LOWER MOKELUMNE RIVER PROJECT
JOINT SETTLEMENT AGREEMENT
TEN-YEAR REVIEW

PARTNERSHIP STEERING COMMITTEE

East Bay Municipal Utility District
California Department of Fish and Game
U.S. Fish and Wildlife Service

2008

LOWER MOKELUMNE RIVER JOINT SETTLEMENT AGREEMENT TEN-YEAR REVIEW

1.0 BACKGROUND

The Federal Energy Regulatory Commission's (FERC) November 27, 1998 Order "Approving Settlement Agreement and Amending License for the East Bay Municipal Utility District's Lower Mokelumne River Project No. 2916" approved the Joint Settlement Agreement (JSA) entered into by East Bay Municipal Utility District (EBMUD), U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG). The JSA included flow and non-flow measures, and required EBMUD, USFWS, and CDFG to develop a plan Water Quality and Resource Management Program (WQRMP) for FERC approval.

The Partnership Steering Committee, composed of one representative each from CDFG, USFWS and EBMUD, developed WQRMP to define reasonable goals, measures, performance criteria and responsive actions associated with the implementation of the JSA. It includes a comprehensive monitoring and applied research program integrated with a well-coordinated program to adaptively manage water and power supply operations, flood control, hatchery operations and ecosystem rehabilitation actions. It was approved by FERC in 2001.

JSA Goals

- Provide, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition
- Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act
- Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River

This report summarizes the findings of the Partnership Steering Committee with respect to the progress and accomplishments resulting from the first ten years of JSA implementation as defined in the Water Quality and Resource Management Program and recommends strategies and measures for continued implementation.

Sandy Morey
California Department of Fish and Game

9-10-08
Date

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2.0 ACCOMPLISHMENTS

2.1 Flow Measures

The JSA specifies minimum flow releases from Camanche Dam and expected flow below the Woodbridge Irrigation District Dam (WIDD) based on time of year and water year types. Water year types are determined based on combined storage in Camanche and Pardee reservoirs (October through March) and the unimpaired runoff into Pardee Reservoir (April through September). Since 1998, there have been 6 Normal and Above, 2 Below Normal, and 2 Dry water year types from October through March; and, 2 Normal and Above, 4 Below Normal, and 4 Dry water year type from April through September. Although the minimum flow releases from Camanche Dam and the expected flows below WIDD are designed to protect the fish resources in the lower Mokelumne River, actual flows have always exceeded the required releases below Camanche Dam (Table 1) and the expected flows below WIDD (Table 2).

Table 1. Comparison of JSA required release and actual releases below Camanche Dam.

Year	Period	JSA Water Year Type	JSA Required Release (Acre-feet)	Actual Release (Acre-feet) [1]
1998/1999	Oct-Mar	Normal & Above	117,294	349,361
1999	Apr-Sep	Below Normal	63,357	320,530
1999/2000	Oct-Mar	Normal & Above	117,939	274,205
2000	Apr-Sep	Below Normal	63,357	200,664
2000/2001	Oct-Mar	Normal & Above	117,294	119,827
2001	Apr-Sep	Dry	50,804	113,937
2001/2002	Oct-Mar	Dry	79,399	87,062
2002	Apr-Sep	Below Normal	63,357	139,500
2002/2003	Oct-Mar	Below Normal	90,227	95,394
2003	Apr-Sep	Dry	50,804	231,018
2003/2004	Oct-Mar	Normal & Above	117,939	130,259
2004	Apr-Sep	Below Normal	84,476	170,839
2004/2005	Oct-Mar	Below Normal	90,227	190,733
2005	Apr-Sep	Normal & Above	107,033	546,981
2005/2006	Oct-Mar	Normal & Above	117,294	388,359
2006	Apr-Sep	Normal & Above	112,982	826,939
2006/2007	Oct-Mar	Normal & Above	117,294	132,694
2007	Apr-Sep	Dry	50,804	124,118
2007/2008	Oct-Mar	Dry	80,481	82,157 [2]
2008	Apr-Sep	Dry	50,804	190,268 [2]

[1] Actual Release from USGS published data for site 11323500
[2] Estimated

Table 2. Comparison of JSA expected flow and actual flow below Woodbridge Dam.

Year	Period	JSA Water Year Type	JSA Expected Flow (Acre-feet)	Actual Flow (Acre-feet) [1]
1998/1999	Oct-Mar	Normal & Above	36,091	313,161
1999	Apr-Sep	Below Normal	36,765	221,223
1999/2000	Oct-Mar	Normal & Above	36,289	249,674
2000	Apr-Sep	Below Normal	36,765	110,477
2000/2001	Oct-Mar	Normal & Above	36,091	97,219
2001	Apr-Sep	Dry	22,983	30,465
2001/2002	Oct-Mar	Dry	28,872	62,923
2002	Apr-Sep	Below Normal	36,765	44,927
2002/2003	Oct-Mar	Below Normal	36,091	71,503
2003	Apr-Sep	Dry	22,983	146,080
2003/2004	Oct-Mar	Normal & Above	36,289	94,034
2004	Apr-Sep	Below Normal	36,765	68,596
2004/2005	Oct-Mar	Below Normal	36,091	151,315
2005	Apr-Sep	Normal & Above	49,773	423,398
2005/2006	Oct-Mar	Normal & Above	36,091	360,198
2006	Apr-Sep	Normal & Above	49,773	726,760
2006/2007	Oct-Mar	Normal & Above	36,091	106,505
2007	Apr-Sep	Dry	22,983	34,054
2007/2008	Oct-Mar	Dry	29,031	66,074 [2]
2008	Apr-Sep	Dry	22,983	94,236 [2]

[1] Actual Release from USGS published data for site 11325500
[2] Estimated

2.2 Fall-run Chinook salmon

Since implementation of the JSA in 1998, the population of fall-run Chinook salmon as measured by total escapement to the lower Mokelumne River has increased (average 1964 through 1997 = 3,636; 1998 through 2007 = 8,455, Figure 1); and as measured by in-river escapement (average 1964 through 1997 = 2,503; 1998 through 2007 = 2,973, Figure 2). Total and in-river escapement, number of redds, and estimated number of outmigrating juvenile fall-run Chinook salmon through the period are shown in Table 3.

