CHAPTER 7

SYNTHESIS OF WATERSHED CONDITIONS AND FOCAL AREAS FOR MANAGEMENT RESPONSES

This chapter summarizes information on stakeholder issues, land use, soils, water resources, natural disturbances, and options for resource management organized into thirteen "analysis areas". Analysis areas consist of one or more subwatersheds in Bear Creek watershed following the delineation by Jack Alderson at the NRCS office in Colusa County (Figure 2.3). Each of the following chapter sections discusses one of the analysis areas in terms of important features, issues, potential projects, and job opportunities. Table 7.1 summarizes by analysis area the major issues identified in this assessment. The accompanying document *Bear Creek Watershed Stewardship Priorities 2010 – 2014* provides more in-depth information on the highest priority projects.

7.1 Brophy Canyon

Land Uses

livestock grazing, recreation and tourism (backpacking, camping, equestrian riding, game hunting, hiking), water delivery

Major Soils

This watershed has non-ultramfic soils; Skyhigh, Sleeper, Millsholm, and Boar series are the most common. Water permeates these soils slowly, and runoff and soil erosion can be very high because of the steep topography. Sleeper and Millsholm soils are slightly alkaline soils, whereas Skyhigh soils are the most acidic of the major soil types in the watershed.

Major Stakeholder Issues

Climate change
Creek channel alterations
Fire
Growing demand for recreation and tourism
Impacts from certain grazing practices and browsing and gnawing animals
Invasive non-native species

Analysis

Brophy Canyon may play an important role in water quality for Bear Creek watershed. As the last large drainage before the mouth of Bear Creek, Brophy Canyon supplies water to dilute the naturally high boron and salinity concentrations in Bear Creek water before it enters Cache Creek.

Table 7.1 – Summary of the distribution of major issues by subwatershed analysis area

Analysis Area	Toxic Chemicals	Sediment Delivery to Watercourses	Creek Channel Alterations	Creek and Tributary Headcuts	Roads, Trails, & Firelines	Fire	Oak Woodlands	Disturbances to Ultramafic Soils	Non-native Invasive Species	Impacts from Grazing & Wildlife	Native Woody Riparian Plants	Recreation & Tourism	Potential Impacts of Energy Projects	Fiscal & Policy Obstacles	Climate Change	Information Gaps
Brophy Canyon			X			X			X	X		X			X	
Craig Canyon / Eula Canyon							X	X	X	X		X			X	X
Deadshot Canyon / Trout Creek		X			X	X		X	X				X		X	X
Doyle Canyon / Gaither Canyon					X			X				X	X		X	X
Hamilton Area / Warnick Canyon		X			X		X		X	X						
Leesville		X	X	X	X		X			X	X			X		
Robbers Flat / Stinchfield Canyon			X		X		X		X	X	X				X	X
Thomson Canyon		X				X	X		X	X		X				X
West of Cortina Ridge		X				X	X			X					X	X
Mill Creek Subwatershed		X	X			X		X		X	X	X				X
Sulphur Creek Subwatershed	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Upper Bear Creek	X	X	X	X			X	X	X	X	X	X		X	X	X
Lower Bear Creek	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X

Creek channel alterations: At least six water impoundments, originally constructed as stock ponds, may be reducing the water flow from the Canyon into Bear Creek. Restoring natural flows to waterways by carefully breaching the impoundments may keep water flowing in Brophy Canyon for a longer period during the dry season. An analysis of the advantages and disadvantages of removing some of the impoundments is needed, in view of the reduction in livestock grazing on public lands.

Growing demand for recreation and tourism: Brophy Canyon is a popular setting for dispersed recreation. The trail along Cache Creek Ridge on the southwest edge of the subwatershed is a destination for visitors with overlooks into the Middle Cache Creek canyon, impressive vistas, and solitude. Erosion is particularly a concern along the steep north side of lower Brophy Canyon. Unstable slopes there are impacting hunter and hiker trails. Trail repair or re-routing is necessary in some areas.

Impacts from certain grazing practices and browsing and gnawing animals + Invasive non-native species: Grazing practices to suppress medusahead is a focus of land management. Current practices are unintentionally releasing yellow starthistle from competition with medusahead.

Fire: The eastern half of the subwatershed burned in 1999 during an arson fire originating along Highway 16. South-facing slopes, which are drier, more sparsely vegetated, and have more flammable chaparral vegetation, are at greater risk of erosion after fires.

Climate change: In the past, chaparral and oak woodland habitats were converted to grassland, particularly in the northwest quarter of the subwatershed. Reestablishment of native chaparral and woodland habitats may become more difficult, however, if wildfires become more frequent under the hotter, drier conditions forecast by climate change modeling.

Potential Projects and Job Opportunities

- Restoration of oak woodlands and chaparral vegetation on lands previously converted to grasslands
- Guided tours for environmental education for youth from Colusa, Lake, and Yolo counties
- Re-examination of management practices to determine whether multiple ecosystem goals are being achieved, especially in regard to managing targeted invasive plants, controlling erosion, improving hydrologic function, and enhancing native vegetation

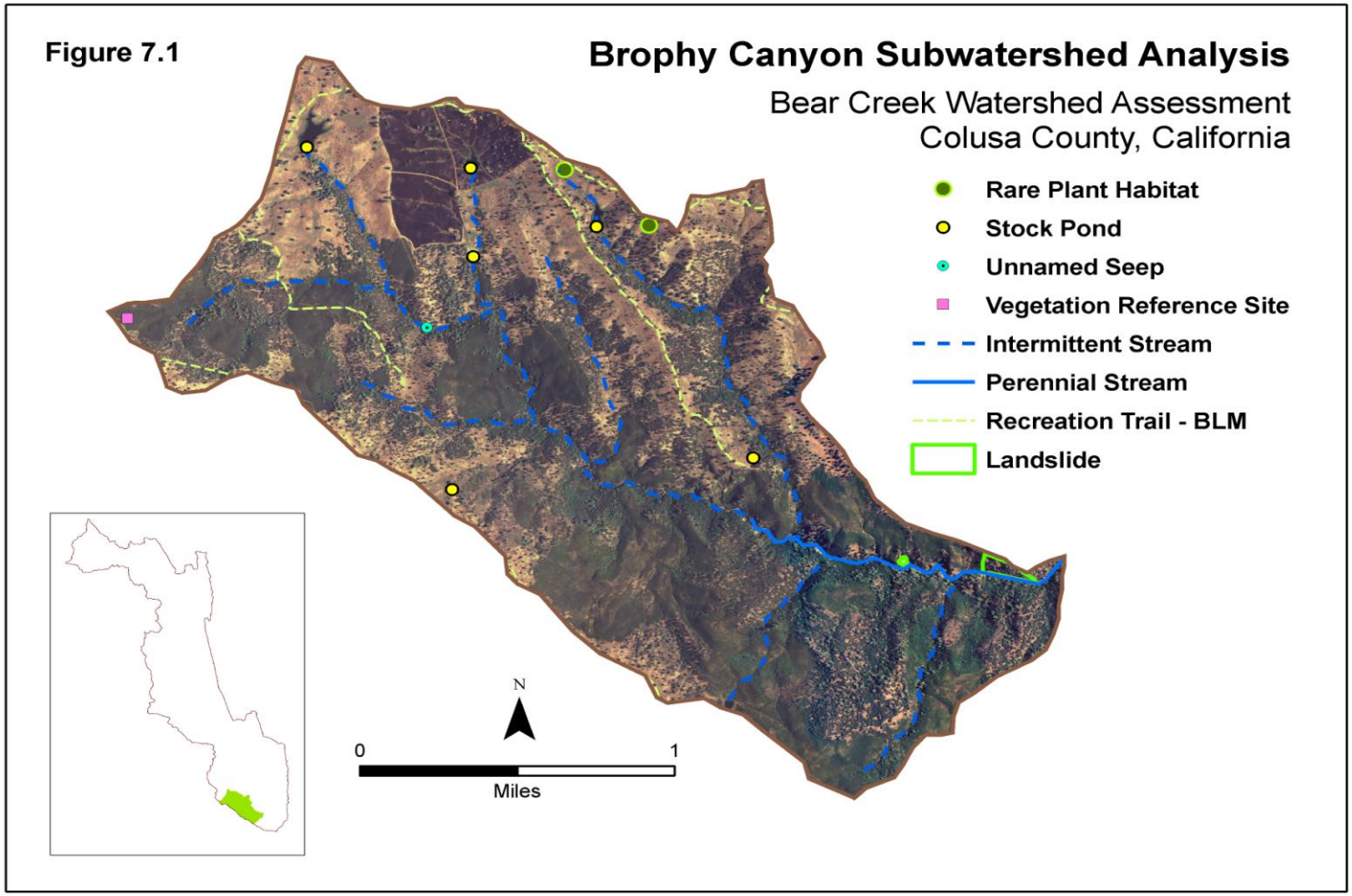


Figure 7.1
Brophy Canyon Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
Rare Plant Habitat
Stock Pond
Unnamed Seep
Vegetation Reference Site
Intermittent Stream
Perennial Stream
Recreation Trail - BLM
Landslide
N
0
1
Miles

7.2 Craig Canyon / Eula Canyon

Land Uses

livestock grazing, recreation and tourism (hunting, hiking, equestrian sport, mountain biking, wildflower viewing), scientific research and monitoring, water delivery, woodland management

Major Soils

Three soils predominate in these canyons: from west to east, Contra Costa on successive narrowly spaced ridges, ultramafic haploxerert soils on barren hills, and Hillgate on lower hills and ending in a floodplain at the edge of lower Bear Creek. The individual soils support marked bands of vegetation: chaparral, ultramafic barrens, and oak woodland from west to east.

Major Stakeholder Issues

Climate change
Disturbances to ultramafic soils
Growing demand for recreation and tourism
Impacts from certain grazing practices and browsing and gnawing animals
Information gaps
Non-native invasive species
Oak woodlands

Analysis

Eula Canyon lies north of Craig Canyon. These small watersheds share similar topography and vegetation. The canyons are notable for the absence of recorded wildfire over the last 60 years.

Impacts from certain grazing practices: Previous land conversion of blue oak woodland to grassland and subsequent overgrazing appear widespread on the east end of Eula Canyon. Current livestock practices are compromising stream bank stability and water quality. Insufficient residual dry matter, livestock trails, soil compaction, and trampling characterize some grazing areas.

Oak woodlands: Valley oaks persist in the pasture created on the terrace at the base of Craig Canyon above Bear Creek. Increasing oak stand cover would increase watershed protection and provide thermal cover for game species.

Disturbance to ultramafic soils + Non-native invasive species:

Plant surveys on the ultramafic barrens have discovered rare plant populations. An infestation of non-native barb goatgrass threatens these rare plant populations. Another invasive plant concern for riparian areas has been the presence of ravenna grass, an outlier infestation that

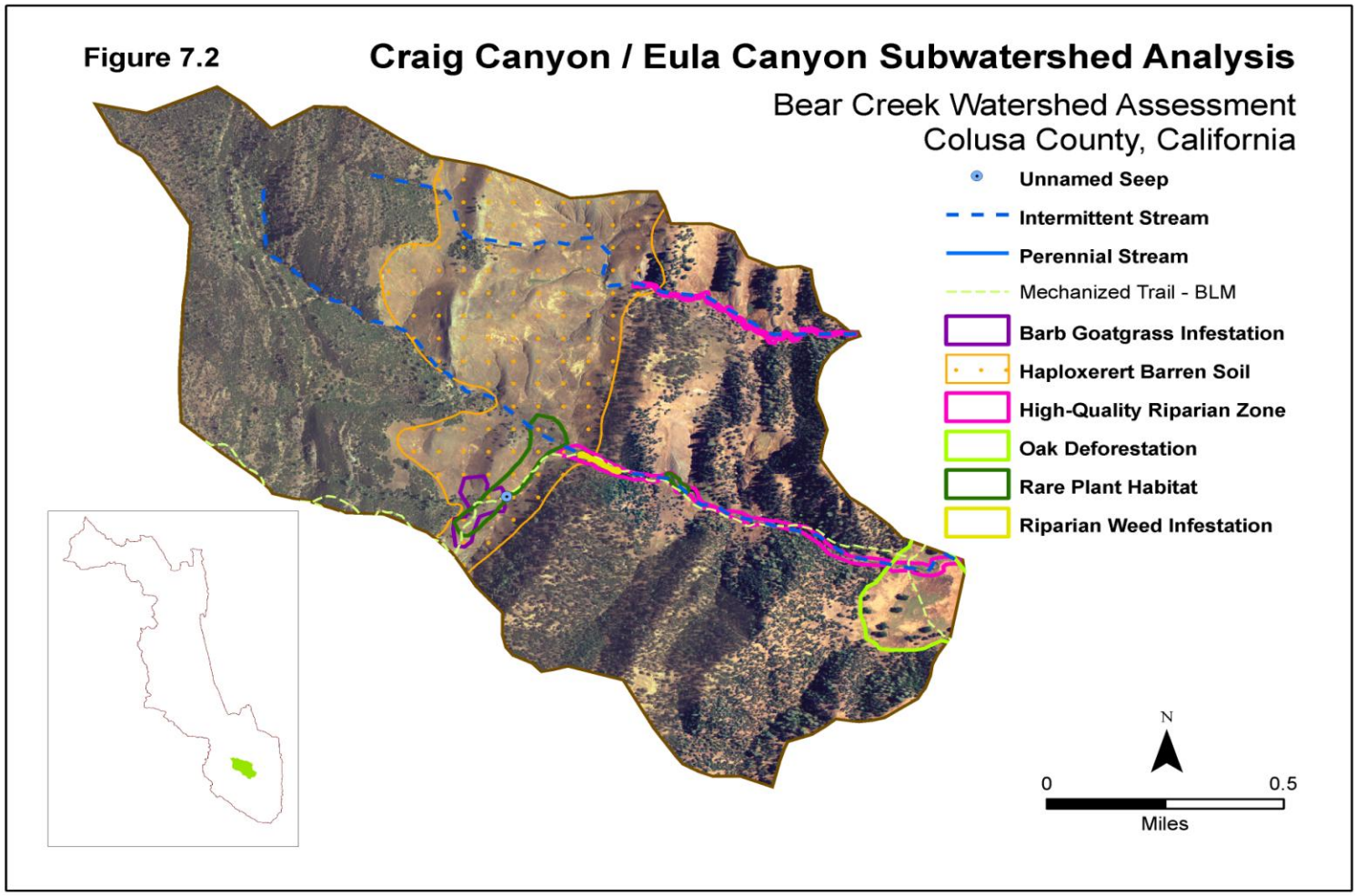


Figure 7.2
Craig Canyon / Eula Canyon Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
Unnamed Seep
Intermittent Stream
Perennial Stream
Mechanized Trail - BLM
Barb Goatgrass Infestation
Haploxerert Barren Soil
High-Quality Riparian Zone
Oak Deforestation
Rare Plant Habitat
Riparian Weed Infestation
N
0
0.5
Miles

was eradicated before it could spread. Livestock in the area are disturbing ultramafic soils and its rare vegetation.

