INTEGRATION WITH OTHER RESTORATION PROGRAMS

LOCAL WATERSHED PLANNING GROUPS

Maintaining and restoring the ecological health of the ecological units in the North Sacramento Valley Ecological Management Zone will depend heavily on local watershed groups, including local landowners, concerned individuals, and local resource experts. The watershed planning groups in this Ecological Management Zone include the Clear Creek Coordinated Resources Management Program fostered by the Western Shasta Resource Conservation District, the Battle Creek Watershed Conservancy, and the Battle Creek Working Group. Additional groups are needed to sponsor watershed planning and restoration on Cow and Bear Creeks.

Ecosystem restoration efforts in the North Sacramento Valley Ecological Management Zone will be linked to cooperation from resource agencies, such as DFG, DWR, USFWS, and the National Marine Fisheries Service (NMFS), as well as participation and support from Reclamation, the U.S. Natural Resources Conservation Service, and private organizations, water districts, and individual landowners. These groups are expected to work together to maintain and restore streamflows and fish and wildlife habitat, reduce the impacts of diversions, and minimize poaching and habitat and water quality degradation in basin streams. In support of this effort, cooperating agencies should seek funding for enhancing streamflows, reducing fish passage problems, screening diversions, restoring habitats, and increasing Fish and Game Code enforcement to protect recovering populations of salmon and steelhead.

SALMON, STEELHEAD TROUT AND ANADROMOUS FISHERIES PROGRAM ACT

Established in 1988 by Senate Bill 2261, this Act directs the California Department of Fish and Game to implement measures to double the numbers of salmon and steelhead present in the Central Valley (DFG 1993, 1996). The DFG's salmon and steelhead restoration program includes cooperative efforts with local governments and private landowners to identify problem areas and assist in obtaining funding for feasibility studies, environmental permitting, and project construction. The vision will help DFG as it progresses toward doubling the number of anadromous fish over the number present in 1988.

CENTRAL VALLEY PROJECT IMPROVEMENT ACT

The U.S. Fish and Wildlife Service and the Bureau of Reclamation (Reclamation) are implementing the Central Valley Project Improvement Act (CVPIA), which provides for restoring habitats and species and eliminating many stressors. Key elements of the CVPIA program include the Anadromous Fish Restoration Program (USFWS 1997) and the Anadromous Fish Screening Program. Other elements are directed at spawning gravel replenishment, fish passage, water temperature control in the reach between Keswick Dam and the Red Bluff Diversion Dam (RBDD), water acquisition, and other measures that will contribute to health of the Sacramento River and Sacramento-San Joaquin Delta Ecological Management Zones.

The vision for the North Sacramento Valley Ecological Management Zone will contribute to and benefit from the Anadromous Fish Restoration Program (AFRP), which strives to double the natural production of anadromous fish in the system over the average production from 1967 through 1991.

Reclamation is willing to assist in restoring Clear Creek fish habitat by providing additional water from Whiskeytown Reservoir. The amount of water committed to maintain salmon and steelhead in this creek is presently recommended not to exceed 200 cfs from October 1 through June 1 and 150 cfs from June 2 to September 30. Flows are being evaluated to determine the instream flow necessary to achieve the strategic objective. Because passage and McCormick-Saeltzer Dam has not yet been achieved, AFRP recommended flows had not been implemented for Clear Creek until 1999. (USBR and DWR 1999).

CALFED BAY-DELTA PROGRAM

CALFED has funded eight ecosystem restoration projects in the North Sacramento Valley. Most projects improve fish passage. One project improves fish passage on Clear Creek by removing McCormick Seltzer Dam. The most significant project in the Zone will re-open 42 miles of fish habitat on Battle Creek

by removing five diversion dams and laddering and screening another three dams.

LINKAGE TO OTHER ECOLOGICAL MANAGEMENT ZONES

The North Sacramento Valley Ecological Management Zone is most closely linked to the Sacramento River Ecological Management Zone and exhibits a high degree of connectivity through the confluences of Clear, Cow, Bear, and Battle creeks with the Sacramento River Ecological Management Zone.

RESTORATION TARGETS AND PROGRAMMATIC ACTIONS

ECOLOGICAL PROCESSES

CENTRAL VALLEY STREAMFLOWS

PROGRAMMATIC TARGET: More closely emulate the seasonal streamflow patterns in Clear, Cow, and Battle Creeks in most year types by providing or maintaining flows that mobilize and transport sediments, allow upstream and downstream fish passage, create point bars, and contribute to stream channel meander and riparian vegetation succession.