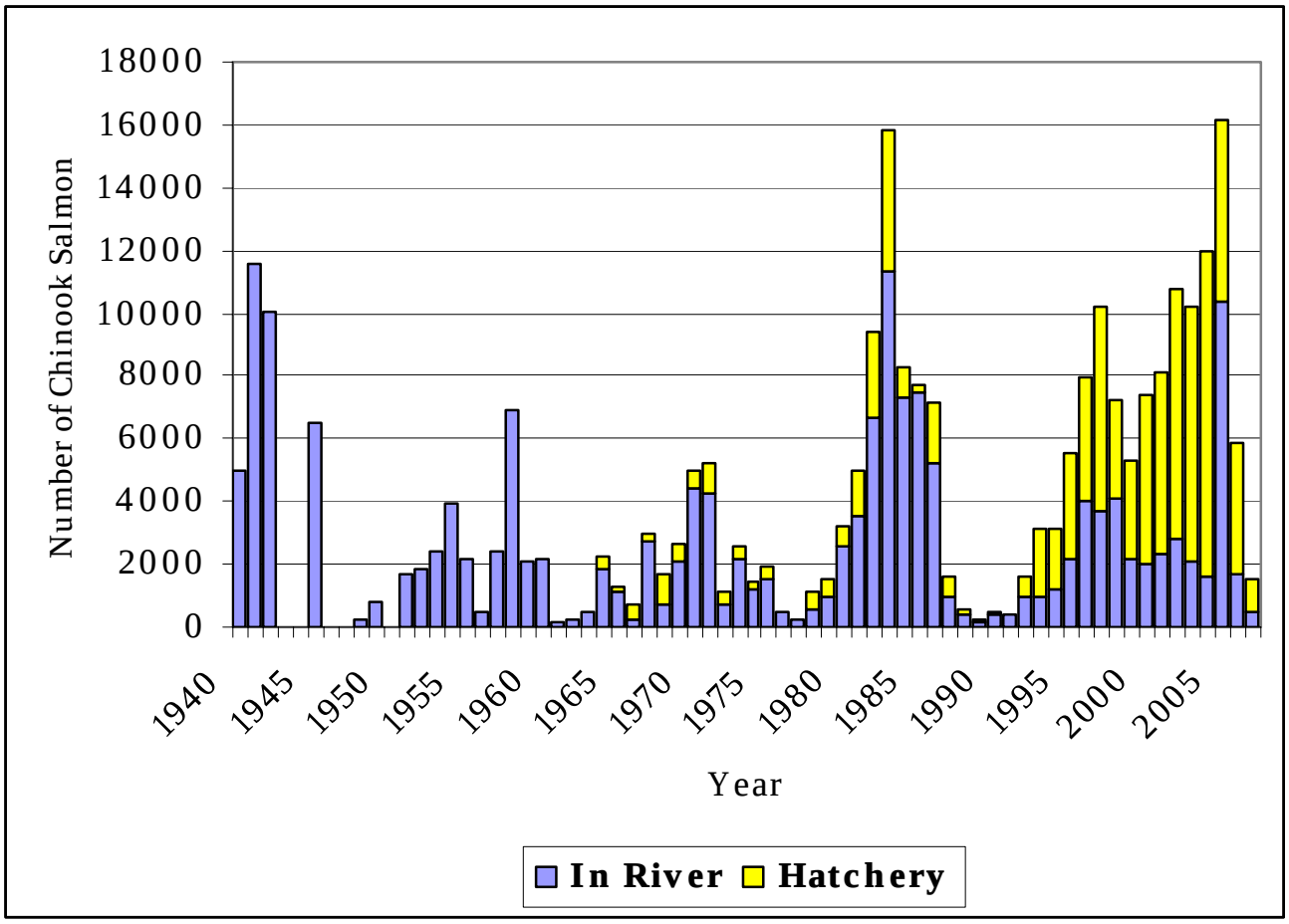


Figure 1. Mokelumne River Fall-run Chinook Salmon Escapement

Table 3. Fall-run Chinook salmon escapement, number of redds and outmigrants observed.

Year	Period	JSA Water Year Type	Preceding JSA Water Year Type	Total Escapement (In-river)	Number of Redds	Outmigrants
1998/1999	Oct-Mar	Normal & Above	Normal & Above	7,213 (4,122)	1,116	
1999	Apr-Sep	Below Normal	Normal & Above			1,535,439
1999/2000	Oct-Mar	Normal & Above	Below Normal	5,333 (2,183)	623	
2000	Apr-Sep	Below Normal	Normal & Above			168,525
2000/2001	Oct-Mar	Normal & Above	Below Normal	7,423 (1,973)	987	
2001	Apr-Sep	Dry	Normal & Above			119,334
2001/2002	Oct-Mar	Dry	Dry	8,116 (2,307)	843	
2002	Apr-Sep	Below Normal	Dry			77,923
2002/2003	Oct-Mar	Below Normal	Below Normal	10,759 (2,840)	848	
2003	Apr-Sep	Dry	Below Normal			140,471
2003/2004	Oct-Mar	Normal & Above	Dry	10,239 (2,122)	807	
2004	Apr-Sep	Below Normal	Normal & Above			87,654
2004/2005	Oct-Mar	Below Normal	Below Normal	11,944 (1,588)	835	
2005	Apr-Sep	Normal & Above	Below Normal			432,874
2005/2006	Oct-Mar	Normal & Above	Normal & Above	16,144 (10,406)	2,170	
2006	Apr-Sep	Normal & Above	Normal & Above			1,187,553
2006/2007	Oct-Mar	Normal & Above	Normal & Above	5,861 (1,723)	754	
2007	Apr-Sep	Dry	Normal & Above			39,627*
2007/2008	Oct-Mar	Dry	Dry	1,519 (470)	305	
2008	Apr-Sep	Dry	Dry			18,347*