Recreation: This portion of the BLM Bear Creek Ranch does not have an extensive network of recreation trails. Monitoring livestock grazing and recreation trail use along the creek and adjacent upland in Craig Canyon is necessary to ensure the functioning of the riparian zone.

Climate change:
The north-south orientation of the vegetation and soils may function as corridors for genetic and species migration during adaptation to climate change. Opportunities for reforestation close to Bear Creek at the base of Craig Canyon may provide greater carbon storage.

Information gaps:
The three bands of differing soils and corresponding different vegetation close by in these canyons are useful research sites for tracking and understanding comparative responses of vegetation associations to climate change.

Potential Projects and Job Opportunities

- Restoration of blue and valley oak woodlands on lands previously converted to grasslands for livestock grazing
- Management of non-native plants, principally documented infestations of perennial pepperweed in riparian zones and barb goatgrass on ultramafic barrens
- Management for oak woodlands to produce traditional cultural resources
- Scientific research on rare and little-known plant communities on the barrens and their development under climate change
- Re-examination of management practices to determine whether multiple ecosystem goals are being achieved, especially in regard to managing targeted invasive plants, controlling erosion, improving hydrologic function, and enhancing native vegetation

7.3 Deadshot Canyon / Trout Creek

Land Uses
development (residential), energy production, livestock grazing, mining, recreation and tourism (hiking, hunting, wildlife and wildflower viewing), scientific research and monitoring, water delivery

Major Soils
Henneke and Okiota ultramafic soils predominate on the highest elevations along Walker Ridge as well as eastward (down slope) across two-thirds of the distance to the Bear Valley

floor. Some metavolcanic soils are interspersed in the Walker Ridge area. A band of Millsholm soils connects the canyons with Bear Valley. Soils on the floor of Bear Valley consist of partially hydric Venado soils and the unique Leesville soil series, both of which are a mixture of alluvial and ultramafic sources.

Major Stakeholder Issues

Climate change
Disturbances to ultramafic soils
Fire
Growing demand for recreation and tourism
Information gaps
Non-native invasive species
Potential impacts of energy development
Roads, trails, and firelines
Sediment delivery to watercourses

Analysis

Trout Creek subwatershed lies to the north of Deadshot Canyon subwatershed. The array of uses or potential uses in the two canyons makes this analysis area important for coordinated watershed management. A discussion of the issues that pertain to the Bear Valley portion of these subwatersheds is found in section 7.12 Upper Bear Creek Subwatershed.

Disturbance to ultramafic soils + Sediment delivery to watercourses: The ultramafic soils and rock in both Deadshot Canyon and Trout Creek have been subject to natural avalanches, indicating unstable ground over the foothill portions of the two subwatersheds. The ravine in Deadshot Canyon appears particularly prone to large slides. It is unclear at present how much sediment from these slides currently reaches Bear Valley.

Several areas of extensive human disturbance to ultramafic soils have occurred. A mine prospect straddles the ridge on the north side of Trout Creek subwatershed. This site may be valuable as a reference site to better understand the composition and rate of natural regeneration on highly-disturbed ultramafic rock and soils. Information from the site would be useful in informing the remediation and revegetation designs at the Rathburn-Petray mine complex found on the same soil type just to the south of Deadshot Canyon.

A ranch development on private land has removed a considerable area of chaparral in the center of Trout Creek watershed. Given that the development area is large and next to a stream, higher than background levels of debris and other sediment may be entering a tributary of Trout Creek. Just below the development are the remnants of a landslide.

Fire: Deadshot Canyon subwatershed partially burned in 2008, but an evaluation of impacts has not been undertaken to determine what kind of restoration or protection measures are needed. The post-fire response from vegetation, especially shrubs and rare endemic plants has yet to be documented.

Non-native invasive plants: Arundo, or giant reed, is found along lower Trout Creek. More recent updates on the extent of non-native invasive plants in the subwatershed are not available.

Potential impacts of energy development: A wind project leasing area covers the Walker Ridge part of the analysis area. The BLM is reviewing a proposal for development from AltaGas Income Trust to construct a wind energy development on a small percentage of the lands inside the wind energy lease area on the Ridge. The wind lease area lies above steeper slopes where landslides occur. The known ranges of rare plants in these subwatersheds as delineated by the California Natural Diversity Database largely lie largely within the wind lease area. Protecting the scenic, biological, and watershed values will require excellent engineering and ecological design standards for the wind project if wind turbines are constructed in this analysis area.

In the event of a wind energy project being installed, raptor birds and bats are likely to die during the course of turbine operations. Monitoring mortalities of raptor birds and bats and studying the impacts to other wildlife species such as black bear and native cats will be necessary to determine compensation for habitat enhancements for these species elsewhere. The impact of energy development on the BLM lands to bat colonies in nearby abandoned mines, especially colonies of pallid and Townsend's big-eared bats, is presently unknown.

Geothermal development is unlikely to occur because of limited access and questionable viability of geothermal production at this edge of the Geysers-Clear Lake volcanic field.

Roads, trails, and firelines + Growing demand for recreation and tourism: Cross-country trails are extensive in Trout Creek subwatershed. In response to the need for fire protection during the Walker Fire, the California Department of Forestry and Fire Protection bulldozed part of a 21-mile fireline across public and private lands across these subwatersheds. The fireline is a long scar on the landscape and efforts to rehabilitate the land have not been undertaken yet. No decision and funding for mitigation appear to be on the horizon.

The only designated OHV trail in the analysis area is Walker Ridge Road. Within the next five-years, the BLM Ukiah Field Office will be determining the final design for its OHV route network in the Walker Ridge / Indian Valley planning area. Considerations of land stability and sensitive ecological environments will be part of the planning effort. Accommodating both motorized recreation visitors and employees and contractors for energy leaseholders on Walker Ridge Road will require travel management on account of environmental constraints and sensitive resources. New roads may be required as well, and these would further disturb ultramafic soils and fragment native vegetation.

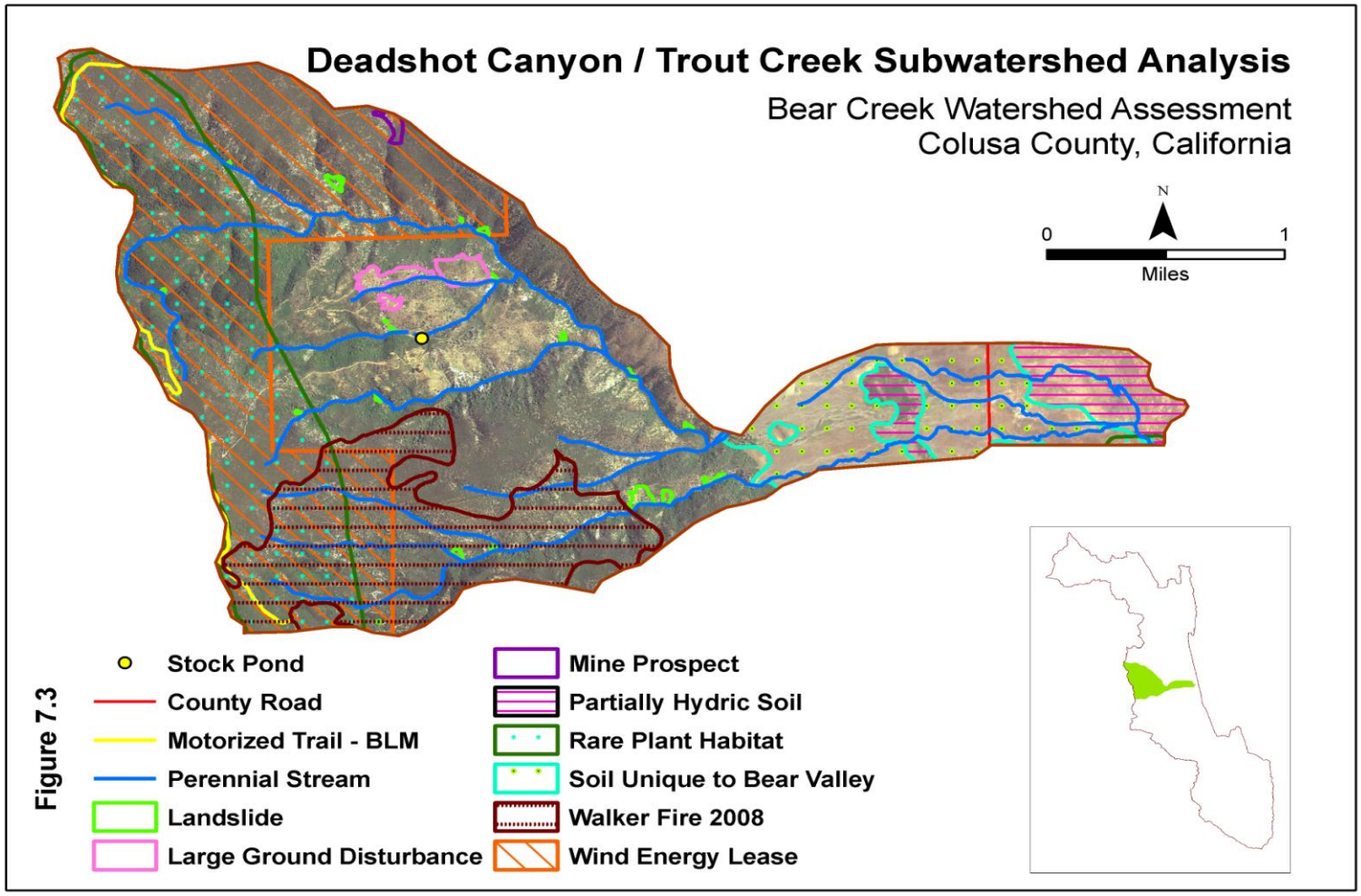

Deadshot Canyon / Trout Creek Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
N
0
1
Miles
Stock Pond
County Road
Motorized Trail - BLM
Perennial Stream
Landslide
Large Ground Disturbance
Mine Prospect
Partially Hydric Soil
Rare Plant Habitat
Soil Unique to Bear Valley
Walker Fire 2008
Wind Energy Lease

Figure 7.3

Climate change: One important question is how best to mitigate adverse impacts of climate change. The Federal government and the State of California both advocate energy production from renewal resources as one mitigating step. Dedicating some public lands to renewable energy projects can contribute to alleviating climate change impacts globally, but on a regional scale other considerations arise. Walker Ridge, a higher-elevation site and a north-south corridor, may be an important location for species to shift their ranges as they adapt to a changing climate. Rare plants dependent on ultramafic soils may be particularly at risk. An inclusive public discussion among stakeholders of the tradeoffs and mitigation measures to avoid losses to biological diversity and watershed values is needed.

Information gaps: Natural resource inventories of the largely unexplored public lands in these subwatersheds are necessary for determining sites for wind turbines in low-impact, energy-efficient locations. Information on the soil and vegetation conditions of the 2008 fireline is not available. An evaluation of altered hydrologic function and impaired water flow and quality is not possible without more information.

Potential Projects and Job Opportunities

- Baseline biological surveys of animals (invertebrate and vertebrate) and plants
- Employment in energy-related construction and wind farm operations
- Plant ecological and physiological studies at the mine prospect site on the ridge dividing Trout Creek and Gaither Canyon subwatershed to guide revegetation elsewhere
- Site analysis for determining which, if any, revegetation and soil erosion control projects are necessary for the Walker Fire fireline

7.4 Doyle Canyon / Gaither Canyon

Land Uses

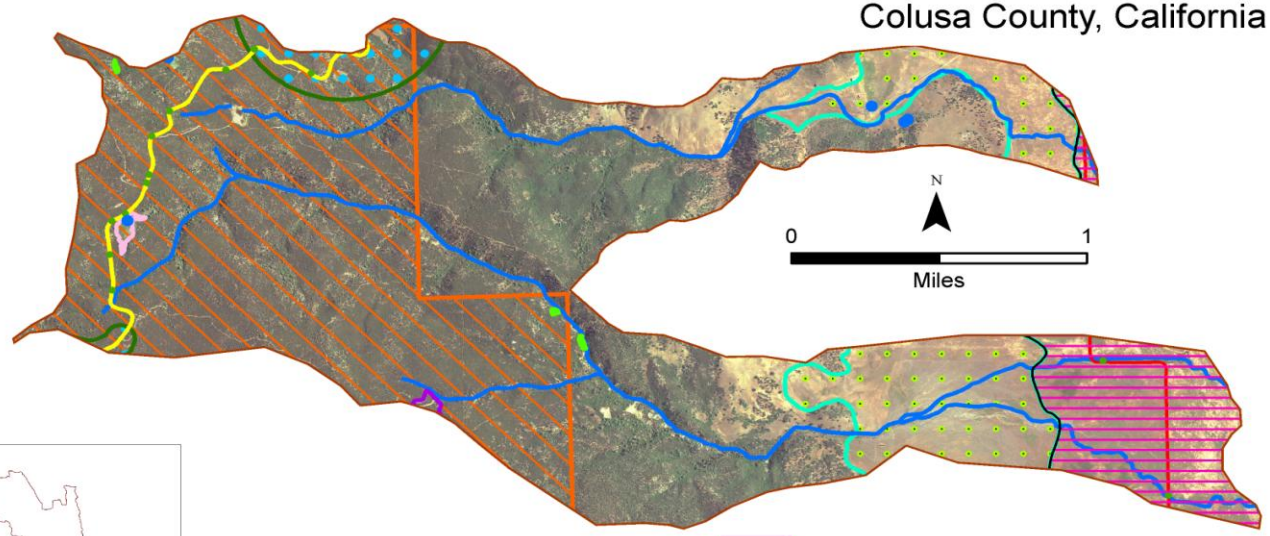
energy production, livestock grazing, recreation and tourism (car touring, hiking, hunting, OHV riding, wildlife and wildflower viewing), scientific research and monitoring, transportation, water delivery

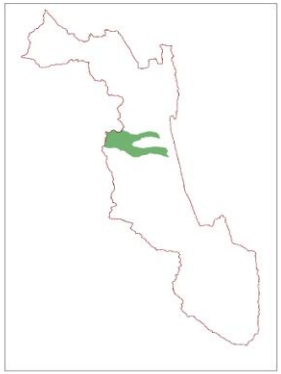
Major Soils

Henneke and Okiota ultramafic soils predominate at the highest elevations along Walker Ridge as well as eastward (down slope) across two-thirds of the distance to the Bear Valley floor. A band of Millsholm soils connects the canyons with Bear Valley. Soils on the floor of Bear Valley consist of partially hydric Venado soils and the unique Leesville soil series, both of which are of alluvial and ultramafic.

Figure 7.4 **Doyle Canyon / Gaither Canyon Subwatershed Analysis**

Bear Creek Watershed Assessment
Colusa County, California





- Culvert
- Spring or Seep
- Perennial Stream
- County Road
- Motorized Trails - BLM
- Landslide
- Mine Prospect
- Partially Hydric Soil
- Rare Plant Habitat
- Sedge Meadow Wetland
- Soil Unique to Bear Valley
- Wind Energy Lease

Major Stakeholder Issues

Climate change	Information gaps
Disturbances to ultramafic soils	Potential impacts of energy development
Growing demand for recreation and tourism	Roads, trails, and firelines

Analysis

A discussion of the issues that pertain to the Bear Valley portion of these subwatersheds is found in section 7.12 Upper Bear Creek. This analysis area historically has had fewer land use impacts. As a result, stakeholder issues are not as numerous.

