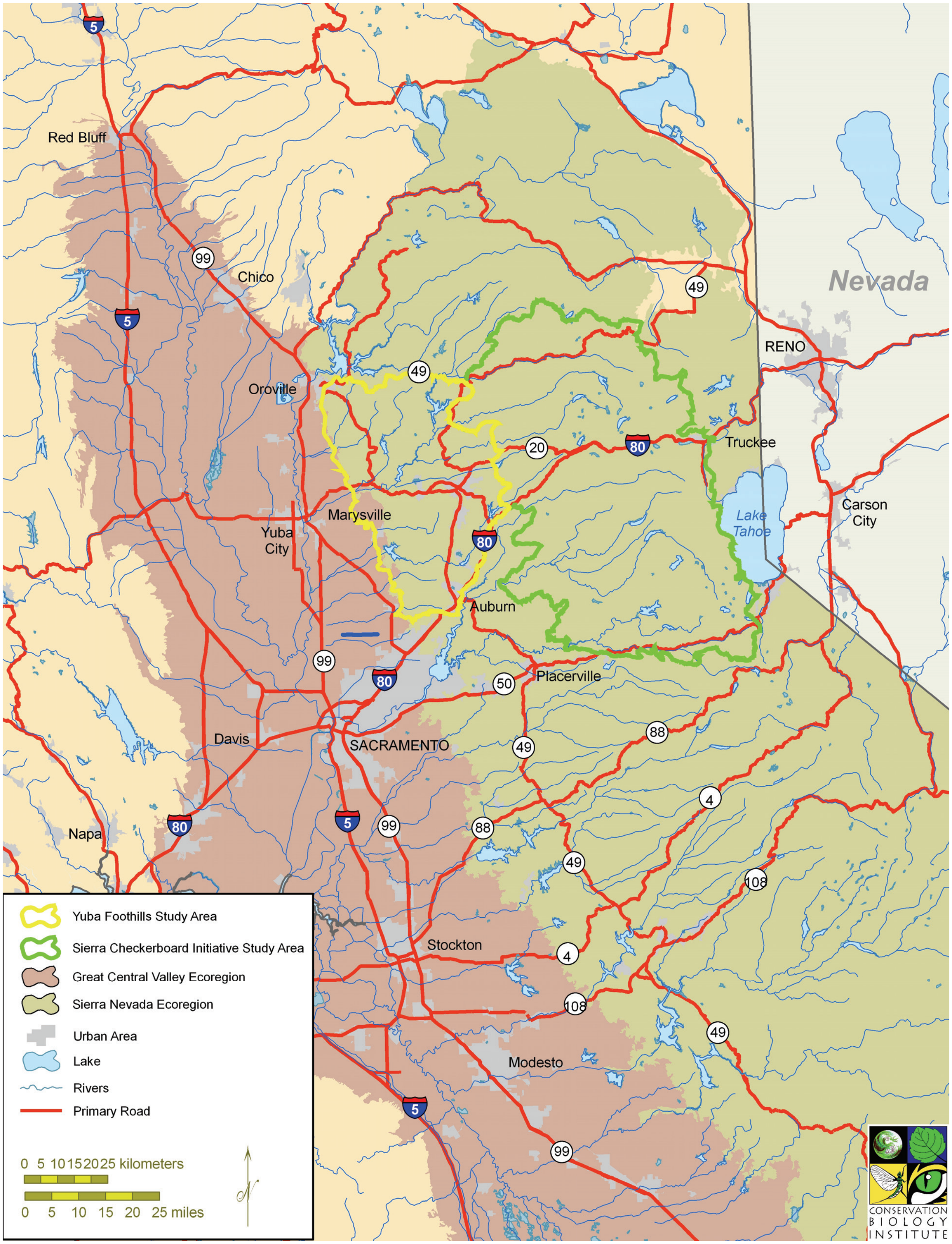

Figure 1. Regional location of the Yuba River Watershed Foothills study area.

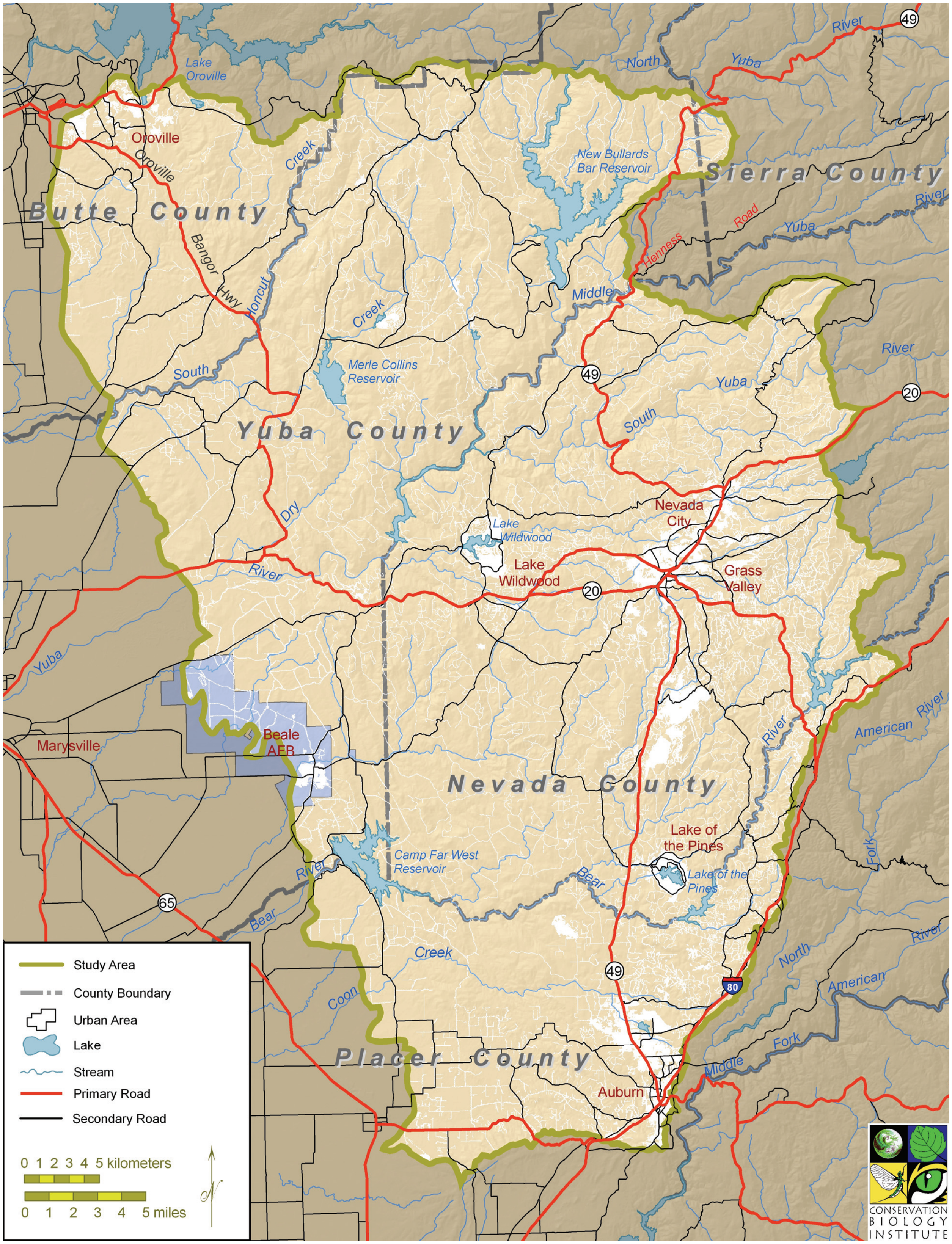

Figure 2. Yuba River Watershed Foothills study area.

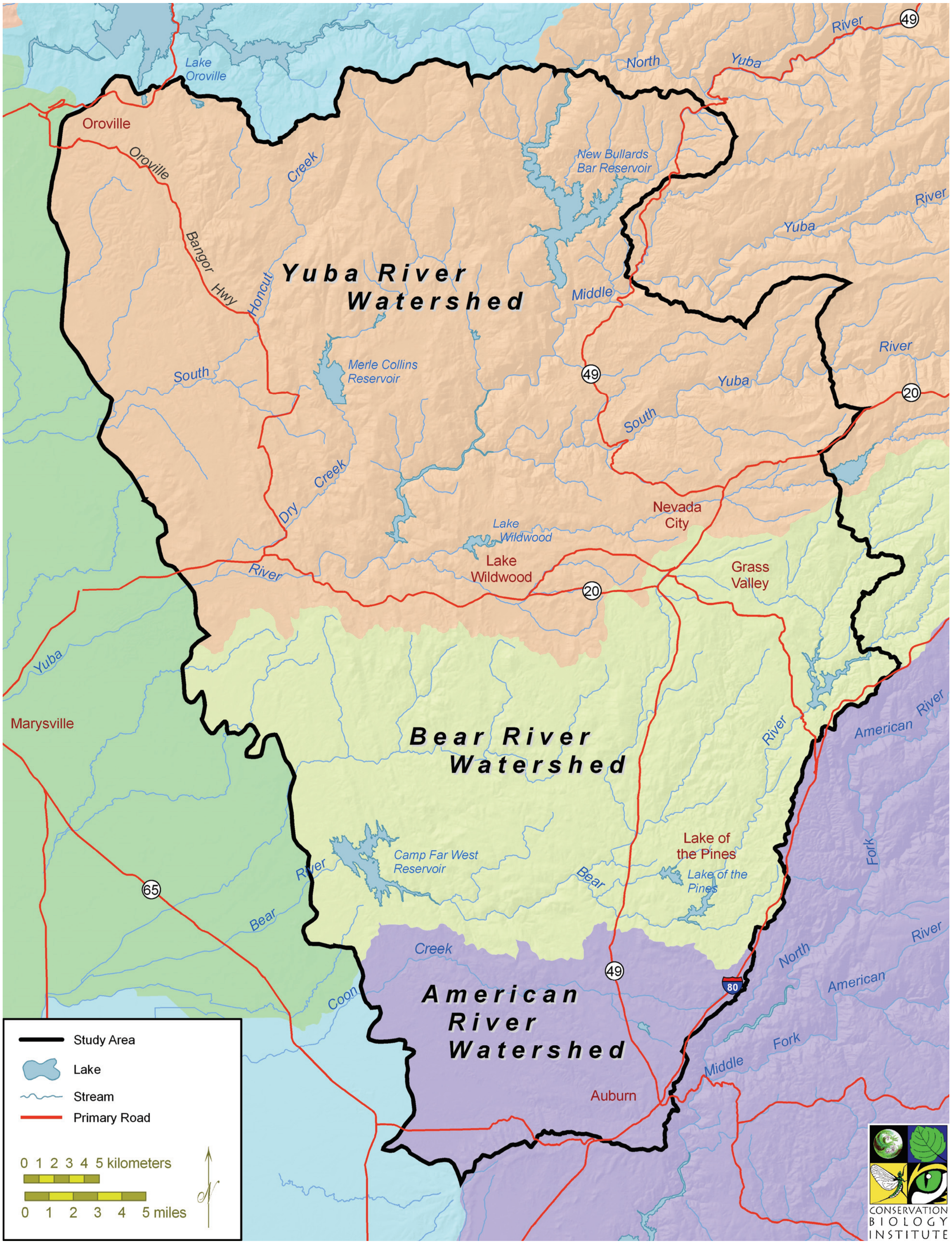

Figure 3. Watersheds in the study area.

Table 1. Wildlife habitats within the Yuba River Foothills study area.