* Sampling season abbreviated due to low flow conditions below WID dam

The lower Mokelumne River contributed about 2% (1.2-3.7%) to the total escapement of California Central Valley fall-run Chinook salmon and about 41% (16-77%) to total escapement of fall-run Chinook salmon in the San Joaquin River system. In-river escapement contributed about 1.1% (0.4-4.3%) to the total in-river escapement of California Central Valley fall-run Chinook salmon and about 22% (5-70%) to the total in-river escapement of fall-run Chinook salmon in the San Joaquin River system. Mokelumne River Fish Hatchery escapement contributed about 6.2% (3-9.3%) to the total hatchery escapement of California Central Valley fall-run Chinook salmon and about 83% (66-97%) to total hatchery escapement of fall-run Chinook salmon in the San Joaquin River system.

Table 4. California Central Valley fall-run Chinook salmon escapement.

YEAR	Sacramento River System		San Joaquin River System		Mokelumne River	
	Hatchery	In-river	Hatchery	In-river	Hatchery	In-river
1998/1999	75,028	151,732	3,890	19,711	3,091	4,122
1999/2000	49,657	341,693	4,787	17,893	3,150	2,183
2000/2001	50,965	385,593	7,396	39,474	5,450	1,973
2001/2002	61,702	528,472	7,391	27,303	5,809	2,307
2002/2003	96,471	739,537	9,753	26,666	7,919	2,840
2003/2004	118,144	451,208	8,666	12,717	8,117	2,122
2004/2005	115,929	246,508	13,626	8,637	10,356	1,588
2005/2006	186,833	226,888	6,159	14,835	5,738	10,406
2006/2007	78,326	203,568	4,266	7,245	4,138	1,723
2007/2008	21,638	70,494	1,128	1,450	1,049	470

2.3 Steelhead/Rainbow trout

Since implementation of the JSA, EBMUD has monitored *Oncorhynchus mykiss* populations in the lower Mokelumne River using video monitoring at the Woodbridge Irrigation District Dam fish ladder, rotary screw traps in the lower Mokelumne River below WIDD, and seasonal fish community surveys (electrofishing and seining) from Camanche Dam downstream to WIDD (Table 5).

Table 5. *O. mykiss* observed in the fisheries sampling conducted in the lower Mokelumne River from Camanche Dam downstream to Woodbridge Dam.

Year	Period	Community Surveys [1]		Rotary Screw Trap [2]		WID Fish Ladder [3]	
		Hatchery [4]	Wild [5]	Hatchery	Wild	Hatchery	Wild
1998/1999	Oct-Mar		347	620	22		555
1999	Apr-Sep		227	6	191		2
1999/2000	Oct-Mar		24	871	19		941
2000	Apr-Sep		205	31	148	8	3
2000/2001	Oct-Mar		274	487	77	3,067	89
2001	Apr-Sep		245	4	381	9	23
2001/2002	Oct-Mar		253	9	154	593	152
2002	Apr-Sep		213	1	50	357	400
2002/2003	Oct-Mar		196	82	78	1,017	117
2003	Apr-Sep		98	15	78	1,312	380
2003/2004	Oct-Mar		175	61	16	385	105
2004	Apr-Sep		131	9	43	749	439
2004/2005	Oct-Mar		410	28	7	265	70
2005	Apr-Sep		335	4	74	816	42
2005/2006	Oct-Mar		781	61	8	28	10
2006	Apr-Sep		189	6	51	108	22
2006/2007	Oct-Mar	2	324	75	15	337	16
2007	Apr-Sep	6	273	2	136	121	23
2007/2008	Oct-Mar		213	1	31	*	*

[1] Includes seasonal electrofishing and seining (Jan-Jun)
[2] Rotary screw trap(s) immediately below Woodbridge Irrigation District Dam (mid-Dec thru Jul)
[3] Includes video monitoring and trapping in old ladder
[4] Fish of hatchery origin (adipose fin clip)
[5] Fish of natural origin
* Monitoring system inoperable due to construction of fish screens at WID canal

The number of *O. mykiss* observed in the fish community surveys has varied (Figure 2). In 2005 EBMUD developed a population estimate of *O. mykiss* in the lower Mokelumne River from Camanche Dam downstream to the Woodbridge Irrigation District Dam using a mark/recapture study with PIT (passive integrated transponder) tags. That estimate was 9,215 ± 1,877.

