The past 10 years have seen the completion of numerous watershed assessments and watershed management plans throughout the Sacramento River Basin. However, the true measure of success of any management program comes from the ability to affect conditions on the ground, i.e., implement actions to protect or improve watershed resources and overall watershed condition. This section briefly describes projects from each subregion area that are examples of watershed improvement work being done by locally directed management groups; by local, state, and federal agencies; and by other public and private entities. The examples presented here include projects to benefit water quality, streamflow and aquatic habitat, fish passage, fire and fuels management, habitat for wildlife and waterfowl, eradication of invasive plant species, flood management, and watershed stewardship education. Support for this work has come from a broad spectrum of public and private sources.
A one mile, privately owned meadow reach on Lassen Creek (tributary to Goose Lake) was impacted by severe channel erosion and entrenchment causing problems for red-band trout habitat, loss of floodplain function during high flows, and progressive drying and vegetation change on the adjacent meadow (grass to sagebrush). The problems started from 1960’s channelization work and continued to evolve from years of summer long, intensive grazing in the meadow. Under the direction of the Goose Lake RCD and their consultant (StreamWise), the project was designed and implemented using a geomorphic approach known as ‘pond and plug’. This approach, which has been used extensively to treat entrenched channel problems in the Upper Feather River watershed, uses earth fill to plug and eliminate the existing gullied stream channel and redirects the flow to remnant stream channels on the surface of the meadow. Soil for filling the gully is acquired by excavating a number of on-site ponds. The end result is a stream bed and channel with a much reduced cross-section area (compared to the treated gullied channel) that annually spreads winter and spring high flows onto the floodplain and recharges meadow hydrology that supports more robust forage growth and augments dry season base flow in the stream. Grazing management was made part of the project that included fencing and off-site water to control livestock access. Construction work was completed in fall, 2005 and subsequent inspection in spring, 2006 found there was need for some follow-up maintenance and modification. With funding assistance from the Dept. of Fish and Game, this work was completed in 2006 and stream conditions have continued on an improving trend since that time.
The Pit River is 303(d) listed as impaired from high temperature, high nutrient loading, and low dissolved oxygen. Though not part of the listing, the river is also known to have problems from active channel erosion that results in deposition of fine sediment and impacts to aquatic life. Both the Central Modoc RCD and the Pit RCD have implemented erosion control projects, using a variety of techniques, to test and demonstrate the feasibility of establishing a stable, well-vegetated riverbank and riparian corridor.

**Bushy Ranch Project**

- **Location:** Pit River near Canby, Modoc County
- **Project Sponsor:** Central Modoc RCD
- **Time Frame:** 1999-2002
- **Funding:** $210,000 (State Water Bond)
- **Project Objectives:**
  - reduce accelerated bank erosion and property loss
  - establish a stable, vegetated river bank
  - demonstrate cost and feasibility of erosion control methods

The Bushy Ranch project was a cooperative effort on the part of the Central Modoc RCD and the Bushy family to address long standing problems of river bank erosion and loss of adjacent pasture land. The project offered an opportunity to demonstrate and compare several stabilization treatments. These included establishing a rock toe at the waters edge with brush layering on the bank above, (2) full vegetated rip rap from the bottom to top of the bank, and (3) placement of root wads and rock, interspaced with willow plantings. Livestock exclosure fencing was also part of the project. All construction materials (rock, willows, and tree root wads) were from local sources. Significant contributions of time and materials came from the Bushy Ranch, local heavy equipment contractors, and public agencies (USFS and BLM). Project construction took place in fall 2000 and subsequent years of monitoring and observation have shown that all treatments were satisfactory in achieving the objective of channel bank stabilization and vegetative enhancement.

**Shaw Ranch Project**

- **Location:** Pit River near Lookout, Modoc County
- **Project Sponsor:** Pit RCD
- **Time Frame:** 2006–2008
- **Funding:** $80,000 (Federal 319, State Water Bond, and NRCS)
- **Project Objectives:**
  - reduce accelerated bank erosion and property loss
  - establish a stable, vegetated river bank
  - demonstrate cost and feasibility of erosion control methods

The Shaw Ranch Restoration Project was implemented to address problems with bank erosion and loss of riparian vegetation and pasture land on the Pit River. This ranch had a history of progressive, innovative resource stewardship and was an ideal candidate for a demonstration project. The project involved placing a series of ‘J-hook’ rock vanes and willow planting along 1,300 linear feet of river back that was actively eroding. Compared to standard rock rip rap techniques, this approach is a relatively low cost, low technology approach for river bank stabilization. Source of the materials used came from nearby rock deposits and willow stands. The rock vanes are positioned so as to re-direct river flow and scour velocity away from the raw, exposed banks, thus allowing vegetation to establish. As this process evolves, roots provide stabilization and the vegetation traps more fine sediment that supports additional plant growth. Several years of post-project monitoring have shown that objectives are being achieved.
The ecological communities of the Upper Pit River watershed have changed drastically over the past 150 years. The reasons are both natural and human caused: climate, fire suppression, invasive exotic plants, agriculture, timber harvest, and domestic livestock grazing. One community that has experienced significant change is western juniper, which is the dominant species for approximately 20% of the watershed and is rapidly expanding. The concurrent histories of grazing management and fire suppression have likely facilitated the spread of juniper. The ecological effects of juniper expansion are problematic and include alteration of local fire disturbance and hydrologic regimes, displacement of sagebrush and other vegetation, and adverse impacts to wildlife habitat for species such as sage-grouse, mule deer, and a recently expanding elk population. The climax condition of the expanding juniper community can become one of complete juniper dominance where virtually all other forbs and forage disappear and springs dry up. The steady conversion of rangeland, forest and wildlife habitat to juniper woodland is deteriorating natural resources in the Upper Pit River Watershed. Juniper removal treatments are a sound practice used to achieve sustainable range management, hazardous fuel reduction, and wildlife habitat improvement.