TARGET 1: Increase flow in Cow Creek by 25 to 50 cfs, corresponding to the natural seasonal runoff pattern, and maintain 25 to 75 cfs during October (◆◆).

PROGRAMMATIC ACTION 1A: Increase flow in Cow Creek by purchasing water from willing sellers or implementing a conjunctive groundwater program.

TARGET 2: Increase flow in Clear Creek to 150 to 200 cfs from October 1 to May 31 and to 100 to 150 cfs from June 1 to September 30 (◆◆).

PROGRAMMATIC ACTION 2A: Develop a cooperative program to improve flow in Clear Creek by increasing releases from Clair Hill and Whiskeytown Dams.

Target 3: Augment flow in Battle Creek by 25 to 50 cfs (◆◆).

PROGRAMMATIC ACTION 3A: Increase flow in Battle Creek by purchasing water from willing sellers or providing compensation for forgone power production. This includes negotiating and renewing an existing interim flow agreement between the Department of the Interior and PG&E, and includes a provision for the release of 10 cfs at the Asbury Pump on Baldwin Creek, a dewatered Battle Creek tributary that provides steelhead habitat. In the longer-term, this action also include increasing flows at the Inskip Diversion Dam and South Diversion Dam.

TARGET 4: Augment flow in Bear Creek by 10 to 20 cfs (◆).

PROGRAMMATIC ACTION 4A: Increase Bear Creek flow by purchasing water from willing sellers or providing alternative sources of water to diverters during important fish passage periods in spring and fall.

RATIONALE: *The streams in the North Sacramento Valley Ecological Management Zone provide extremely valuable habitat for spring-run chinook salmon and steelhead trout. One of the key attributes of streamflow in this ecological zone is providing for successful upstream passage of adult fish. Water is diverted from the streams in this zone during periods that impair upstream passage conditions and prevent fish from reaching important oversummering or spawning habitats. Acquiring water from willing sellers and implementing programs to provide alternative sources of water during important periods are direct approaches to solving this problem. For example, natural flow in Bear Creek is often less than the combined water rights of diverters, resulting in total dewatering of the creek in the valley reach during critical periods for chinook salmon.*

The recommended AFRP flows for Clear Creek, as specified in Target 2, should be implemented immediately. Because steelhead and spring-run chinook salmon do not have access to the better quality habitat upstream of McCormick-Saeltzer Dam, it is all the more imperative that adequate flows be provided to restore some conditions in the reach immediately below McCormick-Saeltzer Dam.

CENTRAL VALLEY STREAM TEMPERATURES

TARGET 1: Maintain suitable water temperatures in Clear Creek for spring-run chinook and steelhead holding, spawning, and rearing (◆◆◆).

PROGRAMMATIC ACTION 1A: Maintain 56° F to approximately 3 miles downstream of McCormick-Saeltzer Dam from June through September.

RATIONALE: *Whiskeytown Dam provides an excellent opportunity to provide cold water releases from the lower depths of the reservoir to maintain adequate temperatures in downstream reaches. Because salmon and steelhead cannot access the higher quality habitat in Clear Creek because of the blockage at McCormick-Saeltzer Dam, greater releases will need to be made from Whiskeytown Dam to provide adequate temperatures in the reach below McCormick-Saeltzer Dam. Preliminary results from an ongoing temperature modeling study indicate that the AFRP recommended flows have the potential to provide adequate temperatures for spring-run chinook and steelhead in most of the reach between Whiskeytown and McCormick-Saeltzer dams. However, higher releases are necessary to achieve adequate temperatures below McCormick-Saeltzer Dam, and should be provided until McCormick-Saeltzer Dam is removed or modified to allow passage.*

COARSE SEDIMENT SUPPLY

TARGET 1: Maintain existing levels of erosion and gravel recruitment in streams of the North Sacramento Valley Ecological Unit and, where necessary, supplement gravel recruitment through adaptive management and monitoring (◆◆).

PROGRAMMATIC ACTION 1A: Cooperatively develop appropriate land use plans that allow the natural recruitment of sediments to streams in the North Sacramento Valley Ecological Management Zone.

TARGET 2: Increase existing levels of erosion and gravel recruitment in Clear Creek by 25 to 50 tons per year (◆◆◆).