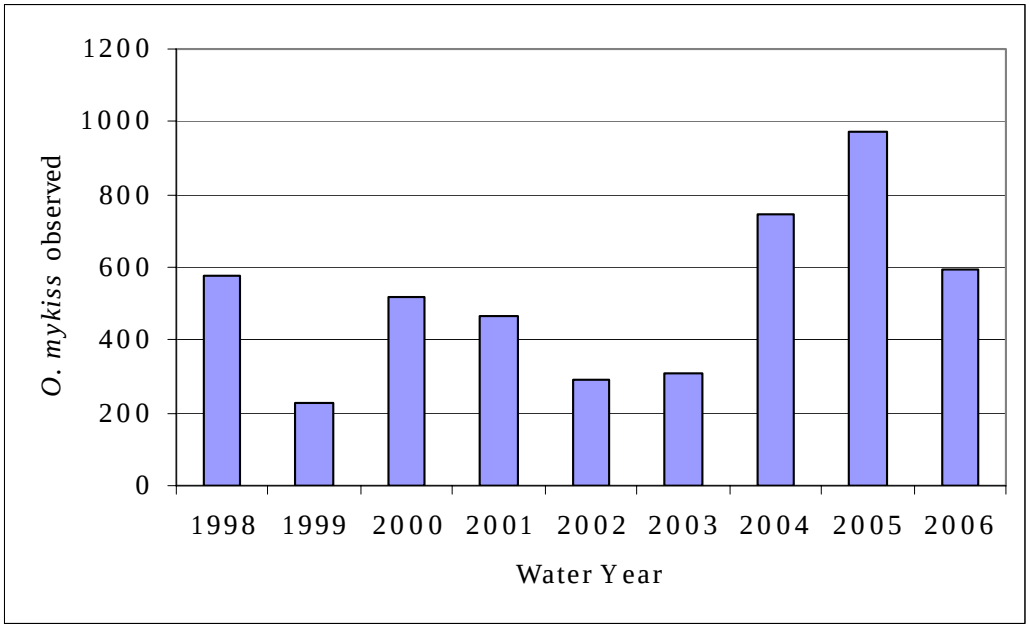


Figure 2. *O. mykiss* observed in the seasonal fish community surveys

Although the number of *O. mykiss* observed in the fish ladder videos and rotary screw traps (Figure 3) may give an impression of upstream (adults, Oct-Mar) and downstream (juveniles, Apr-Sep) movement of fish, it may not be an accurate representation of anadromy.

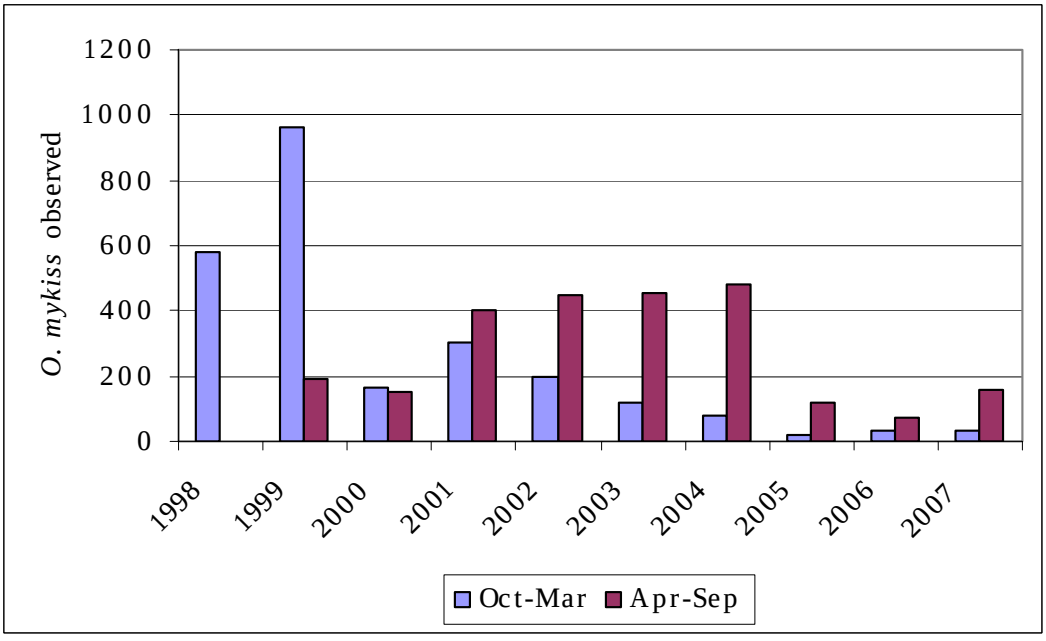


Figure 3. *O. mykiss* observations in the ladder videos and rotary screw traps.

Zimmerman et al. (2008) conducted an analysis of otolith strontium/calcium (Sr:Ca) ratios to determine maternal origin (anadromous v. non-anadromous) and migratory history (anadromous v. non-anadromous) of rainbow trout (*O. mykiss*) collected in tributaries of the Sacramento-San Joaquin River system in the Central Valley of California between 2001 and 2007. Of 964 otoliths examined, 224 were progeny of anadromous rainbow trout (i.e., steelhead) females and 740 were progeny of non-anadromous rainbow trout females. Of the 485 specimens examined from the Calaveras, Stanislaus, and Tuolumne rivers (similar to the Mokelumne river) , less than 1% (4) exhibited anadromous migratory history, and less than 16% (77) were progeny of anadromous females (Table 6).

Table 6. Maternal origin and migratory history of *O. mykiss* from the Calaveras, Stanislaus and Tuolumne rivers.

	AGE					TOTAL
	0	1	2	3	4	
MATERNAL ORIGIN						
Anadromous	6	12	30	17	12	77
Resident	10	72	168	109	49	408
MIGRATORY HISTORY						
Anadromous	0	0	0	0	4	4
Resident	16	84	198	126	55	479
Unknown	0	0	0	0	2	2

The number of *O. mykiss* that have entered the fish ladder and trap in the Mokelumne River Fish Hatchery has steadily increased since implementation of the JSA (Table 7). The proportion of these fish that are hatchery origin has increased from 77% in 2005 to 96% in 2007 and 93% in 2008.

