KESWICK DAM–RED BLUFF REACH

The Keswick-Red Bluff Reach of the Sacramento River, the upper-most reach of the Conservation Area, is unique in many ways.

The reach extends from Keswick Dam (about 10 miles below Shasta Dam) downstream through the cities of Redding and Anderson, past Bloody Island, through Iron Canyon and the City of Red Bluff to the Red Bluff Diversion Dam (Figure 3-1 and Table 3-1). The broad alluvial portion of the reach between Redding and Balls Ferry has the potential to support significant tracts of riparian forest. Along much of the reach, however, riparian forests are confined to narrow corridors at the base of canyon walls. It is the most urbanized and industrialized of the four reaches, while also supporting agriculture. It has three water control structures (Keswick, Anderson-Cottonwood Irrigation District, and Red Bluff Diversion Dams). Historically the river between Redding and Anderson supported several gravel mining operations.

In its 1989 Plan, the SB1086 Advisory Council recommended the establishment of a Conservation Area along the Sacramento River. The Conservation Area includes an inner river zone that would define the locations where interested landowners may participate in voluntary riparian habitat conservation and restoration programs administered or coordinated by the Sacramento River Conservation Area Forum. In 2001, the Sacramento River Conservation Area Board adopted guidelines for the inner river zones. The purpose of the inner river zone guideline is to focus the preservation and reestablishment of a continuous riparian ecosystem on the erosion and flood-prone areas along the Sacramento River in a manner that:

- Uses an ecosystem approach that provides for recovery of threatened and endangered species and is sustainable by natural processes;
- Gives full consideration to local, state, and federal flood control and bank protection programs;
- Works only with voluntary participants;
- Gives full consideration to landowner, public, and local government concerns;
- Uses the most effective and least environmentally damaging bank protection techniques to maintain a limited meander where appropriate; and
- Provides for the accurate and accessible information and education that is essential to sound resource management.

The Keswick-Red Bluff portion of the Conservation Area includes all areas within the 100-year floodplain, existing areas of riparian bottomlands, and all areas of contiguous valley oak woodland. It encompasses approximately 22,000 acres, ranging in width from more than one mile wide in the broad alluvial area near Bloody Island to only 500 feet in the confined canyon near Table Mountain and within Iron Canyon.

Shasta Dam, hydrologic operations, urbanization, and gravel mining operations have disrupted the physical processes that shape riparian forest development in this reach.

However, there are still tracts of riparian habitat, and some flooding and channel movement still occur.

Table 3-1. Features of the Keswick—Red Bluff Reach

River Mile	Feature	River Mile	Feature
302	Keswick Dam	271L	Mouth of Battle Creek
301R	Middle Creek	268R	Mouth of Frazier Creek
300R	Mouth of Salt Creek	267	Jellys Ferry Bridge
299	Lake Redding	265L	Mouth of Inks Creek
299	Southern Pacific Rail Road	258	Bend Bridge
298	Redding Diversion Dam	258	Bend Ferry
297	Highway 299	255L	Bend
295	Cypress Avenue Bridge	253L	Mouth of Paynes Creek
290R	Mouth of Clear Creek	252R	Bald Hill
290R	Olney Creek	251L	Mouth of Sevenmile Creek
285L	Mouth of Churn Creek	248R	Mouth of Blue Tent Creek
285	Interstate 5	247R	Mouth of Dibble Creek
284R/L	Anderson	246R	Mouth of Brewery Creek
284	Airport Road	246	Interstate 5
281	Deschutes Bridge	245R	Mouth of Reeds Creek
281L	Mouth of Stillwater Creek	245R	Brickyard Creek
278L	Mouth of Bear Creek	245R/L	Red Bluff
278L	Dry Creek	244L	Mouth of East Sand Slough
277L	Mouth of Ash Creek	244	Interstate 5
276	Balls Ferry Bridge	244L	Samson Slough
274R	Mouth of Anderson Creek	244L	Paynes Creek Slough
273L	Bloody Island	243	Red Bluff Diversion Dam
273R	Mouth of Cottonwood Creek	243R	Mouth of Red Bank Creek