Wildlife Habitat	Acreage in Study Area	% of Study Area
Annual grassland	102,441	15.54%
Barren	6,496	0.99%
Blue oak-foothill pine	12,862	1.95%
Blue oak woodland	124,403	18.87%
Coastal oak woodland	85	0.01%
Closed cone pine-cypress	148	0.02%
Agriculture - crops	8,876	1.35%
Douglas fir	44,843	6.80%
Freshwater emergent wetland	47	0.01%
Lacustrine	10,105	1.53%
Mixed chaparral	9,218	1.40%
Montane chaparral	598	0.09%
Montane hardwoods-conifer	32,241	4.89%
Montane hardwood	131,508	19.95%
Montane riparian	713	0.11%
Perennial grassland	2	0.00%
Ponderosa pine	45,993	6.98%
Sierran mixed conifer	18,534	2.81%
Urban	86,649	13.15%
Valley oak woodland	3,403	0.52%
Wet meadow	178	0.03%
Not yet mapped	19,771	3.00%
Total	**695,114**	**100.00%**

Annual grassland

Annual grasslands in the study area are generally dominated by nonnative grasses such as wild oats, soft chess, various bromes, and foxtail fescue. Common forbs include filarees, turkey mullein, popcorn flower, and California poppy. Relict populations of perennial native grasses, such as purple needlegrass, may be present. Annual grasslands form the understory of the open blue oak woodland habitats, as well as in the scattered Valley oak woodlands. Much of the annual grassland habitat supports livestock grazing which, along with patterns of annual rainfall, can affect the physical structure of this habitat type. Characteristic wildlife breeding in annual grassland habitats include reptiles (western fence lizard, western rattlesnake, and common gartersnake), mammals (pocket gopher, California ground squirrel, Western harvest mouse, badger, and coyote), and birds (western meadowlark, horned lark, and short-eared owl).

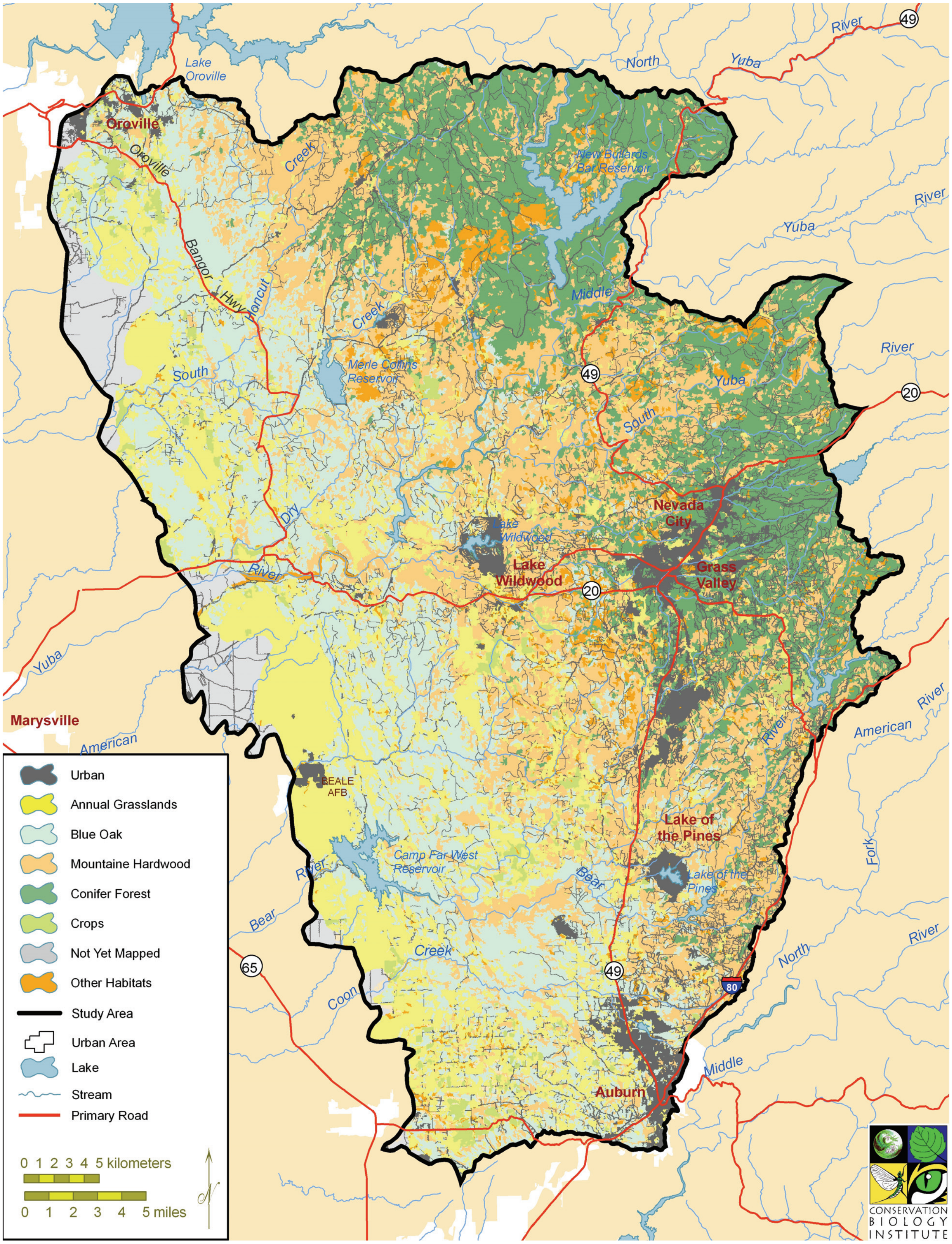

Figure 4. Wildlife habitats in the study area.

Blue oak woodland

Blue oak woodlands and blue oak-foothill pine habitats collectively cover over 1/5 of the study area. Blue oak woodlands, generally occurring at lower elevations, are typically structured in open savanna with an annual grassland understory. The canopy of blue oak-foothill pine tends to be dominated by blue oaks at lower elevations, with an increasing cover of foothill pine at higher elevations. Blue oak-foothill pine habitats often have a greater cover of chaparral shrub species in the understory than blue oak woodland. Low recruitment of blue oaks in the Sierra foothills is often cited as a concern (e.g., Swiecki et al. 1993). However, a review of blue oak demography (Tyler et al. 2006) found that, while some stands show no evidence of recruitment in the past 50 years and many stands have low numbers of seedlings and saplings, adult trees have low mortality rates (2-4% per decade) and many oak woodlands appear to be stable. At least 29 reptiles and amphibian species, 57 bird species, and 10 mammal species are known to use blue oak woodlands for breeding. Acorns produced by blue oaks are an important food source for many species.

Montane hardwood

Montane hardwood habitats, comprising nearly 1/4 of the study area, are often dominated by canyon live oaks in south-facing canyons, and black oaks and Douglas fir at higher elevations, and typically have poorly developed shrub and herbaceous layers. Other tree species include big-leaf maple, Pacific madrone, dogwood, incense cedar, and ponderosa pine. Montane hardwood habitat integrates with montane hardwood-conifer, which has a greater proportion of conifer tree species in the tree layer. Characteristic wildlife species include acorn dispersers (acorn woodpecker, Steller's jay, scrub jay, and western gray squirrel), species that rely on acorns as a major food source (wild turkey, band-tailed pigeon, mountain quail, California ground squirrel, dusky-footed woodrat, black bear, and mule deer), and a variety of reptiles and amphibians that are found on the forest floor.

Conifer forest

Conifer forests, found at higher elevations, cover nearly 17 % of the of the study area. Conifer forests include Douglas fir forest, ponderosa pine forest, and Sierran mixed conifer forest (Table 1). These habitats support varying mixtures of Douglas fir, ponderosa pine, incense cedar, Coulter pine, Jeffrey pine, sugar pine, black oak, and canyon live oak. The development of the understory in these forests is also variable. Conifer forests intergrade with montane hardwoods and, in places, with blue oak woodland. Conifer forests support diverse wildlife and are often important habitats for migratory species moving between the foothills and higher elevations of the Sierra. Some of the conifer forests around New Bullards Bar Reservoir in the northeast portion of the study area are part of the U.S. Forest Service's (USFS') old forest emphasis area because they support mature forest habitat that is of concern to land managers due to its decline in the Sierra relative to its historic distribution (McKelvey and Johnston 1992, Franklin and Fites-Kaufmann 1996). Much of the conifer forest around New Bullards Bar Reservoir is part of the USFS' carnivore network, established to emphasize habitat for forest carnivores such as American marten and Pacific fisher that prefer mature forests, and is known to support nesting California spotted owls.

Riparian corridors

Riparian corridors—riverine systems and associated riparian and wetland habitats—sustain a disproportionately high level of biodiversity relative to the landscape they occupy (National Research Council 2002). They support productive habitat, critical environmental processes, and often serve as movement corridors for many terrestrial and aquatic species (Naiman et al 1993, Noss and Daly 2006). Montane riparian habitats are dominated by willows, cottonwoods, alders, and dogwoods; emergent wetlands found along riverine systems support sedges, rushes, cattail, and arrowhead. The transition to upland vegetation types can be abrupt, but the influence of species and ecological processes in riparian corridors can extend significant distances into adjacent uplands (e.g., Wright et al. 2004). Riparian corridors provide water, shade, movement corridors, and diverse feeding and habitats. A high diversity of wildlife use riparian corridors for various portions of their life cycles, including terrestrial and aquatic invertebrates, fish, amphibians, reptiles, birds, and mammals. Of particular conservation concern are Chinook salmon populations in the Yuba River below Englebright Dam, and connectivity to aquatic habitats in the upper portion of the Yuba River watershed.

Special Status Species

The study area supports at least 15 special status plant species and 14 special status animal species (CNDDB 2008, Table 2). Eight of these species are listed as threatened or endangered by the state or federal governments:

- Layne's ragwort
- Pine Hill flannelbush
- Scadden Flat checkerbloom
- Stebbins' morning glory
- California black rail
- California red-legged frog
- Chinook salmon
- Bald eagle

However, over 110 special status species have been documented in the Northern Sierra Nevada Foothills subregion (CNDDB 2008), and additional surveys in the study area would undoubtedly find additional special status species.

Table 2. Special status species documented to occur in the study area (CNDDB 2008).

Common Name	Scientific Name	G Rank	S Rank	CNPS	State	Federal
Plants						
Brandegee's clarkia	*Clarkia biloba* ssp. *brandegeeae*	G4G5T2	S2.2	1B.2		
Butte County fritillary	*Fritillaria eastwoodiae*	G3Q	S3.2	3.2		
Cantelow's lewisia	*Lewisia cantelovii*	G3	S3.2	1B.2		
Follett's monardella	*Monardella follettii*	G1	S1.2	1B.2		
Jepson's onion	*Allium jepsonii*	G1	S1.2	1B.2		
Layne's ragwort	*Packera layneae*	G2	S2.1	1B.2	SR	FT
Norris' beard-moss	*Didymodon norrisii*	G2G3	S2.2	2.2		
Pine Hill flannelbush	*Fremontodendron decumbens*	G1	S1.2	1B.2	SR	FE
Quincy lupine	*Lupinus dalesiae*	G3	S3.2	4.2		
Scadden Flat checkerbloom	*Sidalcea stipularis*	G1	S1.1	1B.1	SE	
Stebbins' morning-glory	*Calystegia stebbinsii*	G1	S1.1	1B.1	SE	FE
Bog club-moss	*Lycopodiella inundata*	G5	S1?	2.2		
Brownish beaked-rush	*Rhynchospora capitellata*	G5	S2S3	2.2		
Elongate copper-moss	*Mielichhoferia elongata*	G4?	S2.2	2.2		
Red-anthered rush	*Juncus marginatus* var. *marginatus*	G5T5	S2S3	2.2		
Animals						
California black rail	*Laterallus jamaicensis coturniculus*	G4T1	S1	-	CT	
California linderiella	*Linderiella occidentalis*	G3	S2S3	-		
California red-legged frog	*Rana aurora draytonii*	G4T2T3	S2S3	-	SSC	FT
Chinook salmon (spring run)	*Oncorhynchus tshawytscha*	G5T1Q	S1	-	ST	FT
Coast (California) horned lizard	*Phrynosoma coronatum frontale*	G4G5	S3S4	-	SSC	
California spotted owl	*Strix occidentalis occidentalis*	G3T3	S2S3	-		
Pacific fisher	*Martes pennanti (pacifica)* DPS	G5	S2S3	-	SSC	FC
Townsend's big-eared bat	*Corynorhinus townsendii*	G4T3T4	S2S3	-	SSC	
Bald eagle	*Haliaeetus leucocephalus*	G5	S2	-	SE	Delisted
Foothill yellow-legged frog	*Rana boylii*	G3	S2S3	-	SSC	
Grasshopper sparrow	*Ammodramus savannarum*	G5	S2	-	SSC	
Long-eared owl	*Asio otus*	G5	S3	-	SSC	
Northwestern pond turtle	*Actinemys* (=*Clemmys*) *marmorata marmorata*	G3G4T3	S3	-	SSC	
Tricolored blackbird	*Agelaius tricolor*	G2G3	S2	-	SSC	
Vernal pool andrenid bee	*Andrena subapasta*	G1G3	S1S3	-		
Yellow warbler	*Dendroica petechia brewsteri*	G5T3?	S2	-	SSC	

Federal
FE = federally listed as endangered.
FT = federally listed as threatened.
FC = federal candidate species.