Table 6. *O. mykiss* trapped at the Mokelumne River Fish Hatchery.

Year	Females	Males	Juveniles (<40.6 cm)
1999	0	0	
2000	9	23	
2001	17	15	
2002	18	25	
2003	29	23	29
2004	29	30	23
2005	25	22	13
2006	61	79	49
2007	113	132	167
2008	99	135	110

2.4 Non-Flow Measures

As specified in the JSA, East Bay Municipal Utility District, U.S. Fish and Wildlife Service and California Department of Fish and Game established the Lower Mokelumne River Partnership (Partnership) in 1998 and each agency representative has participated in an annual meeting to measure the success of the JSA flow requirements, non-flow measures and other actions pursuant to implementation of the JSA. The Partnership also established the Partnership Coordinating Committee consisting of technical representatives of each agency that meets semiannually to ensure timely implementation of the measures identified in the JSA and the WQRMP.

In January 1999, EBMUD established the $2 million Partnership fund, the interest from which is used to support Partnership programs to protect and enhance the lower Mokelumne River ecosystem. Since its inception, the Partnership fund has committed over $740,000 to approved projects (Table 7). Restoration activities comprised 61% of the expenditures and approximately 17% was committed to research, 16% to outreach, and 6% to law enforcement. Over 92% of the funds were leveraged with additional funding sources or in-kind services.

The Partnership has worked collaboratively with the Lower Mokelumne River Watershed Stewardship Steering Committee to 1) encourage the voluntary participation and cooperation of other stakeholders along the river, 2) recommend ecosystem protection and improvement priorities, and, 3) serve as a communications and coordination forum for stakeholders.

Representatives of the Partnership along with other resource agency staff and technical experts convene the Mokelumne River Technical Advisory Committee semiannually. This meeting provides a forum for sharing technical information about the fisheries, river operations, hatchery operations, and other issues related to ecosystem actions in the lower Mokelumne River.

The Partnership sponsored periodic symposia to present research findings related to ecological studies in the lower Mokelumne River, including the “State of the Rivers” symposia in 1999 and 2001, and the Salmonid Restoration Conferences in 2004 and 2008. Projects associated with implementation of the JSA resulted in completion of one Ph.D. and 6 M.S. degrees, 14 peer-reviewed scientific journal articles, and 18 scientific conference presentations.

The JSA states that a trap and truck program could have some benefit to the fishery resource and recommends that trapping and trucking of anadromous salmonids take place during critical years upon approval of the Partnership Steering Committee. Appendix A presents the trapping and trucking program conducted during the past 10 years.

Table 7. Approved Partnership Fund Projects.

PROJECT	SPONSOR	DESCRIPTION	COMPLETED	FUNDING
Farm Edges Handbook	East Bay Municipal Utility District	Purchase and distribution of resource handbook	10/10/2001	$760
2002 Enhanced Enforcement	California Department of Fish and Game	Increased warden surveillance & equipment	3/2/2002	$15,000
2002 Spawning Gravel Enhancement	East Bay Municipal Utility District	Install supplemental spawning gravel	9/3/2002	$24,685
Distribution, Abundance, and Habitat Association of Swainson's Hawks	San Joaquin County Resource Conservation District	Collect data for developing information to use raptors as ecosystem health indicator	12/9/2002	$15,965
2003 Spawning Gravel Enhancement	East Bay Municipal Utility District	Install supplemental spawning gravel	10/10/2003	$28,074
2004 Spawning Gravel Enhancement	East Bay Municipal Utility District	Install supplemental spawning gravel	9/17/2004	$29,324
Mokelumne River Day Use Area Restoration	East Bay Municipal Utility District	Wildlife habitat restoration	10/29/2004	$34,720
Riparian Area Restoration and Enhancement	San Joaquin County Resource Conservation District	Riparian restoration and invasive species removal	3/20/2005	$33,181
2003-2005 Enhanced Enforcement	California Department of Fish and Game	Increased warden surveillance	4/29/2005	$25,933
Salmonid Rearing Habitat Improvement	East Bay Municipal Utility District	Reestablishment of side channel habitat	9/29/2005	$93,600
2006 Watershed Open House	San Joaquin County Resource Conservation District	Sponsor SJRCD watershed open house event	3/31/2006	$500
2006 Spawning Gravel Enhancement	East Bay Municipal Utility District	Install supplemental spawning gravel	9/30/2006	$84,813
2006 Spawning Gravel Enhancement	East Bay Municipal Utility District	Install supplemental spawning gravel	11/7/2006	$28,797

Table 7. Approved Partnership Fund Projects (continued).

PROJECT	SPONSOR	DESCRIPTION	COMPLETED	FUNDING
Lower Mokelumne River Watershed Coordinator	San Joaquin County Resource Conservation District	Cash match for Dept of Conservation Watershed Coordinator Grant	7/15/2007	$30,000
Cosumnes-Mokelumne River Floodplain Resource Management	Southeast Sacramento County Agricultural Water Authority	Feasibility study of ecosystem restoration/flood hazard reduction	12/31/2007	$50,000
Large Woody Material	University of California, Davis	Develop large woody material budget for LMR	4/1/2008	$25,663
Gil Creek Riparian Improvement	Gil Creek Landowners	Riparian improvement on private land along Gil Creek	Ongoing	$11,191
Calvary Bible Church Riparian Restoration	Calvary Bible Church	Riparian restoration along LMR on church property	Ongoing	$21,408
Hoffman Riparian Restoration	Center for Land Based Learning	Riparian restoration on the Hoffman Farm	Ongoing	$14,988
2008-2010 Watershed Coordinator	San Joaquin County Resource Conservation District	Cash match for Dept of Conservation Watershed Coordinator Grant	Ongoing	$30,000
Watershed Education and Riparian Restoration	San Joaquin County Resource Conservation District	Cash match for Dept of Water Resources CALFED grant	Ongoing	$60,000
Invasive Species Removal - Murphy Creek	Murphy Creek Landowners	Removal of invasive species from Murphy Ck restoration site	Ongoing	$47,212
Steelhead Acoustic Telemetry Study	East Bay Municipal Utility District	Purchase acoustic tags for steelhead acoustic telemetry study	Ongoing	$35,000

