A Summary of the

Habitat Restoration Plan for the Lower Tuolumne River Corridor

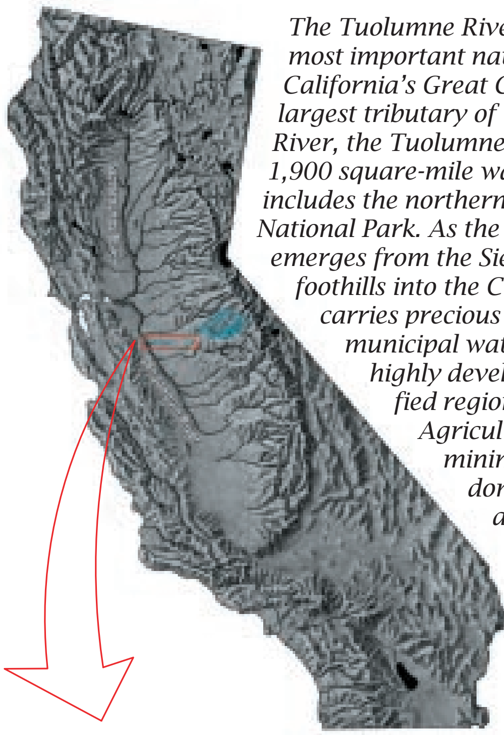
Prepared for:

The Tuolumne River Technical Advisory Committee

March 1999

The Tuolumne River

The Tuolumne River Technical Advisory Committee (TRTAC) has prepared the ***Habitat Restoration Plan for the Lower Tuolumne River Corridor*** to assist in identifying and implementing habitat restoration projects to benefit the river's chinook salmon. This summary of the Restoration Plan provides background information about the TRTAC, the challenges facing the Tuolumne River corridor, some of the technical information used to create the restoration plan, and examples of restoration projects already underway. This summary was prepared to inform the public of the Restoration Plan goals and current and future restoration projects.

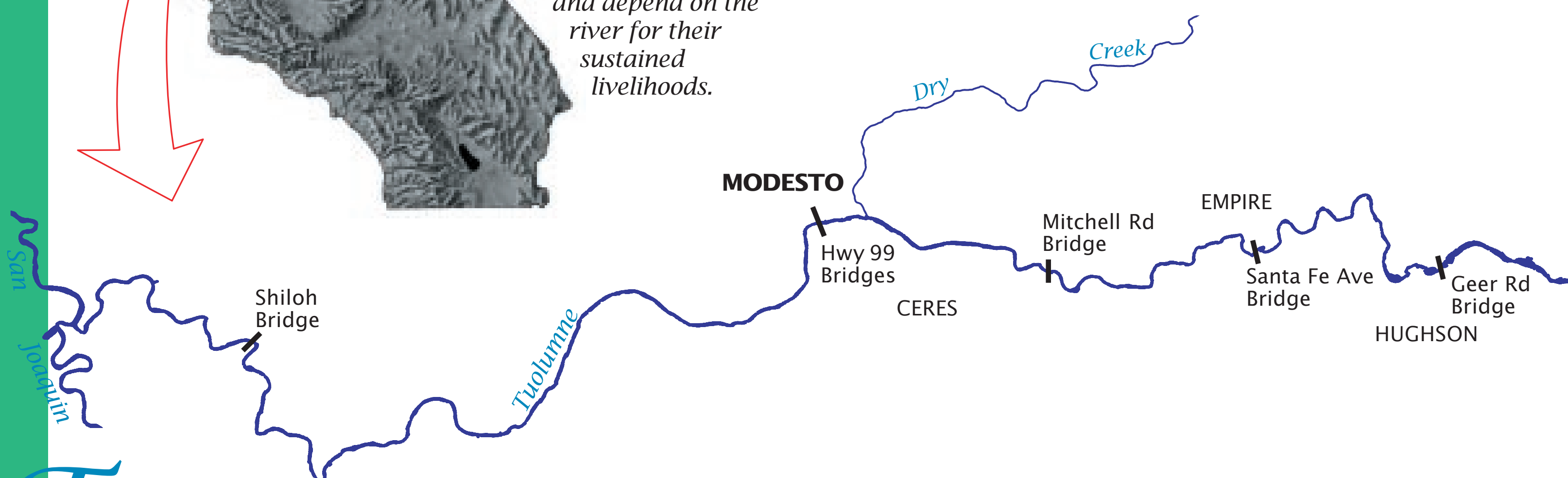


The Tuolumne River is one of the most important natural resources of California's Great Central Valley. The largest tributary of the San Joaquin River, the Tuolumne River drains a 1,900 square-mile watershed that includes the northern half of Yosemite National Park. As the Tuolumne River emerges from the Sierra Nevada foothills into the Central Valley, it carries precious agricultural and municipal water supplies to a highly developed and diversified regional economy. Agriculture, ranching, mining, and tourism dominate the region and depend on the river for their sustained livelihoods.

An enormous biological community also depends on the Tuolumne River. Vast Fremont Cottonwood and Valley Oak riparian forests once insulated the Tuolumne River banks, extending several miles wide in the lower San Joaquin Valley, and merging into riparian forests of the neighboring Merced, Stanislaus and San Joaquin Rivers. These forests provided foraging and breeding habitat for an abundance of resident and migratory bird and wildlife populations, and tremendous populations of migratory waterfowl.

> *"On April 1st [1844] we…were stopped again by a river - the Tuolumne. …[I]ts beauty has been increased by the additional animation of animal life, and now it is crowded with bands of elk and wild horses; and along the rivers frequent fresh tracks of grizzly bears, which are unusually numerous in this country."*
>
> *Captain John C. Fremont*

In the lower foothill reaches of the Tuolumne River upstream of the community of Waterford, annual migrations of spring- and fall-run chinook salmon once filled the river. Fish commonly weighed in excess of 20 pounds and occassionally exceeded 50 pounds! Despite recent declines, the Tuolumne River still supports the largest naturally reproducing population of chinook salmon remaining in the San Joaquin Valley.



Tuolumne history

1848 THE CALIFORNIA GOLD RUSH

No other event transformed the character of California as profoundly as the gold rush. Gold fever brought a roaring boom to the Tuolumne River and the entire Central Valley almost overnight. Sluicing, hydraulic mining, and later dredging left behind a severely disfigured river ecosystem. The legacy of dredging remains today as river rocks piled on former river floodplains in the upper reaches of the Tuolumne River.

1871-1893 EARLY DIVERSION DAMS

The Tuolumne Water Company constructed Wheaton Dam at the falls above La Grange in 1871, initiating streamflow regulation and diversion on the Tuolumne River. Wheaton Dam was later sold to Turlock and Modesto Irrigation Districts, then re-placed by La Grange Dam. Completed on December 13, 1893 at a cost of $550,000, the 127 1/2 ft high La Grange dam (later raised 2 1/2 ft) was the highest overflow dam in the country.

1900s TO PRESENT AGRICULTURAL/URBAN EXPANSION

Agricultural and urban expansion have encroached on the Tuolumne River's space, and have eliminated large areas of fish and wildlife riparian habitats. Entire floodplains were converted for cultivation, bridges and towns were constructed, and berms erected to protect farmlands from floods. Economies developed during the 20th century are now inextricably linked to Tuolumne River resources.

1923 EARLY STORAGE DAMS

The original Don Pedro Dam was completed in 1923 and became the highest dam of its kind (284 ft high). The 289,000 acre-feet of water storage extended the irrigation season through September in most years. The completion of O'Shaugh-nessy Dam in 1923 (Hetch Hetchy) initiated water storage and diversion from the Tuolumne River to supply drinking water to the San Francisco Bay Area.

A candidate for restoration

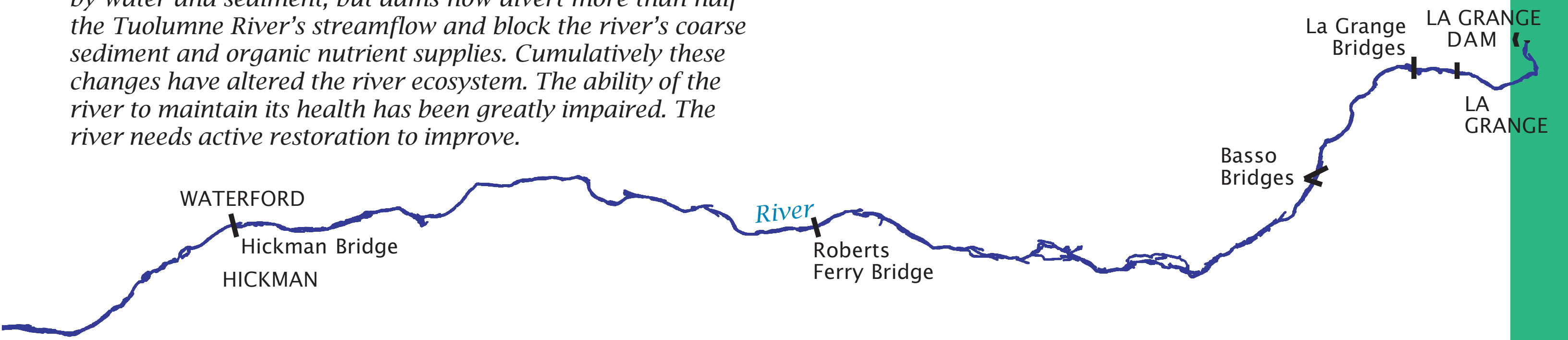
Today, however, the Tuolumne River is changed. More than a century of intensive land and water resource development has transformed the Tuolumne River. Native Americans managed the watershed using fire and selective vegetation harvesting. Placer and hydraulic gold mining began with the Gold Rush, and dredge mining continued into the 1950s. Mining sand and gravel for road and construction material began with miners excavating directly from the river channel in the 1940s, and continues today in adjacent floodplains and terraces.