Disturbances to ultramafic soils: Landslides are virtually absent from the analysis in contrast to the Deadshot Canyon / Trout Creek analysis area. Pre-2008 trails in these subwatersheds may have limited utility for either recreation or possible future wind energy production and need evaluation to know whether they are posing erosion problems. The 2008 fireline discussed in Section 7.3 also traverses this area.

Roads, trails, and firelines + Growing demand for recreation and tourism: Conditions are similar to those described in Section 7.3. In addition, an isolated sedge wetland on ultramafic soil is present along Walker Ridge Road. Some OHV tracks are visible at the perimeter of the wetland. Management to secure the wetland from OHV intrusions and dust deposition is in order, especially if vehicle traffic along Walker Ridge Road increases to meet recreation demand or to facilitate access to wind energy project sites.

Potential impacts of energy development: Refer to Section 7.3.

Climate change: Refer to Section 7.3.

Information gaps: Refer to Section 7.3.

Potential Projects and Job Opportunities

Refer to Section 7.3.

7.5 Hamilton Area / Warnick Canyon

Land Uses

energy production (potential), livestock grazing, recreation (car touring, hunting), transportation, water delivery, woodland management

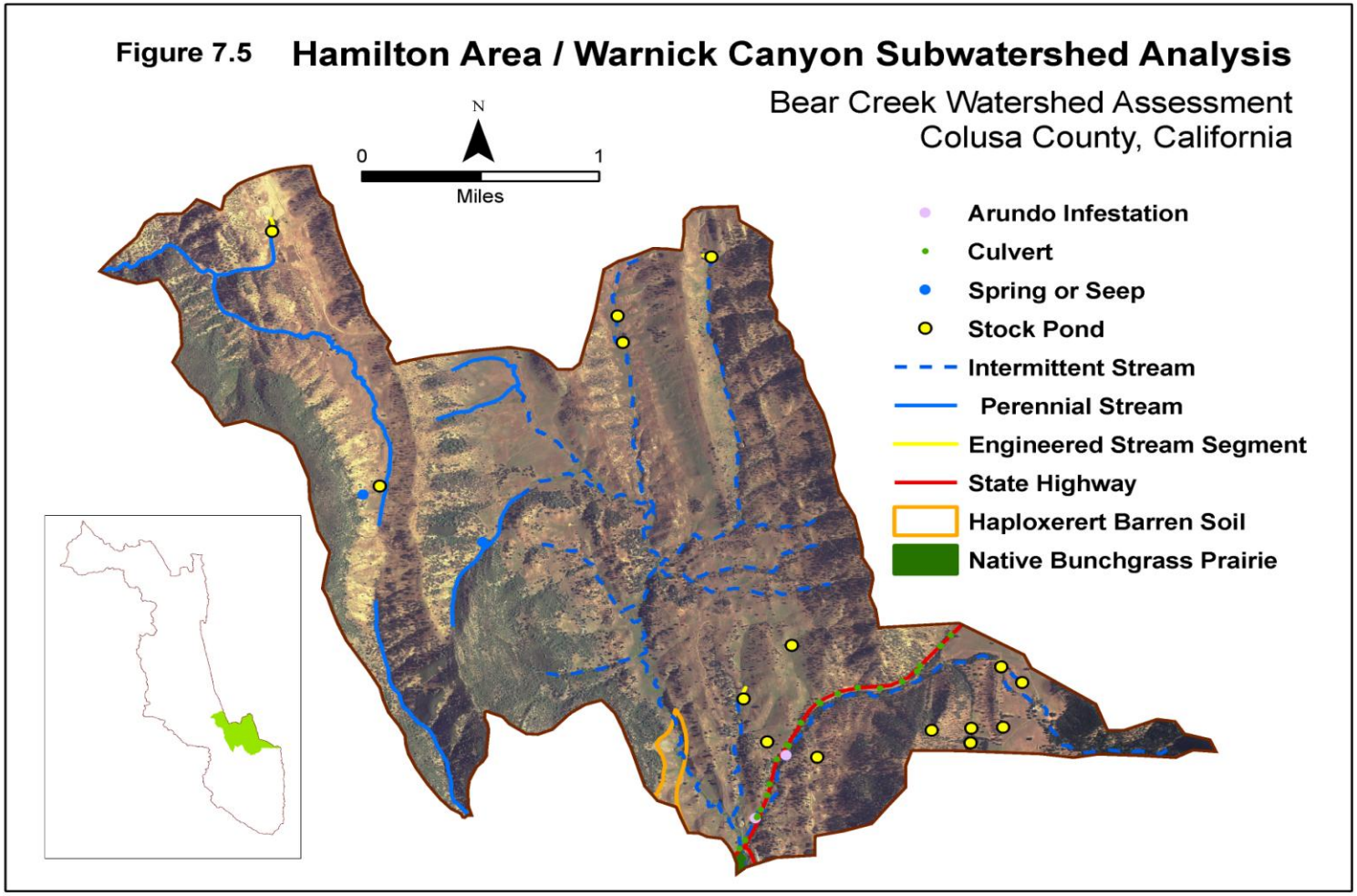


Figure 7.5
Hamilton Area / Warnick Canyon Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
N
0
1
Miles
Arundo Infestation
Culvert
Spring or Seep
Stock Pond
Intermittent Stream
Perennial Stream
Engineered Stream Segment
State Highway
Haploxerert Barren Soil
Native Bunchgrass Prairie

Major Soils

This analysis area is a transition zone between ultramafic soils (Henneke – Okiota) in the southwest part and the more widespread sedimentary-derived Millsholm, Contra Costa, and Hillgate soils elsewhere in the analysis area. A small finger of an ultramafic barren enters the area at the south edge.

Stakeholder Issues

Impacts from certain grazing and browsing and gnawing animals
Non-native invasive species
Oak woodlands
Roads, trails, and fire suppression lines
Sediment delivery to watercourses

Analysis

This analysis area consists almost entirely of private lands. Information about the region is limited. Rare plants are present in a small area covered by an ultramafic barren.

Impacts from certain grazing and browsing and gnawing animals: Livestock grazing is the mainstay economic livelihood in this analysis area. At least fifteen stock ponds are present, with most concentrated in the southeast. No information is available about animal impacts.

Oak woodlands + Sediment delivery to watercourses: Large tracts of blue oak woodlands have been converted to grassland. A statewide program of carbon credits could give incentives to landowners to conserve and replant oak woodlands. The ecological benefits of oak woodland management could enhance oak woodland-dependent wildlife. Reforestation can moderate rainfall impact on soils and reduce sediment delivery to intermittent streams.

Roads: Part of Highway 20 crosses the analysis area and mostly parallels a Bear Creek tributary. Wet meadows are adjacent to the highway. Culverts are functioning well and do not appear to be causing excessive sedimentation, but the tributary streambed is filling with sediment in places and creating bars.

Non-native invasive species: In meadow wetlands, annual grasses and teasel are widespread. The creek along Highway 20 has a diverse complement of native aquatic and riparian species (cattails, sedges). However, at several locations arundo has invaded.

Information gaps: In general, little public information is available for this analysis area because it consists of private lands.

Potential Projects and Job Opportunities

- Reforestation jobs to promote germination, planting, and sapling survival of oaks
- Control for non-native plant species in the CALTRANS right-of-way along, streams, and

wetlands along Highway 20.

7.6 Leesville

Land Uses

development (residential), crop agriculture and livestock grazing, recreation and tourism (car touring, hunting, long-distance running, bicycle racing), transportation, water delivery, woodland management

Predominant Soil Series

Contra Costa and Millsholm soils are present on hillslopes, and Hillgate soil predominates in valleys.

Stakeholder Issues

Creek and tributary headcuts
Creek channel alterations
Fiscal and Policy Obstacles to Meet Targets
Impacts from certain grazing practices and browing and gnawing animals
Low recruitment of native woody riparian plants
Oak woodlands
Roads, trails, and firelines
Sediment delivery to watercourses

Analysis

Leesville subwatershed has a small residential population and is the second most populous area in Bear Creek watershed. Livestock grazing is the principal land use. Private landowners are concerned by the effects of soil loss on the productivity of their lands. The lowered water table, headcuts, and channel incision are reducing land productivity for quality forage.

Creek channel alterations: At least four man-made ponds were developed to provide water for livestock, game animals, forage crops, and home gardens. A hydrological analysis of the Leesville subwatershed is not available to know how the impacts of creek alterations affect water flows and riparian areas.

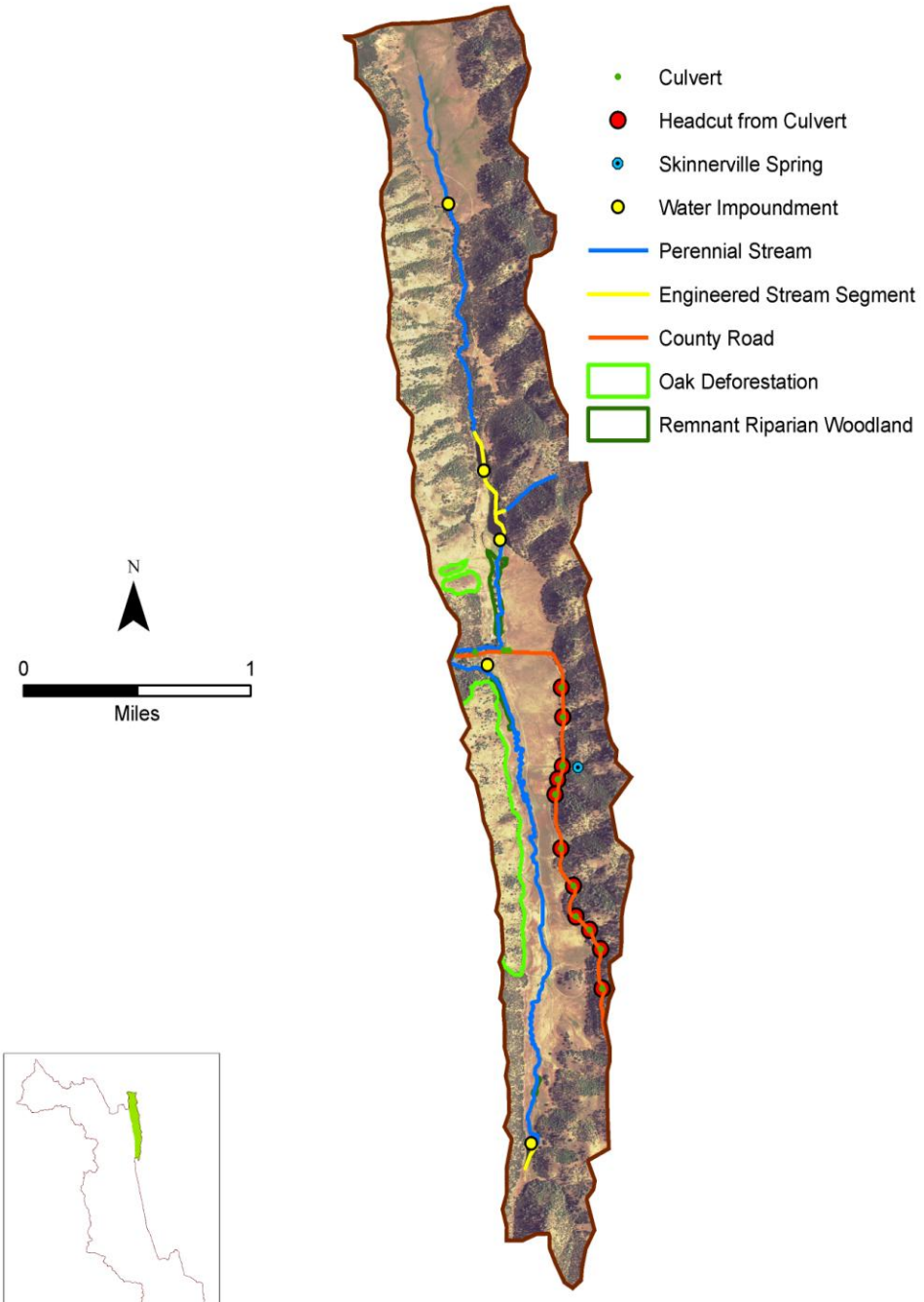
Creek and tributary headcuts + Sediment delivery to watercourses: A large network of headcuts and gulleys covers much of the south valley and has caused considerable soil loss. In the small valley at the north end of the subwatershed, some streams are downcutting.

Roads: Severe headcuts originate in part from twelve poorly designed and placed road culverts at eleven locations along Leesville Road. Some gullying across Huffmeister Road is occurring, particularly near the intersection with Leesville Road. Roads have low vehicle traffic but need extensive maintenance to halt damage to private property.

Figure 7.6

Leesville Subwatershed Analysis

Bear Creek Watershed Assessment
Colusa County, California



Low recruitment of native woody riparian plants + Impacts from certain grazing practices: Loss of upland and riparian vegetation from past overgrazing is a factor contributing to unstable stream banks, channel incision, and soil erosion. The floor of Long Valley has remnants of woody riparian vegetation consisting of old cottonwood, willow, and valley oak trees along the main drainages. These remnant trees do not provide high-quality habitat for wildlife dependent on riparian woodlands. Stream banks would benefit from habitat restoration.

Oak woodlands: The greatest value for wildlife, particularly game species, is the extensive blue oak woodland in upland areas. Large areas of oak woodlands on the west side of the south valley have been cleared, resulting in increased sediment fanning out onto the Long Valley floor.

Fiscal and policy obstacles to meet targets: Adequate funding to maintain more remote roads is not readily available.