The following table summarizes the accomplishments of JSA implementation as defined by the goals, measures, and performance criteria of the WQRMP. The measures and performance criteria were developed by the Partnership Steering Committee as a means to define specific methods to implement the goals of the JSA. The status of the performance criteria during the ten years since JSA implementation suggests that significant progress has been made towards the Partnership goals and that numerous successes and milestones have been achieved.

Goal: Provide, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition

Measure	Performance Criterion	Status
Maintain water temperatures in the lower Mokelumne River to meet the life-history needs of aquatic organisms.	Use best efforts to maintain a minimum of 28,000 acre-feet of hypolimnetic volume (the volume of water colder than 16.4° C as determined by weekly hydro-lab at CAMD) in Camanche Reservoir through October whenever Pardee Reservoir total volume is in excess of 100,000 acre-feet.	Using best efforts, EBMUD managed the hypolimnetic volume in Camanche Reservoir so that at the end of October the volume has exceeded 28,000 acre-feet in every year except 2003 . The Mokelumne River watershed received uncharacteristically high precipitation in April and May 2003 and high flood control releases were required which diminished the cold-water pool during 2003 to 16,700 acre-feet. There was no significant difference in the number of juvenile outmigrating chinook salmon in spring 2004 (0.018/spawning adult) compared to the previous year (0.015/spawning adult) when the hypolimnetic volume was 63,500 acre-feet.
	Operate the upper and lower level outlets in Camanche Reservoir to maintain the best possible release temperatures to meet the life-history needs of aquatic organisms based on EBMUD's operation plan prepared annually in March	EBMUD opens the upper level outlet in Camanche Reservoir after lake turnover and closes the upper outlet when temperatures at Woodbridge Dam reach approximately 18°C to maintain the best possible release temperatures to meet the life-history needs of aquatic organisms
Maintain dissolved oxygen levels and reduce hydrogen sulfide levels in the Camanche Reservoir hypolimnion	Operate the Hypolimnetic Oxygenation System when dissolved oxygen levels in the Camanche Reservoir hypolimnion drop to 2 ppm (as measured at CAMC) during the period May through October	EBMUD operates the Hypolimnetic Oxygenation System (HOS) in Camanche Reservoir to maintain dissolved oxygen levels to prevent the formation of hydrogen sulfide. Since 1998 the system has operated typically from July/August through mid-November (108-143 days) and no hydrogen sulfide has developed.

Goal: Provide, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition

Measure	Performance Criterion	Status
Increase summer and fall base flows in the lower Mokelumne River by developing new water supplies	Increase instream flows beyond the flows specified in Attachment 1 of the Agreement by an amount equal to 20% of the actual yield (up to 20,000 acre-feet) of additional water supplies developed by EBMUD from new facilities. Said gainsharing water shall be available in accord with Section F.2 of the Agreement	To date no additional water supplies have been developed by EBMUD. The Freeport Regional Water Project is a joint venture of the Sacramento County Water Agency and East Bay Municipal Utility District of Oakland to supply water from the Sacramento River to customers in Sacramento County and the East Bay. When operational in 2010, EBMUD will use up to 100 million gallons per day of water during dry years only as a supplemental water source to complement existing conservation programs.
Improve opportunities for the lower Mokelumne River from Camanche Dam downstream to the San Joaquin River to seasonally inundate the floodplain	Examine how revisions to the flood control requirements of the U.S. Army Corps of Engineers and the pattern of the flood flow releases could be modified to support restoration of ecological processes, and not create undue risk of flood damage	The existing agreement between the U.S. Army Corps of Engineers committed EBMUD to provide up to 200,000 acre-feet of flood space in Camanche and Pardee Reservoirs. Prior to the agreement, Mokelumne River flow records showed that True Natural Flow (TNF) had exceeded 100 Thousand Acre Feet (TAF) in every month from November through June, with TNF as high as 270 TAF in November. Since the agreement was signed, even greater runoff has occurred. To date, TNF has exceeded 220 TAF in every month from November through July. The Intergovernmental Panel on Climate Change projects a global temperature increase from 1990-2100. Precipitation is also expected to increase over the 21st century, particularly at northern mid-high latitudes. Based on this information, revisions to the flood control requirements of the U.S. Army Corps of Engineers at Camanche and Pardee reservoirs may change at some point to reflect changing climate conditions.

Goal: Provide, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition

Measure	Performance Criterion	Status
Improve opportunities for the lower Mokelumne River from Camanche Dam downstream to the San Joaquin River to seasonally inundate the floodplain	Conduct a feasibility study to identify activities to minimize flood-related damage and improve flood plain habitats and processes. Activities considered for implementation will be those that respect private property rights, protect water rights and maintain economic viability of land owners and water users. The activities will be identified through a cooperative planning effort that will include landowners, local governments, land and water users, and interested public	Funded by the California Bay-Delta Authority ($1,007,800), EBMUD Partnership Fund ($50,000), Sacramento Area Flood Control Agency ($50,000) and Sacramento County Water Agency ($50,000) and with the Southeast Sacramento County Agricultural Water Authority as the lead agency, the feasibility study developed an Integrated Resource Management Plan (2007) to guide implementation of prioritized management actions to enhance floodplains and riparian habitat, flood management, and groundwater recharge. Additional study partners included The Nature Conservancy, University of California, Davis, San Joaquin County Resource Conservation District, and Reclamation District 800.