A RIVER IMPACTED BY DEVELOPMENT

- *Reduced floodway capacity*
- *Reduced magnitude and frequency of high flows*
- *Reduced variability of seasonal streamflows*
- *Interrupted gravel supply*
- *Fragmented and narrowed riparian corridor and decreased plant species diversity*
- *Decreased regeneration of native riparian plants*
- *Reduced water quality*
- *Reduced quantity and quality of salmon habitat*
- *Declining trend in chinook salmon abundance*
- *Diminished wildlife populations*

Gold dredgers excavated gravel from deep under the river and floodplains, separated out the gold, and deposited the tailing across the valley. Within a few decades (1937 above, 1950 left) the dredgers turned over most of the valley floor from La Grange to Roberts Ferry Bridge.

Agriculture and urban development have also severely confined the river's space. The river is formed and maintained by water and sediment, but dams now divert more than half the Tuolumne River's streamflow and block the river's coarse sediment and organic nutrient supplies. Cumulatively these changes have altered the river ecosystem. The ability of the river to maintain its health has been greatly impaired. The river needs active restoration to improve.



1930s TO PRESENT
GRAVEL MINING

Sand and gravel "aggregate" is a critical resource to a rapidly developing region. Early gravel mining practices created large pits within the river channel that now harbor non-native fish and block gravel movement downstream. As aggregate demand increased, mining shifted to floodplains and terraces and created large pits that now constrict the river between berms that are frequently ruptured during floods.

1971
NEW DON PEDRO PROJECT

The New Don Pedro Project (NDPP) provides irrigation water and hydro-power for Turlock and Modesto Irrigation Districts, municipal water supplies for the City and County of San Francisco, and flood control for the U.S. Army Corp of Engineers. The 545 ft high rock-filled dam was dedicated on May 22, 1971. Initial streamflows were low, and the project license required re-evaluating streamflows after twenty years of operation.

1971-1995
REGULATION UNDER NDPP OPERATION

Fall-run salmon population fluctuated widely during the first 20 years of NDPP operation, from a high of 40,000 fish (1985) to lows of 100 fish (1991-93). Article 39 of the NDPP license mandated extensive studies of salmon ecology to determine how much water was needed to maintain a healthy population. This knowledge now contributes to understanding how environmental factors affect the chinook salmon population.

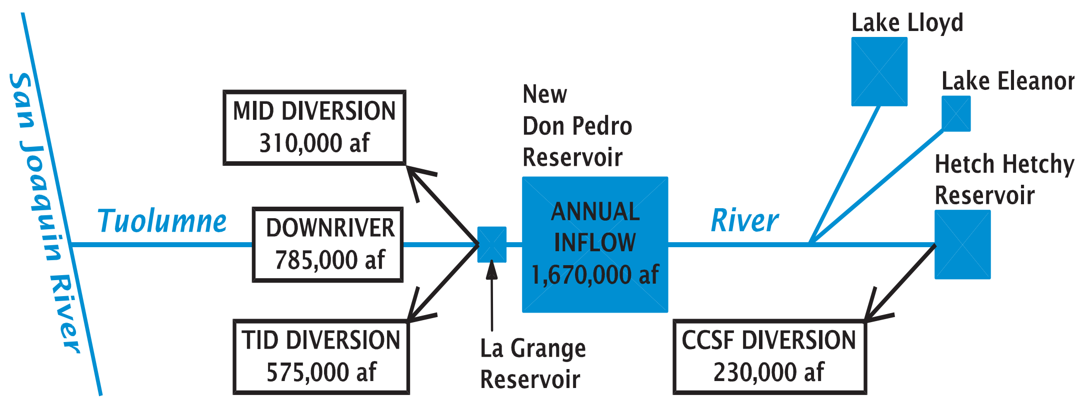
1995
FERC SETTLEMENT AGREEMENT

The NDPP license was re-opened in 1992 to evaluate streamflow requirements. The FERC Settlement Agreement increased streamflows to aid chinook salmon recovery, and formed the Tuolumne River Technical Advisory Committee to oversee restoration and management. The TRTAC has prepared the Habitat Restoration Plan for the Lower Tuolumne River Corridor to guide restoration planning, funding and implementation.

A managed river

The Tuolumne River has a long history of streamflow regulation and diversion. The Turlock and Modesto irrigation districts (TID/MID) have operated storage and diversion facilities on the Tuolumne River for over a century. La Grange Dam, constructed in 1893, was the first TID/MID joint facility and continues to serve as the diversion point for the TID and MID main canals. Increased demands for water resulted in construction of Don Pedro Dam in 1923, which was replaced by the **New Don Pedro Project (NDPP)** in 1971. The NDPP reservoir, with a capacity of 2 million acre-feet (af), is the largest storage facility on the Tuolumne River. The City and County of San Francisco (CCSF) diverts additional water from Hetch Hetchy Reservoir and other upper Tuolumne River projects. Cumulatively, these projects divert more than half the average annual flow from the Tuolumne River.

The Federal Power Commission [now the **Federal Energy Regulatory Commission (FERC)]**, issued the original NDPP license in 1964, which required TID/MID to release minimum streamflows to protect the native chinook salmon population. The NDPP license also required the Districts, in cooperation with Federal and State resource agencies, to study the Tuolumne River to "assure continuation and maintenance of the salmon fishery in the most economical and feasible manner". Studies were carried out cooperatively by TID/MID, U.S. Fish and Wildlife Service (USFWS), and California Department of Fish and Game (CDFG). These studies, summarized in reports submitted to FERC in 1992, described chinook salmon ecology and provided management recommendations based on current scientific understanding of the Tuolumne River.



Over half of the 1.9 million acre-feet (af) of runoff in the Tuolumne River basin is diverted from the river for agricultural and municipal use (water volumes are 1984-1998 averages).

The FERC Settlement Agreement

The NDPP license required FERC to re-evaluate the project's minimum streamflow requirements after 20 years of operation. FERC initiated this evaluation in 1992, and prepared a Final Environmental Impact Statement (FEIS) in compliance with the National Environmental Policy Act (NEPA). The first ever FERC-initiated mediation process resulted in adoption of the **1995 FERC Settlement Agreement (FSA).** The FERC Settlement Agreement participants included TID/MID, the City and County of San Francisco and other water suppliers, state and federal resource agencies, and several environmental groups. The Agreement revised streamflow requirements, required habitat restoration to improve conditions for chinook salmon, and ordered additional fishery studies to evaluate flow and non-flow measures.

FERC SETTLEMENT AGREEMENT PARTICIPANTS

California Department of Fish and Game (CDFG)
California Sports Fishing Protection Alliance (CSPA)
City and County of San Francisco (CCSF)
Federal Energy Regulatory Commission (FERC)
Friends of the Tuolumne Trust (FOTT)
Modesto Irrigation District (MID)
San Francisco Bay Area Water Users Association (BAWUA)
Tuolumne River Expeditions (TRE)
Tuolumne River Preservation Trust (TRPT)
Turlock Irrigation District (TID)
U.S. Fish and Wildlife Service (FWS)

New Don Pedro Dam, completed in 1971 by the Turlock and Modesto Irrigation Districts, is the largest dam on the Tuolumne River and can store an average year's runoff from the watershed.