Potential Stewardship Projects and Job Opportunities

- Road repair and culvert redesign / replacement along Leesville Road
- Restoration of riparian vegetation in Long Valley to slow water flow, maintain soil moisture longer, reduce soil erosion, and provide more forage to benefit livestock
- Development of recreational hunting, marathon runs, and tourism centered in the historic Leesville settlement
- Oak woodland reforestation to supply an even flow of oak fuelwood, improve wildlife habitat, reduce overland erosion, and store atmospheric carbon

7.7 Robbers Flat / Stinchfield Canyon

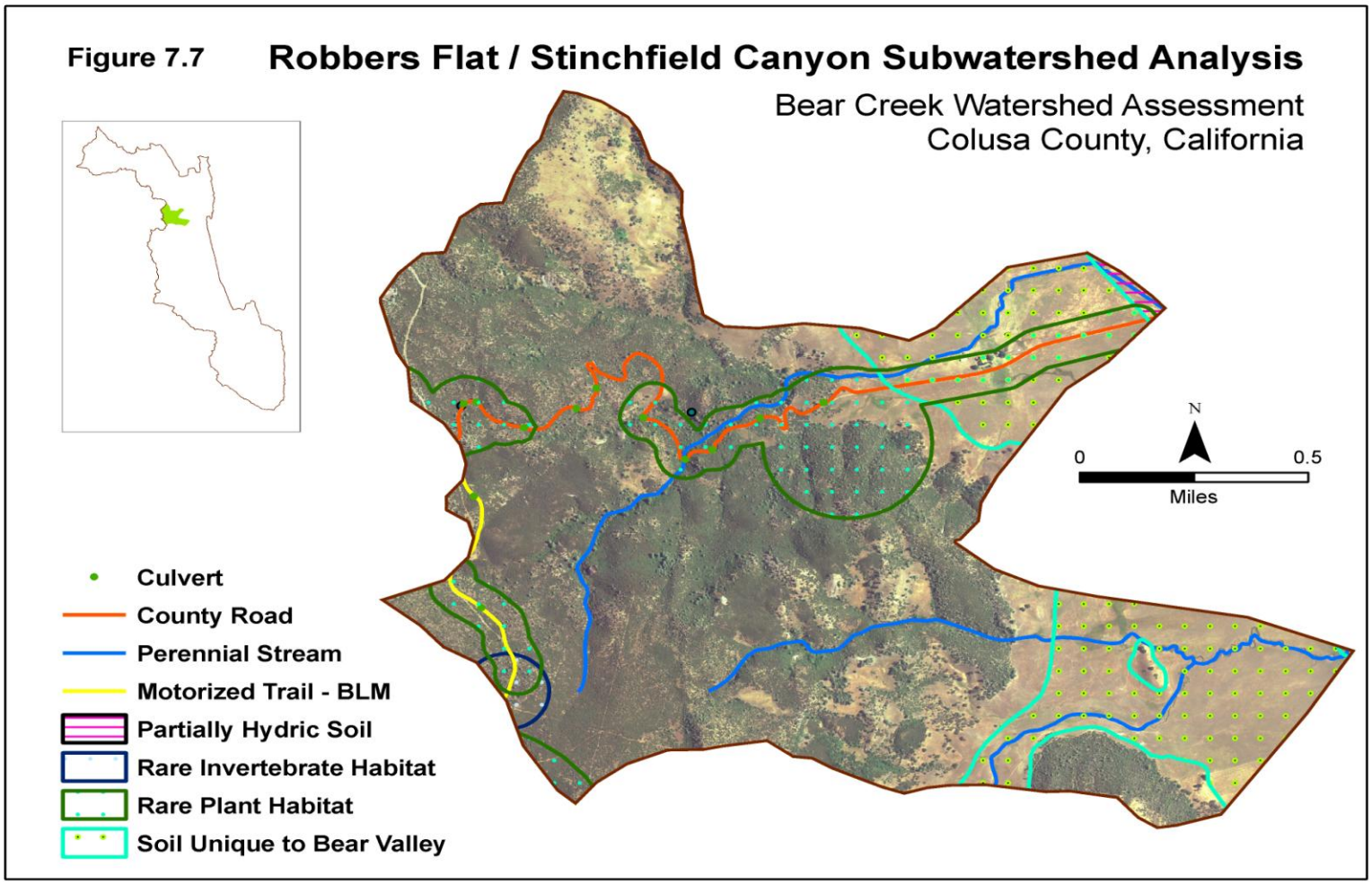
Land Uses

agricultural crops and livestock grazing, recreation and tourism (car touring, game hunting, nature study), scientific research and monitoring, telecommunications, transportation, water delivery, woodland management

Major Soils

Ultramafic Henneke and Montara soils predominate at the top of the headwaters on Walker Ridge. Some metavolcanic rocks are present along part of Walker Ridge. Henneke soils run through mid-elevations. The lowest foothills are interspersed with Millsholm soils. Leesville soils and a sliver of Venado soils comprise the Bear Valley portion of the subwatersheds. Rock outcrops are more frequent here than in other parts of Walker Ridge; a few rock pinnacles are present.

Figure 7.7 **Robbers Flat / Stinchfield Canyon Subwatershed Analysis**



Stakeholder Issues

Climate change
Creek channel alterations
Impacts from certain grazing and browsing and gnawing animals
Information gaps
Low recruitment of native woody riparian plants
Non-native invasive species
Oak woodlands
Roads, trails, and firelines

Analysis

Creek channel alterations: On the Bear Valley floor, parts of the creek through Robbers Flat subwatershed have been straightened and channelized en route to Mill Creek. These actions appear to have dried the wetlands and hydric soils that were once extensive at the base of Mill Creek.

Climate change: Because of the known high number of rare plants on public lands, this area can serve as a long-term conservation area and monitoring site to see how plants dependent on ultramafic soils are responding to climate change.

Low recruitment of native woody riparian plants + Non-native invasive species: Riparian habitats on ultramafic soils in the foothills along Brim Road are in good condition, with abundant and diverse trees, shrubs, and forbs. However, further down slope into Bear Valley all riparian vegetation has disappeared. Channeling and lack of riparian shrubs or trees have devegetated and dewatered the land. Crops are not grown at present. The grasslands and riparian areas are dominated by non-native grasses.

Oak woodlands + Impacts from certain grazing practices: In lowland portions of the Robbers Flat subwatershed, oak woodlands on Millsholm soils appear to have been partially cleared to create grassland.

Roads, trails, firelines: Both Brim Road and Walker Ridge Road are important routes for visitors to the Indian Valley Recreation Area and to the Mendocino National Forest. Robbers Flat subwatershed would likely become more frequently traveled if OHV recreation expanded on public lands in Bear Creek watershed and in the adjacent North Fork Cache Creek watershed. Integrated travel management, recreation, and ecosystem planning is necessary for accommodating increased road use. Considerations include air quality, dust, traffic noise and safety, impacts of road widening on riparian vegetation and water quality, and available funding for county road maintenance.

Information gaps: Botanists have explored the ultramafic chaparral habitat along the upper portion of Walker Ridge Road and along Brim Road down to the Bear Valley Floor for rare

plants. The eight BLM sensitive species known from the area are likely not confined just to road edges where existing records predominate. A detailed inventory of the distributions of rare plants would provide better information to land managers on the species present.

Potential Projects and Job Opportunities

- Botanical surveys, vegetation mapping, and long-term monitoring for responses of vegetation to climate change
- Oak woodland reforestation for carbon sequestration and moderating climate conditions on Millsholm soils
- Improvements to Brim Road and Walker Ridge Road to mitigate impacts from increased vehicle travel to nearby recreation areas and, potentially, to wind energy turbine sites.

7.8 Thompson Canyon

Land Uses

development (residential), livestock grazing, recreation and tourism (hiking, backpacking, equestrian riding, mountain biking, game hunting), scientific research and monitoring, water delivery, woodland management

Major Soils

Four non-ultramafic loamy soils predominate in Thompson Canyon: Boar, Skyhigh, Millsholm, and Sleeper. All but Millsholm are deep soils. Because of their topographic positions, soils may erode after strong storms. A finger of haploxerert barren soil extends into the subwatershed at the northern boundary, where ultramafic soils reach their southernmost extent in Bear Creek watershed.

Stakeholder Issues

Climate change
Disturbances to ultramafic soils
Fire
Growing demand for recreation and tourism
Impacts from certain grazing and browsing and gnawing animals
Information gaps
Non-native invasive species
Oak woodlands
Sediment delivery to watercourses

Analysis

Impacts from certain grazing practices: Long-term livestock grazing has transformed the western part of the watershed. Much chaparral vegetation has been cleared. A network of trails crisscrosses the terrain. Evaluation of these trails for any needed repairs and erosion controls would be useful, particularly where recreation trails parallel ephemeral streams.

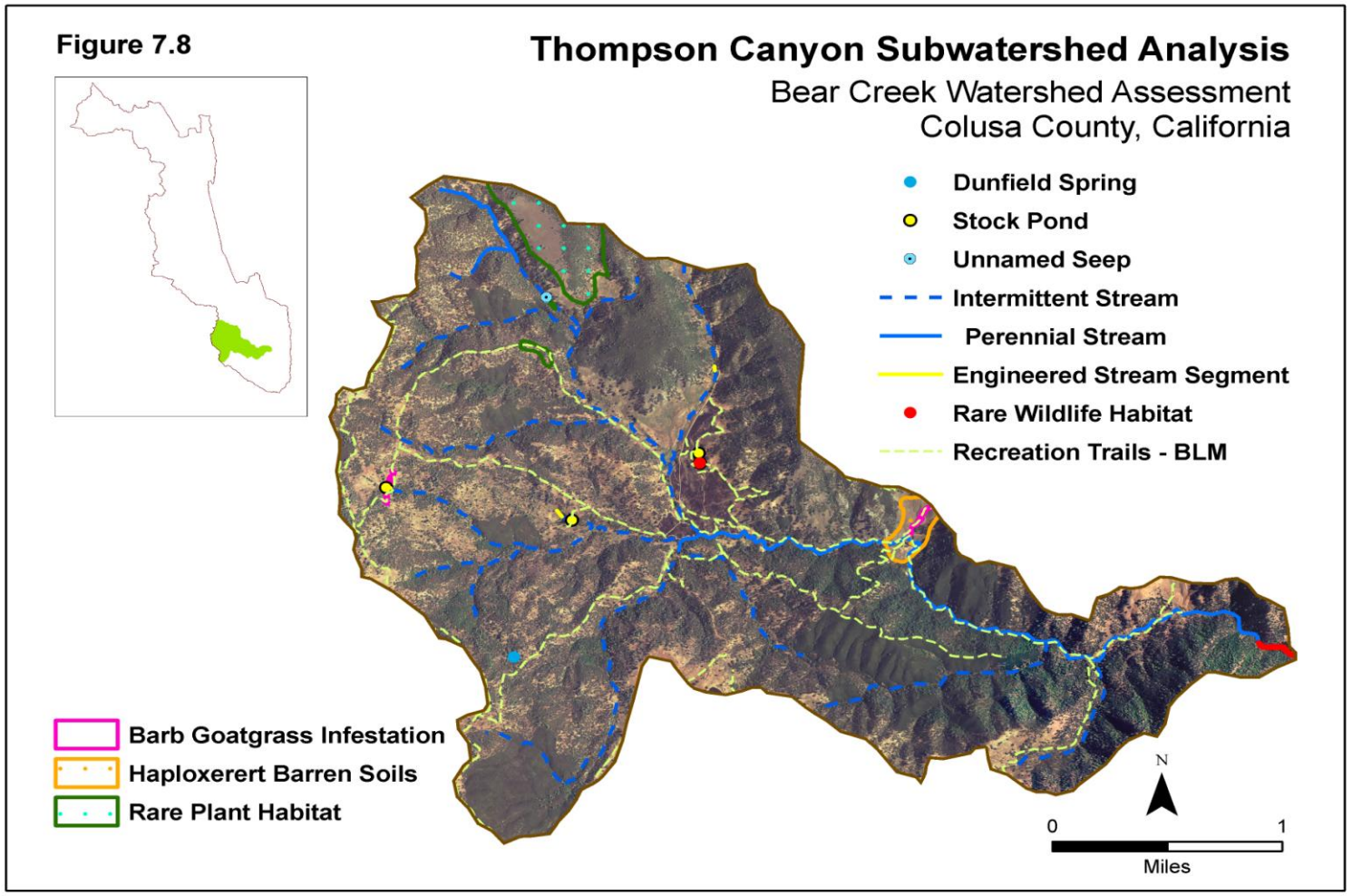


Figure 7.8
Thompson Canyon Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
Dunfield Spring
Stock Pond
Unnamed Seep
Intermittent Stream
Perennial Stream
Engineered Stream Segment
Rare Wildlife Habitat
Recreation Trails - BLM
Barb Goatgrass Infestation
Haploxerert Barren Soils
Rare Plant Habitat
N
0
1
Miles

Fire: Wildfires have only rarely burned in the subwatershed over the last sixty years, but the prescribed burning has been conducted regularly since the 1980s. Investigating the outcomes for soils, vegetation, and wildlife from prescribed burning would help managers determine whether the burns accomplished objectives for invasive weed control and production of forage for game species such as elk and deer.

Disturbances to ultramafic soils + Non-native invasive species: Habitats of rare plants in the subwatershed occur on the ultramafic soils. Barb goatgrass is spreading on the ultramafic barren. A complete survey of non-native invasive species is not yet available for the rest of the subwatershed.

Growing demand for recreation and tourism: The BLM has established a recreation trail network across Thompson Canyon watershed. These trails set the stage for opportunities for environmental science education and outdoor recreation experiences for youth. Other recreation opportunities for the public may be available.

Sediment delivery to watercourses: Many recreation trails follow the courses of streams. With a greater emphasis for recreation and environmental education, trails may receive greater use. Attention to trail design and repair to prevent soil erosion into streams is increasingly important for maintaining watershed health and visitor safety.

Information gaps: Most of Thompson Canyon subwatershed is rugged backcountry. Information about the subwatershed is limited because of lack of public access in the past and remoteness from paved roads. Rare plant habitat occurs in the northwest corner of the subwatershed where ultramafic soils are present.

The mouth of the canyon is habitat for foothill yellow-legged frogs. Effects of prescribed burning on aquatic habitat for western pond turtle are not known. Monitoring for turtles and frogs is needed to ensure that populations of these sensitive species are faring well.

Potential Projects and Job Opportunities

- Revegetating chaparral to lands previously converted to grasslands and testing the effectiveness of revegetation practices for increasing carbon storage
- Jobs for recreation guides, interpretive specialists, and environmental educators in organizing recreational and outdoor education events
- Jobs for youth groups to monitor and repair recreation trails, control erosion, and assist with revegetation projects in the subwatershed
- Developing a plan for environmental education and public outreach for the subwatershed

7.9 West of Cortina Ridge

Land Uses

livestock recreation, recreation and tourism (backcountry hiking and camping on public lands), water delivery, woodland management

Major Soils

Nearly the entire analysis area consists of Millsholm and Contra Costa soils. On steep slopes, these soils are susceptible to erosion.

Stakeholder Issues

Climate change	Oak woodlands
Fire	Sediment delivery to watercourses
Non-native invasive species	Information gaps

Analysis

This analysis area consists of a series of seven small canyons on the east side of lower Bear Creek below Highway 20. The northern part of the analysis area is private land; in the south the BLM manages public lands. Grazing has been the most important land use, but the area has extensive open spaces available for livestock grazing, wildlife conservation, and recreation opportunities.