State
SE = state listed as endangered.
ST = state listed as threatened.
SR = state listed as rare.
SSC = state species of concern.

California Native Plant Society (CNPS)
1B = List 1B species: rare, threatened, or endangered in California and elsewhere.
2 = List 2 species: rare, threatened, or endangered in California, but more common elsewhere.
3 = List 3 species: plants about which more information is needed to determine their status.
4 = List 4 species: plants of limited distribution – a watch list.

New Threat Code extensions and their meanings:
.1 – Seriously endangered in California
.2 – Fairly endangered in California
.3 – Not very endangered in California

- = not applicable

Global Ranks (G Rank)
G1 = Extremely endangered: <6 viable element occurrences (EO), or <1,000 individuals, or <2,000 acres of occupied habitat
G2 = Endangered: about 6-20 Eos, or 1,000 – 3,000 individuals, or 2,000 – 10,000 acres of occupied habitat
G3 = Restricted range, rare: about 21-100 EOs, or 3,000 – 10,000 individuals, or 10,000 – 50,000 acres of occupied habitat
G4 = Apparently secure; some factors cause concern, such as narrow habitat or continuing threats
G5 = Demonstrably secure; commonly found throughout its historic range

State Ranks (S Rank)
Statewide status of a full species or a subspecies: S1 to S5
Same general definition as Global Ranks, but just for taxa within California

T-Ranks
A subspecies is given a T-Rank. This is attached to the Global Rank for the full species. The State Ranks, in this case, will refer to the status of the subspecies within California. The T-Ranks have the same general definitions as the Global Ranks.

Other Notations: applicable to Global Ranks, State Ranks, and T-Ranks
G1G3 = proper rank is most likely within this range of ranks
G2? = proper rank is probably G2
G? = we don't have enough information to rank the species
GH = all sites are historical; this species may be extinct, but further field work is needed
GX = species is extinct (SX = species is extirpated from California)
GXC = species is extinct in the wild but it exists in cultivation
G2Q = species is endangered but there is some question about the taxonomy

Key Ecological Processes

Fire

Wildfire is a natural process in Mediterranean climates, such as that present in the Sierra foothills; however, there has been very little research on historic fire regimes in foothill vegetation communities. Fire scar data collected from blue oaks in the University of California's Sierra Foothill Range Station revealed that fire return intervals differed in three distinct time periods reflecting settlement patterns and land management practices in the area (McClaran and Bartolome 1989). Prior to the extensive settlement of the foothills starting in 1848, fire return intervals occurred at an average of every 25 years. From 1848 to the late 1940s, when fire suppression policies were implemented, fires were much more frequent, occurring on average every 7 years. The few fires that were documented after 1948 when fire suppression policies were in place were attributed to recreational uses at nearby Englebright Reservoir.

Blue oak woodlands are generally tolerant of low and moderate intensity fires (Horney et al. 2002, Pavlik et al. 1991), and several authors have suggested that blue oak recruitment is positively associated with fire (Mensing 1992, Pavlik et al. 1991, McClaran and Bartolome 1989). However, McClaran and Bartolome (1989) speculated that post-fire sprouting from burned seedlings and saplings was responsible for their observed association between oak recruitment and fire, and a lack of evidence for a positive relationship between fire and oak regeneration has been documented by others (Mensing 1992, Swiecki and Bernhardt 2002, Bartolome et al. 2002). Swiecki and Bernhardt (2002) noted that post-fire resprouts remained longer at a size susceptible to subsequent fires or damage from herbivores. Thus, it is not clear that fire is essential for blue oak recruitment, but elevated fire frequency is likely to adversely affect regeneration of oak woodlands, particularly in the face of grazing pressure that maintain young oaks at a vulnerable size.

Humans now cause far more fires than do natural sources of ignition, such as lightning strikes (CAL FIRE 2006). Fires associated with human uses in residential development areas (e.g., equipment use and debris burning), ignitions from vehicles, and power lines account for over half of all wildfires (CAL FIRE 2006), so expanding development within the study area would likely result in increasing fire frequencies. In addition, residential development at densities of 1 dwelling unit/20 acres and higher comprise the *wildland urban interface* (WUI) and are targeted for vegetation management by CAL FIRE in the California Fire Plan (FRAP 2003). Thus, as residential development densities increase, vegetation management emphases must shift to minimizing fire threats to human lives and property rather than maintaining ecological processes and natural resource values. Conservation of larger unfragmented landscapes not only minimizes threats of increasing fire frequencies from human activities, but gives resource managers more flexibility and management options. Maintaining land management flexibility will be increasingly important as climate change modifies fire regimes and vegetation distributions.

Landscape connectivity

Landscape connectivity is the degree to which the landscape facilitates or impedes movement among resource patches (Taylor et al. 2006). Connectivity of natural open space is widely regarded as essential to functional landscapes (e.g., Noss 1987, Noss 1991, Saunders et al. 1991, Beier and Noss 1998, Crooks 2002). In fact, providing for connectivity of conserved lands is a fundamental principle of conservation planning (Noss et al. 1997, CDFG 1993, California Natural Community Conservation Planning Act 2002). Landscape-scale connectivity is also critical to allow species ranges to shift in response to climate change. This is particularly important in the Yuba Foothills where vegetation communities and associated wildlife species are projected to shift their distributions along elevational gradients (Lenihan et al. 2003, 2006).

Significant conservation investments have been made by the State of California in the western portion of the Yuba Foothills, but there is no secured connectivity across State Route 20. There is also no secured connectivity between protected areas and federally administered public lands in the eastern portion of the study area and beyond (i.e., within the Sierra Checkerboard Initiative study area). The long-term value of existing conservation investments relies on maintaining the lands' integrity and intact ecosystem functions by buffering them from human alterations such as development and maintaining connections to other intact areas.

LANDSCAPE ASSESSMENT

To better understand the regional context of the Yuba Foothills' conservation values, we evaluated the landscape within the Northern Sierra Nevada Foothills subregion, which contains the Yuba Foothills study area (Figure 5). Within the foothills of the northern Sierra Nevada, a major threat to conservation values is the loss and fragmentation of habitats by exurban development, associated roads, and other infrastructure. Therefore, in addition to assessing protection status of the subregion, we used three measures to assess condition of the landscape:

1. degree of conversion of habitats by development and agriculture,
2. road density, and
3. residential development density (number of acres per unit, FRAP 2002).

We summarized these measures across 16 different "landscape units" formed by the boundaries of interstate freeways and state routes within the subregion, as highways and roads decrease habitat connectivity for many species via behavioral avoidance or increased mortality (Forman et al. 2003, Clevenger and Wierzchowski 2006) (Figure 6a, Table 3). Thus, these landscape units can be considered patches of habitat isolated from each other by varying degrees. The Yuba Foothills study area is comprised of the majority of landscape units 2, 4, 5, 6, 7, 8 and about one-half of landscape unit 3 (Figure 6a). Methods for this assessment are discussed further in Appendix B.