The Tuolumne River Technical Advisory Committee

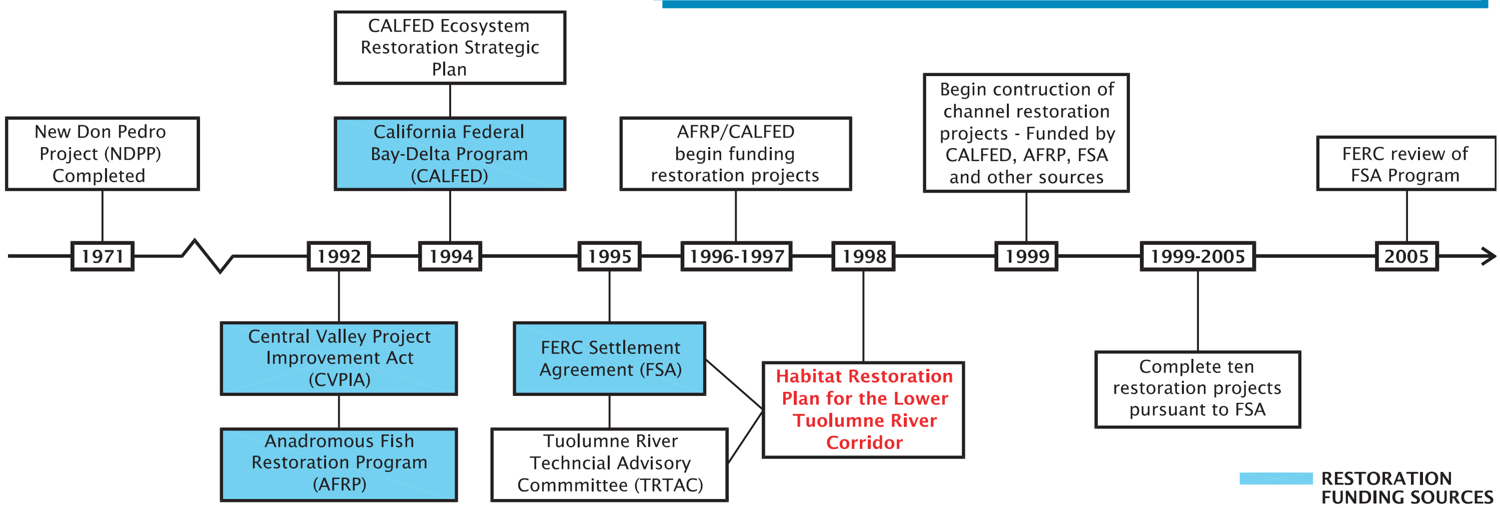
The **Tuolumne River Technical Advisory Committee (TRTAC)** *was formed to coordinate and administer restoration and management activities on the Tuolumne River. The TRTAC participants include the FERC Settlement Agreement signatories and other interested groups.*

The TRTAC was directed to identify and implement ten high priority habitat restoration projects by 2005, at which time progress toward restoring the salmon population will be re-evaluated. To aid in identifying and implementing high priority restoration projects, the TRTAC developed the ***Habitat Restoration Plan for the Lower Tuolumne River*** **(Restoration Plan)**.

The Restoration Plan is intended as a technical resource to help the TRTAC fulfill its obligation under the FERC Settlement Agreement.

FERC SETTLEMENT AGREEMENT GOALS AND STRATEGIES FOR RECOVERING TUOLUMNE RIVER CHINOOK SALMON

- *Increase naturally occurring salmon populations*
- *Protect any remaining genetic distinction of Tuolumne River salmon*
- *Increase salmon habitat in the Tuolumne River*
- *Implement measures generally agreed upon as necessary to improve chinook salmon habitat and increase salmon populations. These measures include increased flows, habitat rehabilitation and improvement, and measures to improve juvenile survival*
- *Use an adaptive management strategy that would initially employ measures considered feasible and have a high chance of success*
- *Conduct a detailed annual review to assess progress toward meeting the goals described in the Settlement Agreement*



Several restoration programs and groups are involved in Tuolumne River restoration, including the FERC Settlement Agreement program administered by the TRTAC

Habitat Restoration Plan for the Lower Tuolumne River Corridor

This document is a summary of the larger technical report, and was developed to assist the TRTAC in presenting the Restoration Plan to the public.

"Restoration" often implies returning to historical or natural environmental conditions. Because removing dams, eliminating water diversion, and ceasing agricultural and mining activities within the river corridor are unrealistic goals, restoring the river to pristine conditions is unrealistic.

VISION FOR RESTORING THE LOWER TUOLUMNE RIVER CORRIDOR

Utilize an integrative approach to re-establish critical ecological functions, processes, and characteristics, under regulated flow and sediment conditions, that best promotes recovery and maintenance of a resilient, naturally reproducing salmon population and the river's natural animal and plant communities.

RESTORATION PLAN OBJECTIVES

- *Investigate and describe current and historical river conditions*
- *Integrate river channel, riparian and fisheries investigations into recommendations and strategies for restoring the Lower Tuolumne River corridor*
- *Develop proposals and designs for specific restoration actions*

Therefore, the Restoration Plan was intended to recommend ways to significantly improve conditions within the Tuolumne River corridor, while recognizing that land and water-use activities will continue. The restoration approach recommended for the Tuolumne River is to improve conditions for chinook salmon and other species by restoring self-sustaining ecological processes. This approach should benefit not only the target species, chinook salmon, but also many other plants and animals dependent on the health and integrity of the Tuolumne River.

Tuolumne River hydrology

Water and sediment are critical ingredients for forming and maintaining the river channel, creating habitat, and supporting the biological communities that depend on flowing water. The Tuolumne River's **natural flow regime** *varied day-to-day, seasonally, and year-to-year depending on rainfall and snowmelt. Scientists now recognize that the dynamic character of streamflow plays a fundamental role in maintaining the health of river ecosystems.*

THE NATURAL FLOW REGIME

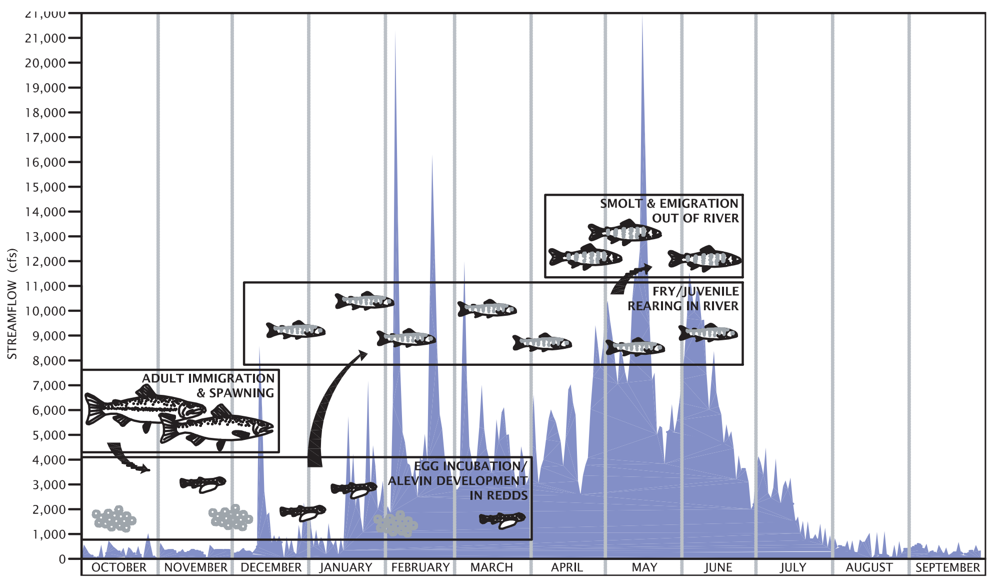
- *Maintains natural channel form*
- *Cleanses spawning gravels of silts and deposits silts on floodplain surfaces*
- *Inundates floodplains during native riparian plant seed dispersal and germination*
- *Occassionally disturbs mature riparian vegetation to maintain diversity*
- *Stimulates chinook salmon immigration and emigration*
- *Maintains spawning habitat*

DOWNSTREAM OF THE DAMS

- *Total volume of water flowing down the river is decreased*
- *Magnitude and duration of floods are reduced*
- *Magnitude of summer baseflows are reduced*
- *Spring snowmelt runoff is reduced*
- *Timing and frequency of natural floods is altered*

Water regulation for irrigation, power generation, and drinking water has altered the natural flow patterns of the Tuolumne over the past 100 years. These impacts have accelerated over the century as more substantial water storage and flood flow modification have occurred with each new and larger dam built.

The Restoration Plan analyzed daily streamflow records for the entire 101 years of flow records (1897-1998), analyzing the seasonal and annual variation and comparing regulated with unregulated conditions. Combined with a flood-frequency analysis, this information was used to determine precisely how the **magnitude, timing, frequency** *and* **duration** *of natural streamflow patterns have been altered, and to suggest ways to improve the management of flow releases without reducing water supplies.*



Unregulated streamflow for the 1995-96 water year (October 1 to September 31) is shown as an annual hydrograph of the daily average flows in cubic-feet per second (cfs). The life cycle of the fall-run chinook salmon (and other riverine species) is adapted to the seasonal variability of natural streamflow patterns.