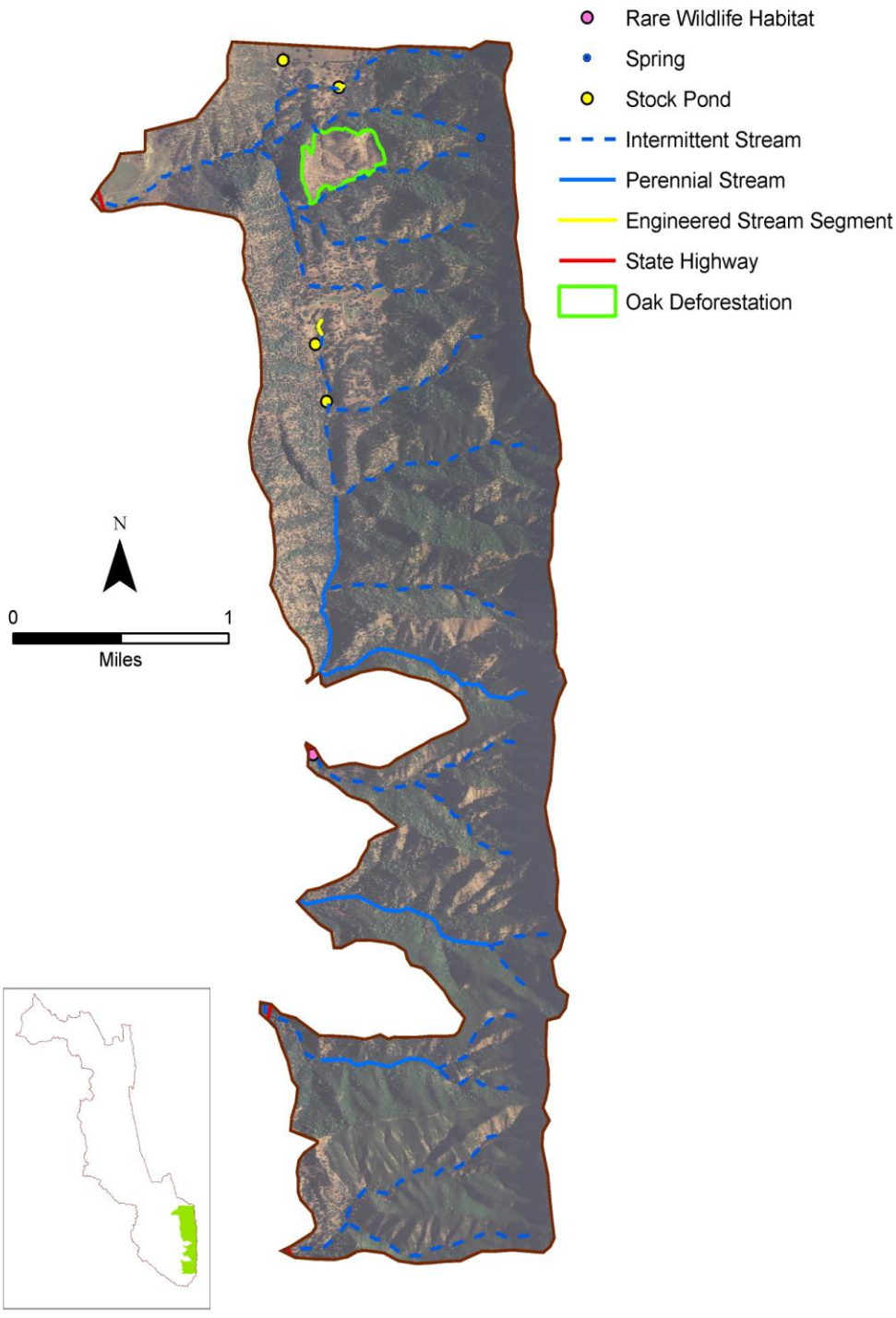
Fire + Climate change + Sediment delivery to watercourses: The southern portion of the analysis area west of Cortina Ridge has remote, steep, and highly dissected terrain. This terrain makes controlling wildfires a logistical challenge. Natural ignitions are rare in the analysis area, but wildfires spreading from human ignitions originating east of Cortina Ridge, in Cache Creek Canyon, or along Highway 16 put the landscape at repeated risk.

Steep, south-facing slopes are especially susceptible to increases in temperature and drought thought to be associated with climate change. If the pace of regeneration of plant cover slows after wildfires, predicted increasingly intense winter storms could generate more slope erosion in this analysis area. Increased erosion on south-facing slopes would increase sediment loads in stormwater flows to Bear Creek.

Oak woodlands + Non-native invasive species: A large block of oak woodland has been cleared on private land at the north end of the analysis area. Other lands near ranch roads also appear to have reduced canopy cover of oak woodlands. The presence of non-native grasses and forbs, such as barb goatgrass and yellow starthistle, may make natural oak germination and sapling growth difficult to achieve.

Figure 7.9 **West of Cortina Ridge Watershed Analysis**

Bear Creek Watershed Assessment
Colusa County, California



Information gaps: Little information is available on biological resources in the analysis area. Techniques for cost-efficient silviculture to reforest blue oak woodlands are needed.

Potential Projects and Job Opportunities

- Reforestation of blue oak woodlands
- Water quality monitoring for sediment loads in streams in the analysis area and throughout the watershed

7.10 Mill Creek Subwatershed

Land Uses

crop agriculture and livestock grazing, mining, recreation and tourism (OHV riding, wildlife viewing, backcountry camping and hiking), scientific research and monitoring, water delivery, woodland management

Major Soils

Ultramafic Henneke, Okiota, and Montara soils are dominant in most of Mill Creek subwatershed. Runoff is high to very high with these soils because of widespread steep terrain. The lowest elevations on the east side of the subwatershed have sedimentary Millsholm and ultramafic alluvial Leesville and Venado soils. Both soils are unique to Bear Creek watershed. Hydric soils are present along the lower course of the main stem of Mill Creek.

Stakeholder Issues

Creek channel alterations
Disturbances to ultramafic soils
Fire
Growing demand for recreation and tourism
Impacts from certain grazing and browsing and gnawing animals
Information gaps
Low recruitment of native woody plants
Sediment delivery to watercourses

Analysis

Mill Creek subwatershed is the most remote and least known part of Bear Creek watershed. Rock outcrops and ultramafic barrens are major visual features in the diverse terrain of Mill Creek subwatershed. The low-elevation southeast portion of the subwatershed comprises the northwest section of Bear Valley.

Creek channel alterations: On agricultural land on the floor of Bear Valley, Mill Creek has several channelized sections that depart from the natural sinuosity expected in a stream that flows over terrain with very low slope. Channels from Robbers Flat subwatershed also flow to

Mill Creek. Section 7.12 expands on the effects of channelization on the hydrology of Bear Valley.

Impacts from certain livestock grazing practices + Low recruitment of native woody riparian species: Expected recruitment of native woody riparian species along streams on the southeast flank of the subwatershed is lacking. Despite loss of riparian vegetation and downcutting along lower Mill Creek, the aquatic environment remains sufficient to support foothill yellow-legged frogs.

Fire: Mill Creek subwatershed is the only part of Bear Creek watershed with two fire management jurisdictions: the Mendocino National Forest and the California Department of Forestry and Fire Protection. The two jurisdictions abut at the boundary between the National Forest and the BLM public lands. Fire suppression in the subwatershed would require aerial operations because of its remoteness. Development of practices and strategies to manage fire and control erosion in this remote area is a challenge for public land managers. In the past six decades, only two fires have burned in the subwatershed, having entered from outside the subwatershed at the north perimeter of the Bear Creek watershed boundary.

Growing demand for recreation and tourism: Public access is only at the top of the watershed on Love Lady Ridge. The ridge is accessible by way of OHV trails designated by the Mendocino National Forest. The trail coming from the north requires advanced motorcycle riding skills, and careful 4-wheel driving is necessary when coming from the south. Remoteness and ruggedness of the landscape are excellent for backcountry camping.

Disturbances to ultramafic soils + Sediment delivery to watercourses: The large area of ultramafic soils in the subwatershed is susceptible to landslides from natural causes. Between 1984 and 2005, one large landslide released 29,000 cubic yards of rock and debris (Hoorn et al. 2008). These events might increase if wild fires were to remove large areas of vegetation from the steepest parts of the watershed and expose soil and rock to the elements.

Small-scale mining for chromite has resulted in one abandoned mine site, the Black Bird mine. Previous efforts at the site to limit watershed impacts appear to prevent significant sediment from flowing into tributaries of Mill Creek from the mine site. The mine is scheduled for full remediation in 2010-2011 (R. Mowery, Mendocino National Forest hydrologist, pers. comm.).

The remoteness of Mill Creek subwatershed is attractive for illegal marijuana cultivation, which already occurs north and west of Love Lady Ridge. Covert cultivation leads to disturbances on ultramafic soils and possible site contamination from herbicides and rodenticides.

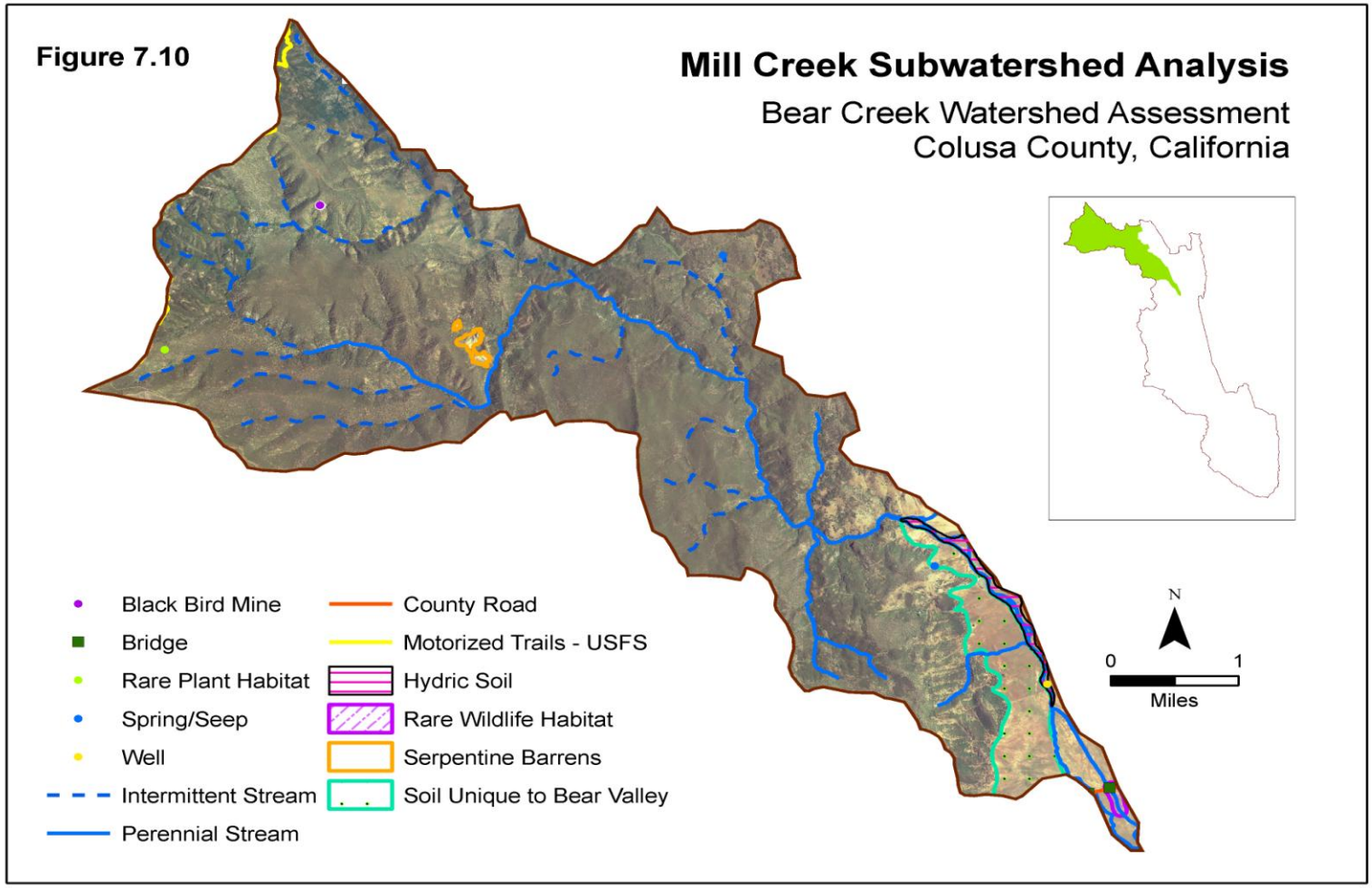


Figure 7.10
Mill Creek Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
Black Bird Mine
Bridge
Rare Plant Habitat
Spring/Seep
Well
Intermittent Stream
Perennial Stream
County Road
Motorized Trails - USFS
Hydric Soil
Rare Wildlife Habitat
Serpentine Barrens
Soil Unique to Bear Valley
N
0
1
Miles

Information gaps: Mill Creek ultramafic habitats lie at their eastern limit in the Inner Coast Range (R. O'Dell, BLM botanist, pers. comm.; Cheung 2004). Inventories of biotic resources in the subwatershed are lacking and would contribute to knowledge about responses of plants and animals to climate change along the steep elevation gradient. Rare plant occurrences are probably more extensive than indicated in Figure 7.10. Surveys in a similar setting in the Frenzel Creek Research Natural Area just outside Bear Creek watershed indicate that plant surveys of Mill Creek ultramafic soil sites would provide new information on the distribution of little-known rare plant species.

Data on Mill Creek water flow and quality do not currently exist. Installation of a water quality monitoring station in lower Mill Creek would provide information about the flow and chemical composition of Mill Creek water.

Potential Projects and Job Opportunities

- Biological inventories, especially for rare plant species adapted to ultramafic soils
- Clean up and remediation at the Black Bird mine
- Surveying for rare plants and mapping plant communities on public lands
- Water quality and flow monitoring just above the confluence of Mill Creek with Bear Creek
- Recovery of riparian vegetation along lower Mill Creek to help reduce soil erosion and slow water flow away from the subwatershed, providing a longer wet season for soils
- Opportunities for guides to lead backcountry hiking and camping trips on National Forest and BLM public lands
- Research opportunities for rare plant conservation and habitat enhancement on public lands in the National Forest and BLM public lands

7.11 Sulphur Creek Subwatershed

Land Uses

development (residential, spa resort), energy production and conveyance, crop agriculture, mining, recreation and tourism (wildlife and wildflower viewing, hiking, OHV riding, spa services, lodging), scientific research and monitoring, telecommunications, water delivery, woodland management

Major Soils

Reflecting the underlying complex geology, soils in Sulphur Creek subwatershed are a complex mosaic from volcanic, ultramafic, and sedimentary sources. The diversity of soil types creates varied vegetation communities. Soils metamorphosed from volcanic rocks are present on Walker Ridge in the northwest and southwest corners of the subwatershed.

Henneke and Okiota ultramafic soils characterize the northern uplands and cross the subwatershed diagonally to the southeast of Walker Ridge. Many springs and seeps with unusual waters are present. In the northeast and the south third of the watershed sedimentary Skyhigh and Millsholm soils predominate.

Stakeholder Issues

Climate change
Creek channel alterations
Creek and tributary headcuts
Disturbances to ultramafic soils
Fire
Fiscal and policy obstacles to meet regulatory targets
Growing demand for recreation and tourism
Information gaps
Low recruitment of native woody plants
Non-native invasive species
Oak woodlands
Potential impacts of energy development
Roads, trails, and fire suppression lines
Sediment delivery to watercourses
Toxic Chemical

Analysis

Land uses have in large measure transformed the subwatershed. Past mining has created significant costs for environmental cleanup. Issues of natural resource management and land uses in the subwatershed are complex, and multiple stakeholders are scrutinizing the subwatershed to make improvements to its environmental quality.