Goal: Provide, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition

Measure	Performance Criterion	Status
Improve opportunities for the lower Mokelumne River from Camanche Dam downstream to the San Joaquin River to seasonally inundate the floodplain	Modify the minimum flow regime, in accord with Section F.1 of the Agreement, to optimize the conditions for ecosystem values provided the total quantity of water released in any given year will not be less than the quantity of water provided by the flow requirements specified in Attachment 1 of the Agreement	Minimum flow modification occurred in March 2004, when Woodbridge Irrigation District (WID) requested EBMUD delay planned April flow increases required by the JSA and release the deferred water in May to allow completion of the fish bypass pipeline component of their dam construction. The California Department of Fish and Game, U.S. Fish and Wildlife Service, NOAA Fisheries, and State Water Resources Control Board concurred and Camanche release was maintained at 330 cfs until mid-April, when WID completed the portion of the work that would be impacted by a higher release rate. The release increased to 515 cfs by the end of April as WID initiated their seasonal diversions. The deferred volume originally scheduled to be released during April was released in addition to JSA requirements in May to coincide with outmigration of juvenile Chinook salmon and the volitional release of juvenile Chinook salmon from the Mokelumne River Fish Hatchery.
Maintain and enhance high quality habitat conditions for terrestrial riparian communities and shaded riverine aquatic habitat	Identify and map the aquatic and terrestrial components of the riparian system from Camanche Dam downstream to tidewater and cooperate with others to identify and map these components downstream to the San Joaquin River	Aquatic habitat in the lower Mokelumne River from Camanche Dam downstream to the San Joaquin River was mapped using aerial photographs and global positioning system equipment (Merz and Setka 2004a). Terrestrial vegetation communities adjacent to the lower Mokelumne River from Camanche Dam downstream to the confluence of the San Joaquin River were classified and mapped using aerial photographs (Reeves and Jones 2004a).

Goal: Provide, to the extent feasible, habitat quality and availability in the lower Mokelumne River to maintain fishery, wildlife and riparian resources in good condition

Measure	Performance Criterion	Status
Maintain and enhance high quality habitat conditions for terrestrial riparian communities and shaded riverine aquatic habitat	Continue monitoring invertebrates, fish, amphibian, reptile, mammal, raptor and neotropical bird communities in the lower Mokelumne River from Camanche Dam downstream to tidewater and cooperate with others to monitor these communities downstream to the San Joaquin River.	Surveys were conducted for invertebrates (Ochikubo-Chan 2003), fish (Merz and Saldate 2004), amphibians and reptiles (Workman and Smith 2004), mammals (Reeves and Jones 2004b), raptors (Reeves and Smith 2004), and neotropical birds (Smith 2004).
	Develop a cooperative program with local interests to improve land management and livestock grazing practices along riparian zones to reduce streambank erosion and fine sediment input	Over $400,000 has been contributed by the Partnership Fund, AFRP, and California Bay-Delta Authority to fund 8 projects that incorporated fencing, streambank protection and riparian vegetation restoration along the lower Mokelumne River. Cooperative efforts on Murphy Creek resulted in the removal of a dam, restoration of riparian habitat and control of livestock grazing (fencing).
Reduce the adverse effects of invasive riparian plants on native species and ecosystem processes	Develop and implement a coordinated control program to reduce or eliminate invasive plant species from the riparian corridor along the lower Mokelumne River	Reeves and Jones (2004c) identified the extent of non-native invasive plant species in the lower Mokelumne River corridor, provided control measures and listed the ongoing management programs designed to reduce or eliminate invasive plant species in the area. The Lower Mokelumne River Watershed Stewardship Plan and the Lower Mokelumne River Conservation Handbook include recommendations to reduce invasive plant species along the lower Mokelumne River. In 2007, the Partnership sponsored removal of Himalayan blackberries in the Murphy Creek watershed.

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Support the assessment of the overall effectiveness of actions implemented pursuant to the Central Valley Project Improvement Act in meeting Anadromous Fisheries Restoration Program production targets	Continue the daily enumeration of migrating adult chinook salmon and steelhead by video monitoring and trapping at Woodbridge Dam (or other appropriate methods). The enumeration begins in August and continues through March	EBMUD has monitored daily migration (escapement) of adult chinook salmon and steelhead at the fish ladders at Woodbridge Irrigation District Dam since 1990. Monitoring is currently conducted by video monitoring and carcass surveys. Data are stored in EBMUD's Oracle database and periodically submitted to the California Department of Water Resources Interagency Ecological Program (I.E.P.) database.
	Continue conducting weekly redd surveys in the lower Mokelumne River between Camanche Dam and the Elliott Road bridge from October through April	Systematic salmonid redd surveys have been conducted in the lower Mokelumne River since 1990. From September through December, surveys are conducted weekly, with bi-weekly surveys for the remainder of the season. The river is surveyed from the base of Camanche Dam to Elliott Road, with three individuals walking abreast down the river (water depths to 1.2 m) and searching for signs of redd construction (Setka 2004). Redd locations are recorded using a hand-held Global Positioning System (GPS) unit. Location of each redd is downloaded from the GPS unit into a Geographic Information System (GIS).