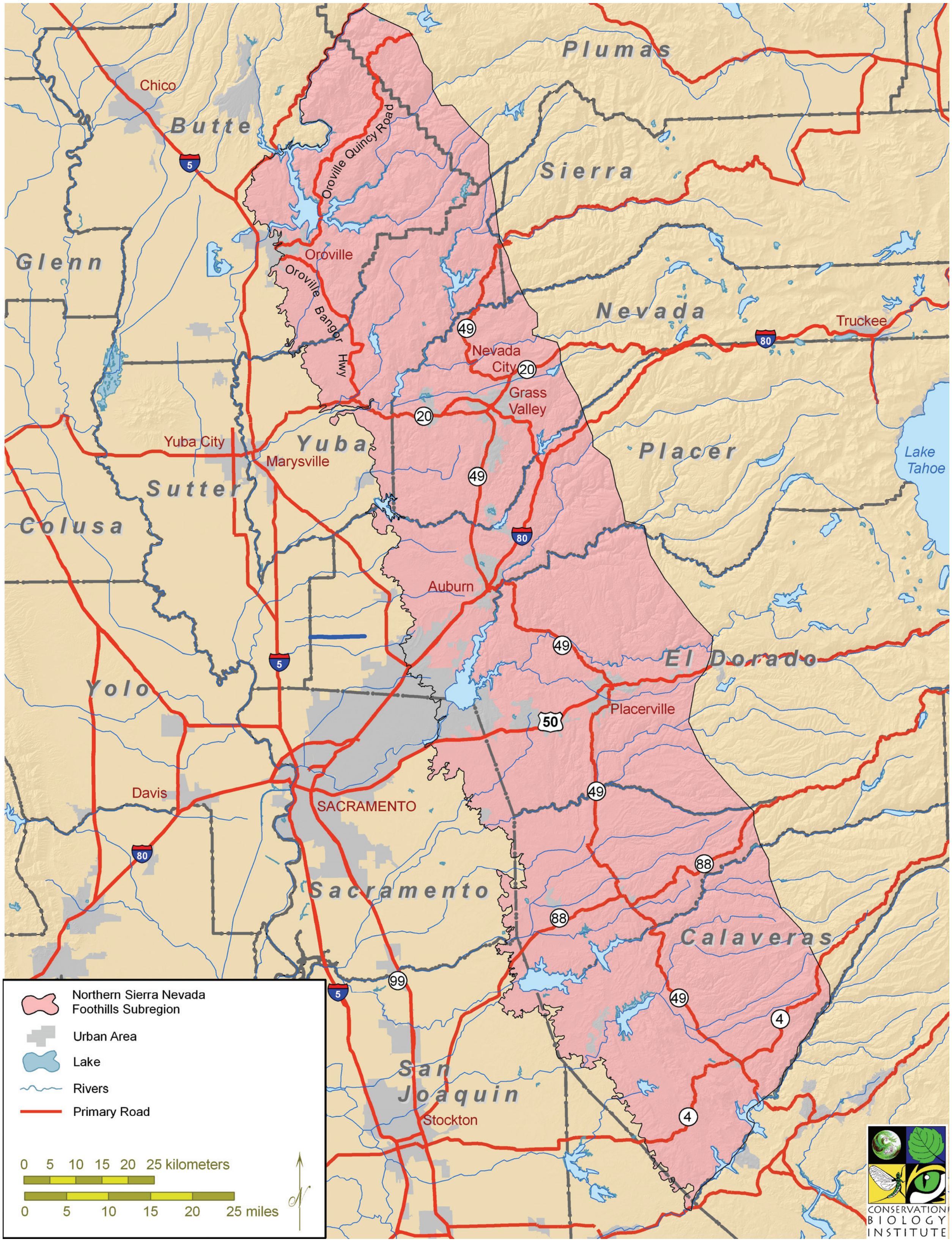

Figure 5. Major highways in the Northern Sierra Nevada Foothills subregion

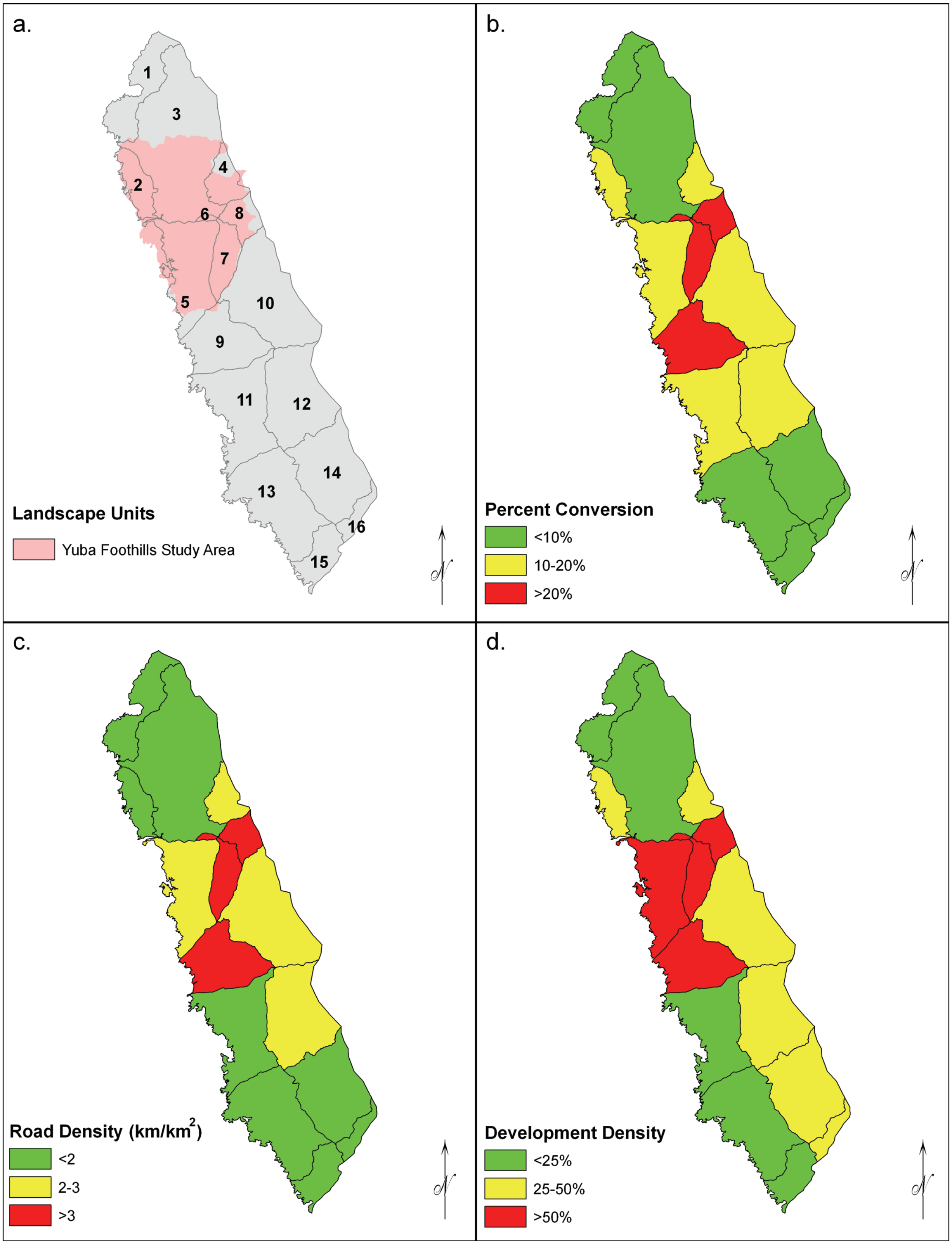

Figure 6. Landscape assessment results for the Northern Sierra Nevada Foothills subregion.

Table 3. Measures of condition for landscape units in the Northern Sierra Nevada Foothills subregion.

Landscape Unit	**Area (acres)**	**Habitat Conversion**	**Road Density (km/km^2)**	**Development Density (>1 DU/40ac)**	**Development Density (1 DU/40ac – 1DU/160 ac)**	**Development Density (<1 DU/160ac)**
1	120,230	6.47%	1.15	4.56%	19.95%	75.62%
2	63,649	12.20%	1.56	39.77%	40.80%	19.69%
3	447,614	8.75%	1.86	20.58%	19.68%	59.73%
4	61,044	11.02%	2.50	47.99%	12.37%	39.66%
5	193,588	16.80%	2.26	52.88%	17.58%	29.66%
6	4,463	34.83%	4.72	66.27%	9.14%	24.58%
7	67,566	29.77%	4.17	88.00%	5.73%	6.27%
8	49,312	23.02%	3.89	55.63%	15.02%	29.37%
9	160,839	27.69%	3.27	66.85%	10.64%	22.51%
10	268,826	12.35%	2.40	33.39%	13.57%	53.03%
11	216,877	10.88%	1.53	20.99%	14.30%	64.83%
12	221,396	12.20%	2.32	48.69%	31.32%	19.99%
13	251,494	7.73%	1.38	20.64%	29.09%	50.38%
14	219,728	8.40%	1.89	34.18%	38.58%	27.21%
15	72,095	6.43%	1.21	10.95%	10.93%	78.22%
16	31,970	7.79%	1.74	39.93%	17.59%	42.55%
Total	**2,450,688**	**12.26%**	**2.37**	**34.39%**	**21.08%**	**44.57%**

Urban landscape units are shaded (see text).

Habitat Conversion

The loss and fragmentation of habitats is considered the single greatest threat to biodiversity at global and regional scales (Myers 1997, Noss and Csuti 1997, Brooks et al. 2002). Over 80% of imperiled or federally listed species in the U.S. are at risk from habitat degradation and loss (Wilcove et al. 2000). We estimated habitat conversion across the Northern Sierra Nevada Foothills subregion by the total acreage of all urban and agricultural land cover types, not including land cover types that may support ranching uses (e.g., annual grasslands and oak woodlands).

Over 210,000 acres (12%) of the subregion has been converted to urban or agricultural land cover types. However, conversion varies across the 16 landscape units in the subregion, with percent conversion of individual landscape units ranging from nearly 35% to about 6% (Table 3). Percent conversion was greatest (>20%) in the landscape units formed by Interstate 80, Highway 50, and State Routes 20 and 49 (Figure 6b). These landscape units (units 6, 7, 8, and 9) support the populations centers of Auburn, Nevada City, Grass Valley, and Sacramento suburbs (Figure 6b), and are referred to as the "urban units" in the remainder of this report. Landscape units with the lowest (<10%) levels of conversion were found south of State Route 88 and north of State Route 20 (Figure 6b).

While a portion of the Yuba Foothills study area is comprised of landscape units with relatively high levels of habitat conversion, most of the study area has moderate to low levels of conversion (Figure 6b). Landscape unit 3, half of which falls in the Yuba Foothills study area, has low levels of habitat conversion, and units 2, 4 and 5 have moderate levels of conversion. Urban units 6, 7, and 8, which comprise the southeastern corner of the Yuba Foothills study area, have some of the highest levels of conversion in the Northern Sierra Nevada Foothills subregion.

Road Density

Roads are associated with adverse direct and indirect impacts to natural resources by serving as sources of pollution, altering hydrologic processes, disrupting migration patterns, changing species behaviors, and causing direct mortality via road kill (Beier 1995, Trombulak and Frissell 2000), and these effects can occur at relatively large distances from the road itself. Adverse effects of roads generally increase with road density (Forman et al. 2003), and road density can be a predictor of habitat quality for some species. For example, van Dyke et al. (1986) found that home ranges selected by mountain lions in Utah had lower road densities (<0.6 km/km^2) than areas outside of their home ranges. Thus, we used road density within individual landscape units as an indicator of landscape integrity across the Northern Sierra Nevada Foothills subregion.

Road density within the subregion as a whole was relatively high, averaging 2.37 km/km^2 (average road density across all of California is about 1.9 km/km^2, Forman et al. 2003), but varied from 1.15 to 4.72 km/km^2 among individual landscape units (Table 3). Not surprisingly, road density was positively correlated with percent conversion, with road density being greatest (>3 km/km^2) in the urban units (Figure 6c). Road density was intermediate in the landscape units adjacent to the urban units and was lowest in the landscape units furthest removed from them (Figure 6c). Thus, road density is generally lower in portions of the subregion north of State Route 20 and south of Highway 50.

As was the case with habitat conversion, much of the Yuba Foothills study area exhibits low to moderate road densities relative to the rest of Northern Sierra Nevada Foothills subregion (Figure 6c). Landscape units 2 and 3 have low road densities, and units 4 and 5 have moderate road densities. Urban units 6, 7, and 8 have the highest road densities of all landscape units in the Northern Sierra Nevada Foothills subregion. Also significant, Interstate-80 generally forms the southern boundary of the Yuba Foothills study area.

Development Density

Urban sprawl, defined as encroachment of low-density, automobile-dependent development into the natural areas outside of cities and towns, imperils 65% of the species listed as Threatened or Endangered in California (Czech et al. 2000). While suburban and exurban development do result in the loss of habitat, many of their effects are indirect, which can greatly exceed the magnitude of direct impacts on natural resources. These indirect effects include fragmenting habitat, increasing habitat edges, increasing light and noise, facilitating invasions of nonnative species, transmission of diseases from pets and livestock, increasing wildlife-human encounters, changing fire regimes, and limiting habitat management options. Therefore, even though habitats may not be directly impacted by development, habitat values can be lost from indirect impacts of development and associated human uses and recreational activities. In addition, these effects can occur at relatively low dwelling unit (DU) densities. For example, several studies have demonstrated adverse effects of development below densities at or below 1 DU per 40 acres (e.g., Friesen et al. 1995, Maestas et al. 2001, Odell and Knight 2001).

For the purposes of this analysis, we broke development into three density categories, reflecting high, moderate, and low or no adverse effects respectively (Table 3):

1. >1 DU/40 acres (High),
2. 1 DU/40 acres to 1 DU/160 acres (Moderate), and
3. <1 DU/160 acres (Low).

Consistent with habitat conversion and road density results, the four urban units had the greatest percentage of high density development (55%-88%), whereas the landscape units to the north (units 1 and 3) and southwest (units 11, 13, 15) of the urban units had relatively low percentages of high density development (Figure 6d). The northern and southwestern landscape units also support the greatest percentages of very low density or no development in the subregion (Table 3). Figure 7 shows the actual distribution of the three development density categories across the subregion.