Sediment delivery to watercourses: Natural landslides are numerous in areas with ultramafic soil and rock. In addition, mine waste adds sediment to Sulphur Creek tributaries. Unstable banks and headcuts in Sulphur Creek valley in the central part of the subwatershed produce tons of soil erosion annually (Hoorn et al. 2008). All such areas are inventoried and mapped.

The Colusa County Resource Conservation District has focused on progress in stabilizing or removing these sediments to reduce their flow into streams in the subwatershed. The CVRWQCB had awarded the District funding for the work to halt erosion from roads as a model project for sediment control for watersheds in the Inner Coast Ranges. Funding cuts and projected high costs forced the CVRWQCB to withdraw funding. Site characterization and planning for sediment control structures in the subwatershed remain critical on both public and private lands.

Toxic chemicals: The mercury minerals in mine and retort waste are much higher than background levels. Sediments with high mercury content enter Sulphur Creek and its tributaries, especially in the lower half of the subwatershed where mercury mines are concentrated. Currently, Sulphur Creek has two TMDLs, for mercury and methylmercury. The TMDLs are based on findings over the last decade about the quantity and movement of mercury-laden sediments and scientists' better understanding of the biochemical processes

that drive the formation of methylmercury, the mercury compound that poses the greatest risk to the health of people and wildlife. Recent data from Morrison et al. (2008) and Holloway et al. (2009a,b) show that mercury has contaminated soils well away from the abandoned mercury mines as well, notably in the floodplain areas in the subwatershed. In the coming years, multiple mine remediation and site restoration projects are anticipated. The BLM has already initiated cleanups at the Clyde and Elgin mines.

Fiscal and policy obstacles to meet regulatory targets: The public has known about the magnitude of mercury contamination in Sulphur Creek watershed since the reports by Suchanek et al. (2002) and Churchill and Clinkenbeard (2003), funded as part of the CalFed Bay-Delta Mercury Project. Response actions have taken years to initiate because the scope and complexity of the mercury problem affecting the Sacramento River Basin and the Sacramento-San Joaquin River Delta is immense. Procedures for regulatory agencies to address mercury contamination are stringent to safeguard the public interest. The State of California requires that the public be involved at every stage of actions to address mercury pollution from abandoned mines. The regulatory agencies involved in Bay-Delta issues have not always had sufficient staff to address mercury contamination in all the affected watersheds flowing into the Sacramento River and Delta. Prioritization of efforts has been necessary. Bear Creek watershed as part of the larger Cache Creek Basin has been a high priority for reducing mercury contamination in the Delta. The CVRWQCB accelerated the process of issuing cleanup orders in 2009 to address the mercury mines on private lands in Sulphur Creek subwatershed.

The federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process directs clean up for hazardous contaminant materials such as mercury mine wastes on public lands. CERCLA permits the agency that cleans up a site with contaminants to obtain compensation for cleanup costs from the one or more parties who were responsible for the contamination. Private landowners with abandoned mine sites for which they are not responsible for resulting contamination are liable for the cleanup costs unless they are able to identify another potentially responsible party (PRP). Current landowners are required to bear the costs for their searches and documentation of liability of an earlier PRP. Time-consuming negotiation and litigation may ensue to settle final responsibility for cleanup costs. Landowners may also incur legal costs to clarify responsibility as well. Perceptions of unfairness in the process can hamper the cooperation of landowners and create delays in dealing with mercury contamination.

Creek channel alterations: The course of Sulphur Creek has shifted as the result of engineering to the Creek during the peak of mercury mining. To stabilize the a portion of Sulphur Creek next to the Wilbur Springs Road, the Colusa County Public Works Department lined the creek bank with riprap in 2007. In addition, rerouting of streamflows from natural

springs has occurred around many of the commercially important hot springs. Effects of these diversions and bank alterations on stream flow are not known.

Fire: Despite the long presence of human communities in the Sulphur Creek subwatershed, wildfires have not started in the area in past decades. However, in 2008, two-thirds of the subwatershed burned during the Walker Fire. To date, no information is available about soil erosion resulting from the fire and the composition and extent of vegetation regeneration since the fire.

Road, trails, and firelines: The narrow track of Wilbur Springs Road is vulnerable to erosion and flood damage. The cutbank along the road exposes rock faces and bare soil profiles in several places. During winter floods, washouts in the road can occur.

Numerous ranch routes and OHV trails are present across the watershed at all elevations. Closing and revegetating redundant routes coupled with redesign and repair of essential routes would contribute to decreasing the amount of soil and mine sediment reaching Sulphur Creek. Trail closures in the vicinity of abandoned mercury mines are a high priority in the lower half of the watershed.

At higher elevations on ultramafic soils in Sulphur Creek subwatershed, the BLM has thus far designated two OHV trails in its Resource Management Plan (2006): Walker Ridge Road and the OHV trail that runs from Walker Ridge Road downslope and eastward to the Rathburn-Petray mine complex. Both routes cross the major block of BLM public land in the subwatershed designated as part of the Indian Valley ACEC. The purpose of the ACEC is to secure undisturbed rare plant habitat. Keeping this road open has encouraged OHV riders to use the mercury mine pits (just outside Sulphur Creek subwatershed) for sport riding. The OHV trail is problematic because it runs through a rare spring-fed wetland on ultramafic soils. The mine trail and unauthorized spur routes are impacting wetland vegetation. Disturbance from the OHV route is likely to increase to accommodate vehicle access during remediation and revegetation of the Rathburn-Petray mine complex.

In the next few years, the BLM will finalize the OHV route designations for Walker Ridge. BLM will close and restore those routes not designated for OHV travel. Closure and restoration of these trails will reduce ultramafic soils erosion down slope into Sulphur Creek.

In 2008, part of the 21-mile long fireline to halt the Walker Fire crossed through the subwatershed. No repair to the habitat fragmentation from the fireline is underway. The Walker Fire fireline can provide avenues for illegal vehicle traffic if no controls to access are in place.

Creek and tributary headcuts: Headcuts in the Sulphur Creek valley are reducing the surface area of the valley, leading to a lower water table, loss of wetland habitat, soil erosion, and sedimentation. Very large volumes of topsoil have been lost in Sulphur Creek valley as headcuts have rapidly moved upstream through the valley in recent years. Soil loss related to headcuts may be releasing more mercury previously stored in soils.

Oak woodlands: During the era of mercury mining, oak woodlands in Sulphur Creek subwatershed furnished the fuelwood for firing mercury retorts. Photographs of the Wilbur Spring area at the turn of the 20th century show the surrounding hillsides nearly void of oak trees. Since that time, significant even-aged blue oak stands have regenerated naturally.

Growing demand for recreation and tourism: Temporary loss of access to the Sulphur Creek subwatershed by way of Wilbur Springs Road occurs occasionally on account of storm damage and erosion. The Colusa County Department of Public Works responds quickly. Loss of road access for an extended period would greatly hamper tourism to the lower part of the subwatershed.

In the upper part of the watershed, designation of OHV access across fragile ultramafic soils with high numbers of rare plants deserves careful consideration. The slow rate of revegetation and growth of plants on ultramafic soils makes these ecosystems vulnerable to vehicular disturbance and wildfire. To date, no designated non-motorized trails are in place for visitors who come to appreciate the unique flora, an unusual ultramafic landscape, solitude, and scenic vistas.

Potential impacts of energy development + Disturbances to ultramafic soils: The western one-third of Sulphur Creek subwatershed is part of a wind energy lease and corresponds to the ultramafic soil zone where landslides have been frequent since 1937. Also, the wind energy lease area encompasses the entire portion of the Indian Valley ACEC within the subwatershed. Wind turbine sites in the ACEC and elsewhere in the ultramafic zone of the subwatershed would add to soil disturbances.

Non-native invasive plants:

The firelines related to the Walker Fire may be providing avenues for non-native invasive plants. Arundo is present at Wilbur Springs where it is used as a screen and ornamental purposes at the resort. Fortunately, growing away from its preferred soil and moisture conditions and possibly on account of water chemistry in the area, arundo has not spread downstream. The source infestation of tamarisk in the watershed was at Wilbur Springs, but a four-year effort has controlled the once extensive infestations there. Downstream of Wilbur Springs, tamarisk is still thriving. A small infestation of barb goatgrass occurs in the Sulphur Creek valley, but it is not under control. In recent years, perennial pepperweed has taken hold

in the valley; in 2007 over 50 patches were mapped. Pepperweed has the potential to become a dominant plant throughout the valley wherever moist soils occur. Similar to most other grassland areas in the watershed that occur on non-ultramafic soils, medusahead and yellow starthistle are abundant.

Climate change: One feature projected for climate change in California is winters with fewer but more powerful storms. The trend toward increased peak storm flows would alter stream courses, flush more mercury-rich soils and sediment from the subwatershed, further deepen stream channels, widen the banks of Sulphur Creek, and pose a greater threat to the integrity of Wilbur Springs Road.

Information gaps: In the last decade, CalFed has invested in many studies to clarify the sources, amounts, and pathways of mercury in Sulphur Creek subwatershed. Applying this information toward containing mercury contamination will lead to significant progress in resolving watershed issues that extend downstream well beyond Bear Creek. The large number of present and potential land uses in the subwatershed, combined with unique and sensitive natural resources, warrant well-considered planning for resource protection.

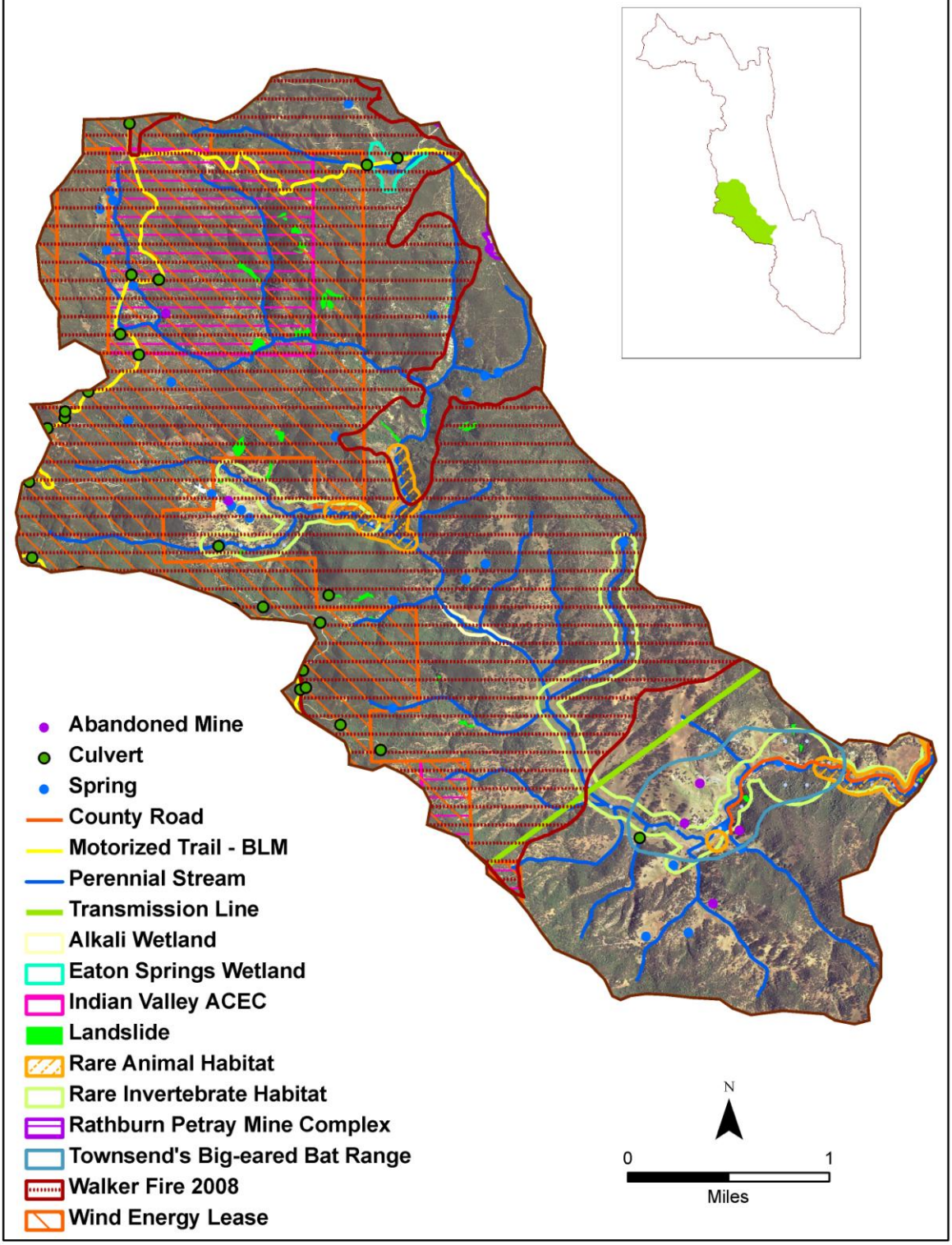
Eight CNPS List 1b and BLM sensitive plant species are known from Sulphur Creek subwatershed. This high number of species indicates the importance of the subwatershed for rare plant conservation. The California Native Plant Society has recommended to the BLM that the Indian Valley ACEC be expanded to include more of the rare plant habitat found here and in the other subwatersheds on Walker Ridge. Virtually no information is available about the ecology of these rare species or about steps to effective management to increase their populations in the subwatershed. In the absence of botanical surveys, resource managers need predictive models of the distributions of rare plant species. Progress in conservation planning for rare plants and their habitats has been slow in the subwatershed. Also, three locally endemic insect species depend on the unusual water chemistry of Sulphur Creek for their life cycle. Documented sightings are needed to ascertain their population status.

Landowners and land managers will need to know whether their management actions to resolve issues are successful and are not creating new problems. A well-designed monitoring system for the subwatershed can validate outcomes and alert stakeholders to unintended consequences from projects in the subwatershed. For example, water quality monitoring can track progress toward achieving the Sulphur Creek TMDL for total mercury and determine where abandoned mine cleanups are working effectively.

Figure 7.11

Sulphur Creek Subwatershed Analysis

Bear Creek Watershed Assessment
Colusa County, California



Researchers at the University of California at Davis are beginning to study responses by vegetation on ultramafic soils to the Walker Fire. Information from these studies will give resource managers insights into the rates of shrub regeneration, populations and ranges of rare plants, and the invasibility of burned sites on ultramafic soils by non-native invasive species.