PHYSICAL SETTING

Geology and Soils

The geologic characteristics of this reach vary greatly. From Keswick Dam to Redding the river flows through volcanic and sedimentary formations. The canyon is relatively narrow here with little floodplain and a correspondingly narrow riparian corridor. From Redding to the Cow Creek confluence there are limited areas where the river has meandered over a broader floodplain of alluvium derived from the Klamath Mountains and the Coast Ranges. From the Cow Creek confluence to near Red Bluff the river is almost entirely controlled by the Tuscan Formation (DWR, 1981). Here the channel is often narrow and deep, between high canyon walls. Table Mountain, a 2-mile long volcanic plateau adjacent to the river and steep-sloped Iron Canyon (RM 250-253) are both examples of Tuscan Formation outcrops. At Red Bluff the river flows out onto the broad alluvial floodplain of the Sacramento Valley.

The potential for riparian habitat restoration is closely related to soils and geology. Portions of the Keswick–Red Bluff Reach have deep loamy soils suitable for both agricultural use and the growth of riparian forests. Much of the proposed Conservation Area, however, contains cobbly alluvial lands and gravel pits (USDA, 1974).

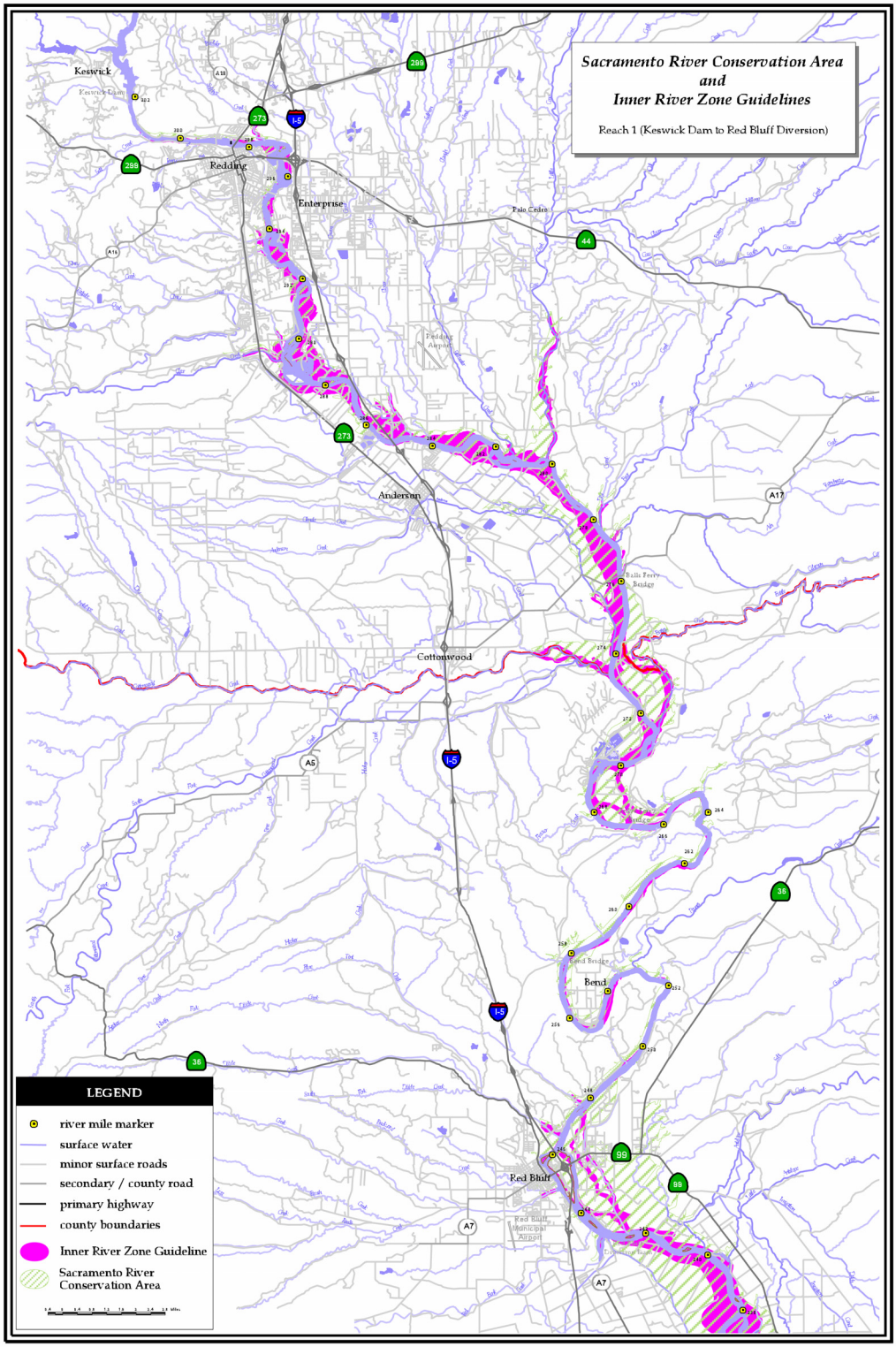

Figure 3-1. Sacramento River Conservation Area, Keswick Dam to Red Bluff

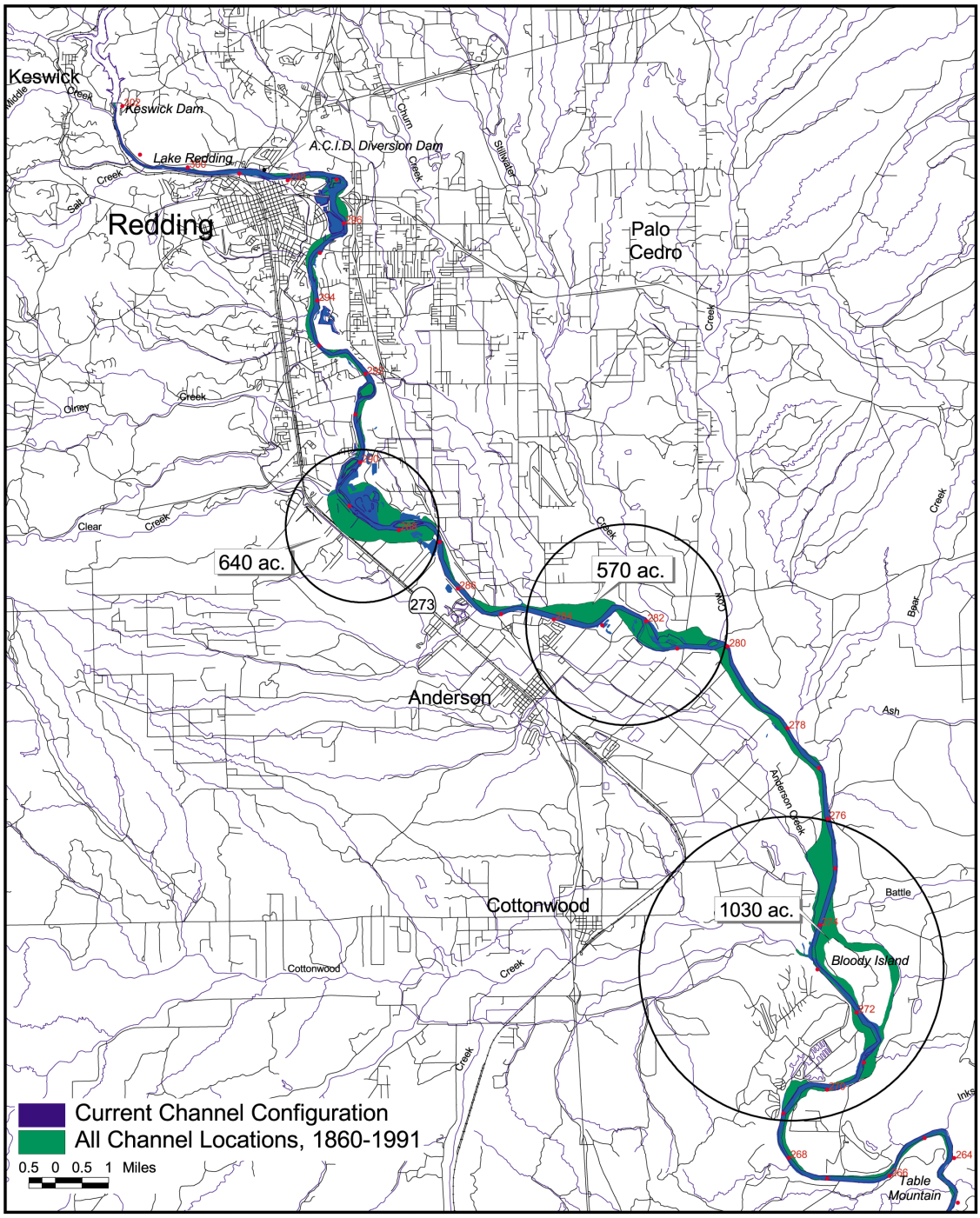

Figure 3-2. Portions of the Keswick–Red Bluff Reach showing the most channel movement since 1860. Acreage denotes approximate land surface area of these meandering subreaches.

Historical Channel Movement

