CHAPTER 8

NEXT STEPS

This chapter outlines next steps for addressing stakeholder issues to attain watershed goals. In preparing the Bear Creek watershed assessment, we gathered and evaluated multiple sources of information: historical facts, research data, geographic information, reviews of new science and technology, and judgments of experts familiar with the watershed. Although many aspects of the watershed are still not well understood, the overall intent of this work has been to provide information on the current state of knowledge as a guide for future decision making and to identify what we need to be learning. Watershed assessment does not suffice by itself; it must be coupled to actions on the ground in the watershed and to learning on the part of stakeholders.

This chapter focuses on three general action areas for progress:

- determining and implementing voluntary best management practices (BMPs) for concerted actions
- learning for better decision making in natural resource stewardship, consisting of four components: inventories, technical evaluations, scientific research, and monitoring
- recovering diminished ecosystem services and natural resources through remediation and restoration projects, as prioritized by stakeholders.

8.1 Best Management Practices for Watershed Stewardship

Best management practices (BMPs) refer to controls, procedures, and operations designed to protect and improve environmental conditions. The original context for BMPs concerned water quality, but the term is used more broadly now to include conservation measures to protect other resources such as soils and wildlife and to halt the spread of invasive plants or pathogens, for example. BMPs for Bear Creek watershed would cover stakeholder issues including, among others: controls for mercury pollution and sediment control; standards to restore creek channels and recover native vegetation of riparian areas; road and trail maintenance for erosion control; prescribed fire treatments; oak woodland conservation; limits to disturbances on ultramafic soils; integrated weed management practices; reductions of impacts from energy developments; and responses to mitigate or adapt to impacts from climate change.

Some sets of BMPs are already in place for public lands in Bear Creek watershed. They do not refer to any other lands than to the BLM and US Forest Service lands. However, they may serve as points of departure for broader stakeholder discussions of BMPs for application watershed wide.

The BLM Ukiah Field Office Resource Management Plan (RMP) (2006) contains two sets of BMPs that relate to two stakeholder issues in Bear Creek watershed: impacts to other resources from energy resource development and demand for recreation. The references for these BMPs appear below.

Appendix I - Wind Energy Best Management Practices, available online at:
http://www.blm.gov/ca/pdfs/ukiah_pdfs/rmp-eis/Appendices/Appendix_I.pdf

Wind energy BMPs cover site monitoring and testing in advance of development, preparing the plan of development, construction procedures for an approved project, subsequent project operation, and site decommissioning. Natural resources addressed by BMPs include: wildlife (bats and birds especially), unique habitats, and special-status plant species.

Appendix J – Recommended Off-Highway Vehicle Management Guidelines from the BLM Northwest California Resource Advisory Council, available online at:
http://www.blm.gov/ca/pdfs/ukiah_pdfs/rmp-eis/Appendices/Appendix_J.pdf

The BMPs ("guidelines") for motorized recreation deal with planning and management to protect, water quality, riparian and wetland habitats, biological diversity, and soils.

The Pacific Southwest Region (Region 5) of the US Forest Service has established BMPs for water quality management, a major stakeholder issue in Bear Creek watershed. These BMPs are currently in effect for the Mendocino National Forest portion of the watershed. The document *Water Quality Management for National Forest System Lands in California* (2000) is available online at:http://www.fs.fed.us/r5/publications/water_resources/waterquality/water-best-mgmt.pdf

The range of topics for water quality management covers forestry, mining impacts, recreation effects, livestock grazing, and road and trail construction. As technical knowledge grows, the Pacific Southwest Region plans to refine its water quality BMPs.

The California Department of Transportation (CALTRANS) addresses the stakeholders' transportation issue in part with its *Construction Site BMP Manual* (2003). The document is available online at: http://www.dot.ca.gov/hq/construc/stormwater/CSBMPM_303_Final.pdf.

The applicability of the BMP Manual extends beyond transportation construction. Sections cover soil stabilization and stockpile management, sediment control measures, and handling of contaminated soils and hazardous waste. These BMPs also assist stakeholders in managing abandoned mine reclamation, stabilizing stream banks, and revegetating disturbed lands. The Landscape Architecture Program at CALTRANS provides further BMPs for erosion and methods for implementing BMPs using the Caltrans Erosion Control Toolbox, available on-line

at: http://www.dot.ca.gov/hq/LandArch/ec/.