PROGRAMMATIC ACTION 2A: Develop a cooperative program to improve gravel quality and quantity in lower Clear Creek to maintain high-quality spawning conditions for fall-run and late-fall-run chinook salmon by evaluating the addition of 5,000 to 10,000 cubic yards annually as needed. Evaluate the need to acquire or relocate existing mining operations. Alter McCormick Dam so that it no longer serves as a sediment trap.

TARGET 3: Increase existing levels of erosion and gravel recruitment in Cow Creek by 5 to 10 tons per year (◆◆).

PROGRAMMATIC ACTION 3A: Develop a cooperative program to protect existing gravel and bedload movement in Cow Creek to maintain and increase future spawning gravel and sediment input to the Sacramento River by 5 to 10 tons per year by evaluating the need or opportunity to acquire or relocate existing gravel mining operations.

RATIONALE: *Replenishing gravel supplies to a level sufficient to support target populations of salmon and steelhead will help to improve populations to desirable levels and to maintain such levels once achieved. Replenishing gravels to maintain channel-forming processes and stream meanders will help to maintain fish and wildlife habitats, aquatic algae and invertebrate production, and streamside vegetation (California Department of Water Resources 1980). A predevelopment level of gravel recruitment should be adequate to restore the natural ecological processes supported by gravel recruitment, but may require experimenting, monitoring, and experience to determine the exact amount of gravel supplies necessary to meet the objective. Sediment supplementation programs, particularly in Clear Creek, need to be integrated with downstream channel forming processes, which will be subject to adaptive management, as well as to a different set of indicators, monitoring, and focused research.*

Rivers with a natural shape and hydrologic condition generally support the most diverse mixture of habitats and fish and wildlife species and are the most resilient to natural or human disturbance.

STREAM MEANDER

PROGRAMMATIC TARGET: Preserve or restore the 50- to 100-year floodplain and existing channel meander characteristics of Clear Creek, particularly in low-gradient areas where most sediment deposition occurs and where stream channel meander is most pronounced.

TARGET 1: Create a more defined stream channel in the lower 8 miles of Clear Creek to facilitate fish passage (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to improve lower Clear Creek by

maintaining flow connection with the Sacramento River and by regrading the channel and controlling vegetative encroachment.

RATIONALE: *Gravel deposits in Clear and Cow Creeks are essential to maintaining spawning and rearing habitats of spring-run and fall-run chinook salmon, steelhead trout, and other native fishes. Whiskeytown Dam and extensive gravel extraction in the lower section of Clear Creek continue to reduce the amount of gravel transport to near zero; Cow Creek has only a limited natural supply and has been adversely affected by gravel mining in its lower reach near the Sacramento River. Although small, Cow Creek provides an important source of sediments to the Sacramento River, particularly for the 8- to 10-mile reach between its confluence with the river and the mouth of Cottonwood Creek.*

The Clear Creek stream meander belt is the area in which natural bank erosion and floodplain and sediment bar accretions occur. Natural stream meander belts in alluvial systems function dynamically to transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish, as well as surfaces that are colonized by natural vegetation that support wildlife. The flow regime in Clear Creek has recently been improved by adding supplemental water under provisions of the CVPIA. This improved flow will assist in reactivating or reestablishing the natural stream channel. Because of low flow releases from Whiskeytown Lake in the past, vegetation has encroached into the lower 3 miles of the active stream channel on Clear Creek, prevented meander, and fixed stream sediments so that they no longer contribute to sediment load or provide substrate for fish spawning.

NATURAL FLOODPLAIN AND FLOOD PROCESSES

TARGET 1: Increase and maintain the Clear Creek floodplain in conjunction with stream meander corridor restoration (◆◆◆).

PROGRAMMATIC ACTIONS 1A: Develop a cooperative program, consistent with flood control requirements, to evaluate the feasibility of altering stream channel configuration in the lower reach of Clear Creek to increase the areal extent of floodplains inundated during high flow periods.

TARGET 2: Reestablish natural floodplain and stream channel meander in the lower 8 miles of Clear Creek (◆◆◆).

PROGRAMMATIC ACTION 2A: Acquire floodplains by direct purchase or easement from willing sellers.