Channel movement in this reach has been mapped as far back as 1860 (DWR, 1980). Most movement has taken place in three subreaches (Figure 3-2), with a combined land surface area of approximately 2,240 acres. Channel movement is inhibited primarily because of geologic factors. Bank protection minimizes erosion in some of the urban areas (DWR, 1981).

Sediment Transport

The bed material and floodplain deposits of this portion of the Sacramento River consist generally of well-rounded material composed of various metamorphic, sedimentary, and igneous rocks. The size of this material ranges from clay fines to boulders (DWR, 1981). Since the closure of Shasta Dam in December 1943, the transport of sediment from reaches upstream of the dam has ceased. As it flows from Keswick Dam, the water of the Sacramento River is "hungry," with a large capacity to transport sediment. This has resulted in an armored channel surface below the dam as the river has transported sediments out of the area (DWR, 1981).

Two other factors influence the sediment supply in this reach:

1. The urbanization of the Redding-Anderson area and increasing value of riverfront property has resulted in reduced bank erosion due to the installation of bank protection and levees.
2. Large quantities of sand and gravel are being mined at locations in and adjacent to the Sacramento River and its tributaries (DWR, 1981). Because tributaries contribute a significant amount of sediment to the river, the effects of the lower sediment supply to the river are less obvious with distance downstream.

Hydrology and Tributaries

The Keswick-Red Bluff Reach is highly influenced by the altered hydrology resulting from the operation of the Central Valley Project (CVP). The operation of the CVP in this reach includes Shasta and Keswick Dams on the main stem of the Sacramento River, as well as the diversion of Trinity River and Clear Creek water to Keswick Reservoir via the Spring Creek tunnel.