Flood flow evaluation

Floods are natural events within river corridors, and are critical to a healthy river ecosystem. While the Restoration Plan did not address long-term flood management, the January 1997 flood did provide a unique opportunity to re-evaluate the role of floods on the Tuolumne River.

The 60,000 cfs release from the dam that occurred on January 3, 1997 historically occurred about every 35-50 years. While uncontrolled floods of these magnitudes threaten lives and property and should be avoided, controlled floods of lower magnitude are essential for the river's recovery and long-term health, and should be encouraged. Expanding the floodway provides a "win-win" solution. A larger flood corridor gives dam operators greater flood release flexibility when faced with large inflows into New Don Pedro Reservoir. This will reduce the risk of future floods like the '97 flood. An expanded floodway will also allow operators to occasionally release managed floods that are necessary for channel maintenance.

Managed floods can improve many important river and riparian processes, including more variable streamflow patterns; more frequent cleansing and downstream movement of river gravels to maintain high quality spawning gravel; channel migration within its floodway; and floodplain inundation at moderate-to-high streamflows to help stimulate riparian plant regeneration.

FLOODWAY ASSESSMENT

The Army Corps of Engineers (ACOE) completed a "Reconnaissance Study" of the Tuolumne River floodway in October 1998, which identified potential alternatives for managing future floods, and encouraged continued environmental restoration within the Tuolumne River corridor. The ACOE is now proceeding with a "Feasibility Study" to identify a preferred alternative to reduce the risk of future catastrophic flooding and improve flood management. The ACOE and California Reclamation Board are also conducting the "Sacramento and San Joaquin River Basins Comprehensive Study" to assess flood management on a broader scale.

Chinook salmon life history

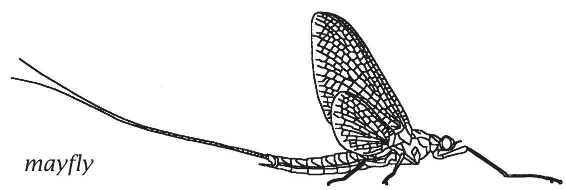
Chinook salmon are anadromous, having a river-to-ocean, ocean-to-river life cycle. Young salmon migrate to sea shortly after emerging from spawning gravels, and spend most of their life in coastal waters where they grow large from abundant food supplies. Fall-run chinook adults return to spawning grounds in the fall and early winter, after $1\frac{1}{2}$ to $3\frac{1}{2}$ years in the ocean. The female digs a pit in river gravels and deposits her eggs as the male fertilizes them. Both die shortly after spawning, spending their final days guarding the nest. Juveniles emerge from spawning gravels between December and April and "rear" in deep, slow portions along river margins, either upstream near the spawning beds or downstream in the Sacramento-San Joaquin Delta. Historically, high spring flows during the snowmelt runoff helped juveniles migrate out to sea before high summer temperatures made river conditions less hospitable.

Fall-run chinook salmon constitute over 90% of the salmon in the Central Valley, and support the bulk of commercial and recreational salmon harvest.

Chinook salmon are superbly adapted to natural river conditions such as annual streamflow patterns of floods and low-flow periods, cold water temperatures, the natural river morphology (deep pools and shallow riffles), as well as the native fish community. Human activities that detrimentally impact natural river conditions also diminish survival and reproductive success of salmon. Declining populations become unstable and may not recover if conditions are not substantially improved.

FACTORS AFFECTING SALMON PRODUCTION AND SURVIVAL

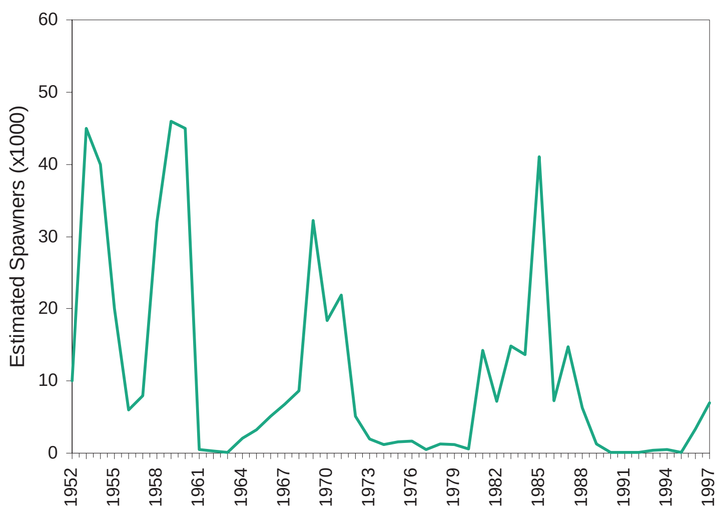
- *Spawning gravel supply and gravel quality*
- *Juvenile rearing habitat availability and condition*
- *Streamflow during fry, juvenile, and adult migration periods*
- *Predation by non-native fish species (bass)*
- *Bay/Delta and ocean mortality (predation, delta pumping, sport/commercial harvest)*
- *Water temperatures and water quality*



mayfly

Current status of chinook salmon

Despite the efforts of fisheries managers, chinook salmon populations have continued to decline. The spring-run chinook salmon, historically the most abundant salmon run in the San Joaquin River basin, was extinct by the early 1950s, as early dams blocked fish from reaching their high elevation spawning grounds. In the decades following, the fate of the remaining fall-run chinook population has hung precariously in the balance. Periods of abundant adult returns were punctuated by years of dangerously low returns of 500 fish or less (1962, '63, '77, '91, '92, and '93). The return of 8,000 spawners to the Tuolumne River in 1998 has restored confidence that a population of wild salmon can be rebuilt from low numbers.



The fall-run chinook salmon population has fluctuated widely over the years, in response to environmental conditions the fish experience as juveniles, delta water exports, ocean conditions, and commercial and recreational harvest.

As of October 1997, five Pacific Coast salmon runs were listed as endangered under the Federal Endangered Species Act. Currently, the National Marine Fisheries Service is reviewing all 19 Pacific Coast chinook salmon populations, including the San Joaquin River basin (includes Tuolumne River) fall-run chinook salmon, to determine if further threatened or endangered species listings are warranted.

The Restoration Plan provides guidance toward a long-term solution to restoring and protecting the chinook salmon population by incorporating the physical processes that create and maintain good habitat conditions. Additionally, restoration will benefit other riverine species and the vegetation community that provides habitat for birds and other wildlife populations.

Natural channel processes...

The foundation of a river ecosystem is the dynamic interaction of flowing water, sediment, and riparian vegetation. Alteration of one of these factors disrupts the balance of the other factors. For example, clearing riparian vegetation may increase bank erosion and channel meandering. Dams block the downstream movement of gravel from the upper watershed, causing gravel bars downstream of dams to be scoured away without being replaced. Absence of floods allows fine sediments to accumulate in gravels, inhibiting the survival of chinook salmon eggs. These impacts in turn degrade or eliminate important fish and wildlife habitat and reduce their populations.

> *"The channel is carved by the flowing water, but it takes the form dictated by the sediment carried."*
> *Luna Leopold*

Based on an historical evaluation of Tuolumne River hydrology (streamflow patterns) and geomorphology (river channel form), and a review of scientific literature, the ***Attributes of River Ecosystem Integrity*** *were developed to describe how the Tuolumne River functioned historically, and also to serve as measurable restoration objectives. By managing streamflows, reducing unwanted fine sediment supply, increasing important coarse sediment supply, and restoring a natural channel form, many of the critical river attributes and processes can be achieved.*

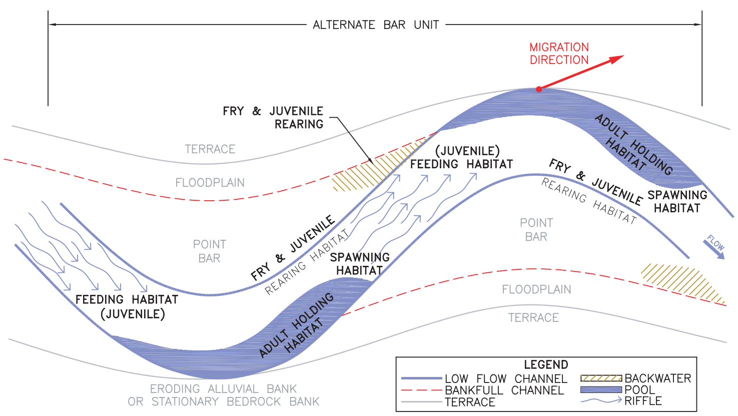
This restoration approach focuses on restoring a natural pattern of periodic disturbance and continual re-growth that creates a mosaic of high quality habitat for many species, including salmon. Without these dynamic processes, the river has become static and less biologically productive.