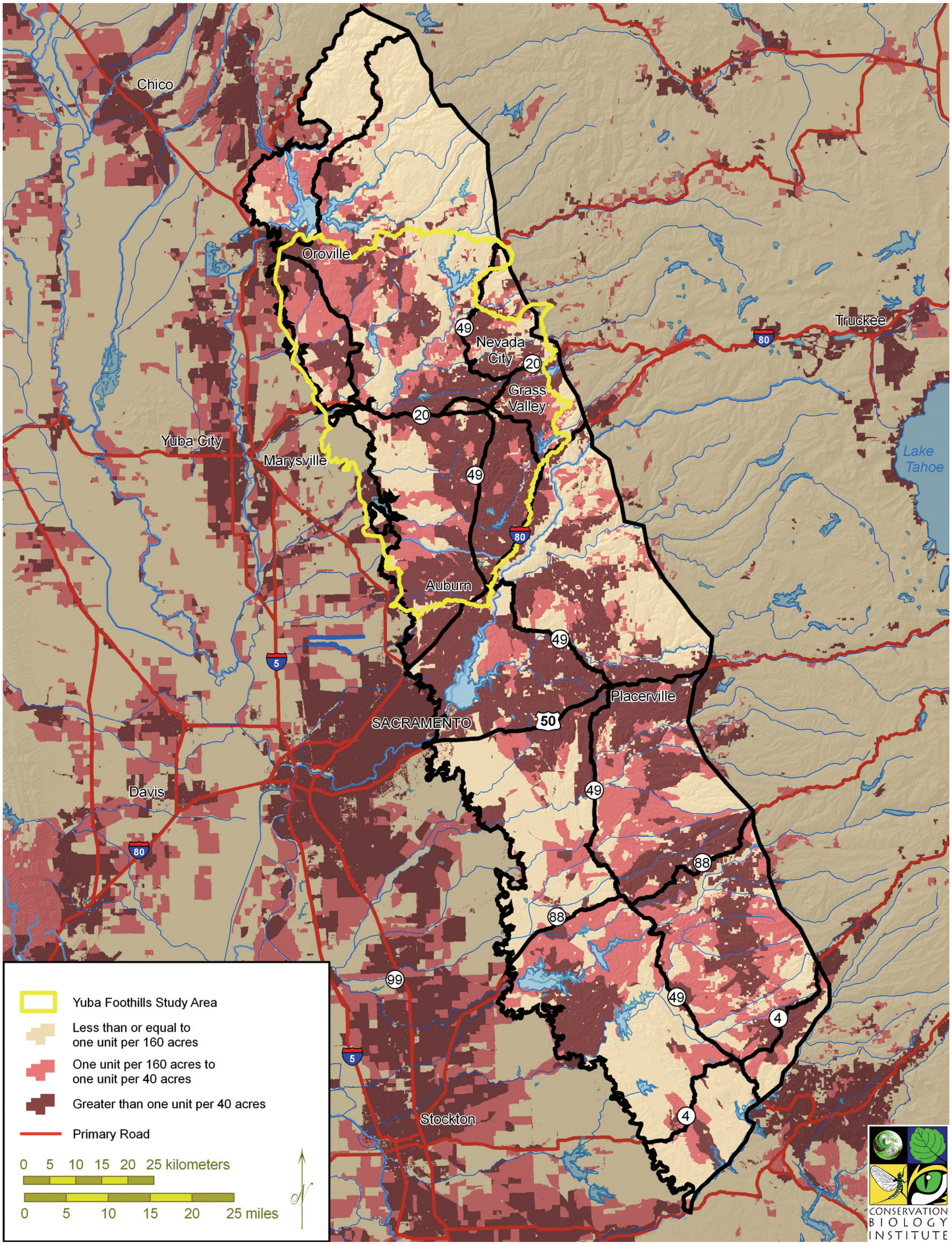

Figure 7. Development density in the vicinity of the Northern Sierra Nevada Foothills subregion.

Many of the landscape units that comprise the Yuba Foothills study area support high development densities (Figure 6d). Landscape units 5, 6, 7, and 8, located in the southern half of the study area, all support the highest percentages of high density development. Landscape units 2 and 4, at the western and eastern margins of the study area respectively, support moderate levels of high density development. Landscape unit 3 in the northern portion of the study area is characterized by a relatively low amount of high density development.

Protection Status

The aim of natural resources conservation efforts is to protect biodiversity at all levels—ecosystems, biological communities, and genetically distinct taxa. Therefore, conservation efforts must capture a sufficient proportion of all resource types to adequately protect regional biodiversity. Gap analysis (Scott et al. 1993) is a coarse-filter approach for prioritizing conservation efforts—it examines the regional ownership, levels of protection, and management patterns, by vegetation communities and other indicators of regional biodiversity, to identify gaps in their protection, i.e., identify resources that are under-represented in protected areas. Table 4 shows the protection status of the dominant habitat types in the Northern Sierra Nevada Foothills subregion (annual grassland, blue oak woodland, montane hardwood, and conifer forest), where Gap 1 and 2 lands have the highest level of protection and Gap 3 lands are moderately protected. Figure 8 shows the distribution of protected areas within the Northern Sierra Nevada Foothills subregion.

A very low percentage (<3%) of all major habitat types in the Northern Sierra Nevada Foothills subregion have the highest levels of protection (Gaps 1 and 2, Table 4). The percentage of major habitats under moderate protection (Gap 3) tends to increase along an elevational gradient–with lowest levels of protection of low elevation annual grasslands (3.1% of the subregion) and high elevation conifer forests with the highest levels of protection (38.4%). This is a reflection of the public lands in National Forests or administered by the Bureau of Land Management (BLM) that generally occur at higher elevations in the eastern portion of the subregion (Figure 8). Only 5.6% of the acreage of blue oak habitats (combination of blue oak woodlands and blue oak-foothill pine habitats) and 17.4% of the montane hardwood habitats (montane hardwood and montane hardwood-conifer habitats) in the Northern Sierra Nevada Foothills subregion are moderately protected. The majority of protected lands in the Yuba Foothills study area lie at the eastern edge of landscape units 3 and 4, or scattered along the western sides of units 3 and 5 (Figure 8). Only about 7% of blue oak woodlands and montane hardwoods in the study area have any formal protection status.

Although there are no established thresholds for habitat protection, targets exist that can be used as guidance. The Convention on Biodiversity has established a global target of effective conservation of 10 % of each of the world's ecological regions. Davis et al. (1995) considered vegetation communities in the South Coast ecological region at risk if less than10% of their distribution was in Gap 1 and 2 areas or if less than 30% of their distribution was in Gap 1, 2 or 3 areas. The Nature Conservancy has used conservation goals ranging from 20-30% of historical distributions (as opposed to current distributions reflecting habitat losses) in its ecoregional planning assessments (Nachlinger et al. 2001), and Groves (2003) suggests that conservation

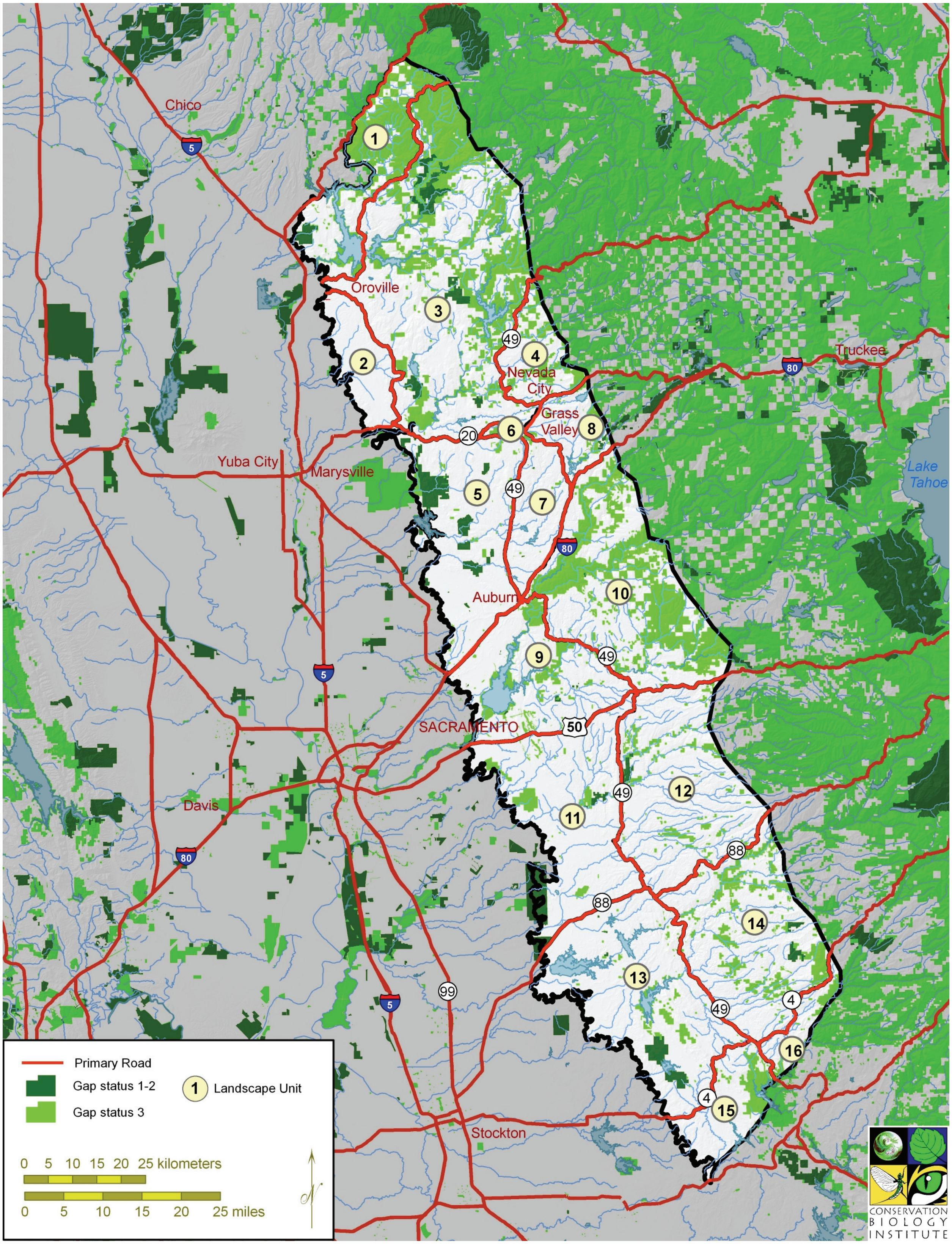

Figure 8. Protected areas in the vicinity of the Northern Sierra Nevada Foothills subregion.

Table 4. Protection status of habitat types in the Northern Sierra Nevada Foothills subregion.

Habitat Type	Gap 1 & 2 (High)	Gap 3 (Moderate)	Gap 1, 2, & 3 (Total Protected)
Annual grassland	**2.6%**	**3.1%**	**5.7%**
Blue oak-foothill pine	0.8%	16.8%	17.6%
Blue oak woodland	2.8%	3.7%	6.5%
Total blue oak woodland	**2.5%**	**5.6%**	**8.2%**
Montane hardwood	1.7%	15.9%	17.6%
Montane hardwood-conifer	1.8%	22.0%	23.8%
Total montane hardwood	**1.7%**	**17.4%**	**19.1%**
Sierran mixed conifer	1.4%	47.9%	49.4%
Douglas fir	4.1%	44.4%	48.5%
Ponderosa pine	0.5%	23.8%	24.3%
Total conifer	**2.1%**	**38.4%**	**40.4%**

Gap 1—an area with an active management plan in operation that is maintained in its natural state and within which natural disturbance events are either allowed to proceed without interference or are mimicked through management.

Gap 2—an area that is generally managed for its natural values, but which may receive use that degrade the quality of natural communities.

Gap 3—most non-designated public lands, including USFS, BLM, and state park lands. Legal mandates prevent permanent conversion to anthropogenic habitat types (with some exceptions, such as tree plantations) and confer protection to populations of federally listed endangered, threatened, and/or candidate species.

goals in the 30-40% range should be adequate to conserve most species in the face of habitat fragmentation. By most of these criteria, the major habitats in the Northern Sierra Nevada Foothill subregion, including the portion comprising the Yuba Foothills study area, are not adequately protected, but annual grassland and blue oak habitats are particularly underrepresented in protected areas.

Climate Change

Scientists have documented changing climate patterns around the world and are convinced that these changes are the result of the accumulation of anthropogenic greenhouse gases in the atmosphere (Parry et al. 2007). Increasing global temperatures and sea levels have been documented (Parry et al. 2007), as have a variety of biological responses to these changes (Parmesan 2006). Current research is predicting that average annual temperatures in California will increase by at least 3-4 ºF to as much as 8-10 ºF by 2100 (Cayan et al. 2006). Predictions of precipitation changes through 2100 are less certain, but a consistent prediction is that snowpack in the Sierra Nevada is expected to decrease by 30% to as much as 90% as a result of rising temperatures (Hayhoe et al. 2004).