The Butte Creek Project

- **Location:** Butte Creek Watershed, Upper Pit River, Lassen County
- **Project Sponsor:** Pit RCD
- **Time Frame:** 2007–2008
- **Funding:** $192,000 (Cooperative Sagebrush Initiative)
- **Project Objectives:**
  - Reduced juniper expansion to benefit range, wildlife habitat, and fire management

The Butte Creek area southeast of Adin is a prime example of juniper invasion and the significant benefits treatments provide to wildlife habitat, rangeland health, and overall watershed condition. The Pit RCD’s 550-acre Butte Creek Project involved a broad partnership that included the California and Lassen County Fire Safe Councils, Susanville Indian Rancheria, Lassen County, USFS, BLM, NRCS, Cal Fire, and more than 20 private landowners. Restoration treatments addressed invasive western juniper expansion into sagebrush scrub and eastside pine habitats. Juniper was removed through a low impact shearing and chipping, biomass utilization process that produced more than 2,000 tons of fuel for the use in clean renewable energy production. Vegetation monitoring transects were established prior to treatments to monitor changes in species richness, density, and percent cover. Richness (native plants/m²) increased from 7 (pretreatment) to 14 two years (post-treatment). Percent cover (% native plant cover/per square meter) increased from 16.6% pretreatment to 22% two years post-treatment.

The Pit RCD’s Cooperative Sagebrush Steppe Restoration Initiative partnership has restored over 10,000 acres of private and public land watersheds through the removal and biomass utilization of western juniper over the past 8 years.
Bear Creek Meadow lies at the base of the 84-square mile Bear Creek Watershed, immediately upstream of the confluence with spring-fed Fall River. As a result of past channel manipulation, together with season-long intensive grazing, Bear Creek’s once numerous shallow, vegetated, and meandering channels progressively degraded into what can be described as two unstable, erosive gullies. This channel incision led to the near complete loss of in stream spawning habitat, lowering of the groundwater table in the meadow, loss of the riparian and meadow plant community, and accelerated bank erosion/sediment discharge that severely affected Fall River.

Driven by the desire to improve the degraded creek and meadow, and reduce impacts on Fall River, the landowner (1000 Springs Ranch) undertook a program to restore the historical geomorphic, hydrologic, and ecological processes in Bear Creek meadow. The founder of modern fluvial geomorphology, Luna Leopold, and highly experienced stream restorationist, Dave Rosgen, were recruited to participate in a multi-year pre-project data collection effort. Following an agreed upon design and permit acquisition, project construction began in the summer of 1999 using a methodology known as pond and plug. Discrete sections of the gullied channel were plugged with soil while a new channel was constructed nearby. The fill material needed to create the plugs was derived from adjacent floodplain deposits, creating a series of large ponds in the meadow. More 100,000 native herbaceous plants (mostly sedge and rush species) and 4,500 native trees and shrubs were planted. Upon completion of the project that fall, 2.2 miles of restored stream and 42 acres of new ponds existed in Bear Creek Meadow.

In the following 6 years, ecological conditions in the meadow were monitored by the ranch manager, agency personnel, and UC, Davis scientists. These studies documented the following project response:

- significant reduction in sediment discharge to Fall River
- increased effectiveness of sediment trapping in the meadow floodplain
- increased frequency and duration of seasonal meadow flooding
- dramatic recovery of herbaceous plants in the meadow and woody vegetation along the restored channel
- improved fish rearing habitat
- increased use of the meadow by waterfowl, other birds, and amphibians
In fall 2002, more than 15,000 Chinook salmon migrated out of the Sacramento River and into the shallow waters and gravel beds of Lower Clear Creek. By contrast, between 1967 and 1991, the average fall-run salmon population in Clear Creek was fewer than 1,700 fish. This remarkable upswing in the fish population was the product of a dramatic transformation from a severely degraded waterway to a healthy and functional stream ecosystem, accomplished through completion of a project called the Lower Clear Creek Floodway Rehabilitation Project.

Clear Creek originates in the Trinity Mountains west of Redding, flows through Whiskeytown Reservoir, and then 16.5 miles to the Sacramento River. Through a series of landscape perturbations (gold mining, gravel extraction, and dam building), the channel morphology of Lower Clear Creek between Whiskeytown Dam and the Sacramento River was altered drastically. Problems included loss of gravel bars, disconnected floodplain, channel scouring and entrenchment, degraded riparian vegetation, and fish stranding in isolated dredger ponds. Beginning in 1995, state and federal agencies together with the Western Shasta RCD and the Clear Creek CRM began site assessment and the development of a restoration plan to create a new bankfull channel, functional floodplain, gravel supply, and native riparian vegetation. Work began in 1998 and was completed over a series of phases that involved reduction of salmon stranding, floodplain creation, in-stream channel improvements, and gravel supply augmentation.