Attributes of river ecosystem integrity

ATTRIBUTE #1

Spatially complex channel shape (morphology)

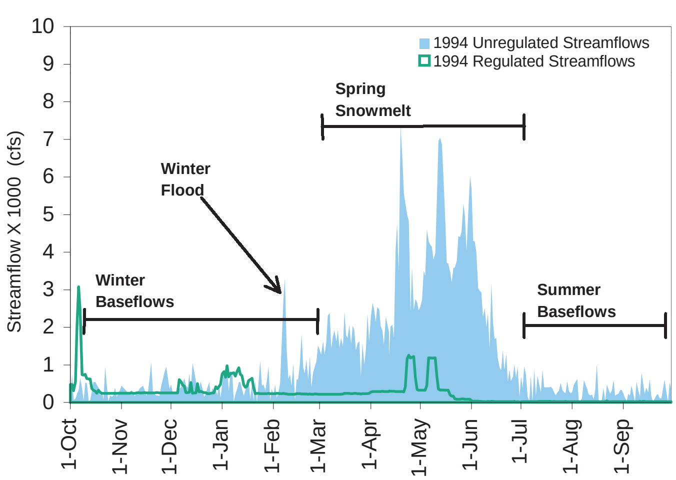
No single segment of river provides habitat for all species, but the sum of different areas of the river provides high-quality habitat for native species.



ATTRIBUTE #2

Variable streamflow patterns

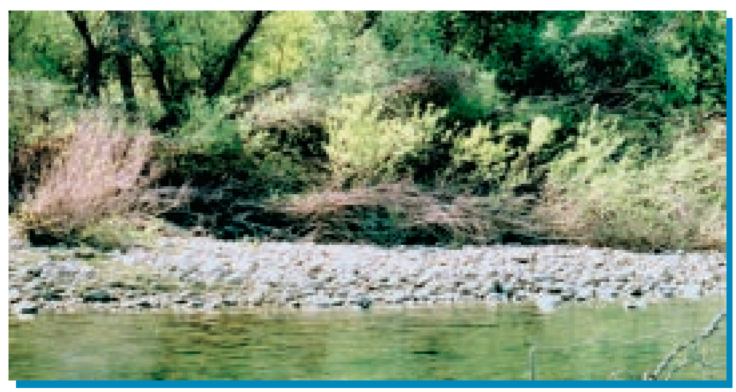
Seasonal streamflow patterns are broadly predictable, but specific flow magnitudes, timing, durations, and frequencies are unpredictable due to runoff patterns produced by storms, droughts and snowmelt. Streamflow variability is a foundation of river ecosystem health.



ATTRIBUTE #3

Frequently disturbed riverbed surface

In the upper river (from La Grange Dam to Hughson) where the river bed is mostly made of gravel, surface gravels and cobbles are moved downstream by moderate streamflows which occur on average every 1 or 2 years. In the lower river (from Hughson to the San Joaquin River) where the bed is mostly sand, sand is moved downstream during much of the year, creating migrating "dunes" and shifting sand bars.



ATTRIBUTE #4

Periodic riverbed scour and fill

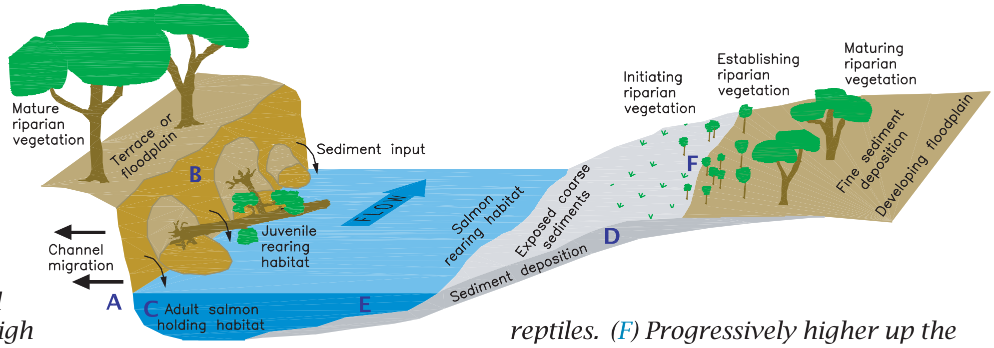
In gravel-bedded reaches, larger floods move entire gravel bars, not just their surface layers. These large floods occur on average every 3 to 5 years. This "scour" is typically accompanied by "fill" from upstream gravel sources, which maintains a balance in natural channel form. This process is important for removing fine sediments from salmon spawning gravels.

ATTRIBUTE #5

Balanced fine and coarse sediment volumes

The location and volumes of sediment within a river reach may vary year to year, but over the long term the amount of sediment entering and leaving the river is balanced, and the channel form remains similar. A balanced sediment load implies that streamflows are periodically high enough to move most sediment sizes (sand and boulders) in the river.

...the technical aspects of river ecosystems

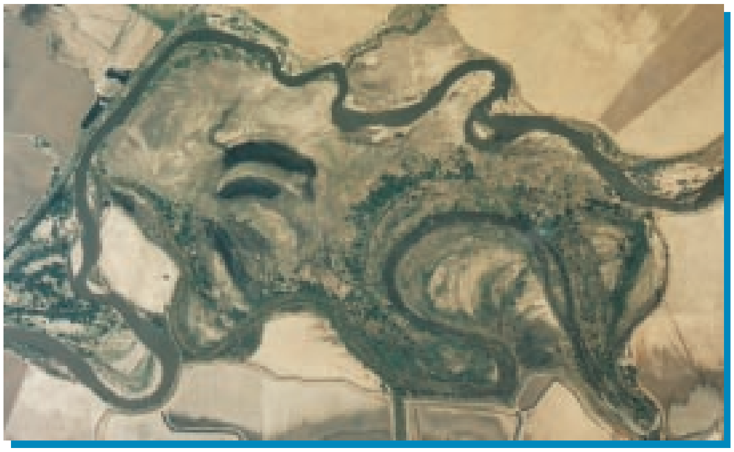


An example of the dynamics of natural rivers is depicted at right. (A) A channel with adequate space to migrate (Attribute 6) erodes the channel bank on the outside of the meander bend during high flows (Attribute 2), (B) encouraging aged riparian trees to topple into the channel (Attribute 9). (C) A deep pool also forms here, which provides structural complexity (Attribute 1) for good fish habitat. As bank erosion continues, the pool "migrates" downstream (Attribute 6), but high quality habitat is maintained. (D) On the opposite bank, high flows (Attribute 2) scour and redeposit coarse sediments (Attributes 4 and 5), forming a shallow bar on the inside of the meander bend (Attribute 1), and providing clean spawning gravels. (E) This area, in turn, provides ideal slow-water rearing conditions for juvenile chinook salmon, as well as habitat for aquatic insects (fish food), amphibians and reptiles. (F) Progressively higher up the gravel bar surface, a dynamic interplay occurs between receding water levels during the spring snowmelt (Attribute 2), and the presence of riparian tree seeds (Attribute 7). These woody riparian trees are sporadically scoured out (Attribute 8), and those established high enough on the bank are toppled into the channel as the channel migrates back across the valley (A).

ATTRIBUTE #6

Periodic channel migration and/or avulsion

The channel erodes riverbanks, deposits new gravel bars, and establishes meander patterns based on variable streamflows, valley slope, river channel confinement, sediment supply, and sediment size. In the gravel-bedded reaches, the channel moves from one location to another by sudden change, leaving much of the abandoned channel intact. In the sand-bedded reaches, meanders gradually erode through banks and cut off meander bends, leaving oxbow lakes and wetlands.



ATTRIBUTE #7

A functional floodplain

Every one or two years, on average, high streamflows inundate the lowermost floodplains, deposit silts and sand, and stimulate germination of riparian vegetation. Lower terraces, at a slightly higher elevation than floodplains, are inundated by less frequent floods.

ATTRIBUTE #8

Infrequent channel resetting floods

Single large floods (recurring once every 10 to 20 years) cause major channel changes that rejuvenate riparian processes, form and maintain side channels, and create off-channel wetlands, such as oxbows.

ATTRIBUTE #9

Self-sustaining, diverse riparian corridor

Based on species life history strategies and streamflow patterns, the riparian plant community is maintained by a continual cycle of germination, growth, and death. The riparian community thus contains young and old vegetation, and a diversity of species.

ATTRIBUTE #10

Naturally fluctuating groundwater table

Groundwater fluctuates on a seasonal and annual basis in floodplains, terraces, and sloughs.

Tuolumne River restoration strategies

Rivers are resilient ecosystems with enormous capacity for self-rejuvenation. However, given that land-use practices and water regulation and diversion will continue, the river cannot recover in a reasonable timeframe without help. The Restoration Plan recommends several strategies to initiate recovery, such as filling mining pits, introducing spawning gravels, lowering selected floodplains to allow inundation, and re-planting native riparian vegetation. Equally important, flood and gravel management will help re-establish processes to maintain restored areas and improve other areas.