Central Valley Project operation reduces flood peaks during the winter and spring and increases discharge between floods during the summer and autumn. For example, without the CVP, a 100-year flood (a flood with a probability of occurring one time in 100 years) is calculated to be about 336,000 cubic feet per second (cfs) at Bend Bridge. Under the controlled operation of the project, however, this is reduced to 202,000 cfs. A smaller 2-year flood (a flood with a probability of occurring 50 times in 100 years) is reduced from 110,000 cfs to 70,800 cfs (TNC, 1996). During July, August, and September, the mean monthly flows of the Sacramento River at Keswick since 1963 are nearly 400 percent higher than the mean monthly flows prior to 1943 (DWR, 1981). The effect of these changes to hydrology is most obvious directly below the dams. Because of the influence of tributaries with distance downstream, the hydrologic changes due to the Central Valley Project are less pronounced in the lower reaches. The principal west side tributaries to the Sacramento River in the Keswick-Red Bluff Reach

include Clear, Cottonwood, and Dibble Creeks. These creeks flow from the valley floor and parts of the Klamath Mountains to the Sacramento River. Main east side tributaries include Churn, Stillwater, Cow, Bear, Ash, Battle, and Paynes Creeks. Battle and Paynes Creeks originate in the Cascade mountains east of Redding and flow through confined canyons before joining the Sacramento River. Riparian corridors along the tributaries provide important connections for wildlife between the Sacramento Valley and the surrounding foothills and mountains.