RATIONALE: *Floodplain inundation is a secondary ecosystem process related to water and sediment flow through the Sacramento-San Joaquin Basin in combination with geomorphology. Floodplain inundation is the seasonal flooding of floodplain habitats, including riparian and riverine aquatic habitats. Flooding of these lands provides important seasonal habitat for fish and wildlife and provides sediment and nutrients to both the flooded lands and aquatic habitats that receive the returning or abating floodwater. The flooding also shapes the plant and animal communities in the riparian, wetland, and upland areas subject to flooding. Opportunities to restore or enhance this process are possible by changing landscape features, geomorphology, and seasonal distribution of flow volume through the system.*

HABITATS

RIPARIAN AND SHADED RIVERINE AQUATIC HABITATS

TARGET 1: Develop a cooperative program to establish riparian habitat zones along streams in the North Sacramento Valley Ecological Management Zone through conservation easements, fee acquisition, or voluntary landowner measures (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to establish, restore, and maintain riparian habitat on Clear Creek through conservation easements, fee acquisition, or voluntary landowner cooperation.

PROGRAMMATIC ACTION 1B: Encourage the development of long-term measures in the comprehensive watershed management plan to improve water temperatures further. Develop a cooperative approach with counties and local agencies to implement land use management that protects riparian vegetation along the streams and develop programs to restore lost riparian vegetation

PROGRAMMATIC ACTION 1C: Cooperatively negotiate long-term agreements with local landowners to maintain and restore riparian communities along the lower reaches of Cow, Bear, and Battle Creeks.

RATIONALE: *Many species of fish and wildlife in the North Sacramento Valley Ecological Management Zone depend on or are closely associated with riparian habitats. Of all the habitat types in California, riparian habitats support the greatest diversity of wildlife species. Degradation and loss of riparian habitat have substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions.*

FRESHWATER FISH HABITAT AND ESSENTIAL FISH HABITAT

TARGET 1: Maintain and improve existing freshwater fish habitat and essential fish habitat through the integration of actions described for ecological processes, habitats, and stressor reduction or elimination (◆◆).

PROGRAMMATIC ACTIONS: No additional programmatic actions are recommended.

RATIONALE: *Freshwater fish habitat and essential fish habitat are evaluated in terms of their quality and quantity. Actions described for ecological processes, stressor reduction, and riparian and riverine aquatic habitat should suffice to maintain and restore freshwater fish habitat and essential fish habitat. For example, maintaining freshwater and essential fish habitats is governed by actions to maintain streamflow, improve coarse sediment supplies, maintain stream meander, maintain or restore connectivity of creeks in the Ecological Management Zone and their floodplains, and in maintaining and restoring riparian and riverine aquatic habitats.*

Successful implementation of theses actions will improve conditions for anadromous fish and native resident fish species such as roach and Sacramento suckers, as well as a variety of riparian dependent avian species.

ELIMINATING OR REDUCING STRESSORS

WATER DIVERSIONS

TARGET 1: Reduce or eliminate conflicts between the diversion of water and chinook salmon and steelhead populations at all diversion sites on Battle Creek (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative approach to improve conditions for anadromous fish in Battle Creek by installing fish screens at diversions on the North Fork, three diversions on the South Fork, and one diversion on the mainstem, or acquire water rights to eliminate the need for diversion and screening.

PROGRAMMATIC ACTION 1B: Improve the survival of adult salmon and steelhead in Battle Creek by installing a rack at the head of Gover Diversion Canal to prevent straying.

TARGET 2: Reduce or eliminate conflicts between the diversion of water and chinook salmon and steelhead populations at all diversions on Clear Creek (◆◆◆).

PROGRAMMATIC ACTION 2A: Acquire water rights on Clear Creek at the McCormick Dam to eliminate the need for diversion.

RATIONALE: *Diversion, storage, and release of water in the Clear and Battle Creek watersheds directly affect fish and other aquatic organisms and indirectly affect habitat, foodweb production, and species abundance and distribution. Diversions cause consumptive loss of water, nutrients, sediment, and organisms. Seasonal and daily patterns of water released from storage may affect habitat, water quality, and aquatic organism survival. In both Clear and Battle Creeks, water diversion and water diversion structures have caused direct mortality by removing juvenile fish from the population. Water diversion also reduces the quantity and quality of stream habitats and the resiliency of fish populations. Where possible, it is more desirable to acquire water rights and eliminate the diversion than to install positive-barrier fish screens.*

Coleman National Fish Hatchery receives its water supply directly from Battle Creek. Because of past incidences of disease at the hatchery, adult salmon and steelhead were blocked from ascending the creek

to prevent disease contamination of the hatchery water supply. Restoring naturally spawning fish in the upper watershed will be limited until water can be supplied to the hatchery in a manner that will not contribute to disease outbreaks.