- **Phase 1 (1998)** constructed a large gravel berm (27,000 cu.yds) to isolate salmon from gravel pit stranding.
- **Phase 2 (1999)** filled gravel extraction pits with dredger tailing piles along with 70 acres of riparian planting.
- **Phase 3A (2002)** reconstructed a primary channel and restored floodplain surfaces and riparian vegetation.
- **Phase 3B (2006)** restored a 0.8 mile section of the creek and revegetated 20 acres of new floodplain.

The history of gold mining had left a complex of large pits and ponds that frequently would capture adult and juvenile salmon when stream flows rapidly dropped. These were filled and the area was leveled to an elevation more likely to receive floodwater under the controlled releases from Whiskeytown Dam. More than 105 acres of floodplain were reconstructed and 78 acres of that were replanted with native riparian vegetation. The in stream channel work involved converting a barren bedrock channel back to a cobble-bedded stream with natural gravel bars, pools, and riffles. The Western Shasta RCD installed large trees and root-wads that protect the banks of the newly constructed stream channel and provide shelter for juvenile fish. Other aspects of the Lower Clear Creek Restoration and Management Plan included:

- augmentation of 151,219 tons of gravel to reverse the loss of salmon and steelhead spawning habitat from 1998–2009;
- a revised schedule of controlled flow releases from Whiskeytown Dam to benefit migrating and spawning fish;
- removal of the 15-foot-high McCormick-Seltzer Dam built in 1903 to divert irrigation water, creating a barrier to fish spawning and rearing habitat in the upper 10 miles of Clear Creek; and
- implementation of projects in the upland areas to reduce erosion, prevent catastrophic wildfire, and improve watershed conditions overall.

All aspects of the Clear Creek project are being carefully monitored by the RCD, private consultants, and state and federal agencies to evaluate project performance. More than 10 years of data collection have shown a dramatic increase in fall and spring-run salmon, a recovery of the riparian plant community, marked increase in song bird populations, and a generally properly functioning stream channel and floodplain. The land acquisitions and public greenway established by BLM’s Redding Resource Area Office have provided a several-mile-long stream corridor that is now available for public use and enjoyment.
The Sunflower CRMP was created in 1980 as a state supported, landowner driven organization designed to enhance the environment of the Sunflower Flat area of western Tehama County. This area of concern encompasses 72,000 acres of which 57,600 are privately held, while the remaining lands are federally managed. Many years of fire suppression policy has resulted in a chaparral landscape of overly dense and decadent brush species that are of poor quality for range and wildlife, and are a constant threat for large catastrophic wildfires.

The CRMP's primary mission is to enhance 40,000 acres of chaparral belt land in order to make the area more productive and safe for the social, financial, and environmental needs of the watershed community. CRMP participants include 65 individual landowners and a variety of local, state, and federal resource agencies.

The ‘Holistic Goal’ of the Sunflower CRMP is stated as follows: “To achieve something extraordinary for our area. To create a landscape that encourages people to enjoy our area and be happy and healthy. To work harmoniously with government agencies and neighboring businesses to achieve our common goal and respect each others individual goal and needs. To create a landscape that is sustainably healthy and fire safe (to protect crops, range, timber) so that all landowners may enjoy our landscape and profit from diverse enterprises that do not conflict with our quality of life.”

Over the past ten years the CRMP has accomplished a number of on-the-ground environmental improvement projects:

**Fuel Breaks and Burns**
Completed 87 miles of 300-500 ft. wide defensible fuel profile zone (DFPZ) within the chaparral belt of the CRMP area. 2,000 acres of brush on either side of the DFPZ were crushed using a ball and chain and mastication.

Several thousand acres of controlled burns were completed in cooperation with the USFS, Cal Fire's Vegetation Management Program, and BLM’s burn program.

**Sunflower Water Development**
Several springs were developed and two reservoirs (7 ac.ft. and 10 ac.ft.) were completed to provide for fire protection and wildlife habitat water sources.

**Herbivore Experiment**
The CRMP organized and managed a large experimental herd (1000 -1300 hd) of meat goats and hair sheep to maintain fuel breaks and control burn areas. Working with UC California and Chico State University, the economic return from the animals was assessed as a means to cover the cost of managing the herd.

Several types of monitoring are in place to develop base-line data and determine the impact of brush treatment on non-game and game species, water quality, and general watershed condition.

Future goals for the Sunflower CRMP are to expand the developed system of chaparral management into neighboring counties of Shasta, Glenn, and Colusa. The CRMP is working with the Northern Region of CAL-FIRE to develop an 80,000 acre “Equipment/Operation/Fire Training and Safety” area for training equipment operators and fire fighters in the safe procedures for attacking inevitable wildfires. The vision is for a sustainable chaparral management program throughout the westside of the Sacramento River Basin that will continue long into the future.
The Allied Stream Team is a long-standing, permanent committee of the Rotary Club of Redding. The official name of this forty member committee is the Environment Committee (EC) and the “Allied” comes from the numerous non-Rotarians who have played a significant role in the many stream improvement projects implemented by this group over the past ten years. These ‘other’ participants include local schools, Boy and Girl Scouts, Shasta Co. Agricultural Commissioner, state, federal, and local resource agencies, and many citizens and landowners of the Greater Redding Area.