Land Use

The Keswick-Red Bluff Reach has a variety of land uses—urban, residential, industrial, and agricultural. About 35 percent of the area is in agriculture, and about 12 percent is urban, residential, or industrial (Table 3-2). The most predominant agricultural crop within the Conservation Area is walnuts (1,920 acres), with mixed pasture (989 acres) and prunes (708 acres) also important. Land use acreage was determined using DWR land use surveys (DWR, 1994; DWR 1990), and overlaying this information with the Conservation Area boundary.

Industrial land uses within the Conservation Area in this reach include lumber mills and gravel removal operations. Because the Conservation Area includes the cities of Redding, Anderson, and Red Bluff, residential and commercial land uses are common as well. This reach has the most recreational facilities on the river.

Table 3-2. Land use, Keswick-Red Bluff Reach

Land Use Category	Inner River Zone Guideline		Conservation Area	
	Acres	% of Land Surface Area	Acres	% of Land Surface Area
Agriculture	1,334	17%	6,459	35%
Riparian Vegetation	1,490	19%	2,191*	12%*
Upland Vegetation	3,274	41%	6,210*	34%
Urban	852	11%	2,188	12%
Water Surface (excluding main channel)	372	5%	644	3%
Miscellaneous (includes barren)	643	8%	767	4%
Total Land Surface Area	**7,965**	**101%**	**18,459**	**100%**
Channel Surface Area	3,005		3,005	
Total	**10,970**		**21,464**	

*The purpose of DWR land use surveys is to map agricultural crops. **Refer to Appendix D Part 2 for the most accurate riparian vegetation data.** Land use data based on DWR agricultural land use surveys of Shasta, Tehama, Butte, Glenn, Colusa, Sutter, and Yolo Counties (see References). Percentages may not be equal to 100 due to rounding.

RIPARIAN VEGETATION

Current Acreage

The most current survey of the riparian resources within this reach is based on aerial interpretation of 1999 photos. The survey was performed by the Geographic

Information Center at California State University, Chico. There are 4,674 acres of riparian habitat within the Conservation Area.

Table 3-3 presents a summary of the riparian and closely related habitats within the Conservation Area. Because portions of the channel within this reach are geologically confined, the width of riparian vegetation is often very narrow (Figures 3-3 and 3-4). Areas with potential for the development of large tracts of riparian vegetation are often converted to agriculture or are under other types of development. Approximately 128 acres of valley oak woodland are contiguous with the outer boundaries of the 100-year flood line.

Unlike the downstream reaches, a large amount of native upland vegetation (such as chaparral and various woodland types) occurs within the Keswick-Red Bluff Reach. A total of 6,210 acres of these vegetation types occur within the Conservation Area, often functioning as "buffer" areas between the river habitats and developed areas. Native vegetation (both riparian and non-riparian) currently represents almost 40 percent of the total land surface of the Conservation Area.