Other important BMPs for Bear Creek watershed may deal with fire management. The California Department of Forestry and Fire Protection is an important stakeholder and source for information in this regard. Topics for BMPs could cover: (1) protecting sensitive vegetation types, especially on ultramafic soils; (2) controlling non-native invasive species spread after prescribed burns and wildfires; (3) reducing emissions of mercury generated from wildfires; (4) avoiding landslide hazards, especially on ultramafic soils after fires; and (5) protecting aquatic and riparian ecosystems during and after fires.

8.2 Information Needs for Resource Management

This section summarizes assessment findings about information needs in four tables: Table 8.1 Resource Inventories; Table 8.2 Technical Evaluations; Table 8.3 Science Research; Table 8.4 Monitoring. All projects proposed to meet information needs address the stakeholders' overarching goal for maintaining economic livelihoods and creating jobs. The new jobs generated to fill information needs are a source of employment for skilled workers. But the information generated is designed to increase the productivity of soil and water resources for sustaining ranching in Bear Creek watershed and for delivering water for agriculture and municipalities downstream. Because the cost to acquire desired information in Bear Creek watershed exceeds the limit of realistic funding, stakeholders will be prioritizing those information needs that promise the greatest return toward attaining watershed goals and addressing stakeholder issues.

To keep the size of the tables small, the following list displays abbreviated terms for the stakeholders' issues and goals as originally stated in Chapter 1:

Goal Abbreviation	Watershed Goal
Biological Diversity	Protect and enhance biological diversity
Catastrophic Events	Reduce the likelihood and impacts of catastrophic events
Employment	Maintain economic livelihoods and create jobs
Energy Development	Develop energy resources
Hydrologic Function	Restore hydrologic
Recreation	Enhance recreation
Soil Conservation	Conserve topsoil and stabilize erosion-prone areas
Water Quality	Improve water quality

Issue Abbreviation	Stakeholder Issue
Animal Grazing / Browsing	Impacts from certain livestock grazing practices and browsing and gnawing animals
Channel Alterations	Creek channel alterations
Climate Change	Climate change
Energy Resources	Potential environmental impacts of energy developments
Fire	Fire
Headcuts	Creek and tributary headcuts
Information Gap	Information gaps
Invasive Species	Non-native native species
Oak Woodlands	Oak woodlands
Policy Obstacles	Fiscal and policy obstacles for landowners to meet regulatory targets
Recreation Demand	Growing demand for recreation and tourism
Roads	Roads, trails, and fire suppression lines
Sediment	Sediment delivery to watercourses
Toxics	Toxic chemicals
Ultramafic Soils	Disturbances to ultramafic soils
Woody Riparian Plants	Low recruitment of native woody riparian plants

Resource Inventories (Table 8.1)

Managing natural resources is difficult if resource managers and landowners do not have a complete inventory of the resources over which they exercise stewardship. Table 8.1 summarizes the resource inventories identified in previous chapters of the watershed assessment and their relevance to stakeholders' issues and goals. Tasks include field work, aerial photo interpretation, and GIS mapping.

Table 8.1 – Resource inventories to improve management decisions for Bear Creek watershed