The EC’s beginnings were linked to the annual gathering of roadside litter in the Whiskeytown National Recreational Area west of Redding. A 2001 creek inventory identified problems and project opportunities in local streams and thus began a program of storm drain labeling, stream and trail identification that continues today. One of those projects, the Canyon Hollow Fishway, generated the following comment from the Redding area Dept. of Fish and Game biologist, “All this restoration is well and good, but if you do not remove Arundo from area streams, such anadromous fish efforts will be for naught”. This statement started the quest to eliminate this plant menace from Shasta County. To date, 134 sites are under active treatment or have been treated to terminate the plant colony. The largest project is the 16-mile Stillwater Creek Arundo Elimination Project now in its fourth year of five.

Community Creek Clean Up is an annual event in conjunction with the CA Coastal Commission’s Coastal Cleanup Day. Several hundred tons of litter as well as extirpation of non-native plants such as Ailanthus, Himalayan blackberry, Mimosa, Mulberry, Privet, Acacia and others have been undertaken in this event by 400 to 700 working volunteers. The central idea is to make public lands along a well established trail system serve as a template for appreciation of the stream and riparian ecosystem. Other smaller projects have been performed to contribute to the goal of resource recovery through volunteerism and dedication to a healthy local ecology. The Stream Team is guided by the message:

“We must handle the water, the wood, the grasses, so that we will hand them on to our children and our children’s children in better and not worse shape than we got them.”

— THEODORE ROOSEVELT, 1908
Cow Creek is one of the Sacramento River Basin’s priority watersheds for natural spawning of Chinook salmon and steelhead. The stream is also heavily used for irrigation agriculture and there are a number of irrigation diversion dams that have historically been problematic for successful passage, spawning, and rearing of anadromous fish. The Bassett Diversion Fish Passage Project is located on Old Cow Creek (one of five main branches of Cow Creek) about 20 miles east of Palo Cedro. The existing diversion structure includes a concrete dam with flashboards installed during the irrigation season. This project involved two phases. Phase I was the installation of a new intake structure at the dam where water is diverted into the head of the Bassett Canal. The new intake structure included fish screening facilities to prevent fish stranding in the canal and on irrigated fields. Phase II was the construction of a side channel on the south side of the diversion dam that allows anadromous fish to pass beyond the dam to access upstream spawning habitat.

The Bassett Canal water intake structure included a state-of-the-art fish screen with automated cleaning capability. Fish that enter the canal intake structure and become blocked by the screen mechanism are directed back into Cow Creek through newly constructed side chute. Assistance on project design and construction was provided by the Dept. of Fish and Game fish screen personnel in Redding. The side channel in Cow Creek used to pass upstream migrating fish beyond the diversion dam was enhanced by construction of a berm between the main creek channel and the side channel and excavation of the side channel at a proper elevation to allow for water flow and fish passage above and below the dam.

In addition to completion of the Bassett Diversion improvements, Cow Creek Watershed Group and Western Shasta RCD have implemented similar improvements on the Woodman Diversion on North Cow Creek and have completed feasibility and design studies on the Millville Diversion on Clover Creek. Concurrent with the diversion structure improvements, the watershed group and RCD have completed a feasibility report and are seeking funding for improvements on several major canals to improve water use efficiency and enhance instream flow in Cow Creek.
Upper Battle Creek offers a unique opportunity to restore declining populations of salmon and steelhead in the Sacramento River Basin. The cold, spring-fed waters of Battle Creek historically supported some of the Basin’s largest runs of Chinook salmon and Central Valley steelhead. In the early 1900’s diversion dams were constructed in the watershed for hydroelectric power production. These dams and water diversions caused problems for fish by reducing instream flow and blocking access to habitat in large sections of both North Fork and South Fork Battle Creek. Beginning in 1995, plans were developed to restore naturally spawned anadromous fish populations in Battle Creek. In 1999, public and private partners agreed on a plan to remove five hydroelectric diversion dams, place new screens and ladders on three other dams, and increase instream flows in North and South Fork Battle Creek. The project is the largest restoration effort funded by the California Bay Delta Authority and the Dept. of Fish and Game. After a lengthy period of environmental analysis and permit acquisition, construction began in summer, 2010.

When complete, the project will implement the following changes to PG&E facilities and operations: 1) decommissioning of five dams (Wildcat, Coleman, South, Lower Ripley, and Soap Creek diversion dams); 2) laddering three diversion dams and screening their associated diversions (Eagle Canyon, North Battle Creek Feeder, and Inskip diversion dams); 3) increasing flow releases from all remaining diversion dams in Battle Creek’s anadromous fish reaches; and 4) constructing powerhouse tailrace connectors to eliminate redundant screening requirements and mixing of North and South Fork waters. The project will result in 42 miles of newly accessible anadromous fish habitat and improved water quality for the Coleman National Fish Hatchery. USBR will implement the physical modifications and PG&E will implement the operational changes. PG&E’s water rights have been dedicated to fish and wildlife resources pursuant to Water Code Section 1707 for the decommissioned dams, and where possible, will be done also for other remaining dams.