Table 3-3. Riparian and closely related habitats within the Conservation Area, Keswick –Red Bluff Reach

Vegetation Type	**Inner River Zone Guideline**		**Conservation Area**	
	Acres	**% of Land Surface Area**	**Acres**	**% of Land Surface Area**
Riparian Forests	2,022	25%	2,801	15%
Riparian Scrub	1,101	14%	1,439	8%
Valley Oak Woodland	218	3%	315	2%
Marsh	49	<1%	58	<1%
Blackberry Scrub	37	<1%	61	<1%
Total Riparian Vegetation	**3,427**	**43%**	**4,674**	**26%**

Figure 3-3. Narrow corridor of riparian vegetation bordered by native upland vegetation

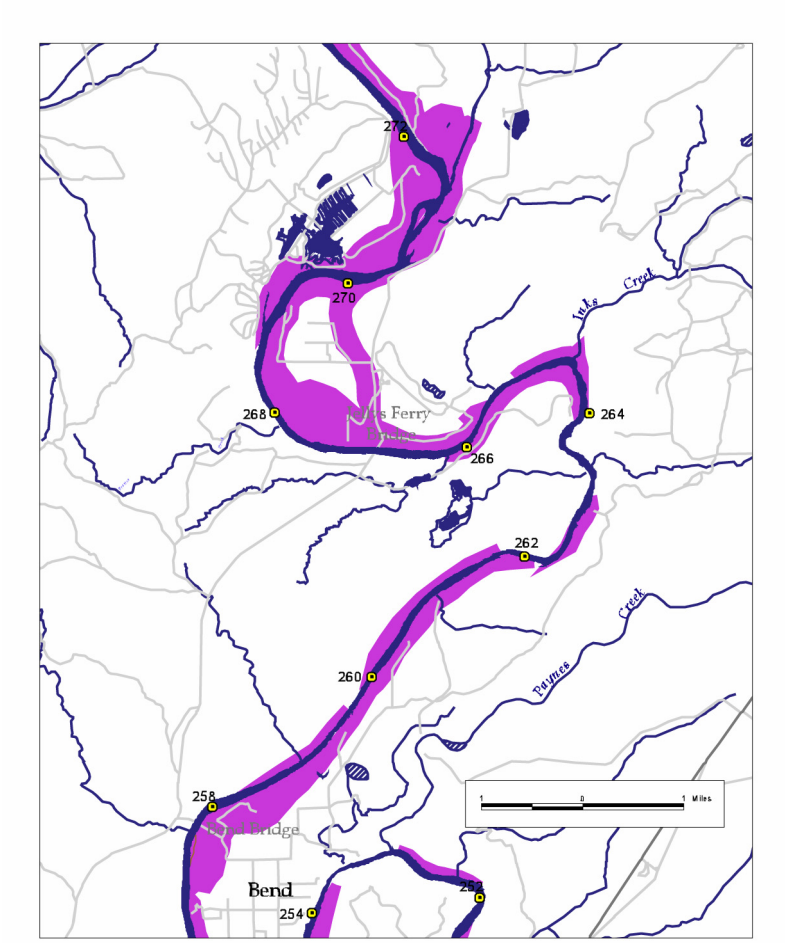

Figure 3-4. Sacramento River near Bend (RM 257-273) showing area inundated by a 2.5-year recurrence interval flood.

Ownership

More than 82 percent of the Conservation Area within the Keswick-Red Bluff Reach is privately owned (Table 3-4). The Keswick-Red Bluff Reach contains parts of the Sacramento River Area that the Bureau of Land Management (BLM) owns and manages. About 500 of the 12,000 acres that BLM owns lie within the Conservation Area, including approximately 14 miles of river frontage.

Other significant publicly owned parcels that include riparian habitat are holdings by the City of Redding along both banks of the river, and the associated 200 acre Redding Arboretum and Kutras River Access, a former gravel mining site (RM 287R). California Department of Fish and Game (DFG) owns 264 acres largely in riparian habitat at Anderson River Park, which the City of Anderson manages (RM 282R). DFG's Cottonwood Creek Wildlife Area near the mouth of Cottonwood Creek (571 acres, RM 273 R) also falls within this reach. The state also owns several fishing and small public access sites. South of Red Bluff, between RM 242L and 243L, the U.S. Forest Service (USFS) owns a 299-acre parcel at the Red Bluff Recreation Area. A

portion of this parcel is being actively restored to riparian habitat in cooperation with the Sacramento River Discovery Center (Chapter 7).