Resource Inventory	Principal Stakeholder Issue(s)	Watershed Goal(s)	Focal Area(s)	Work Done to Date
Anthropogenic				
Prescribed burns: field work, photo Interpretation	Fire, Invasive Species	Biological Diversity	BLM Public Lands	none
Stream alterations: field site descriptions, mapping	Channel Alterations	Hydrologic Function	Bear Valley and Leesville, Lower Bear Creek, and Sulphur Creek subwatersheds	some
Vegetation conversion to grassland: field work, mapping	Climate Change, Invasive Species, Oak Woodlands	Biological Diversity, Soil Conservation	Watershed-wide	none
Biologic				
Baseline for vascular plants and vertebrate animals: field work	Energy Resources, Information Gap, Ultramafic Soils,	Biological Diversity, Employment, Energy Development	Walker Ridge, Mill Creek subwatershed	some
Native invertebrates: field work	Channel Alterations, Fire, Information Gap, Woody Riparian Plants	Biological Diversity, Hydrologic Function	Walker Ridge and Lower Bear Creek, Mill Creek, and Sulphur Creek subwatersheds	none recently
Non-native plant invasions: field work, remote sensing, photo Interpretation	Animal Grazing / Browsing, Invasive Species, Oak Woodlands	Biological Diversity Recreation, Soil Conservation,	Watershed-wide	some
Ranges of sensitive species: field work	Fire, Invasive Species, Ultramafic Soils	Biological Diversity, Catastrophic Events	BLM and US Forest Service Public Lands	some
Geoscientific				
Headcut characterization: field work	Headcuts, Sediment	Hydrologic Function, Water Quality, Soil Conservation	Bear Valley and Leesville, Lower Bear Creek, and Sulphur Creek subwatersheds	some
Landslides and mass wasting: field work, photo interpretation	Energy Development, Fire, Roads, Sediment, Ultramafic Soils	Catastrophic Events, Energy Development, Soil Conservation	Lower Bear Creek and West of Cortina Ridge subwatersheds	some
Longitudinal and cross-sectional stream profiles	Animal Grazing / Browsing, Channel Alterations, Sediment	Hydrologic Function	Bear Valley and Lower Bear Creek and Sulphur Creek subwatersheds	some

Technical Evaluations (Table 8.2)

In some cases, before stakeholders can undertake projects to recover impaired ecosystem services and restore productivity of specific environments in Bear Creek watershed, they may need technical evaluations upon which to base decisions. Table 8.2 summarizes the key technical evaluations identified in previous chapters of the Bear Creek watershed assessment. They are intended as decision support tools based on best available information. Technical evaluations may be expensive, and hiring consulting experts can be cost-prohibitive. Stakeholders from government agencies can sometimes provide in-house expertise to assist in technical evaluations and offset costs.

Science Research (Table 8.3)

Science research has transformed our understanding of Bear Creek watershed. For example, the CalFed-sponsored research and subsequent studies by scientists from the US Geological Survey have helped stakeholders understand the magnitude of mercury contamination in the watershed and the impacts to aquatic ecosystems and wildlife.

The efficiency of scientific research ensures that just enough information is gathered to attain a desired level of confidence (often 95%) that the scientific findings are accurate. The high probability of accuracy furnishes new information that landowners and resource managers can rely on for decision making. Table 8.3 lists the major topics identified as needed research in the preceding chapters and the issues and goals that the research addresses. Scientists have already initiated some of these research topics.

Achieving continuity in a program of science research is seldom possible without substantive commitments of funding from stakeholders in government, industry, or non-profit foundations as well as the support of landowners and land managers. Watershed stakeholders can build on existing relations with government agencies in Sacramento and research institutions such as the University of California at Davis, both of whom have longstanding involvement in research in the watershed.

Table 8.2 – Technical evaluations, syntheses, or modeling to improve management decisions for Bear Creek watershed

Evaluation, Synthesis, or Modeling	Stakeholder Issue(s)	Watershed Goal(s)	Focal Area(s)	Work Done to Date
Anthropogenic				
Air quality risks to people from asbestos, mercury, and dust Inhalation	Energy Resources, Recreation Demand, Roads, Toxics, Ultramafic Soils	Energy Development, Recreation	Subwatersheds originating on Walker Ridge	none
Economic benefits from channel alterations to landowners	Channel Alterations	Employment, Hydrologic Function, Quality	Bear Valley, Leesville and Sulphur Creek subwatersheds	none
Options to repair headcuts, culverts, and stream alterations	Channel Alterations, Headcuts, Roads, Sediment	Hydrologic Function	Watershed-wide	some
Biologic				
Map of vegetation alliances per Sawyer et al. (2009) and ecological site descriptions tied to soils	Animal Grazing / Browsing, Climate Change, Energy Resources, Fire, Oak Woodlands, Ultramafic Soils, Woody Riparian Plants	Biological Diversity, Energy Development, Hydrologic Function, Soil Conservation	Watershed-wide	some
Predictive habitat models for rare and sensitive species and game species under current and climate change conditions	Animal Grazing / Browsing, Climate Change, Energy Resources, Fire, Invasive Species, Oak Woodlands, Recreation, Ultramafic Soils, Woody Riparian Plants	Biological Diversity, Catastrophic Events	Watershed-wide	some
Climatic				
Potential for reforestation to store carbon	Climate Change, Fire, Oak Woodlands, Policy Obstacles, Woody Riparian Plants	Catastrophic Events	Watershed-wide	none
Geoscientific				
Geological hazard mapping	Energy Resources, Information Gap, Sediment, Ultramafic Soils	Catastrophic Events, Employment	Watershed-wide, as needed for projects	some
More detailed soil mapping at sensitive sites	Energy Resources, Fire, Roads, Sediment, Ultramafic Soils	Energy Development, Recreation, Soil Conservation	Watershed-wide, as needed for projects	none
Hydrologic				
Model of historical wetlands and hydric soils in Bear Creek watershed	Channel Alterations, Headcuts, Roads, Sediment	Biological Diversity, Employment, Hydrologic Function, Soil Conservation, Water Quality	Watershed-wide	none