DAMS AND OTHER STRUCTURES

PROGRAMMATIC TARGET: Eliminate or reduce water uses that conflict with increasing the success of spawning adults and survival of juvenile chinook salmon and steelhead by managing or reconstructing facilities and structures that impair fish passage and fish survival.

TARGET 1: Work with landowners and diverters on Cow Creek to reduce the adverse effects of 13 seasonal diversion dams in South Cow Creek, 10 diversion dams in Old Cow Creek, two diversion dams in North Cow Creek, and one diversion dam in Clover Creek that are barriers to migrating chinook salmon and steelhead. This would allow access to 100% of the habitat below any natural bedrock falls (◆◆◆).

PROGRAMMATIC ACTION 1A: Improve passage conditions on Cow Creek by acquiring water rights from willing sellers, removing diversions, or providing alternative sources of water during important periods.

TARGET 2: Work with landowners and diverters on Bear Creek to reduce the adverse effects of dewatering the stream channel at seasonal diversion dams, which results in no passage for migrating chinook salmon (◆◆◆).

PROGRAMMATIC ACTION 2A: Improve passage and habitat conditions in Bear Creek by acquiring water rights from willing sellers, evaluating the removal of diversion dams, or providing alternative sources of water during important periods.

TARGET 3: Work with landowners, diverters, and other state or federal agencies managing Battle Creek to improve fish passage (◆◆◆).

PROGRAMMATIC ACTION 3A: Develop a cooperative program to upgrade or replace existing fish ladders or evaluate the removal of diversion dams and other impediments to passage.

TARGET 4: Work with landowners and diverters on Clear Creek to improve fish passage between its mouth and Whiskeytown Dam (◆◆◆).

PROGRAMMATIC ACTION 4A: Develop a cooperative program to improve fish passage on Clear Creek by upgrading or replacing the fish ladder at McCormick-Saeltzer Dam or removing or modifying the dam.

TARGET 5: Reduce or eliminate conflicts in Battle Creek that require excluding anadromous fish from the upper section to protect the Coleman National Fish Hatchery water supply (◆◆◆).

PROGRAMMATIC ACTION 5A: Develop an alternative or disease-free water supply for Coleman National Fish Hatchery to allow naturally spawning salmon and steelhead access to the full 41-mile reach of Battle Creek above the Coleman National Fish Hatchery weir.

TARGET 6: Investigate possibility of providing access for steelhead to streams above Whiskeytown Dam (◆).

PROGRAMMATIC ACTION 6A: Develop a cooperative program to investigate the feasibility/desirability of providing access to tributaries above Whiskeytown Dam.

RATIONALE: *Dams and their associated reservoirs block fish movement, alter water quality, remove fish and wildlife habitat, and alter hydrological and sediment processes. Fish passage in the North Sacramento Valley Ecological Management Zone is impaired in Clear, Cow, Bear, and Battle Creeks by a variety of permanent and seasonal dams used to divert water for irrigation or power production. Other human-made structures may block fish movement or provide habitat or opportunities for predatory fish and wildlife, which could be detrimental to fish species of special concern, such as spring-run chinook salmon and steelhead, as well as the other stocks of chinook salmon. Improved fish passage will allow anadromous fish to reach the habitat they require to oversummer or to spawn in good health, which will increase their chances of successfully spawning. Improved fish passage will allow anadromous fish to reach the habitat they require to oversummer or to spawn and rear in good health, which will increase their chances of successful spawning.*

HARVEST OF FISH AND WILDLIFE

TARGET 1: Develop harvest management strategies that allow wild, naturally produced fish spawning populations to attain levels that fully use existing and restored habitat, and focus harvest on hatchery-produced fish (◆◆◆).

PROGRAMMATIC ACTION 1A: Control illegal harvest by providing increased enforcement efforts.

PROGRAMMATIC ACTION 1B: Develop harvest management plans with commercial and recreational fishery organizations, resource management agencies, and other stakeholders to meet the target.

PROGRAMMATIC ACTION 1C: Continue the mass-marking program and selective harvest regulations for hatchery steelhead.

PROGRAMMATIC ACTION 1D: Evaluate a marking and selective fishery program for chinook salmon.