Climate change will likely produce ecosystem-level changes in the Sierra Nevada. For example, there is already evidence of hydrologic alterations of river systems associated with warming (Field et al. 1999). The loss of snowpack from a warmer climate would further alter runoff patterns in Sierran rivers, with a relatively greater proportion of stream flow likely to occur in fall and winter and relatively less in spring and summer than currently occurs (Field et al. 1999). Recent studies are also documenting changes in species distributions resulting from climate changes, with many species shifting their ranges northward and to higher elevations (Parmesan 2006).

Changing climates and associated vegetation community responses are also likely to affect fire regimes in the Sierra Nevada. Predictions are for larger and more frequent wildfires throughout much of the Sierra (Miller and Urban 1999), which would contribute to vegetation community changes. This altered fire regime would also result in increased greenhouse gas emissions from fires, thereby exacerbating climate change in a positive feedback cycle.

Human alterations of natural landscapes can exacerbate the adverse consequences of climate change and negatively affect conservation values. For example, as previously discussed, some floral and faunal species may shift their distributions over time in response to changing climates. However, alteration and fragmentation of the landscape by development, roads, and other human land cover changes may effectively block migration and colonization by many plant and animal species. This may result in local extirpations of species that are particularly sensitive to fragmentation and other human modifications. Conservation of large, intact, and interconnected blocks of land is critical to allow biological systems to adapt to new environmental conditions produced by climate change and to maintain resiliency in the face of changing ecological process, such as fire and hydrologic regimes. Furthermore, large intact landscapes provide greater flexibility for future land managers to address the consequences of climate change. Thus, the degree of existing habitat conversion and fragmentation in parts of the Yuba Foothills study area is cause for concern, and there is an urgent need for conservation actions to protect the remaining intact portions of this landscape.

Discussion

Intact ecosystem functions (e.g., natural fire and hydrologic regimes and connectivity of habitats and species populations) tend to be associated with landscapes with high ecological integrity, measured here as low levels of human-induced conversion and fragmentation of habitats. High integrity landscapes tend to be more resilient to disturbance events and are better able to accommodate ecosystem adaptations to longer term changes, for example, those associated with climate change. The highways in the Northern Sierra Nevada Foothills subregion have effectively broken this landscape into a series of discrete patches (i.e., landscape units) with varying levels of ecological integrity. The urban landscape units associated with the population centers of Auburn, Grass Valley, Nevada City, and the suburbs of Sacramento (units 6, 7, 8, and 9) have the highest levels of habitat conversion, greatest road density, and highest development densities in the subregion. The human land use alterations and infrastructure associated with these urban landscape units have eliminated and severely fragmented the habitats within them, and Interstate 80, which connects the three largest urban units in the center of the subregion, compounds these impacts. The result is that structural connectivity between the northern and southern halves of the subregion has essentially been severed. The portion of the subregion supporting urban landscape units comprises two of the *Missing Linkages* identified in the Sierra Nevada ecoregion (Penrod 2000), where north-south landscape connectivity was noted as being threatened by Interstate 80 and surrounding residential development. Our analysis confirms this significant regional connectivity constraint.

Ecological integrity is still relatively high in landscape units farthest removed from the urban units in the northern and southern portions of the subregion (Figure 6), and there are still opportunities for significant conservation actions in these areas. For example, northern landscape units 1 and 3 and southern units 13, 14, 15, and 16 still have relatively low levels of conversion, low road densities, and low development densities. The intact northern units generally occur within the Yuba Foothills study area. Conservation opportunities may also exist within some of the less intact landscape units in this area, but are not highlighted by the coarse scale of the analysis. For example, landscape unit 5, which also falls within the Yuba Foothills study area, exhibits moderate levels of habitat conversion, road density, and high development density relative to other landscape units (Figure 6), but the actual distribution of development density (Figure 7) shows relatively low development density in the northwest portion of the unit. The configuration of development within this landscape unit may provide opportunities for protecting conservation targets, buffering existing protected areas, and maintaining connectivity across State Route 20 to intact areas within landscape unit 3. In addition, the Yuba River supports regionally significant aquatic resources, such as Chinook salmon habitat, and provides connectivity to upper portions of the watershed. Thus, when considered at a subregional scale, the Yuba Foothills study area supports significant conservation values and opportunities and should be targeted for conservation actions. Maximizing the size and integrity of the habitat patches, and maintaining or enhancing the connectivity between them, is critical to maintaining viable populations of species in the Northern Sierra Nevada Foothills subregion, and this should be an overarching conservation objective for the Yuba Foothills study area.

VISION FOR A NETWORK OF PROTECTED AREAS IN THE YUBA RIVER WATERSHED FOOTHILLS

The foothills of the Yuba River watershed provide significant opportunities for conservation within the relatively intact northern third of the Northern Sierra Nevada Foothills subregion. These opportunities include protecting intact landscapes supporting important resources, such as blue oak woodlands, connecting existing protected areas within the subregion to those in the adjacent conifer-dominated habitats of the High Sierra Nevada ecological subregion, and conserving regionally important riverine habitats. The Yuba Foothills support over 137,000 acres of mapped blue oak woodlands, which intergrade with annual grasslands at lower elevations and montane hardwoods and conifers at higher elevations. This represents 36% of the mapped blue oak woodlands in the entire Northern Sierra Nevada Foothills subregion. This region of the Sierra is threatened by habitat fragmentation from development and associated infrastructure, particularly in the eastern portion of the study area and along major transportation corridors, but, as discussed above, large portions of the Yuba Foothills are still relatively intact.

Conservation actions in this area could secure core areas of intact habitats, particularly blue oak woodlands and grasslands, and connectivity between existing conservation investments. In addition, the Yuba River supports regionally important habitat for Chinook salmon and conservation actions could facilitate future riverine habitat restoration activities.

Connectivity of natural open space is a fundamental principle of conservation planning. While there have been conservation investments in the Yuba Foothills (Figure 9), such as the California Department of Fish and Game's (CDFG's) Spenceville Wildlife Area, CDFG's Daugherty Hill Wildlife Area, University of California Sierra Nevada Foothill Range Field Station, Challenge Experimental Forest, and other public lands administered by the Bureau of Land Management (BLM) and U.S. Forest Service (USFS), they are not well connected to each other. The value of these existing conservation investments relies on maintaining the lands' integrity and ecosystem functions by buffering them from development and maintaining connections to other intact areas. In addition, establishing protected areas networks extending across elevational gradients (i.e., foothills to high Sierra), will accommodate shifts of species distributions in response to climate change.

Conservation opportunities must be focused and prioritized because of limited resources at funding agencies and conservation organizations. Therefore, because local governments generally allow at least one dwelling unit per legal parcel, and higher densities of residential development results in lower ecological integrity, we used the level of parcelization to assess and prioritize conservation opportunities. Larger parcels and contiguous groups of parcels under the same ownership are often more efficient landscape-scale conservation targets than smaller parcels. This does not, however, imply that smaller parcels have no value. Small parcels can support significant local resources and provide important community open space. In this analysis, we merged all contiguous parcels with the same owner, eliminated those less than 80 acres in size from further consideration, and categorized the remaining merged parcels by size (Figure 10).

Terrestrial Resource Areas

There are five general areas with clusters of larger parcels in the study area (Figure 11a):

Honcut Creeks: This area is generally located along and between North and South Honcut creeks, west and northwest of Collins Reservoir. It includes the northwest unit of the Daugherty Hill Wildlife Area, which is connected through a single large parcel to the area around the Daugherty Wildlife Area and UC Sierra Nevada Foothill Range Field Station. The distribution of large parcels extends north along North and South Honcut creeks and south to the headwaters of Jack Slough. Many blocks of small parcels are interspersed among the larger parcels in this area.

Daugherty Hill Wildlife Area: Large parcels are located around the southwestern unit of the Daugherty Wildlife Area and adjacent UC Sierra Nevada Foothill Range Field Station, which is adjacent to the Yuba River. Large parcels in this area extend north along Dry Creek to the Challenge Experimental Forest.

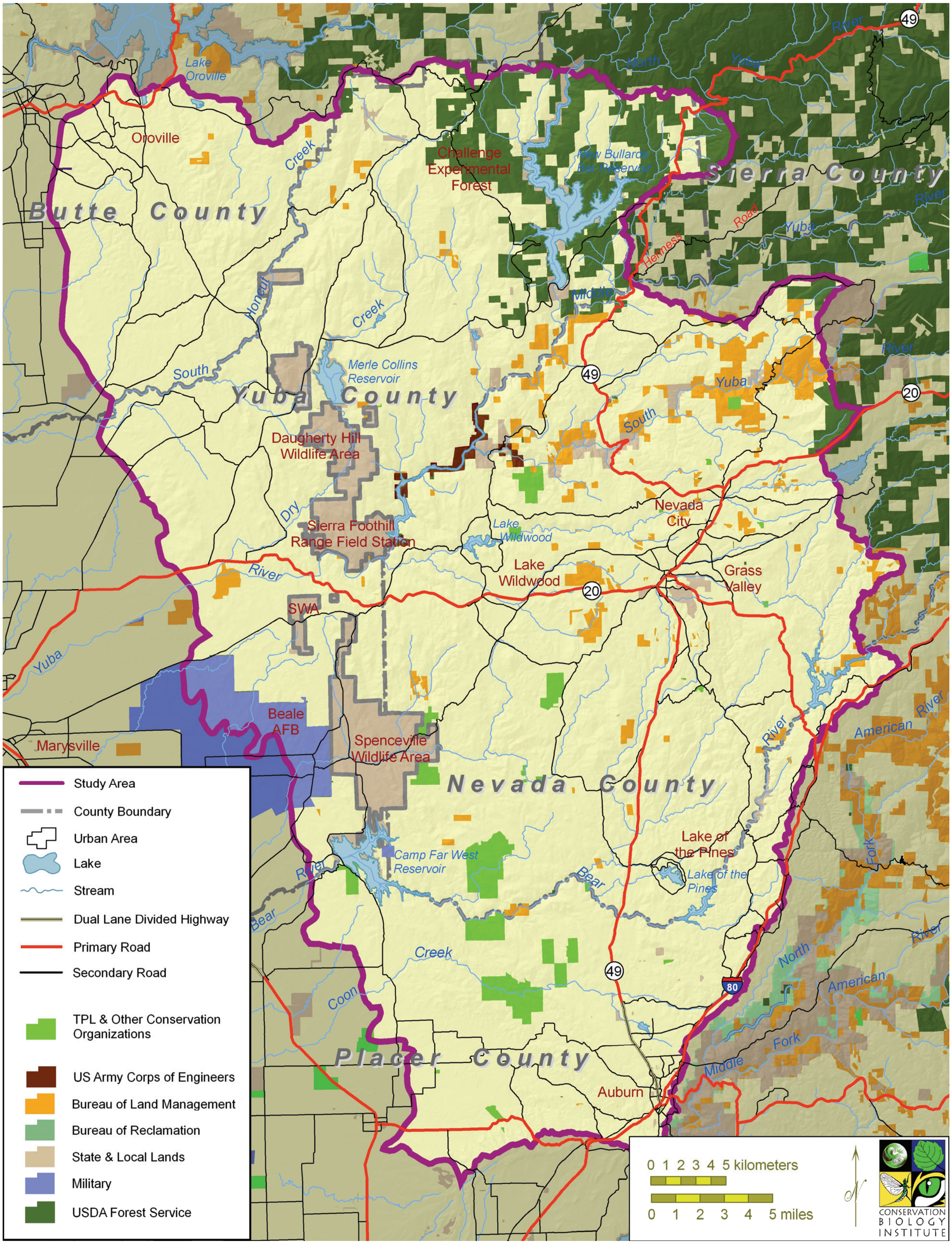

Figure 9. Ownership of protected areas in the study area.