Table 8.3 – Research to improve management decisions for Bear Creek watershed

Research Topic	Stakeholder Issue(s)	Watershed Goal(s)	Focal Area(s)	Work Done to Date
Biologic				
Invasive plant control	Animal Grazing / Browsing, Fire, Information Gap, Invasive Species, Ultramafic Soils, Woody Riparian Plants	Biological Diversity, Employment, Hydrologic Function, Soil Conservation	Bear Valley and Leesville, Lower Bear Creek, and Sulphur Creek subwatersheds	some
Optimal fire regimes for vegetation alliances	Climate Change, Fire, Information Gap, Invasive Species, Ultramafic Soils, Woody Riparian Plants	Biological Diversity, Catastrophic Events, Soil Conservation	Watershed-wide	some
Identification of native pollinators of rare plant species and potential native pollinators for agricultural crops	Climate Change, Invasive Species, Ultramafic Soils	Biological Diversity, Catastrophic Events, Employment	Watershed-wide	some
Ecology and range of pallid and Townsend's big-eared bats using abandoned mercury mines	Energy Resources, Toxics	Biological Diversity, Employment, Energy Development	Subwatersheds originating on Walker Ridge	none recently
Geoscientific				
Background and contamination amounts of mercury and other elements with MCLs in soils	Animal Grazing / Browsing, Recreation, Toxics, Ultramafic Soils	Soil Conservation	Sulphur Creek and Upper Bear Creek subwatersheds	some
Mercury transport from Rathburn Petray mine complex to the floor of Bear Valley	Animal Grazing / Browsing, Toxics, Ultramafic Soils	Soil Conservation, Water Quality	Upper Bear Creek subwatershed	some
Hydrologic				
Relation between animal waste and mercury methylation	Animal Grazing / Browsing, Toxics	Water Quality	Sulphur Creek and Upper Bear Creek subwatersheds	some
Aquatic hot spots for mercury methylation	Sediment, Toxics	Water Quality	Bear Valley and Lower Bear Creek and Sulphur Creek subwatersheds	none

Environmental Monitoring (Table 8.4)

In the feedback system for adaptive management, monitoring provides the information to landowners and resource managers about the effectiveness of the management actions thus far undertaken to meet watershed goals. Key features of a robust monitoring system are:

- development and adoption of statistically well-designed, peer-reviewed, and practical protocols
- attention to quality assurance for continuous training and checking that people follow protocols
- production of quality-controlled data
- high standards for processing, management, storage, and sharing of monitoring data electronically.

Monitoring is sometimes costly. Land and resource management agencies, generally underfunded and understaffed, rarely adopt extensive monitoring programs. When funding is insufficient, agency monitoring staff is cut back. Therefore, the fifth element in a robust monitoring system is an active fund-raising effort to secure continuous funding for monitoring. Collaborative partnerships among stakeholders can contribute greatly to making monitoring fiscally sustainable.

Table 8.4 displays the monitoring topics required by regulatory agencies and additional monitoring needs for watershed stakeholders to consider. Details of specific monitoring are discussed below.