RATIONALE: *Restoring and maintaining populations of chinook salmon and steelhead to levels that fully take advantage of habitat may require restricting harvest during and even after the recovery period. Involving the various stakeholder organizations should help to ensure a balanced and fair allocation of available harvest. Target population levels may be such that existing harvest levels of wild, naturally produced fish cannot be sustained. For populations supplemented with hatchery fish, selective fisheries may be necessary to limit the harvest of wild fish, while hatchery fish are harvested at a level to reduce their potential to disrupt the genetic integrity of wild populations.*

ARTIFICIAL PROPAGATION OF FISH

TARGET 1: Minimize the likelihood that hatchery-reared salmon and steelhead produced in the Coleman National Fish Hatchery will stray into non-natal streams, thereby protecting naturally produced salmon and steelhead (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to evaluate the benefits of stocking hatchery-reared salmon and steelhead in the Sacramento River and Battle Creek. Stocking may be reduced in years when natural production is high.

TARGET 2: Limit hatchery stocking if populations of salmon or steelhead can be sustained by natural production (◆◆◆).

PROGRAMMATIC ACTION 2A: Augment populations of fall chinook salmon and steelhead only when alternative measures are deemed insufficient to provide recovery of the populations.

TARGET 3: Minimize further threats of hatchery fish contaminating naturally produced stocks of chinook salmon and steelhead (◆◆◆).

PROGRAMMATIC ACTION 3A: Adopt methods for selecting adult spawners for the hatchery from an appropriate cross-section of the adult population available to the hatchery.

RATIONALE: *In watersheds such as the Sacramento River and Battle Creek, where dams and habitat degradation have limited natural spawning, hatchery supplementation may be necessary. This would sustain fishery harvest at former levels and maintain a wild or naturally spawning population during adverse conditions, such as droughts. Hatchery augmentation, however, should be limited so as not to inhibit recovery and maintenance of wild populations. Hatchery-reared salmon and steelhead may directly compete with and prey on wild salmon and steelhead. Hatchery fish may also threaten the genetic integrity of wild stocks by interbreeding with the wild fish. Although irreversible contamination of the genetics of wild stocks has occurred, additional protective measures are necessary to minimize further degradation of genetic integrity. Because of the extent of development on the Sacramento River and Battle Creek, chinook salmon and steelhead stocking may be necessary to rebuild and maintain stocks to sustain sport and commercial fisheries.*

SPECIES

STEELHEAD TROUT

SUPPLEMENTAL TARGET 1: Investigate the feasibility of using native rainbow trout currently isolated above dams to rebuild or recreate a steelhead run (◆).

PROGRAMMATIC ACTION 1A: Conduct a comprehensive, basin-wide genetic evaluation of Central Valley steelhead stocks that includes analysis of self-sustaining populations of rainbow trout

isolated above dams for purposes of identifying a suitable broodstock.

PROGRAMMATIC ACTION 1B: Conduct hatchery/release investigations to determine if progeny of native resident rainbow trout raised in a hatchery will emigrate to the ocean.

RATIONALE: *Resident rainbow trout and anadromous steelhead likely comprise a single, interbreeding population in specific stream systems (IEP Steelhead Project Work Team 1999). Native, resident rainbow trout presently isolated above dams could possess the genetic traits that would allow their use as an experimental broodstock to restore steelhead. Planned and ongoing genetic analyses, conducted through the Comprehensive Central Valley Steelhead Genetic Evaluation (see ERPP Vol. 1, Species Vision for Steelhead Trout) and the Fish and Wildlife Service Upper Sacramento River Rainbow Trout Genetic Analysis, should be able to elucidate genetic relationships of resident and anadromous rainbow trout. If it is determined that native populations exist, experiments could be undertaken to determine if anadromous steelhead could be derived from an experimental hatchery population. If this is successful, then restoration of some stocks of native Central Valley steelhead thought to be extinct may be achievable through this method.*

REFERENCES

Azevedo, R.L., and Z.E. Parkhurst. 1958. The upper Sacramento River salmon and steelhead maintenance program. 1949-1956. U.S. Fish and Wildlife Service, Office Report. 96 pp.

California Department of Fish and Game. 1993. Restoring Central Valley Streams: a plan for action. November 1993.

California Department of Fish and Game. 1998. Report to the Fish and Game Commission: A status review of the spring-run chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River Drainage. Candidate Species Status Report 98-01.

California Department of Water Resources. 1994. Use of alternative gravel sources for fishery restoration and riparian habitat enhancement in Shasta and Tehama counties, California. Northern District. August 1994

Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, Assessment, and Research on Central Valley Steelhead: Status of Knowledge, Review of Existing Programs, and Assessment of Needs. *in* Comprehensive Monitoring, Assessment, and Research Program Plan, Tech. App. VII-11

The Nature Conservancy. 1995. Sacramento Valley and foothill bioregional biological scoping project. August 1995.