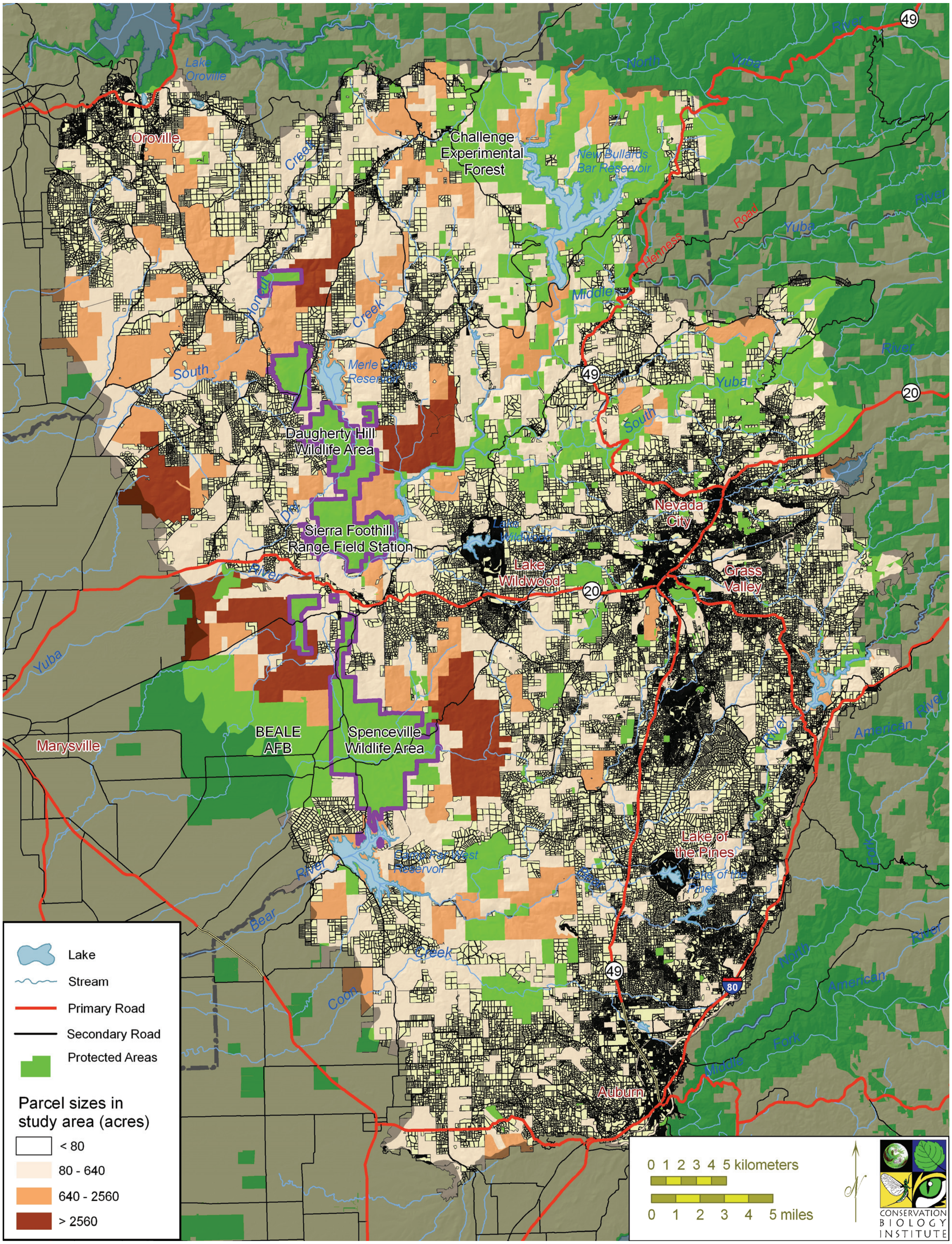

Figure 10. Parcel sizes of private land in the study area.

New Bullards Bar Reservoir: This area is centered on New Bullards Bar Reservoir, which is surrounded by significant amounts of USFS land, including the Challenge Experimental Forest. Large parcels are interspersed with public land around New Bullards Bar Reservoir, are adjacent to the public land west of the reservoir, and extend south of the reservoir along the Yuba River.

Spenceville Wildlife Area: Large parcels extend from the Wildlife Area to the north and east sides of Beale Air Force Base and north to the Yuba River. Large parcels are also located east of the Wildlife Area. Connectivity from this area through large parcels exists to the Yuba River and Daugherty Wildlife Area to the north and to the Camp Far West Reservoir/Bear River area to the south. South of State Route 20, there is no structural connectivity through large parcels from this area to open space east of State Route 49.

Bear River: There are groups of large parcels west of Camp Far West Reservoir and extending to the east of the Reservoir along Bear River. Large parcels are also located along Coon Creek, south of Bear River. The Bear River area includes several publicly owned parcels and conservation projects already completed by Placer Legacy, Placer Land Trust, Nevada County Land Trust, and TPL. This area is connected to the Spenceville Wildlife Area by the South Sutter Water District land at Camp Far West Reservoir. This area has no significant connectivity through large parcels to open space east of State Route 49, but connectivity to the west can be achieved along Bear River and Coon Creek.

River Corridors

In addition, there are two linear aggregations of larger parcels along river corridors in the study area (Figure 11b):

Yuba River: The mainstem Yuba River is contiguous with the Spenceville Wildlife Area to the south and the Daugherty Hill Wildlife Area to the north, and is key to maintaining connectivity between these two terrestrial core areas across State Route 20. The mainstem Yuba River provides important habitat for Chinook salmon and steelhead trout and significant aquatic habitat restoration potential that are key to conservation of these species in the entire watershed. The Yuba River also provides important recreational opportunities for many user groups.

South Yuba River: The large parcels along the South Yuba River form a significant riverine corridor and form a connection between the Daugherty Hill Wildlife Area and blocks of USFS and BLM lands to the east in the upper Yuba River watershed. The South Yuba River also provides important recreational opportunities.

Conservation Priorities

Based on the distribution of conservation targets, existing protected areas, and conservation opportunities, conservation priorities for the study area include:

- maximizing protection of areas of intact habitats, including blue oak woodlands/grasslands and mature conifer forests, that build on existing protected areas.

- protecting key riverine corridors supporting important aquatic resources and recreational opportunities, and that are necessary for future habitat restoration actions for anadromous fish species.
- securing connectivity between areas of intact lands in the study area, large areas of public lands to the east of the study area, and conservation targets west of the study area.

Following are some examples of where these objectives could be accomplished:

1. South of State Route 20, little opportunity exists for connectivity to the east; therefore, conservation should focus on building the size of protected areas in the Spenceville Wildlife Area and Bear River areas and maintaining connectivity between these areas and areas to the west of the study area along Coon Creek and Bear River. These conservation actions are targeted primarily at blue oak woodlands and grasslands.
2. North of State Route 20, conserve land to increase the size and connectedness of protected areas in the Daugherty Hill Wildlife Area and Honcut Creeks areas, which target conservation of blue oak woodlands and grasslands.
3. Secure landscape connectivity across State Route 20 between the Spenceville Wildlife Area and the Daugherty Hill Wildlife Area. Land conservation along the Yuba River, particularly in the vicinity of the Timbuctoo Bend of the Yuba River, appears to be the most efficient place to achieve this connectivity.
4. In the vicinity of New Bullards Bar Reservoir, build on the existing protected lands by conserving key inholdings and adjacent large parcels. Conservation actions should focus on preserving and enhancing mature conifer habitats. Maintain connectivity from New Bullards Bar to public lands east of the study area, including along the North and Middle Yuba rivers, and to the Honcut Creeks and Daugherty Hill Wildlife Area to the west.
5. Protect corridors along the Yuba River and its tributaries, including connectivity to downstream reaches west of the study area, to conserve important aquatic resources and facilitate future aquatic habitat restoration opportunities for anadromous fish species. Moreover, river corridors in the Sierra supporting high value scenic and recreational resources are a conservation focus of TPL's (White et al. 2008), and the Yuba River system and Bear River are conservation priorities for other stakeholders in the region (Sacramento State University 2008).

   These corridors also serve to connect conserved lands in the Yuba Foothills with public lands to the east (Figures 10 and 11). Conserving land along riparian corridors will maximize the diversity of habitats in the linkage, allow access to water and food sources from upland areas, provide natural travel routes for many species, and protect hydrologic functions (Noss and Daly 2006, Pringle 2006). Large parcels are nearly continuously distributed along the South Yuba River from the UC Sierra Nevada Foothill Range Field Station to the Tahoe National Forest, forming a corridor 1-2 miles wide. The New Bullards Bar Reservoir area serves to connect the study area to important mature conifer forests in the North and Middle Yuba River watersheds.

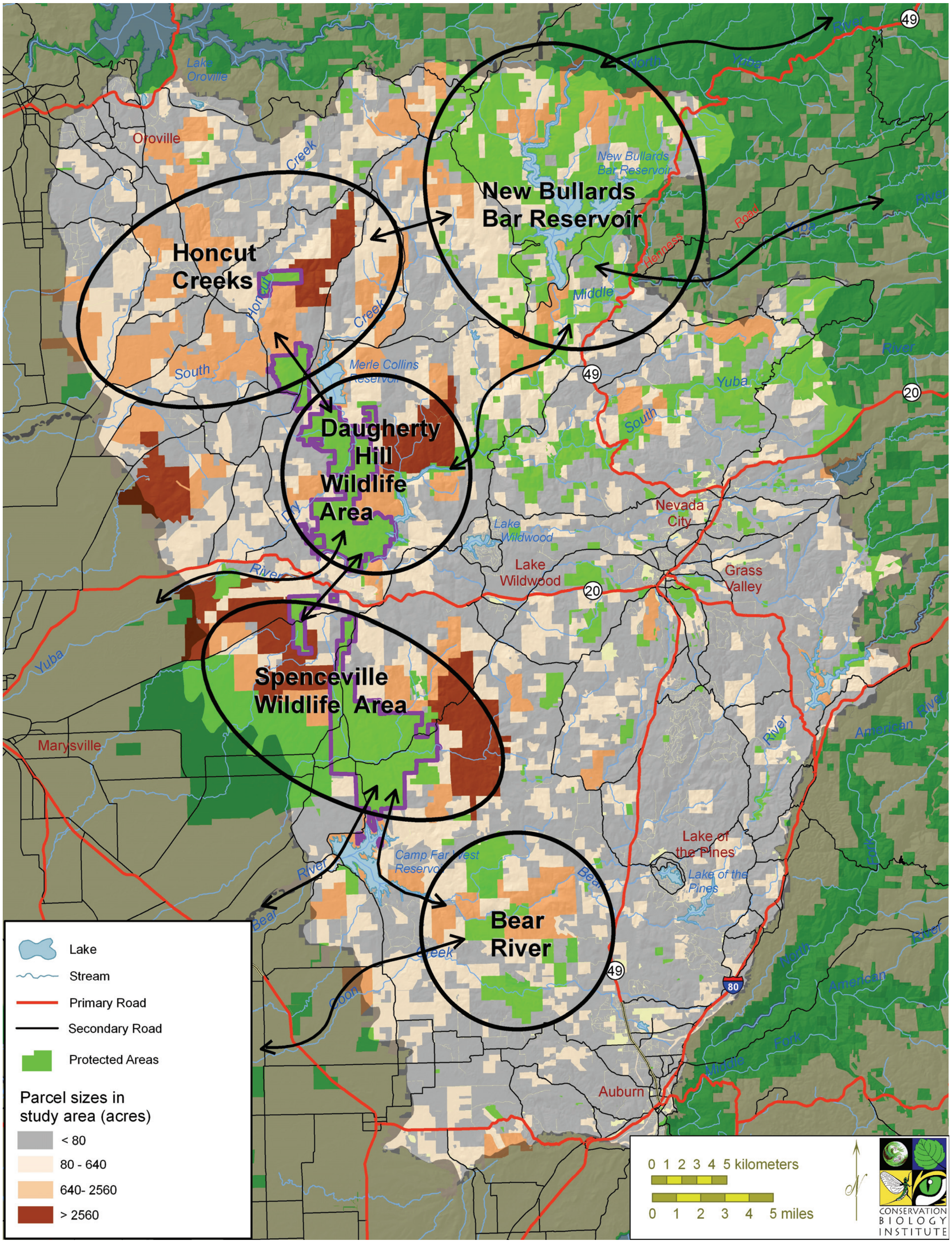

Figure 11a. Opportunities for conserving blocks of intact habitat (circles) and connectivity (arrows) in the study area.