Post-project monitoring will continue for at least 10 years with the most focused monitoring during the first 5 years. Salmon/trout populations, species variation, and distribution will be monitored using a number of techniques including underwater video and fish trapping. Flow and velocity will be measured at each ladder, spillway, and diversion dam temperature will be monitored at numerous stream locations.
Antelope Creek Watershed Stewardship — Lassen National Forest

- **Location:** Antelope Creek Watershed, Tehama County
- **Project Sponsor:** US Forest Service, Lassen National Forest
- **Time Frame:** 2002 – 2005
- **Cost:** $849,000 (CALFED, other watershed partners)

**Project Objectives:**
- Improve channel and habitat conditions in upper Antelope Creek by addressing high priority sites of accelerated erosion
- Provide technology transfer and public education of watershed restoration practices

Antelope, Deer, and Mill Creeks in the Sacramento River Basin are eastside tributary watersheds that support valuable natural reproducing stocks of anadromous fish. In 1997, the Lassen National Forest (LNF) received a Phase I CALFED grant to plan extensive restoration work and implement and monitor several demonstration projects within the Deer, Mill, and Antelope Creek watersheds. A Watershed Analysis for this area found the condition of two key watershed elements (surface erosion and near stream disturbance) differed significantly from ‘desired condition’. Erosion in the upper watershed was estimated to be 60% higher than historic condition. The analysis further determined that roads were a primary source of the near stream disturbance, and also the primary source of accelerated surface erosion. It was estimated that most (70%) of the accelerated erosion was produced by 5% of the road segments.

In the 1997 Phase I project, Lassen National Forest identified, analyzed, and prioritized over 80 restoration sites within the Antelope Creek watershed. That project also included the implementation and monitoring of several demonstration restoration sites. Concurrent with the Antelope Creek restoration work, problem road sites were being identified and restored in the Deer Creek and Mill Creek watersheds, both on Forest Service and on private lands in partnership with Collins Pine Company and Sierra Pacific Industries.

In 2002, Lassen National Forest started Phase II of the Antelope Creek Watershed Stewardship Project. This project involved two principal tasks:

- **Task 1** – A total of 143 individual treatments were implemented at 43 restoration sites. The treatments involved erosion/sediment control projects designed to reduce sediment source production and produce more natural patterns of runoff. These natural processes of runoff, sediment transport, and woody debris recruitment contribute to conditions favorable to salmon, steelhead, and their habitat. The treatments also involved restoring wetlands and riparian areas through decommissioning of roads and restoring natural stream morphology, and improved fish passage by upgrading culverts or replacing them with fords. Significant in-kind match was provided by the Tehama County Roads Dept.
- **Task 2** – This task involved technology transfer and education outreach to watershed partners and stakeholders by packaging the restoration program monitoring results that included data collection, problem site identification methods, development of restoration techniques, cost/benefit analysis, and before and after photographs.

Project work was completed in 2005 along with filming for presentations on erosion control treatments, a discussion of the importance of Antelope Creek (and Deer and Mill Creeks) to Sacramento River anadromous fisheries, and an overview of the findings of the watershed analysis.
ecologic, economic, and fire reduction objectives. Treatment activities include shaded fuel breaks called Defensible Fuel Profile Zones (DFPZs), forest thinning by group and individual tree selection, and riparian management. The desired condition is an all-aged, multi-storied, fire resilient forest that provides a continuous supply of forest products and promotes community stability. DFPZs have been widely implemented throughout the pilot project area. When wildfires coincided with completed treatments, the DFPZs have consistently slowed the rate of fire spread, reduced fire intensity, reduced impacts to soils and vegetation, and improved suppression capabilities. Following are three example treatments:

Example 1 – The Pitville DFPZ, located on the Hat Creek Ranger District south of Fall River Mills, included 5,500 acres that were commercially thinned, and 5,500 acres of controlled burn. The Peterson fire impacted a portion of the DFPZ. Hat Creek district fire officers estimated that without the DFPZ, the fire would have been at least 1000 acres larger and would have been a dangerous crown fire as opposed to a slow moving ground fire. Vegetation treatment costs were about $500/acre. Fire suppression costs in CA generally are about $1000 to $2000/acre.

Example 2 – The Kingsbury Rush DFPZ, located northwest of Quincy, was implemented on the Mt Hough Ranger District of the Plumas National Forest. The area was treated with mechanical thinning and controlled burning in 2003-2005. In July 1998, the Rich wildfire started at the bottom of Feather River Canyon. The DFPZ shaded fuel break slowed the fire so much that fire fighters were able to concentrate suppression efforts on higher priority areas closer to communities. A fire that was expected to burn long into the summer, costing additional money, tying up fire fighting resources and damaging natural resources quickly ran out of steam when it hit the DFPZ. Fire fighters were able to suppress the fire before it could burn communities and watersheds.

Example 3 – The Calpine DFPZ is located on the Sierraville Ranger District (Tahoe NF) near the community of Calpine. It had been precommercially thinned, slash piled and burned several years before the Angora Wildfire burned through the area in June 2007. It was initially contained at 2 acres within the DFPZ by a small crew. However, a spot fire approximately 1/8 mile away started and burned out of the DFPZ. When the fire left the untreated area, it aligned with the slope and wind and began torching and crown runs. The fire burned uphill into a second DFPZ with significant intensity. The second DFPZ caused the fire to drop to the ground and once again became a slow moving, ground surface fire.
The Red Clover/McReynolds Restoration Project encompasses a 775-acre area of privately owned and Plumas National Forest land. This portion of Red Clover Cr drains an area of 84 sq. mi. and is tributary to Indian Cr and then to the East Branch North Fork Feather River. The combination of road and historic railroad features, past grazing, and a 1950's beaver eradication effort resulted in severe incision (downcutting) of the stream channel through Red Clover Valley. The extensive gully lowered groundwater levels in the meadow and changed plant communities from riparian grass and willow species to sage. This in turn resulted in loss of meadow productivity, diminished summer base flows, and increased sediment transport from channel bank erosion. A 1989 Natural Resource Conservation Service report found that the Red Clover Creek watershed was the third highest sediment-producing tributary to the East Branch North Fork Feather River. In 1985, the Feather River CRM completed its first erosion control demonstration project in this area, using a series of check dams to raise water levels in the stream and create a functioning floodplain area.