Water Quality in Streams

Monitoring required by regulatory agencies covers principally water and its contaminants with respect to numeric maximum contaminant levels (MCLs) established by the State of California. For reference, Appendix G outlines water regulations in California. The major MCL of concern is mercury. The TMDLs for methylmercury and total mercury established the CVRWQCB are the governing MCLs for mercury and mercury compounds in the Bear Creek watershed. The US Geological Survey has recently completed a protocol, statistical design, and plan for monitoring mercury at strategic sites throughout Bear Creek watershed (Suchanek et al. 2010).

Sulfate, sulfide, and dissolved organic matter in water relate to mercury because they facilitate conversion of molecular mercury to methylmercury. High levels of these ions together in water may indicate that methylmercury is forming in significant amounts. Boron is the other element of concern. The Yolo County Flood Control and Water Conservation District monitors boron in Bear Creek water regularly.

The California Department of Water Resources tracks water quality from one station on lower Bear Creek. At present, monitoring for fecal coliform bacteria rarely takes place, and monitoring for industrial organic compounds (e.g., herbicides, rodenticides) has not occurred since 2001.

Water Flow

The US Geological Survey maintains one station in lower Bear Creek. Other stations have operated in the past. Water flow data are needed especially at the mouth of Sulphur Creek, on Mill Creek at Brim Road, and at the south end of Bear Valley for estimating total amounts of mercury or methylmercury in daily and annual flows at these critical points in the watershed. The Yolo County Flood Control and Water Conservation District could use these data as an alert to high flows that might put communities downstream such as Rumsey and Woodland at risk of flooding.

Other Water-Related Monitoring

Three other areas of water monitoring are needed. Little is known about groundwater in Bear Creek watershed. Baseline information about groundwater in Bear Valley and the Sulphur Creek subwatershed is important to understand the water quality, existing consumption, and potential uses for groundwater.

Springs in Bear Creek watershed are major background sources of unusual chemical elements, other than mercury. Monitoring loads of these elements at springs and at sites just downstream from abandoned mines can determine which elements are exceeding their established MCLs because of human-caused sources related to abandoned mines. Data on flows from springs may also signal changes in groundwater recharge or loss of connections between springs and geologic water deep in the earth as the result of seismic shifts.

Some of the rarest and most vulnerable habitats are wetlands on ultramafic soils, including those outside of Bear Valley. A designated OHV trail presently passes through the Eaton Springs wetland in Sulphur Creek subwatershed, and Highway 20 runs next to the seasonally wet Destinella Flat.

Population Trends for Special Status Species

Little monitoring is in place to track populations of special status species. Monitoring is needed especially for Indian Valley brodiaea, a plant species listed as endangered by the State of California. Sections 2.9 and 2.10 provide basic information on these species.

Climate Change

Weather and climate stations strategically placed in the watershed can provide information on changing climate. RAWS and SCAN stations are not present in Bear Creek watershed; one RAWS stations lies just outside the watershed boundary. Stations on Walker Ridge, in Bear

Table 8.4 – Monitoring for regulatory requirements and for feedback to stakeholders about management actions

Monitoring Topic	Stakeholder Issue(s)	Watershed Goal(s)	Focal Area(s)	Work Done to Date
Anthropogenic				
Outcomes over time to vegetation and wildlife after prescribed burns	Animal Grazing / Browsing, Fire, Invasive Species, Ultramafic Soils	Biological Diversity, Soil Conservation	BLM Public Lands	none
Sediment loads coming from roads and trails	Recreation Demand, Roads, Sediment, Ultramafic Soils	Energy Development, Hydrologic Function, Soil Conservation, Water Quality	All state highways, county roads, BLM and US Forest Service designated OHV routes, and eventual energy project rights-of-way	none
Biologic				
Extent of non-native invasive plant infestations	Animal Grazing / Browsing, Fire, Recreation Demand, Roads, Ultramafic Soils	Biological Diversity, Recreation, Soil Conservation	Watershed-wide	ongoing
Population trends of important game species	Animal Grazing / Browsing, Fire, Oak Woodlands, Recreation Demand, Woody Riparian Plants	Biological Diversity, Recreation	Watershed-wide	ongoing
Population trends of sensitive species	Channel Alterations, Climate Change, Energy Resources, Fire, Invasive Species, Oak Woodlands, Recreation Demand, Ultramafic Soils, Woody Riparian Plants	Biological Diversity	Public lands watershed-wide	some
Climatic				
Vegetation reference sites to detect and observe effects of climate change	Climate Change, Fire, Invasive Species, Oak Woodlands, Ultramafic Soils, Woody Riparian Plants	Biological Diversity, Catastrophic Events, Soil Conservation	Watershed-wide	none
Data from RAWS and SCAN weather stations				none
Hydrologic				
Bacterial contaminants	Animal Grazing / Browsing, Demand for Recreation	Recreation, Water Quality	Bear Valley and Leesville, Lower Bear Creek, and Sulphur Creek subwatersheds	none recently
Boron	Sediment	Water Quality	Lower Bear Creek and Sulphur Creek subwatershed	ongoing