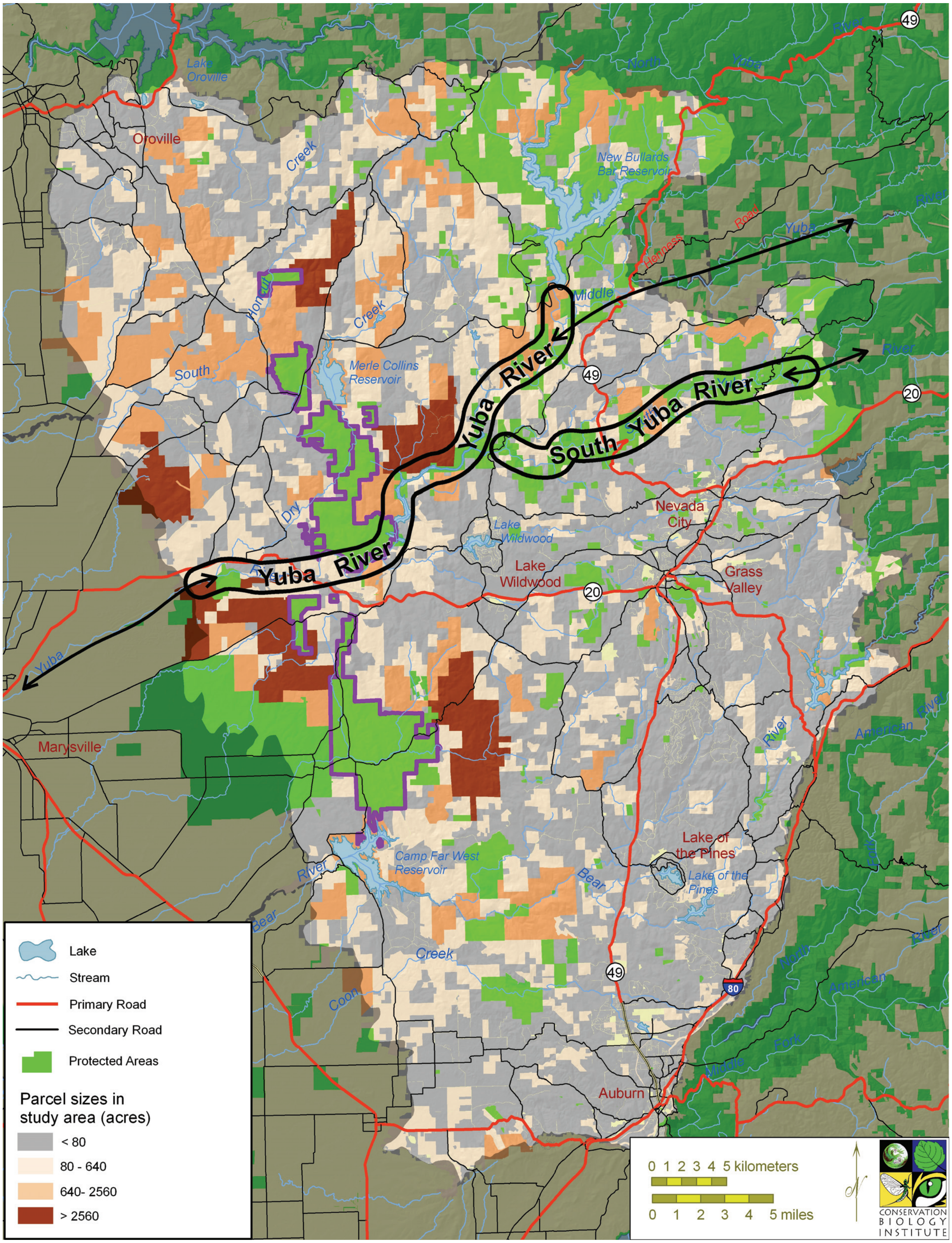

Figure 11b. Opportunities for conserving key river corridors and connectivity (arrows) in the study area.

The Yuba Foothills support significant opportunities to conserve regionally important resources, including blue oak woodlands, grasslands, mature conifer forests, and riverine aquatic habitats supporting anadromous fish species, as well as significant recreational opportunities. The resources in this region are not well protected, only 7% of the blue oak woodlands are in protective status, and are threatened by subdivision and rural residential development. The existing protected areas in the Yuba Foothills provide important building-blocks of a regional protected areas network, but the long-term value of these conservation investments relies on maintaining the lands' integrity and ecosystem functions by buffering them from development and maintaining connections to other intact areas. The threat to the viability of the Yuba Foothills is immediate—loss of a few key properties to development could profoundly compromise conservation values in this area and eliminate opportunities to maintain connectivity across this landscape. However, opportunities to secure protection for this area do exist, and the current downturn in the real estate market provides a window to act on them. Investments in conservation actions such as land acquisition, conservation easements, and management agreements would not only secure the natural resources in the Yuba Foothills, they could protect valuable recreational resources and working landscapes that benefit local economies. The time to act to protect an historic piece of California is now.

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APPENDIX A
ORGANIZATIONS WORKING IN THE YUBA FOOTHILLS

CABY Integrated Regional Management Project
www.cabyregion.org

Middle Mountain Foundation
www.middlemountain.org

Nevada County Land Trust
www.nevadacountylandtrust.org

Northern California Regional Land Trust
www.landconservation.org/

Placer Land Trust
www.placerlandtrust.org

River Partners
www.riverpartners.org

Sierra Fund
www.sierrafund.org

Sierra Nevada Conservancy
www.sierranevada.ca.gov

Sierra Cascade Land Trust Council
www.sierracascadelandtrustcouncil.org

South Yuba River Citizens League
www.syrcl.org

Yuba County Land & Water Conservancy
www.yubariverconservancy.org

APPENDIX B
DATA SOURCES AND METHODS

Table B-1. Digital data sources used in the assessment.

Name	Type	Scale	Date	Source
CNDDB California Natural Diversity Database	point	unknown	2008	California Dept. Fish and Game
County boundaries	Polygon	1:100,000	2000	US Census Tiger Data
Digital Elevation Model—	Raster	30m	varies	U.S. Geological Survey
Ecoregion Regions and Subregions California	Polygon	unknown	1996	UC Davis Information Center for the Environment 1996
Lakes	Polygon	1:24,000	2006	ESRI Streetmap Data
Development footprint—California	Raster	1:100,000	2000	California Department of Forestry and Fire Protection
Protected areas—California	Polygon	varies	2004	CBI Protected Areas Database 2004
Protected areas—Private	Polygon	unknown	2008	GreenInfo Network (2008)
Protected areas—Nevada County Land Trust	Polygon	unknown	2008	Nevada County Land Trust/Natural Resources Conservation Service 2008
Ownership-Yuba, Placer, Nevada, Butte Counties	Polygon	unknown	2005 - 2008	GreenInfo Network 2008, Placer County 2005, Nevada County 2005
Public ownership BLM	Polygon	1:24,000	2004	US Bureau of Land Management
Roads-	Line	1:100,000	2000	US Census Tiger Data
Roads-	Line	1:24,000	2006	ESRI Streetmap Data
Streams-	Line	1:24,000	2006	ESRI Streetmap Data
Urban areas—California	Polygon	1:100,000	2000	US Census Tiger Data
Urban areas—California	Polygon	unknown	2002	USGS National Landcover Program
Vegetation—MRLC	Polygon	30m	2001	USGS National Landcover Program
Vegetation (CALVEG)—	Polygon	unknown	2003	CA Dept. of Forestry & Fire Protection
Watershed boundaries	Polygon	1:24,000	1999	CA Dept. of Forestry & Fire Protection

Land Cover Database

Vegetation communities within the region have been mapped by the USDA Forest Service Region 5 Remote Sensing Lab and the California Department of Forestry and Fire Protection's Fire and Resource Assessment Program (FRAP), using both the California Wildlife Habitat Relationship (CWHR) and the Forest Service's Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG) classification systems (FRAP 2005). The data set also mapped urban and agricultural land cover types. To more accurately reflect the current status of land cover in the study area, we updated urban and agricultural land cover types in the vegetation community data using the Multi-Resolution Land Characteristics (MRLC) data set (MRLC 2001).

We extracted the following urban and agricultural cover types from the MRLC data set and unioned them with the FRAP vegetation data set to create the composite land cover data set used in the assessment.

- **20. Developed** - Areas characterized by a high percentage (30 percent or greater) of constructed materials (e.g. asphalt, concrete, buildings, etc).
- **21. Developed, Open Space** - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
- **22. Developed, Low Intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
- **23. Developed, Medium Intensity** - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
- **24. Developed, High Intensity** - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to100 percent of the total cover.
- **80. Planted/Cultivated** - Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75-100 percent of the cover.
- **81. Pasture/Hay** - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation
- **82. Cultivated Crops** - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

Landscape Assessment

The boundary of the Northern Sierra Nevada Foothills subregion was from a coverage developed by the UC Davis Information Center for the Environment (1996). Landscape units for the Northern Sierra Nevada Foothills subregion were created by intersecting the linework from the ESRI Streetmap dataset (ESRI 2006) representing all interstates, major, and minor highways on the Subregion boundary coverage. We further divided two large units in the northern portion of the subregion by using two connecting highways Oroville - Quincy Road and Oroville - Bangor Hwy.

For each landscape unit we calculated three metrics: 1) percent conversion, 2) road density, and 3) percent of three development density classes.

- Percent conversion was estimated as the percentage of each landscape unit support urban or agricultural land cover classes for the composite land cover database.
- Road density was calculated with the ArcMap line density tool on 1 Km x 1 Km grid using all roads from the Streetmap dataset (ESRI 2006).
- Development density was base on the FRAP Development Footprint dataset for California (FRAP 200). We divided the data into three classes: developed density < 1 dwelling unit/160 acres, developed density = 1 unit/160 acres to 1 unit/40 acres, developed density

> 1 unit/40 acres, and calculated the percentage of each landscape unit supporting each development class.

Protected Areas and GAP Analysis

Protected area data were derived from a number of sources including CBI's Protected Areas Dataset (CBI 2004), GreenInfo Network's California Protected Areas Database (GreenInfo 2008), lands protected by the Nevada County Land Trust (NCLT/NRCS 2008), and assessor's parcel data for the four counties comprising the study area. All of these data sources were used to develop protected areas maps for the Yuba Foothills study area and Northern Sierra Nevada Foothills subregion. The GAP analysis conducted for the assessment used only CBI's Protected Areas Dataset, as this is the only dataset that has consistent GAP codes assigned.


COVER IMAGES: *(Left) Looking west to the Yuba River Goldfields and the Sutter Buttes; (right) Majestic interior live oak. Images by Emily Rosenberg.*

BACK PAGE IMAGES: *(Left) Hidden Falls Regional Park; (right) Oak woodlands above the Narrows of the Yuba River. Left image by David Sutton and right image by Emily Rosenberg.*

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