U.S. Bureau of Reclamation and California Dept. of Water Resources. 1999. Effects of the Central Valley Project and State Water Project operations from October 1998 through March 2000 on steelhead and spring-run chinook salmon. Biological Assessment for ESA Section 7 consultation.

U.S. Bureau of Reclamation. 1999. Value Planning: Lower Clear Creek Hydraulic Analysis at Whiskeytown Dam. May 7, 1999.

U.S. Fish and Wildlife Service. 1997. Revised draft restoration plan for the anadromous fish restoration program: a plan to increase the natural production of anadromous fish in the Central Valley of California. May 30, 1997.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of chinook salmon in the Central Valley Drainages of California. Cited in: Sierra Nevada Ecosystem Project, Final Report to Congress, vol. III, Assessments, Commissioned Reports, and Background Information. University of California, Davis, Centers for Water and Wildland Resources.

◆ COTTONWOOD CREEK ECOLOGICAL MANAGEMENT ZONE

INTRODUCTION

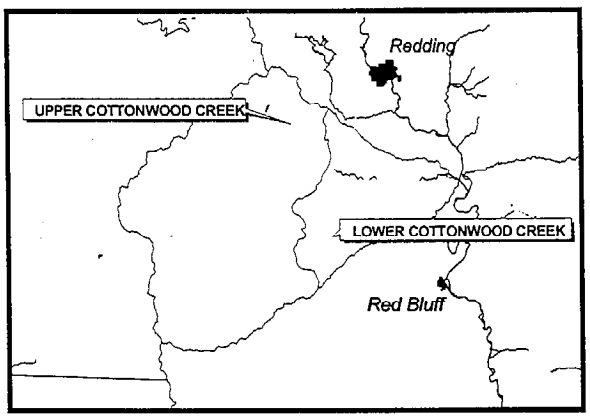
The health of the Sacramento-San Joaquin Delta is influenced by the interdependence and connectivity of the component ecosystem elements, particularly the 14 ecological management zones. The Cottonwood Creek Ecological Management Zone is located many miles from the Delta, but its status and health are ultimately reflected in the health of the Delta. The intermediate zone between the Delta and Cottonwood Creek is the Sacramento River. The Sacramento River Ecological Management Zone and its respective habitats and fish, wildlife, and plant assemblages depend on Cottonwood Creek, primarily for its ability to supply sediments and gravel to the river, but also for its seasonal contributions of flow.

DESCRIPTION OF THE MANAGEMENT ZONE

Cottonwood Creek drains an area of 930 square miles on the west side of the Central Valley and enters the Sacramento River a short distance downstream of the Redding-Anderson area, approximately 16 miles north of Red Bluff. One of the outstanding attributes of Cottonwood Creek is its status as the largest undammed tributary on the westside of the Sacramento Valley.

The creek spans a broad elevational range and functions as an important regional wildlife corridor and neotropical bird habitat. Well-developed montane, foothill, and valley riparian forests are found throughout the Cottonwood Creek Ecological Management Zone, and these forests have good connectivity with the Sacramento River Ecological Management Zone. One of the most important ecological attributes of Cottonwood Creek is its role as the primary source of coarse sediments and spawning gravel for the Sacramento River. Cottonwood Creek supplies almost 85% of the gravel introduced into the Sacramento River between Redding and Red Bluff.

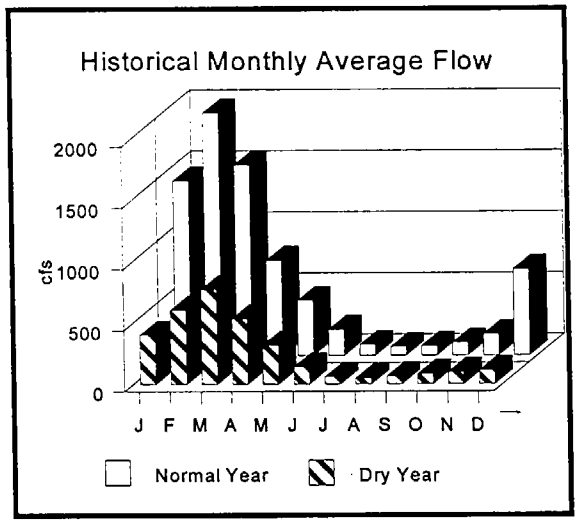
Attributes that affect the ecological health of the Cottonwood Creek Ecological Management Zone include streamflow, coarse sediment supply, gravel recruitment and transport, stream meander, and vegetation succession. Important fish and wildlife habitats include freshwater fish habitat, essential fish habitat, gravel substrate for invertebrate production and chinook salmon and steelhead spawning, riparian scrub and woodlands, and shaded riverine aquatic habitat.