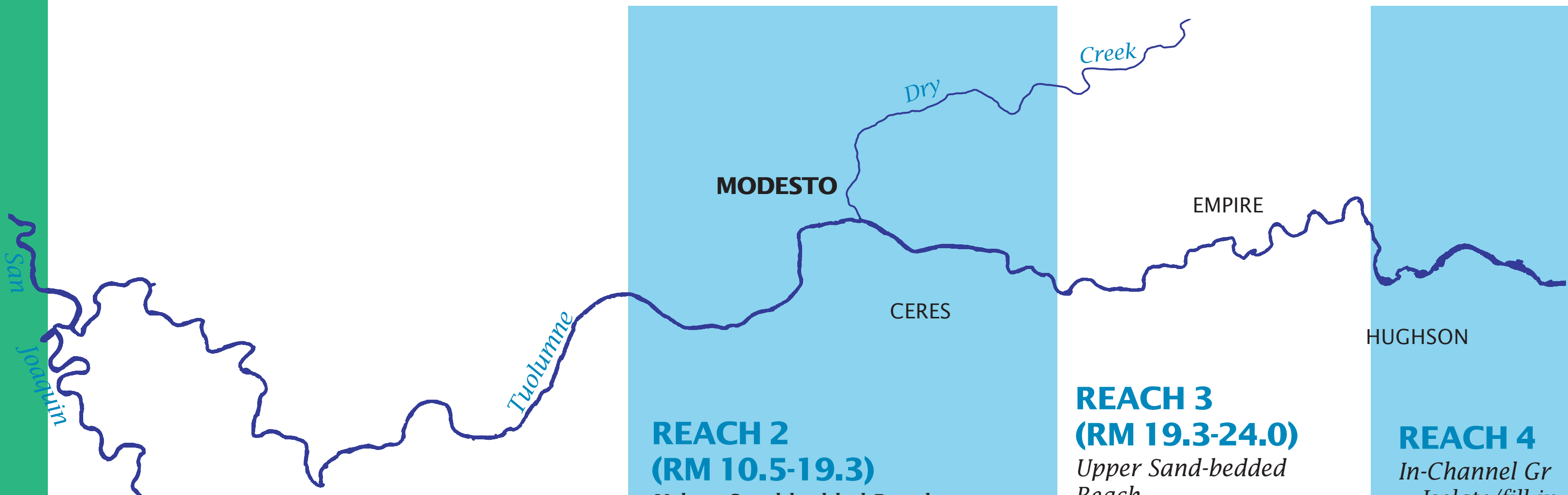
The Restoration Plan recommends general restoration strategies for different reaches along the river, as well as specific restoration projects within those reaches. Inherent with any restoration plan of this scale is some degree of uncertainty regarding the effectiveness of specific restoration actions. Therefore, an adaptive management program would require 1) monitoring restoration sites, 2) evaluating restoration success against desired conditions, and 3) improving restoration strategies. This will ensure progress toward recovery goals.

Implementation of any restoration project will be subject to prior environment review by local, state, and federal regulatory agencies. The TRTAC participants recognize that decisions affecting the Tuolumne River are influenced by diverse policies relating to land use, water supply and use, water quality, flood control, fish and wildlife, and recreation, and are not governed solely by habitat considerations. Additionally, the TRTAC recognizes the importance of cooperation and participation from private landowners, the local business community, and the general public.

Long-term restoration recommendations

SAND-BEDDED ZONE (RM 0.0 TO RM 24.0)

- *Restore floodway capacity to 15,000 cfs or greater above Dry Creek and 20,000 cfs or greater below Dry Creek*
- *Reduce urban and agricultural encroachment to create/maintain a 500-2,000 ft or greater floodway width*
- *Remove rip-rap and berms where feasible to restore floodplains and to allow migration within the floodway*
- *Seek conservation easements and/or land acquisitions (especially of flood-prone lands) from willing landowners*
- *Remove exotic plants within riparian corridor and replant native species*
- *Secure protection for existing mature valley oaks and Fremont cottonwoods*
- *Improve water quality by managing urban, agricultural and industrial runoff into the river and into Dry Creek*



REACH 1 (RM 0.0-10.5)

Lower Sand-bedded Reach

- *Restore off-channel wetlands to increase wildlife habitat*
- *Create vegetative buffer to reduce soil erosion and filter agricultural runoff*
- *Restore functional floodplains and native riparian forests*

REACH 2 (RM 10.5-19.3)

Urban Sand-bedded Reach

- *Increase public awareness of the Tuolumne and promote cleanup, restoration and monitoring*
- *Improve Tuolumne River Regional Park by increasing area of native riparian trees*
- *Create and preserve riparian buffer along urban/industrial zones*
- *Remove trash and debris, eliminate chronic sources of pollution, and actively prohibit illegal dumping*

REACH 3 (RM 19.3-24.0)

Upper Sand-bedded Reach

- *Preserve existing urban setback from river*
- *Create and preserve a riparian buffer along urban/agricultural zones*

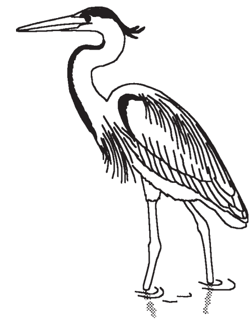
REACH 4

In-Channel Gr

- *Isolate/fill in predation on bedload tran*
- *Restore a nat*
- *Create and m along urban/*

RIVER-WIDE RESTORATION GOALS

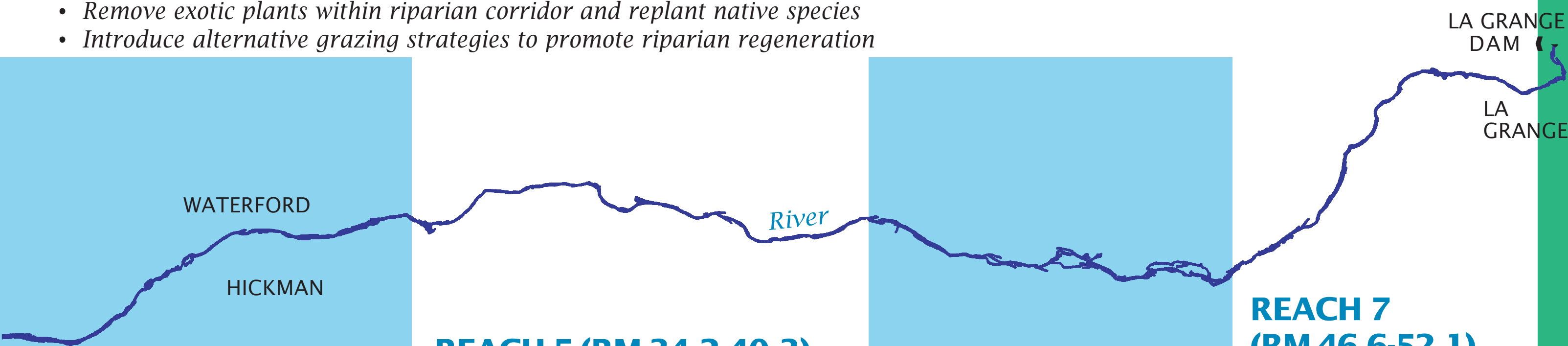
- *Chinook salmon habitat maintained by natural processes, sustaining a viable, naturally reproducing chinook salmon population*
- *Adequate quantity of high quality gravel, maintained by periodically replacing gravels transported downstream by high flows*
- *A dynamic river channel, maintained by floods of variable magnitude and frequency that periodically initiate critical channel processes*
- *A continuous river floodway and riparian corridor from La Grange Dam to the confluence with the San Joaquin River*
- *Increased extent of naturally regenerating native riparian stands and decreased extent of exotic plants*
- *Adaptive management program that continually reviews and refines restoration and management activities, and addresses areas of scientific uncertainty that will improve our understanding of river ecosystem processes*
- *Improved water quality through urban and agricultural runoff management programs*
- *Increased public awareness and involvement in the Tuolumne River restoration effort*



Great Blue Heron

GRAVEL-BEDDED ZONE (RM 24.0-52.1)

- *Increase gravel supply throughout the zone and increase the frequency of gravel movement*
- *Reduce fine sediment supply and storage*
- *Restore floodway capacity to 15,000 cfs or greater*
- *Reduce agricultural and mining encroachment to create/maintain a 500 ft or greater coridor width*
- *Remove rip-rap and berms where feasible to restore floodplains and to allow migration within the floodway*
- *Manage flood control releases to initiate bed movement and other dynamic channel processes*
- *Restore a continuous corridor of native riparian vegetation*
- *Improve habitat quality of off-channel wetlands*
- *Seek conservation easements and/or land acquisitions (especially of flood-prone lands) from willing landowners*
- *Remove exotic plants within riparian corridor and replant native species*
- *Introduce alternative grazing strategies to promote riparian regeneration*