Initiated in 2004, the Red Clover/McReynolds Creek Restoration Project was a cooperative effort by the Feather River CRM, the private landowner, George Goodwin, and the Plumas National Forest. Field surveys were completed by CRM staff to establish flood frequency information and prepare a Hydrology and Geomorphology report. A Technical Advisory Committee reviewed the project plan and design. Construction began in July 2006 using the "pond and plug" technique to return stream flows to remnant channels and original meadow/channel elevations. The existing gully was filled and compacted using material from excavation of adjacent ponds. 3.3 linear miles of entrenched, eroding stream channel were treated. Additional fencing for livestock and a grazing management plan were also made part of the project.

The pond and plug technique addresses floodplain function as the fundamental precursor to all other project objectives (i.e. reduced bank erosion, improved water quality, improved fish and wildlife habitat, reduced flood flows, and increased base flows). After 22 years, and completion of 60 restoration projects, it has been the experience of the CRM program and staff that once full floodplain function has been restored, other project objectives are more effectively achieved, because in a riparian ecosystem, they are inextricably linked.

Post project monitoring has been performed each year subsequent to project completion. Monitoring parameters include flow above and below the project, sediment and turbidity, vegetation changes in the meadow, and surveys of fish and wildlife within the project area. A complete report on project monitoring can be found on the CRM website, but in summary, data and observation shows that there has been a remarkable change in Red Clover Valley and project objectives are being achieved.
FEATHER RIVER REGION

School Based Watershed Education — Upper Feather River

Location: Upper Feather River Watershed, Plumas County

Project Sponsor: Feather River CRM, Plumas Unified School District, Feather River College, Plumas National Forest

Time Frame: Ongoing

Project Objectives:

- Promote watershed education and awareness for students from elementary grades through college level

The Feather River Coordinated Resource Management Program (FRCRM), together with several partner agencies and organizations, have established and are implementing a variety of school based educational activities with the overall goal of expanding watershed education and awareness throughout the Upper Feather River watershed. These activities include the following:

Six Grade Watershed Course

Beginning in 2004, the FRCRM and Plumas Unified School District began a watershed program organized around the idea that we have a back yard and a front yard. The back yard is where the students reside in the headwaters of the Feather River watershed. The sixth graders study their million-acre backyard to learn where they live and how water interacts with the natural and cultural history of their home through a 4-day outdoor education camp and monthly field trips. The students then turn their attention to the front yard, the land that lies before them as they go downriver. Through a 5-day ‘Plumas to the Pacific’ event they follow the river as it meanders to its ultimate destination point at the Pacific Ocean. Students see the numerous ways the river is used, the ways it is changed, and the way it affects the land and the people it passes. Every sixth grade student in the district participates in this program. Students, parents, teachers and administration have all expressed a unanimous desire to integrate this program into the permanent curriculum but future funding is uncertain. The Plumas To The Pacific sixth grade program responds to a growing disconnect of youth from the natural world. Even in rural areas young people have increasingly less familiarity and understanding of the natural environment and this program provides a strong stewardship relationship between water and future generations of California.

Stewardship and Classroom Education

The FRCRM coordinates with local high school classes and Feather River Community College to involve students in a number of the CRM and Plumas National Forest restoration projects. This includes site visits and collecting native plant and seed materials for project revegetation. FRCRM has provided numerous presentations/demonstrations in local elementary classrooms that include water quality and how to keep drinking water safe, properties of water, identification of aquatic insects as indicators of water quality, the water cycle, and protecting riparian areas.

Trout in the Classroom

FRCRM, Trout Unlimited, and Dept. of Fish and Game have established the Trout in the Classroom program in schools throughout Plumas County, providing participating classrooms with supplies, curriculum, teacher training and support.

Youth Environmental Stewardship Summit

In the spring of 2009, the first Youth Environmental Stewardship Summit (YESS) was held in partnership with Feather River College. This was a youth watershed stewardship conference targeting 7th-12th grade students and some 55 teachers in a day-long event that included a poster-session, key-note speakers, presentations and outings. It is hoped that this will be a catalyst for further regional collaboration and become an annual event.

W.A.T.E.R.S.

Watershed Awareness Through Education, Recreation, and Stewardship (WATERS) started in 2001 as an Education Committee to further community and school-based watershed education programs. This committee evolved into a larger, more encompassing group of educational partners and meets quarterly to share, discuss, and coordinate watershed education efforts throughout the Upper Feather region.
AMERICAN REGION

Bear River Setback Levee Project

The Three Rivers Levee Improvement Authority (TRLIA) is working to improve levees on the Yuba, Feather, and Bear Rivers in the Sacramento Valley. The existing levees provide flood protection for approximately 16,000 acres of farms and urban land, including 25,000 current residents and 12,000 future households in the planned residential development of Plumas Lake.