Location Map of the Cottonwood Creek Ecological Management Zone and Units.

Cottonwood Creek has a natural flow pattern of high winter and low summer and fall flows, which is typical of many Sacramento Valley streams that originate in the foothills rather than at higher elevations in the Cascade or Sierra Nevada mountain ranges. In summer and fall months of low rainfall years, flows average 40 to 80 cubic feet per second (cfs). In the wettest years, flows in winter average 5,000 to 11,000 cfs. In winter

months of dry years, average monthly flows reach only 400 to 800 cfs. In the driest years, average winter monthly flows reach only 50 to 150 cfs.



Historical Streamflow of Cottonwood Creek, 1952-1992
(Dry year is the 20th percentile year; normal year is the 50th percentile year.)

In the past, streamflow in Crowley Gulch, a tributary to lower Cottonwood Creek, was intermittently augmented by the release of water from a waste gate on the Anderson-Cottonwood Irrigation District (ACID) canal. Waste gate releases during fall have attracted chinook salmon into an area where they became stranded and subsequently died without having spawned. This problem has been eliminated by operational changes by ACID personnel.

The estimated mean annual suspended sediment load transported from the Cottonwood Creek basin is second only to that of Cache Creek in the Sacramento River basin below Shasta Dam. The U.S. Army Corps of Engineers estimates that, of the total average annual gravel load transported by Cottonwood Creek, particles greater than 2.0 millimeters in diameter total approximately 19,000 tons per year. This amount is consistent with the average annual bedload of approximately 65,000 tons estimated by the U.S. Geological Survey. The California Department of Water Resources (1980) estimated that gravel mining reduced potential sand and gravel contributions to the Sacramento River by about 60%, resulting in a calculated bedload of 20,000 tons per year, with 3,000 tons of particles above one-half inch in diameter.

More is known about the hydrology and sediment transport process of Cottonwood Creek than about that of other streams in the northern Sacramento Valley because of studies conducted for the construction of several dams and environmental impact reports for gravel mining projects. Bankfull discharge (i.e., with the creek full to the tops of its banks) has been estimated at 20,000 cfs with a return interval of 1.8 years. The creek has a wide meander belt and a braided channel with perennial flow. The active channel width at low flow ranges from 50 to 150 feet but reaches more than 1,500 feet at bankfull discharge. The channel banks are mostly sand, gravel, and cobbles. The width of the floodplain varies, but it is generally wider and more poorly defined downstream. Sinuosity values (i.e., the ratio of creek length to the linear distance over which the creek travels) for Cottonwood Creek are low, ranging from 1.04 to 1.47. The low degree of sinuosity is attributable primarily to the high gravel and low silt and clay content of the bank material. The main channel tends to change course during large floods, resulting in a fairly wide belt of distributary channels and abandoned stream courses.

Some of the fish, wildlife, and plant resources dependent on the ecological health of Cottonwood Creek are fall-run, late-fall-run, and spring-run chinook salmon and steelhead trout. Although northern spotted owls, northwestern pond turtles, and foothill yellow-legged frogs in the South Fork will benefit from proposed restoration actions, these species are not a direct focus of actions in the Cottonwood Creek Ecological Management Zone.

The use of Cottonwood Creek by chinook salmon and steelhead trout is determined by the timing of rainfall. In years when storms arrive late in the season, the migration of salmon and steelhead is delayed. In some years, early rainfall allows salmon to enter the creek and spawn, but subsequent low winter and spring flows limit the production of young salmon.

The average annual return of fall-run salmon is approximately 1,000 to 1,500 adults but has ranged from a few hundred to more than 8,000 fish. The return of late-fall-run salmon is much smaller, consisting of fewer than 500 fish each year. The late-fall-run salmon enter Cottonwood Creek and spawn in the main stem and lower reaches of the North, Middle, and South Forks of the creek.

Salmon spawning gravel habitat in the lower reaches of Cottonwood Creek has been degraded. Some areas