(RM 24.0-34.2)

avel Mining Reach

stream mining pits to reduce bass juvenile salmon and reestablish sport continuity

ural river and floodplain morphology

aintain riparian buffer (corridor) agricultural zones

REACH 5 (RM 34.2-40.3)

Gravel Mining Reach

- *Isolate off-channel mining pits to prevent river connection during floods up to 15,000 cfs to reduce salmon stranding and bass predation on juvenile salmon*
- *Increase floodway width to at least 500 feet*
- *Restore a natural river and floodplain morphology*
- *Restore and maintain riparian corridor through gravel mining zones*

REACH 6 (RM 40.3-46.6)

Dredger Tailing Reach

- *Reconstruct remnant channel left by gold dredger operations to a natural river and floodplain form*
- *Restore riffles to increase salmon spawning and rearing habitat*
- *Regrade floodplains to reduce salmon stranding and promote riparian regeneration*
- *Reduce riparian encroachment onto low flow channel*
- *Reduce grazing impacts to promote riparian regeneration on floodplains*
- *Secure remnant dredger tailings for future restoration*

REACH 7 (RM 46.6-52.1)

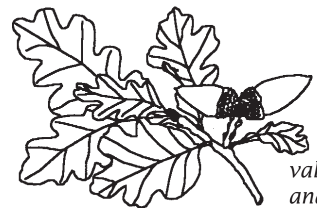
Critical Spawning Reach

- *Reduce sand input into river and storage in riverbed (especially in spawning gravels)*
- *Increase and maintain spawning gravel supply*
- *Restore riffles to increase salmon spawning and rearing habitat*
- *Regrade floodplains to reduce salmon stranding and promote riparian regeneration*
- *Reduce riparian encroachment onto active channel*
- *Reduce grazing impacts to promote riparian regeneration on floodplains*

Restoration in progress

Responding to the FERC Settlement Agreement mandate to implement ten priority restoration projects by 2005, the TRTAC has received funding for several projects from the CALFED Ecosystem Restoration Program and the CVPIA's Anadromous Fish Restoration Program (AFRP), implemented by the US Fish and Wildlife Service. The TRTAC has selected six projects (Phases I-IV of the Gravel Mining Reach and Special Run Pools 9 and 10) which are now in the planning and design phase. The remaining four projects are currently being evaluated.

Other entities are also proposing or conducting restoration activities on the Tuolumne River, including the US Army Corp of Engineers, US Fish and Wildlife Service, California Department of Fish and Game, Natural Resources Conservation Service, East Stanislaus Resource Conservation District, Friends of the Tuolumne, California State Parks, and the Joint Powers Authority (City of Modesto, City of Ceres, and Stanislaus County). Several of these projects are illustrated below.



valley oak leaves and acorns

TUOLUMNE RIVER REGIONAL PARK

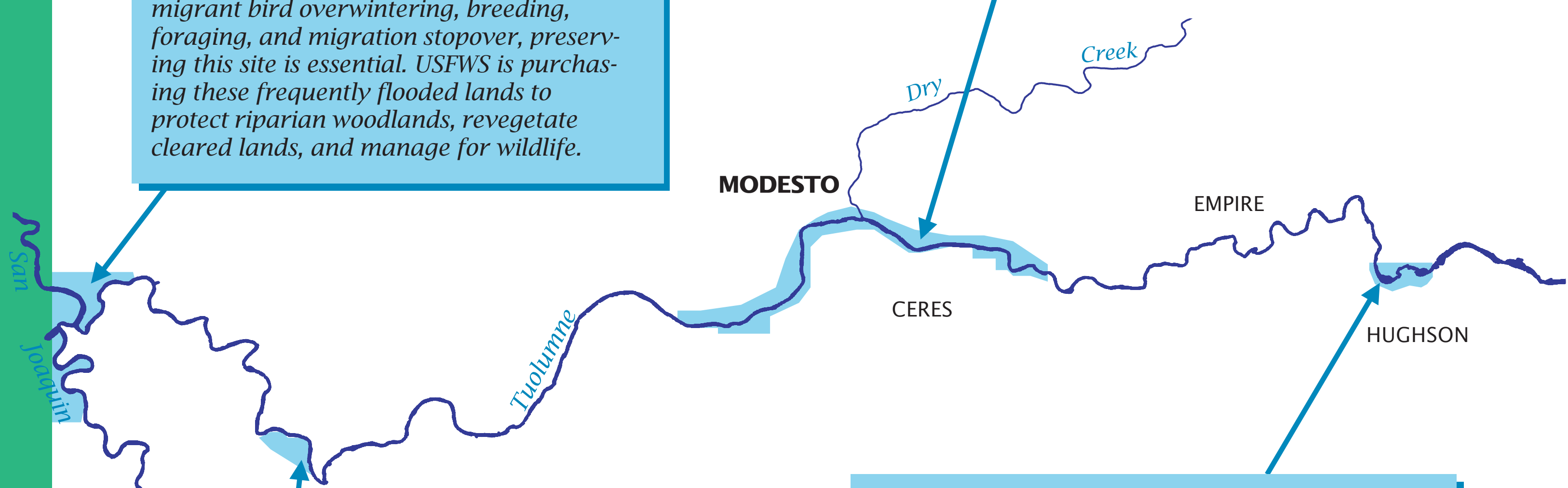
Joint Powers Authority
(City of Modesto, City of Ceres, Stanislaus County)

This project has been undertaken by the Cities of Modesto and Ceres, and Stanislaus County since 1967 with the vision of creating a continuous river park through the greater Modesto urban area. Approximately 700 acres of riverside property have been acquired to create the Park. The Joint Powers Authority is now revising the land use plan for the Park, preparing a Master Plan for the Gateway Parcel at the Dry Creek confluence, and will soon be implementing a variety of restoration activities within the Park.

SAN JOAQUIN RIVER NATIONAL WILDLIFE REFUGE

US Fish and Wildlife Service

This site represents one of the few remaining floodplains in the San Joaquin basin that has much of its riparian habitat intact. Since this habitat is critical for resident and migrant bird overwintering, breeding, foraging, and migration stopover, preserving this site is essential. USFWS is purchasing these frequently flooded lands to protect riparian woodlands, revegetate cleared lands, and manage for wildlife.



SPECIAL RUN POOLS 9 AND 10 CHANNEL RESTORATION

Tuolumne River Technical Advisory Committee

SRPs 9 and 10 are large in-channel gravel mining pits located in a mile-long reach downstream of Fox Grove County Park. These pits harbor populations of non-native bass that are known to prey on young salmon. Restoration will eliminate bass habitat and increase riparian vegetation. These projects have received funding from CALFED and USFWS/AFRP, and construction will begin in 1999 (see p. 13 for more detailed description).

GRAYSON RIVER RANCH CONSERVATION EASEMENT

Natural Resources Conservation Service
East Stanislaus Resource Conservation District
CALFED/AFRP

The Grayson River Ranch site, located 5 miles from the confluence with the San Joaquin River, is subject to frequent flooding. A partnership of non-profit, local, state and federal agencies and groups are funding a Perpetual Conservation Easement for this land. The Grayson project has the potential to become a model for future conservation of floodplain and riparian habitats on the Lower Tuolumne River. (See p. 14 for a more detailed description.)

Restoration Types

Floodway expansion: *Provide a wider floodway and restore floodplains to reduce river confinement, allow natural channel migration, provide additional flexibility for dam operations to reduce the risk of catastrophic floods, increase riparian vegetation, and improve river habitat conditions.*

Riparian restoration: *Replant riparian vegetation to help promote natural regeneration, specifically targeting Fremont cottonwood and valley oak species.*

Channel reconstruction: *Rebuild a natural channel shape that allows gravel movement, channel migration, floodplain inundation, riparian regeneration, and sand/silt deposition on floodplains.*

Conservation easements: *Preserve riparian areas (especially flood-prone lands), while ownership of the land is maintained by private individuals. Riparian restoration could be implemented within the conservation easement.*

Preservation sites: *Preserve sites containing stands of mature riparian trees.*

Sand management (fine sediment): *Reduce fine sediment within riverbed gravels, by prevention, mechanical means and/or periodic managed flood releases.*

Gravel management (coarse sediment): *Provide an initial large volume of gravel to replace the gravels lost over the past century, then periodically introduce gravel to balance the loss of gravels moved downstream during high streamflows.*

Additional management approaches: *Increase water quality by controlling urban and agricultural runoff; introduce alternative grazing strategies within floodway to promote native riparian regeneration and reduce bank erosion; introduce vegetative buffer strips along the river and within agricultural and urban lands to reduce soil loss, and to decrease sound, air and non-point source pollution into the riparian corridor.*

BASSO ECOLOGICAL RESERVE LAND PURCHASE

California Department of Fish & Game, Stanislaus County

Acquisition of three parcels totaling 42 acres is being funded by CALFED. This land between La Grange Bridge and Basso Bridge represents the "missing link" connecting adjacent 350-acre (west) and 185-acre (east) county-owned parcels. This reach is one of the primary chinook salmon spawning areas, and the land purchase will protect this critical spawning habitat.