Potential Projects and Job Opportunities

- Mine remediation, involving teams of engineers, machine operators, laborers
- Inventories of rare species, especially bats, plants, aquatic insects, and frogs
- Plant ecologists and field crews to revegetate redundant roads and trails, reclaimed mine surfaces, riparian zones, and firelines
- Road redesign of Wilbur Springs Road to reduce soil erosion and sedimentation into Sulphur Creek
- Engineers, maintenance staff, and construction crews for developing industrial and domestic sources of solar, geothermal, and wind energy
- Hydrologic restoration of wetlands and streams impacted by land uses, particularly in regard to headcutting and loss of riparian vegetation
- Multi-year studies of the flora and fauna of the region to better document the overall biological value of public lands in this subwatershed, as well as its link to surrounding areas
- Long-term monitoring of total mercury and methyl mercury in Sulphur Creek stream water
- Mapping the extent and concentration of heavy metals, and especially mercury, in the subwatershed soils

7.12 Upper Bear Creek

Land Uses

development (residential), livestock grazing, crop agriculture, beekeeping, mining, recreation and tourism (car touring, hunting, long-distance running, wildlife and wildflower viewing), scientific research and monitoring, transportation, water delivery, woodland management

Major Soils

The floor of Bear Valley contains the Bear Valley, Leesville, and Venado soils, unique to this watershed on account of the unusual blending of alluvial soils from both ultramafic and sedimentary rock sources. Venado soils cover a substantial part of the valley, particularly along Bear Creek itself. These soils are in part hydric and could be important to conserving water in the Valley. Ultramafic soils, especially Henneke and Okiota, predominate in the foothills on the west side of the Valley while Millsholm soils coincide with the band of hillsides and oak woodlands on the east side of Bear Valley. The portion of the Bear Valley

Buttes within the subwatershed contains intermixed Buttes and Millsholm soils. The unique Buttes soils occur only on the Bear Valley Buttes.

Stakeholder Issues

Climate change
Creek channel alterations
Creek and tributary headcuts
Disturbances to ultramafic soils
Fiscal and policy obstacles to meet regulatory targets
Growing demand for recreation and tourism
Impacts from certain grazing and browsing and gnawing animals
Information gaps
Low recruitment of native woody riparian plants
Non-native invasive species
Oak woodlands
Sediment delivery to watercourses
Toxic chemicals

Analysis

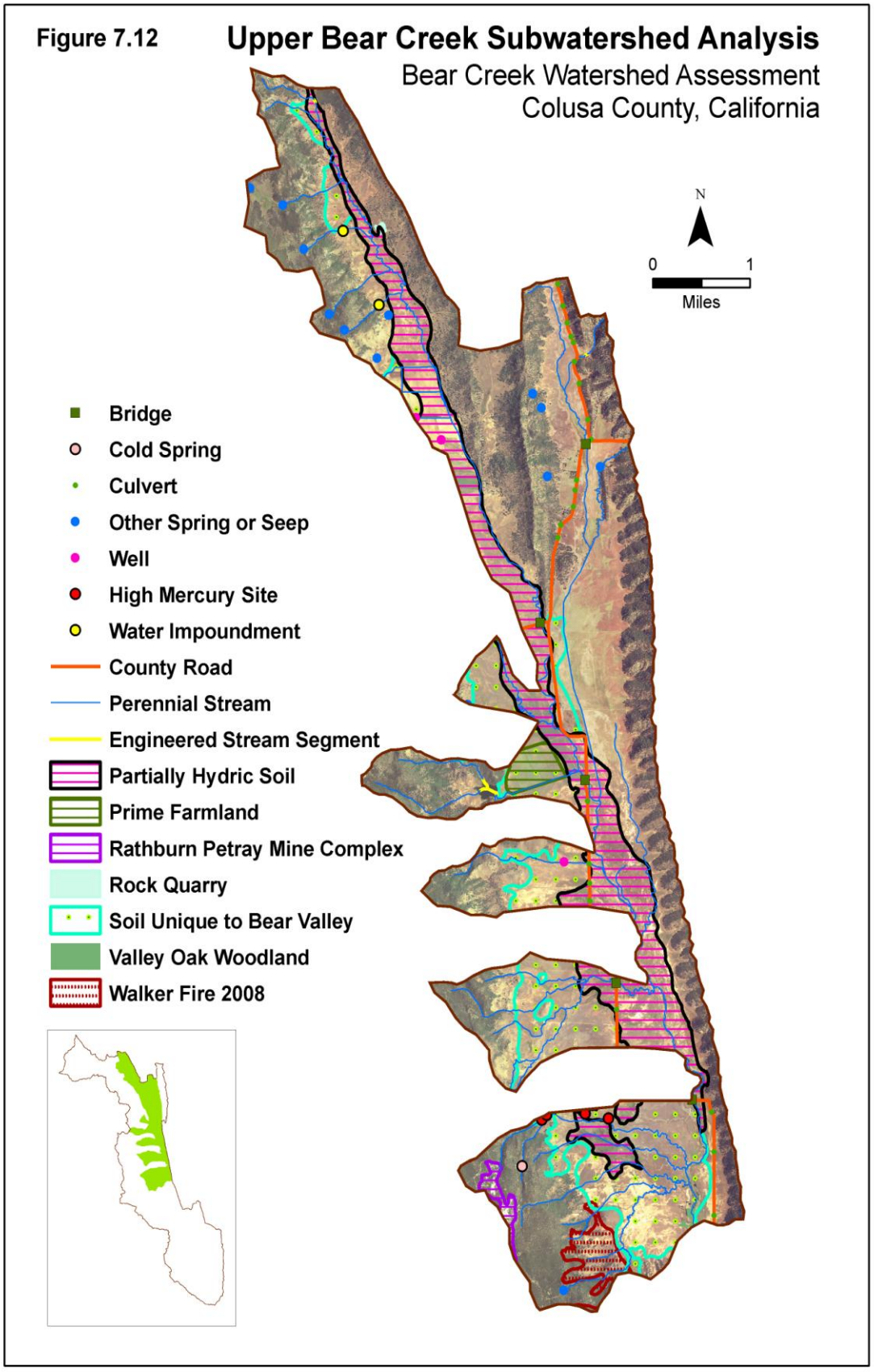
Upper Bear Creek subwatershed is the most agricultural of the Bear Creek subwatersheds. Continuous agricultural land use for more than 150 years has maintained notable natural resources of statewide significance along Upper Bear Creek. Bear Valley has the only prime farmland in the watershed as designated by the State Department of Conservation. This analysis also encompasses similar issues from the parts of Bear Valley that form the eastern ends of multiple subwatersheds previously discussed (that is, from north to south: Mill Creek, Robbers Flat, Stinchfield Canyon, Doyle Canyon, Gaither Canyon, Trout Creek, and Deadshot Canyon).

Toxic chemicals: Environmental problems relating to water quality are locally acute. In the southwest corner of the subwatershed, the abandoned Rathburn-Petray mine complex has been in need of remediation since mining ended in the early 1970s. Currently, the BLM Ukiah Field Office is remediating the mine complex and sampling the quality of water leaving the mine complex site. Water quality sampling upslope from Bear Valley is critical to understanding how much the mine complex is exporting mercury in runoff to the Valley. Concerns stem from the recent discovery of high amounts of mercury and methylmercury in the soil and in cold springs in the southernmost alluvial fan in the Valley. It is uncertain still whether the mercury from the cold springs stems solely from natural "background sources" or whether surface and subsurface water flow from the mine complex upslope contributes a man-caused source of mercury contamination on the valley floor.

Creek channel alterations + Creek and tributary headcuts: People have modified, both intentionally and unintentionally, the hydrologic function of this stretch of Bear Creek over the last 120 years. These developments have led to a suite of issues that concern hydrologists, natural resource managers, and landowners.

Figure 7.12 **Upper Bear Creek Subwatershed Analysis**

Bear Creek Watershed Assessment
Colusa County, California



The presence of remnant hydric soils on the broad valley bottom indicates the potential for reestablishing or expanding existing wetlands and recreating marshes (National Riparian Service Team 2001). Knowledge of the past condition of wetlands in Bear Valley is incomplete, but the low gradient of the valley floor, stream sinuosity, and naturally wide and shallow undisturbed channels indicate that water once flowed through the Valley more slowly than at present. An excerpt from an undated letter quoted by Green (1950) describes Bear Valley in the late 19th century as follows:

> "The banks of Bear creek are, along the valley, rather low, and the land on either side subject to overflow. The springs on the hill-sides keep the ground moist and the valley is nearly always covered with green grass and flowers."

Longer residence time of water once kept native vegetation green longer by keeping soils moist during more of the year. Rates of stream bank erosion were likely very low and riparian vegetation was widespread in the past.

As people impounded tributary water to Bear Creek, the supply of water to Bear Creek may have diminished. Modifications to Bear Creek such as dynamiting channels may have also accelerated water flow rate out of the valley. Soils on the valley are now in general more arid and less productive due to the lowered water table and loss of topsoil. Bear Creek and its tributaries downcut their banks and lowered the streambed and water table. Riparian vegetation is establishing along Bear Creek at the level to which the streambed has dropped. Examining historical photographs would help to clarify how these changes to hydrologic functioning and riparian habitat occurred.

Sediment delivery + Disturbances to ultramafic soils: Sediment is a particular concern in upper Bear Creek because of the ongoing loss of soil from diverse sources: headcuts, culverts, stream downcutting, and loss of stream bank stability resulting from missing riparian vegetation. Improvements to the pattern of water flow in Bear Valley would have benefits downstream. Reducing the winter rate of water flow leaving the Valley and making water flow more evenly throughout the year would reduce soil loss in the Valley and curb bank erosion along lower Bear Creek.

Most soils in Bear Valley are unusual alluvial ultramafic soils in that they consist of a blend of ultramafic and sedimentary soil sources mostly washed down slope from opposite sides of Bear Valley. Venado soils and riverwash soils along Bear Creek and its valley tributaries now have considerably reduced hydric function as a result of creek channel alterations, downcutting, and headcuts. These resulting local human-caused disturbances to topography in Bear Valley have led to a functional loss in the water holding ("sponge") capacity of hydric soils to retain water longer throughout the year. Restoring water storage capacity would be an important goal for reestablishing a more natural water flow system in Bear Valley.

Oak woodlands + Low recruitment of native woody riparian plants: The extensive valley oak woodland at the south end of the subwatershed provides an image of what riparian vegetation might have looked like in Bear Valley before 1850. Woody riparian habitat is now mostly absent on the valley floor.

Impacts from certain grazing practices: To revegetate riparian corridors and protect banks from eroding further, the NRCS has worked with landowners in the Valley to fence stream banks to allow them to revegetate with native plants and prevent further bank erosion.

Removing livestock from the Bear Creek channel may be important to water quality. The unexpectedly high ratio of methylmercury to mercury found in water at the north end of Bear Valley away from mercury mine sources occurs in streams with high amounts of dissolved organic matter (DOM). DOM contributes the methyl portion to methylmercury. The role of livestock in increasing DOM and the resulting comparatively high methylmercury production is currently under study in the Putah Creek watershed nearby.

From their research work in Bear Valley, Gelbard and Harrison (2003) have demonstrated that livestock grazing on the valley floor benefits the spring wildflower bloom that draws visitors to Bear Valley. Livestock grazing may be critical for controlling non-native invasive annual grasses that compete for water and growing space with wildflower populations in Bear Valley.

Growing demand for recreation and tourism: Bear Valley offers magnificent views of strikingly different scenery around its perimeter. The wildflower fields in the spring are remarkable and draw many visitors. Incorporating Bear Valley into automobile touring routes of the backroads in western Colusa County could provide business opportunities for landowners. Opportunities for game hunting exist on private ranches where game species are less intensively hunted than on public lands.

Non-native invasive plants: The CDFG has delineated the wildflower field at the southern end of the Valley (found on Bear Valley and Venado soils) as an outstanding biological area for its plant species diversity. Three rare plant species ranked by the California Native Plant Society as meriting the highest conservation concern are found in the Valley. However, the wildflower field and other areas of the Valley are under threat from non-native invasive plants. Major invasive species in Bear Valley are barb goatgrass, tall wheatgrass, medusahead, perennial pepperweed, and yellow starthistle. They are displacing native vegetation in both upland and riparian parts of the Valley.

Fiscal and policy obstacles to meet regulatory targets: Current landowners have largely prospered despite the altered hydrologic condition and reduced soil moisture in Bear Valley. They may not have a strong incentive to replace current conditions at great expense with a

wetland and stream system that resembles more the original valley of the mid-1800s. Regulators and beneficiaries of Bear Creek water downstream need to consider their role in furnishing incentives for private landowner participation in a landscape-scale effort to restore the Valley.

Further funding from state water and wildlife agencies or tax breaks for landowner incentives could support project work. Current economic conditions and state revenues for water restoration projects may be insufficient to address all of the Upper Bear Creek hydrology and habitat restoration at this time. The State of California faces critical choices in developing water policy and projects that meet the future demand for water by Californians. Restoring the whole of the wetland system of Bear Valley in one large project may rank as a lower priority statewide.

An alternative strategy to improve hydrology in Bear Valley is to work as opportunities arise, incrementally on a small scale and in a patchwork fashion. This "small projects" approach relies on interest in stewardship on the part of individual landowners. In time, the cumulative benefits of smaller projects can restore hydrologic function and native habitats in Bear Valley. Currently, the Colusa County Resource Conservation District is proposing such a smaller-scale project with a Valley landowner to the State of California Wildlife Conservation Board.

Climate change: Restoring the hydrology of Bear Valley may not be easy in a time of climate change. People interested in improving hydrology and the stream and wetland habitats for holistic livestock management there may have to resort to a program of partial recovery. If the water supply in the watershed declines as the result of more severe droughts, replicating past conditions may be difficult. Design of an adapted hydrologic system that functions under changing climate conditions can still foster desired habitat and ecosystem improvements. Climate change requires re-thinking the usefulness of the term "restoration". Adaptation and mitigation of climate impacts may be more apt goals upon which to base improvements to the hydrology of Upper Bear Creek.

Information gaps: A feasibility study would clarify the scope of work needed to repair and improve hydrologic function in Bear Valley. Knowing what practical engineering and ecological solutions are available plus the consideration of associated costs and benefits would provide stakeholders with basic information for good decisions.

The possibilities for improving the hydrologic system require a better understanding of how the present system works. A computer model of the existing hydrology in Bear Valley and the Bear Creek tributaries flowing into the Valley would familiarize stakeholders, planners, and engineers with Bear Valley watershed function. To understand what conditions were like before people modified Bear Valley, a simulation model could create the best picture of how

people think the Valley originally functioned. Stakeholders could then use models of current and past conditions to consider a range of alternatives for future hydrological improvements.

Wildlife note: Upper Bear Creek subwatershed contains known nesting habitat for the following uncommon or declining raptor birds: prairie falcon, golden eagle, burrowing owl, and potentially Swainson's hawk. Existing land use practices in the subwatershed are sustaining populations of these species. More information on raptor population dynamics under climate change effects would support habitat management decisions to sustain raptor birds in the subwatershed.