In 2005, TRLIA broke ground on the construction of the Bear River Setback levee, which was designed to replace an existing levee that was weakened by major structural deficiencies. The setback levee portion of the improvements is approximately 9,600 feet long and replaced portions of the existing Bear River and Feather River levees, at the confluence of the two rivers. The old levees were removed and used for construction of the new Setback Levee.

Benefits of the setback levee range from public safety to environmental. The new levee has been designed to provide a 200-year level of flood protection; Yuba County will be the first urban area in the Central Valley to offer 200-year flood protection. In addition, a partnership with River Partners resulted in the planting of one million shrubs and trees in the setback area, which is critical to preventing erosion within the expanded floodway. Approximately 600 acres of wildlife habitat has been created, benefiting several threatened and endangered species including: Swainson’s hawk, yellow-billed cuckoo, valley elderberry longhorn beetle and Chinook salmon.

- **Location:** Yuba and Sutter Counties
- **Project Sponsor:** Three Levees Improvement Authority
- **Timeframe:** 2005-2006
- **Funding:** $25,327,229 from California Proposition 13 Grants
  $36,521,228 from Development impact fees and advances
- **Project Objectives:**
  - Replace weakened levee with setback levee
  - Establish a stable, vegetated river bank
  - Increase wildlife habitat
AMERICAN REGION

SYRCL's Water Quality Monitoring Program

South Yuba River Citizens League (SYRCL) is the leading voice for the protection and restoration of the Yuba River and the Greater Yuba Watershed. Founded in 1983 through a rural, grassroots campaign to defend the South Yuba River from proposed hydropower dams, SYRCL has developed into a vibrant community organization with over 3,500 members and volunteers based in Nevada City, CA.

SYRCL's River Monitoring Program began in October 2000, and has become an award-winning model of a citizen-based effort to monitor and assess water quality conditions in the Yuba River watershed. In November 2001, The Yuba River Monitoring Program was honored with the Sierra Nevada Group of the Sierra Club's prestigious Citizen Activist Award. The award commends the program's outstanding work for the local environment and the community.

The core of the River Monitoring program involves monthly water quality testing at sites throughout the watershed. Water temperature, dissolved oxygen, pH, conductivity and turbidity are routinely monitored. Additionally, tests are performed for bacteria, nutrients and toxic metals according to a monitoring plan designed to identify particular problems and evaluate possible remedial actions. The program is based on the scientifically-credible Quality Assurance Program Plan approved by the Regional Water Quality Control Board.

Over recent years, SYRCL has expanded the number of water quality monitoring sites – including tributary locations – to provide a more thorough coverage of the watershed. In addition, they have launched several special monitoring projects that will allow them to more powerfully assess the condition of the watershed and evaluate potential actions aimed at protection or restoration.

River Monitors are the key to SYRCL's successful program. River Monitors are community members who have become trained in water quality sampling and participate in monthly sampling occasions. These volunteers range from high school students to senior citizens, dedicating a year of their time and energy to the river. With more than 80 active River Monitors, SYRCL is able to monitor conditions at up to 44 stations. River Monitors commonly report that their contributions to the program are a rewarding form of volunteerism. Many River Monitors have been with the program since its inception.

» Location: Yuba and Nevada Counties
» Project Sponsor: South Yuba River Citizens League
» Timeframe: 2000 - continuous
» Project Objectives:
  • Monitor water quality conditions
  • Evaluation of potential actions aimed at protection or restoration
  • Share results with community
Early in its history, Iron Mountain Mine (IMM) was famous for being the most productive copper mine in California and one of the largest in the world. In recent years, the legacy of mining at IMM turned its fame to infamy, as the site became known as the largest source of surface water pollution in the US and the source of the world’s most corrosive water.

IMM is located in Shasta County approximately 9 mi. northwest of the City of Redding. The IMM Superfund site encompasses 4,400 acres and includes several individual underground mines, a former flotation mill, a mining ore railroad loading station, Spring Creek Reservoir, and the Spring Cr arm of Keswick Reservoir. While the Shasta County copper mining era peaked in the early 1900’s, IMM continued operations up until 1963. Nearly 100 years of mining activity left numerous waste rock and tailings piles and an extensive network of underground tunnels. The fractured bedrock above the underground workings provided an effective means for air and water to reach the enormous sulfide deposits within the mountain. Researchers call Iron Mountain a ‘worst case scenario’ with regard to formation of acid mine drainage. The acidic drainage from IMM flowed into adjacent streams and then into Keswick Reservoir, a run-of-river reservoir on the Sacramento River below Shasta Dam. As early as 1900, the CA Fish Commission investigated fish kills in the Sacramento River attributed to pollution from IMM. State records document more than 20 fish-kill events in the river since 1963. Those harmed included all four runs of Chinook salmon, steelhead, and resident trout.

Remediation efforts began with the 1963 completion of Spring Creek Reservoir, intended to prevent mine sediment from entering Keswick Reservoir and regulate the quantity of mine drainage entering the Sacramento River. This was only marginally effective and periodic events of toxicity in the river continued. In 1975, the CA RWQCB initiated enforcement action against the current mine owners and in 1983, IMM became an EPA Superfund Site. Many years of site assessment, further litigation, and alternative project plans followed. In 1994, a lime neutralization treatment plant was constructed to collect and treat all drainage from the mine’s underground workings (Richmond and Lawson Tunnel portals) effectively eliminating the largest source of acid and metal discharge. Numerous other projects were completed, e.g. diversion of clean water around the mine workings, sealing of waste rock and tailings piles, and construction of a large reservoir on Slickrock Creek to collect diffuse mine seepage and deliver it to the treatment plant.