GRAVEL MINING REACH FLOODWAY RESTORATION

Tuolumne River Technical Advisory Committee

This 7-mile reach near Waterford (from Roberts Ferry Bridge to the Old Reed Rock Plant) supports active off-channel gravel mining, and was extensively damaged during the 1997 flood. CALFED and USFWS/AFRP have funded the first of four phases of this project, with Phase I, the upper two miles of the project, set to begin in 1999. Phases II-IV will proceed in subsequent years. Restoration activities will include increasing floodway capacity to convey at least 15,000 cfs, increasing salmon spawning and rearing habitat, protecting dikes and off-channel pits from future flood damage, and restoring riparian forests on floodplains.

SPAWNING GRAVEL SUPPLEMENTATION

California Department of Fish & Game, TRTAC

Construction of La Grange Dam in 1893 permanently ended gravel supply to downstream reaches of the Tuolumne River. Restoring gravel supply to the Tuolumne River below La Grange Dam will greatly improve salmon spawning and rearing habitats. The project starts with initial mechanical placement of a large volume of gravel to begin replacing over 100 years of lost gravel supply, followed by periodic augmentation to maintain supply as gravels slowly move downstream during high flows.

Special Run Pools 9 and 10: A channel reconstruction project

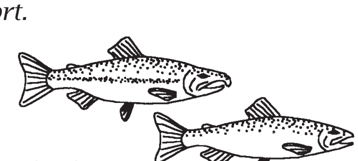
An excellent way to understand the scope of river restoration on the Tuolumne River is to witness a project in progress. The opportunity will soon be afforded by the **Special Run Pool 9 (SRP 9) Restoration Project**. *SRP 9 is located immediately downstream of Fox Grove County Park and is visible looking west from the Geer Road Bridge. The Technical Advisory Committee selected SRP 9 as one of the Settlement Agreement projects, and received approximately $2.5 million in funding from CALFED and USFWS/AFRP. At present, environmental permitting and compliance documents are nearing completion, engineers are preparing final design details, and construction is scheduled to begin in summer of 1999. The Turlock Irrigation District is administering the project for the TRTAC.*

Instream and off-channel gravel mining began in this reach in the 1950s. Today, 30-foot deep pits provide habitat for bass (a predator of juvenile salmon) and also block sediment movement through this reach.

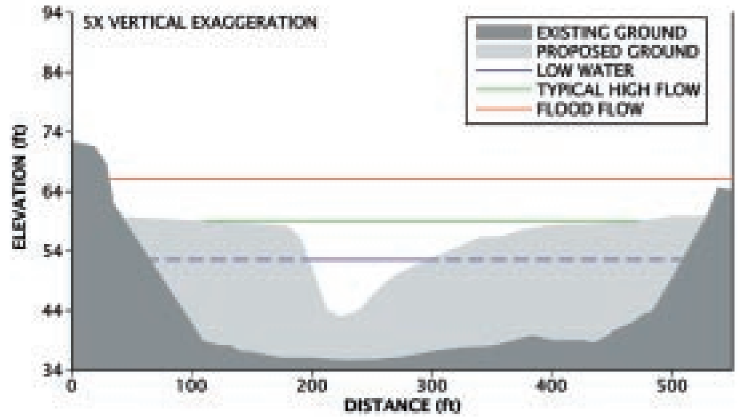
WHAT TO DO

Section 12C of the Settlement Agreement specifies "at least two pond isolation projects will be included in the 10 priority projects." The TRTAC considered a variety of alternatives for restoring SRP 9, such as constructing a dike to separate the channel from the large backwater pit, or actively removing unwanted predator fish, leaving the pond intact. In the end, the TRTAC determined that the best solution was to refill the entire pit with gravel and cobble to reconstruct a natural river channel, restore a natural channel and floodplain form, and re-vegetate floodplains with cottonwoods, valley oaks and other native vegetation. This approach will help restore natural river processes, provide additional riparian habitat, and improve conditions for chinook salmon by creating new juvenile habitat and eliminating predator habitat. By trying to restore "ecosystem processes", in addition to improving conditions for a single species, the SRP 9 project is essentially a large-scale experiment, and will be thoroughly monitored over the next several years to determine if project objectives are met.

When complete, the restored project reach may provide a permanant solution to decades-old problems, and represent a significant piece of the 52-mile Tuolumne River corridor restoration effort.



chinook salmon



As shown in a typical cross section through the SRPs, the existing channel is four times wider and at least two times deeper than it should be. Narrowing the channel will eliminate bass habitat, allow gravels to move through the reach, and provide floodplains for replanting riparian vegetation.

A BRIEF HISTORY

Beginning in the 1930s, gravel miners extracted valuable sand and gravel aggregate directly from the river channel, creating large pits in the river with water depths up to 36 ft. Excavating these ponds eliminated salmon spawning and rearing habitat, as well as entire floodplains and riparian vegetation. These large pits now trap all coarse sediment (gravel and cobble) carried downstream by high flows, and provide warm-water habitat for non-native bass species that eat chinook salmon smolts as they migrate out to sea. Studies found largemouth bass densities to be as high as 750 adult bass per river-mile. Since every chinook salmon juvenile produced on the Tuolumne River must pass through this reach, bass have the potential to consume many thousands of juvenile salmon during the outmigration season. Reducing bass predation by eliminating their habitat is thus a high priority objective for restoring the chinook salmon population.

In 1937, prior to aggregate extraction, this reach of the Tuolumne River had a natural channel form and floodplain. Riparian vegetation was scattered across the floodway and gravel bars were exposed at low flows.

Grayson River Ranch: A perpetual conservation easement

The Grayson River Ranch project is an excellent example of ways in which voluntary public participation and leadership from local agencies can make the vision for a Tuolumne River floodway come to life. Located between river miles 5 and 6 from the mouth of the Tuolumne River, the 140 acre Grayson River Ranch parcel was historically a river floodplain vegetated with riparian hardwood species. The property was cleared for cultivation as early as 1937, and has flooded repeatedly over the years.

Following the 1997 flood , the property owner applied for and may receive a **Perpetual Conservation Easement** for parts of the Grayson River Ranch parcel. The USDA Natural Resources Conservation Service administers easement agreements in cooperation with the East Stanislaus County Resource Conservation District, linking with various local, state, federal, and non-profit (e.g. FOTT) partners. The easement would allow for seasonal flooding and restoration of riparian habitats, while keeping the property in the hands of private owners. If the easement agreement is finalized, the NRCS will develop plans for restoring the parcel to more natural conditions, which may include revegetation with native riparian hardwood species, and/or creating off-channel wetlands. With restoration, this land will provide increased fishery, wildlife, and flood management benefits.

A few large stands of riparian vegetation persist along the Tuolumne. Although it took only decades to clear much of the land, centuries old valley oaks are not as quickly replaced. This multi-story, diverse canopy architecture provides habitat for many species of birds and wildlife.

Even with dikes, many parcels of land near the confluence with the San Joaquin River are frequently flooded (note traces of soil erosion from 1997 floods). These former floodplains contain soils of marginal quality for agricultural production, and generally support feed crops for livestock. However, they are ideally suited to sustain native hardwood forests as well as a lush understory of flood-dependent plant species.

Before the land along the Tuolumne had been converted to agriculture, old-growth oak forests extended across the floodplain to merge with the forests along the Stanislaus, Merced and San Joaquin Rivers. In 1937, clearing of the Grayson River Ranch parcel was well underway.

VALLEY OAK

The majestic valley oak, once a symbol of the native California landscape and a dominant figure in riparian forests, is now nearly gone. Confined to less than 2 % of its original habitat state-wide, this flood-dependent native is endemic - it grows nowhere else but in California. Land acquisitions or conservation easements may be the only way to preserve the rare remaining groves of valley oak and allow new trees to propagate.

Front cover photographs (clockwise from top-left)

- *Adult chinook salmon returning to the river to spawn*
- *A dynamic gravel bar near Basso Bridge at river mile 49.2*
- *La Grange Dam at river mile 52.2*
- *Mature valley oak and Fremont cottonwood riparian forest*

THIS DOCUMENT IS A SUMMARY OF THE

Habitat Restoration Plan for the Lower Tuolumne River Corridor

PREPARED FOR

The Tuolumne River Technical Advisory Committee

WITH ASSISTANCE FROM

US Fish and Wildlife Service
Anadromous Fish Restoration Program

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