Potential Projects and Job Opportunities

- Projects to improve hydrologic function, wetlands, native plant populations, and game populations on ranchlands in Bear Valley
- Tourism promotion for Bear Valley as a wildflower and wildlife destination
- Valley oak woodland restoration
- Expansion of off-stream watering systems for livestock under the current assistance program with the Colusa County Resource Conservation District
- Recovery of woody riparian vegetation
- Development of a watershed model for Bear Valley that depicts current conditions, approximates historical conditions, and simulates outcomes of proposed alternatives to improve hydrologic function in the Valley

7.13 Lower Bear Creek, including Lynch Canyon

Land Uses

livestock grazing, crop agriculture, energy conveyance, recreation and tourism (bicycling, car touring, equestrian riding, hunting, kayaking, mountain biking), development (governmental, residential), scientific research and monitoring, telecommunications, transportation, water delivery, woodland management

Major Soils

Millsholm soils are the most widespread of the sedimentary soils and occur in the eastern and southern parts of the subwatershed. Skyhigh and Sleeper soils form mosaics with Millsholm soils particularly on the west side of Bear Creek. These soils erode easily on several steep banks along Bear Creek and at roadcuts along Highway 16. Henneke soils predominate at higher elevations on the west side of Bear Creek in a band stretching both north and south of Highway 20. Ultramafic barrens occur in the area immediately to the west of Cowboy Camp on the BLM Bear Creek Ranch and along Bear Valley Road near Highway 20.

Stakeholder Issues

Climate change
Creek and tributary headcuts
Creek channel alterations
Disturbances to ultramafic soils
Growing demand for recreation and tourism
Fire
Fiscal and policy obstacles to meet regulatory targets
Impacts from certain grazing practices and browsing and gnawing animals
Information gaps
Low recruitment of native woody plants
Non-native invasive species
Oak woodlands
Roads, trails, and fire suppression lines
Sediment delivery to watercourses
Toxic chemicals

Analysis

Lower Bear Creek subwatershed drains from the south end of Bear Valley to the confluence with Cache Creek at the Colusa-Yolo county line. This part of Bear Creek watershed experiences the greatest human travel and visitation.

Roads: Transportation is a major land use in this subwatershed. Most of the length of state highway corridors that traverse Bear Creek watershed passes through this subwatershed. The intersection of Highways 16 and 20 is the busiest traffic point. Because Highway 16 parallels lower Bear Creek and its adjacent steep terrain to the mouth of Bear Creek, the highway has the potential to impact Bear Creek adversely. Engineering for the highway requires intensive maintenance to keep the road in good working order over its narrow course. The large number of culverts along Highway 16 is necessary to direct overland flows to Bear Creek with the least impact to soils and water quality. Deferred maintenance is a problem because sediment fills and buries many culverts along the highway. Other culverts are damaged and do not direct water to Bear Creek as intended. In some places, riprap has been the solution used for bank stabilization. Three large eroding slopes are failing along the highway just north of the mouth of Bear Creek.

Initial estimates of sediment-laden runoff from state highways in the watershed are considerable (>12 tons solid sediment and > 12 tons dissolved material annually). Trash and dumping have been a problem in the travel corridor. The BLM and CALTRANS have taken steps make sure that dumping does not continue.

CALTRANS has taken precautions to prevent landslides on steep terrain along Highway 20 west of the intersection with Highway 16. Drainage pipes are installed in several locations, and long culverts and ducts convey water into Bear Creek with minimal soil disturbance to side slopes. CALTRANS has removed soil from a ten-acre parcel on BLM public lands. The scraped site now exposes ultramafic rocks that fracture easily. Rock sediments and remnants

of soil now erode from the site. The parcel is unsightly from the highway and from viewsheds on public lands. CALTRANS had initiated a well-conceived revegetation project but has abandoned that effort.

Several wetlands lie along Highway 20 and some are at risk of compromised biological integrity. For example, Destinella Flat at the Colusa County line, which contains a seasonal wetland, is at risk from infestations of barb goatgrass in upland areas, extensive pepperweed patches, and grazing practices that are degrading the wetland. Widening of the parking strip along the highway is a problem as sediment drains from the road verge into the adjacent wetland.

Over the years, volunteers have controlled weed infestations to maintain the diversity of native wildflowers and grasses found in the Bear Creek Botanical Management Area established by CALTRANS along Highway 20. Recent realignment of the Highway 20 bridge over Bear Creek has required extensive disturbance of the Management Area north of Highway 20, although the core prairie complex on the south side of Highway 20 next to BLM land has remained mostly protected from earthworks. Volunteer activity has ceased, and barb goatgrass and yellow starthistle infestations are likely to spread.

Growing demand for recreation and tourism: Another major land use for this subwatershed is recreation. Lower Bear Creek subwatershed is a gateway via Highway 16 from Yolo County to recreation and tourism opportunities on the BLM Bear Creek Ranch, Walker Ridge, and the county roads in Bear Valley. Stopping along Highway 16 can be hazardous since the narrow canyon terrain does not have room for many road shoulders and easy pullouts. Signs for safe places to park vehicles are not in place. Unauthorized recreational shooting is creating problems, especially where people litter the landscape with cartridges and shells. Increasing popularity of the Ranch and the range of outdoor recreation available suggest that a comprehensive recreation plan is in order to accommodate diverse recreation groups and minimize conflicts among user groups.

Toxic chemicals: The CVRWQCB has requested that the BLM and private landowners curtail developments along the lower Bear Creek riparian zone because of the likelihood of dislodging mercury bound in stream and bank sediments. Recent findings by the CVRWQCB staff (Bosworth and Morris 2009) have shown that an estimated 91 kg (200 lbs) of total mercury are present in sediment deposition zones on banks along lower Bear Creek.

One challenge to stakeholders is how to manage sites known or suspected of being hot spots for mercury methylation. Researchers have not yet investigated to what extent lower Bear Creek below the confluence of Sulphur Creek (the major source of mercury) functions as an incubator for methylating mercury. Methylation production from streamside pools during low

summer flows, for example, deserves research. With this information, resource managers can map levels of methylation production for lower Bear Creek and then focus on managing the aquatic ecology at mercury hot spots to suppress mercury methylation.

Oak woodlands: Oak harvesters have removed blue oak woodlands over much of Bear Creek Ranch and elsewhere in portions of the subwatershed for fuelwood and short-term increases for forage production. Large gaps appear in the continuity of woodlands. Given the change in emphasis for land uses on Bear Creek Ranch, the benefits of past vegetation management may not apply to future management needs. Rangelands are often difficult sites to revegetate as oak woodlands. Drought, weeds, multiple browsing by animals, securing an adequate supply of acorns at the right time, loss of soil fertility, and imperfect silvicultural practices all come in to play. Some large-scale natural oak woodland regeneration has occurred.

Low recruitment of native woody riparian plants: Steps to reduce animal browsing are underway along lower Bear Creek, and signs of recovery are apparent near the confluence with Cache Creek. Where valley oaks have persisted in the Bear Creek riparian zone, seedlings are present but survival to saplings and older tree stages is rare.

Non-native invasive species + Disturbance to ultramafic soils: Perennial peppergrass, tall wheatgrass, and tamarisk are the most dominant invasive plant species in the lower Bear Creek riparian zone, especially at sites with deeper soils. They are transforming the appearance and function of riparian zones. Barb goatgrass invasion on ultramafic soils is also extensive.

Sediment delivery to watercourses + Impacts from certain livestock practices and browsing and gnawing animals: Livestock grazing occurs occasionally on private land on the east side of Bear Creek and annually on the BLM Bear Creek Ranch. Stakeholders involved with the Ranch are concerned about the effects of intensive livestock grazing on hydrologic function, site stability, and water quality in lower Bear Creek riparian areas. Current grazing practices are causing riparian vegetation loss, livestock trampling, and animal waste to get in the water. For example, west of Cowboy Camp, headcuts and gullies are widespread, and sufficient vegetation to curb erosion is missing on upland and riparian zones. These conditions would benefit from changes to the timing, location, and intensity of grazing.

Fiscal and policy obstacles to meet targets: Public and regulatory expectations for resource management issues in the Lower Bear Creek subwatershed require ongoing stakeholder collaboration. Stakeholder agreement on goals, specific issues, priorities, and management pathways is for necessary steps to plan, identify bottlenecks and stewardship solutions, locate funding, and implement and monitor projects for watershed improvements.

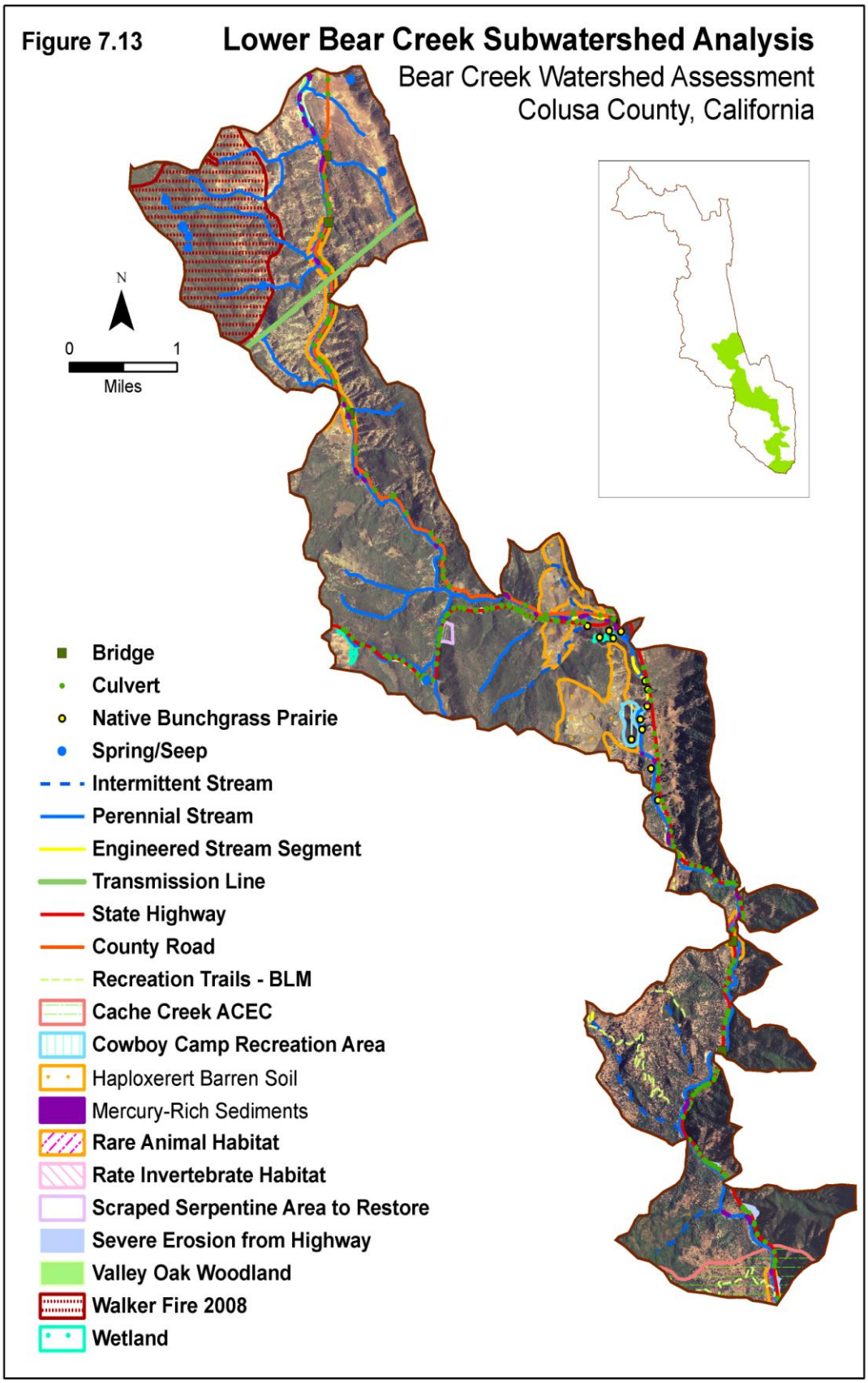


Figure 7.13
Lower Bear Creek Subwatershed Analysis
Bear Creek Watershed Assessment
Colusa County, California
N
0
1
Miles
Bridge
Culvert
Native Bunchgrass Prairie
Spring/Seep
Intermittent Stream
Perennial Stream
Engineered Stream Segment
Transmission Line
State Highway
County Road
Recreation Trails - BLM
Cache Creek ACEC
Cowboy Camp Recreation Area
Haploxerert Barren Soil
Mercury-Rich Sediments
Rare Animal Habitat
Rate Invertebrate Habitat
Scraped Serpentine Area to Restore
Severe Erosion from Highway
Valley Oak Woodland
Walker Fire 2008
Wetland

Fire: Arson fires have been a problem along Highway 16 in the past. A concern is that with the increase of visitors to public lands the risk of wildfires will increase. If climate change affects fire behavior and frequency, the composition and amount of required revegetation may be unprecedented. Multiple prescribed fires have occurred on the BLM Bear Creek Ranch since 1993, but no one has documented or quantified the benefits of prescribed burning for the Ranch.

Climate change: Forecasts of a warmer, drier climate for the region, however, point to longer droughts that might cause Bear Creek to cease flowing more often than in the past. Impacts of more frequent and longer disruptions of stream flow in Bear Creek are likely to threaten populations of foothill yellow-legged frogs. There is a need to prepare for future changes for specific vulnerable sites using best available information.

Information needs: A model of the depositional processes and methylation rates of mercury in sediment accumulations and summer season pools along Bear Creek can better predict locations where mercury management is most critical to reduce mercury and methylmercury exports to Cache Creek.

Note on biological diversity: Under the direction of Dr. Ellen Dean, with the Center for Plant Diversity at UC-Davis, the BLM Bear Creek Ranch has been the focus of intensive botanical inventories. Over 450 species of plants have been documented, six of which are BLM sensitive plant species. Five of these species are endemic to ultramafic soils.

The riparian corridor is also important to foothill yellow-legged frogs and western pond turtles, both BLM sensitive animal species. The frogs are especially common in Bear Creek above the confluence with Sulphur Creek. Bald eagles are common along the Creek, especially during the winter. One small tributary just north of the confluence with Sulphur Creek has historically maintained a population of the Wilbur Springs Shorebug, but the species has not been recorded there since 1979.

Potential Projects and Job Opportunities

- Revegetation of the BLM land along Highway 20 where CALTRANS scalped soil to avoid landslides covering the highway
- Planning and implementing removal of mercury-rich sediment piles in deposition zones along lower Bear Creek
- Stewardship and research to increase the extent of blue oak and valley woodlands as mitigation for climate change impacts, carbon sequestration, and wildlife habitat improvement

- Increased outdoor recreational, interpretative, and scientific programs for children and young adults sponsored by schools, recreation groups, and educational foundations, patterned on events such as the Cache Creek Watershed Discovery Day
- Conservation planning and project implementation to protect and enhance habitat for sensitive and special status aquatic species
- Management of aquatic habitats identified as hot spots for mercury methylation to reduce net methylation in lower Bear Creek
- Monitoring for aquatic and terrestrial wildlife along lower Bear Creek as indicators of stream proper functioning condition
- Studies of the effectiveness of past prescribed burns