Table 3-4. Land ownership within the Conservation Area, Keswick-Red Bluff Reach

Ownership Category	Inner River Zone Guideline		Conservation Area	
	Acres	% of Land Surface Area	Acres	% of Land Surface Area
Private	5,799	73%	15,067	82%
Public				
Federal	786	10%	1,556	8%
State	551	7%	945	5%
Local District, City, County	848	11%	906	5%
Total (Land Surface Area)	**7,984**	**101%**	**18,474**	**100%**
Channel Surface Area	3,005		3,005	
Total:		**10,989**	**21,479**	

DWR Sacramento River GIS (May 2000); DPR (1994). Rounded to nearest 100 acres.

Restoration Strategy

Restoration activities carried out through the SB1086 program shall be conducted in a manner that:

- Uses an ecosystem approach that contributes to recovery of threatened and endangered species and is sustainable by natural processes;
- Uses the most effective and least environmentally damaging bank protection techniques to maintain a limited meander where appropriate;
- Operates within the parameters of local, state, and federal flood control and bank protection programs;
- Participation by private landowners and affected local entities is voluntary, never mandatory;
- Gives full consideration to landowner, public, and local government concerns; and
- Provides for the accurate and accessible information and education that is essential to sound resource management.

Inner River Zone Guideline

The inner river zone guideline for Reach 1 consists of the combined width of the 100-year meanderbelt and recent river alluvium, including both channel and over-bank deposits, within the Sacramento River Conservation Area. Projects within the inner river zone should be evaluated according to the established restoration priorities (Chapter 1):

1. Protect physical processes where still intact

Because much of the river is contained within a geologically stable corridor, meandering in this reach is limited. A number of areas where the river has moved

significantly in the last 100 years, such as the Turtle Bay area near Redding, are either surrounded by urban development or subject to highly regulated flows. Because such development and associated bridges must be protected from bank erosion, the physical processes necessary for river meandering at these locations no longer exist. *Areas such as the meanders near RM 270-272 where erosion, deposition, and establishment of successional stages of riparian forest is still feasible should receive the top priority for protection.* For the Keswick-Red Bluff Reach, however, the natural process of flooding, rather than erosion/deposition, has a greater influence on the establishment of riparian vegetation. Areas currently subject to inundation at a fairly frequent interval, such as 2.5- to 4-year events, should be left undisturbed to allow for the natural establishment of riparian vegetation. Figure 3-5 shows the area inundated by a 2.5-year flow near Bend. While much of this area currently supports riparian habitat, the potential for additional habitat is present.

2. Allow riparian forest to reach maturity

Areas of early successional stages such as willow and cottonwood forest exist within the Conservation Area. The protection of these habitats and the more mature stages, either through acquisition or other programs, is necessary to ensure a complex array of habitat types.

3. Restore physical and successional processes

Because of the influence of flooding on the establishment and survival of riparian species in this reach, any feasible method to reestablish a suitable hydrologic regime is desirable. For example, some areas are currently protected from relatively frequent flows by low man-made berms; relocation of these berms to higher elevations of the floodplain would greatly increase the potential for natural habitat restoration. Another method would be the scheduling of regulated flows to coincide with the release of seeds by species such as willows and cottonwoods, thus ensuring the establishment of early successional stages.

4. Conduct reforestation activities

The construction of the Shasta Dam has curtailed the natural flooding cycle that leads to the establishment of riparian habitat, particularly for areas of the Sacramento River above Cottonwood Creek. Without the reestablishment of a natural hydrologic regime, large tracts of habitat, which once supported riparian habitat or currently support remnant stands, may need active reforestation activities. *The first option under this priority should be the reestablishment of areas that contribute to a continuous riparian corridor along the Sacramento River.* Other areas for reforestation should be ranked on the feasibility of linking large tracts of riparian lands or linking to tributaries with established vegetation. Finally, areas such as terraces with potential to support valley oak woodlands can also serve as buffer areas between the river and developed lands. These should be considered for active reforestation.