Monitoring Topic	Stakeholder Issue(s)	Watershed Goal(s)	Focal Area(s)	Work Done to Date
Elemental contaminants with MCLs, other than mercury	Roads, Sediment, Toxics	Water Quality	Watershed-wide	some
Groundwater	Information Gap, Policy Obstacle	Water Quality	Bear Valley and Leesville and Sulphur Creek subwatersheds	none
Industrial organic compounds	Information Gap, Toxics	Water Quality	Watershed-wide	none recently
Methylmercury for TMDL standards in stream loads	Toxics	Water Quality	Watershed-wide	ready to start when funding is available
Total mercury for TMDL standards in stream loads		Water Quality	Sulphur Creek subwatershed	
Springs	Climate Change, Toxics	Recreation, Water Quality	Watershed-wide	none recently
Stream flow	Channel Alterations, Climate Change, Headcuts	Hydrologic Function	Watershed-wide	ongoing locally
Wetlands on ultramafic soils	Energy Resources, Fire, Sediment, Recreation Demand, Roads, Ultramafic Soils	Biological Diversity, Energy Development, Hydrologic Function, Recreation, Water Quality	Walker Ridge and Sulphur Creek and Upper Bear Creek subwatersheds	none

RAWS – Remote Automated Weather Station at the USDA Forest Service in partnership with other federal land management agencies

SCAN - Soil Climate Analysis Network at the USDA Natural Resource Conservation Service

Valley, and in the Brophy Canyon, Leesville, Mill Creek, and Sulphur Creek subwatersheds would clarify how environmental conditions are varying across the watershed. SCAN stations are particularly useful for tracking changes to soil moisture. Bear Valley stations could track changes in soil moisture as projects to restore hydrologic function in the Valley are implemented.

8.3 Stewardship Priorities for Remediation and Restoration

At its best, a watershed assessment leads to implementation of projects that benefit the land and people connected to the watershed. In this regard, the assessment and a separate document titled *Bear Creek Stewardship Priorities, 2010-2014*, have identified projects needed to repair or protect the natural capital of the watershed. The projects aim to sustain ecosystem services, goods, benefits, and livelihoods for stakeholders. These projects also produce new jobs. For implementation, projects will require good design, thoughtful application, monitoring, and long-term collaborative stewardship efforts. Assessment information can provide background for watershed project planning and for completing the environmental documentation required under the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA) to ensure that projects are successful. New watershed projects are already moving forward in 2010 for abandoned mine site remediation at the Rathburn-Petray mine complex and revegetation of ultramafic sites along Highway 20.

8.4 Updating the Bear Creek Watershed Assessment

Watershed assessment is an ongoing process among stakeholders. New information about Bear Creek watershed is appearing continually as researchers, resource managers, landowners, and other stakeholders learn more about Bear Creek watershed. Reassessing to reflect changing conditions on the ground and new knowledge is necessary over time as part of adaptive management. Incorporating new information about the watershed as it becomes available and then updating analyses and evaluations then becomes a recurring process. In this way, the assessment develops in response to changes in watershed conditions, stakeholders' priorities, regulatory requirements, and government policies. One option for stakeholder consideration is to update the assessment every five years and to time the revision with a new version of the *Bear Creek Stewardship Priorities* for the period, 2015 to 2019.