A final remediation component was completed in 2010 that involved dredging and removal of contaminated sediment that had accumulated over the years in the Spring Creek arm of Keswick Reservoir. More than 20 years of work by EPA, other Federal and State agencies, and responsible private parties – much of it undertaken by Superfund – is finally paying off in a big way. Remediation and pollution control activities now neutralize almost all the acid mine drainage and control 95% of the copper, zinc, and cadmium that used to flow out of Iron Mountain into nearly streams and then into the Sacramento River. EPA and the State secured funding from one of the site's previous owners in one of the largest settlements with a single party in Superfund history. The settlement terms should enable continuous operation and maintenance of the treatment facilities for the foreseeable future.
Completed in 1964, the Red Bluff Diversion Dam (RBDD) is located on the Sacramento River at Red Bluff and features a series of 11 gates that, when lowered, provide for gravity diversion of irrigation water from the Sacramento River into the Tehama-Colusa and Corning Canals. The RBDD has been a serious impediment to upstream and downstream fish migration and a significant portion of the Sacramento River spawning habitat for endangered salmon and steelhead occurs upstream of the dam. Adult fish moving upstream have difficulty finding and using the ladders for passage over the dam, and juveniles migrating downstream through the dam become disoriented by the turbulence resulting in significant mortality from predator fish. The main species of concern are winter- and spring-run Chinook salmon, Central Valley steelhead, and green sturgeon.

The National Marine Fisheries Service’s 2009 ‘Biological Opinion’ for operation of the Central Valley Project mandated a ‘Reasonable and Prudent Alternative’ for RBDD that required the gates to be raised year-round by 2012. The Fish Passage Improvement Project is the culmination of over 40 years of efforts by various entities to find a balanced solution that improves fish passage and the reliability of irrigation water deliveries. Highlights include:

- A pumping plant and flat-plate fish screen near the existing canal head-works that will deliver up to 2500 cfs into the Tehama-Colusa and Corning Canals.
- Construction that began in spring, 2010 following a groundbreaking event attended by Secretary of the Interior Ken Salazar and Governor Schwarzenegger.
- An adaptive management program to evaluate project performance will include a Policy Review Board with representation from agencies and interest groups, (i.e. USBR, TCCA, City of Red Bluff, Sacramento River sport fishing groups, Commercial fishing representatives)
- USBR will seek measures to reduce the potential impacts of the project on local recreation and economic interests, such as providing a short gates-in period to accommodate the Memorial Day boat races held annually on Lake Red Bluff. As stated by TCCA Manager Jeff Sutton at the groundbreaking in March, 2010, “This is the first step. What we really look forward to is being back here in two years for a ribbon cutting”.

SACRAMENTO VALLEY REGION
Red Bluff Diversion Dam Fish Passage Improvement

- **Location:** Sacramento River at Red Bluff
- **Project Sponsor:** US Bureau of Reclamation, Tehama-Colusa Canal Authority
- **Time Frame:** 2010-2012
- **Cost:** $220 Million (ARRA, USBR, TCCA)
- **Project Objectives:**
  - Improve reliability to safely pass anadromous fish and other species of concern.
  - Improve reliability and reduce cost of water diversion to TCCA district users.
Hamilton City is located on the Sacramento River approximately 80 miles north of Sacramento in Glenn County. The population of 2000 and the surrounding agricultural lands are only marginally protected from flooding by an old (1904) substandard private levee called the “J” Levee. This levee only offers protection against a 10-year flood and as a result Hamilton City has been evacuated due to flooding concerns six times since 1980. Citizens of Hamilton City attempted to formulate a solution over the past 30 years but could not produce a project with a positive cost-benefit ratio. In 2001, the Corps created new planning policies that credited both flood damage reduction and ecosystem restoration. This policy, together with a new collaboration of flood control advocates, state and federal resource agencies, and environmental organizations resulted in the first project alternative in over 20 years that met requirements for federal participation.

Key features of this multipurpose project include removal of the degraded “J” Levee and replacement with 6.8 miles of set-back levee, and restoration of approximately 1400 acres of Sacramento River floodplain. Flood protection for Hamilton City and surrounding agricultural lands will be increased from less than a 10-year level to a 75-year level. The project enjoys broad based and bipartisan support through a balanced approach that meets the needs of a diverse partnership.

The project was authorized in the Water Resources Development Act of 2007. Pending full federal funding for FY 2011, construction will begin in the spring of that year, generating about 245 jobs. The local community continues to actively participate in moving the project forward. Citizens have held annual Levee Festivals, started in 1998, to sell homemade food and have raised over $100,000 through direct donations and proceeds from the festivals. The community also formed a new Reclamation district and assessed themselves for annual operation and maintenance funds. This is a true multipurpose project that will result in major improvement to the riparian and aquatic ecosystem of the Sacramento River. The new levee will be setback from the river to reconnect and restore riparian lands. Approximately 1400 acres will be restored to native habitat using techniques pioneered by Nature Conservancy, connecting habitat that is part of the Sacramento River National Wildlife Refuge and a DFG State Wildlife Area. The resulting total area of 4000 acres of riparian habitat will directly benefit the 50 listed species that inhabit the area, including four runs of Chinook salmon, steelhead trout, raptors, and neotropical migrant birds.