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Support the assessment of the relative effectiveness of water management modifications, structural modifications, habitat restoration and fish screen installations to meet Anadromous Fisheries Restoration Program targets	Continue estimating the emigration of juvenile chinook salmon and steelhead by trapping at Woodbridge Dam and operation of the rotary screw traps below Woodbridge Dam (or other appropriate methods) and marking a portion of the natural outmigrants. The trapping begins in December and continues through July	EBMUD has monitored daily emigration of juvenile chinook salmon and steelhead at Woodbridge Irrigation District Dam since 1990. Monitoring is currently conducted by rotary screw trap(s) and trapping in the fish bypass system (when WID is diverting). Data are stored in EBMUD's Oracle database and periodically submitted to the California Department of Water Resources Interagency Ecological Program (I.E.P.) database. EBMUD has marked (coded-wire tag) over 230,000 juvenile fall-run Chinook salmon since 1994.
	Continue monitoring CAMC and CAMD in Camanche Reservoir to measure temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential, and turbidity. In addition, collect monthly water quality samples at CAMC and CAMD to analyze for volatile suspended solids (VSS), total suspended solids (TSS), nutrients (total and dissolved phosphorus and nitrogen), chlorophyll (corrected and uncorrected for phaeopigments), and phytoplankton and zooplankton abundance and taxonomic composition (to genus)	Monitoring of temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential, turbidity, volatile suspended solids (VSS), total suspended solids (TSS), nutrients (total and dissolved phosphorus and nitrogen), chlorophyll (corrected and uncorrected for phaeopigments), and phytoplankton and zooplankton abundance and taxonomic composition (to genus) at CAMC and CAMD was performed from December 1999 through May 2005. Based on the six-year review of the data collected, it was determined by the Partnership that this monitoring would be modified. Since May 2005 EBMUD has collected and analyzed monthly samples of temperature, pH, dissolved oxygen, conductivity and oxidation-reduction potential at CAMC and CAMD.

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Support the assessment of the relative effectiveness of water management modifications, structural modifications, habitat restoration and fish screen installations to meet Anadromous Fisheries Restoration Program targets	Collect monthly water quality samples in the lower Mokelumne River at the Elliott Road Bridge to analyze for VSS, TSS, nutrients (total and dissolved phosphorus and nitrogen), chlorophyll (corrected and uncorrected for phaeopigments), and phytoplankton and zooplankton abundance and taxonomic composition (to genus). In addition, the samples are analyzed for hardness, Al, Cd, Cr, Cu, Fe, Ni, Pb, Zn, Hg, Ti, pH and turbidity	Monitoring of VSS, TSS, nutrients (total and dissolved phosphorus and nitrogen), chlorophyll (corrected and uncorrected for phaeopigments), and phytoplankton and zooplankton abundance and taxonomic composition (to genus), hardness, Al, Cd, Cr, Cu, Fe, Ni, Pb, Zn, Hg, Ti, pH and turbidity at the Elliott Road Bridge was performed from December 1999 through May 2005. Based on the six-year review of the data collected, it was determined by the Partnership that monitoring hardness, Cd, Cu, and Zn at the Elliott Road Bridge would continue and monitoring the other constituents would be discontinued.
	Collect monthly water quality samples at CAMA and PENN20 in Camanche Reservoir to analyze for TSS, hardness, Al, Cd, Cr, Cu, Fe, Ni, Pb, Zn, Hg, Ti, pH, and turbidity	Monitoring of TSS, hardness, Al, Cd, Cr, Cu, Fe, Ni, Pb, Zn, Hg, Ti, pH, and turbidity at CAMA and PENN20 was performed from December 1999 through May 2005. Based on the six-year review of the data collected, it was determined by the Partnership that monitoring hardness, Cd, Cu, and Zn would continue at PENN20 and monitoring the other constituents would be discontinued.
Maintain processes that provide for adequate sediment supply, channel meandering, and other fluvial geomorphologic attributes	When river flows allow it, provide average annual supplementation of approximately 1,200 cubic yards of suitably sized spawning gravel in the active stream channel to maintain and enhance spawning areas and to replace gravel that is transported downstream	Since fall 1998, EBMUD has placed 27,000 yds^3 of spawning gravel in the lower Mokelumne River. In addition, the Partnership restored two side channels to provide rearing habitat for salmonids adjacent to the spawning area below Camanche Dam.

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Maintain processes that provide for adequate sediment supply, channel meandering, and other fluvial geomorphologic attributes	Continue monitoring spawning reach substrate characteristics, including channel configuration and gradient; substrate size; intergravel permeability, dissolved oxygen content, and temperature; and macroinvertebrate community structure (composition and abundance)	The extensive monitoring of salmonid substrate characteristics in the lower Mokelumne River that has been conducted (Merz 2004a, 2004b, Merz and Setka 2004c, Merz et al. 2004, Ochikubo-Chan 2003, Pasternak et al. 2004, Wheaton 2003, and Wheaton et al. 2004a, 2004b) demonstrated the substantial benefits of annual supplementation of spawning gravel in the active stream channel of the lower Mokelumne River.
Reduce entrainment of juvenile fish into water diversions to increase survival and contribute to restoration goals	Work cooperatively with the Woodbridge Irrigation District to install state-of-the-art fish screens and fish bypass system at Woodbridge Dam	EBMUD has worked cooperatively with the Woodbridge Irrigation District (WID) since 1998 to support WID's Lower Mokelumne River Restoration Program to improve fish passage at WID dam while maintaining WID's access to its water rights. In 2004-05, WID constructed a new bypass pipeline to transport fish migrating downstream from the existing fish screen to a location below the dam, and a smolt trap in the bypass pipeline. In addition, a new fish screen at the Woodbridge canal is currently under construction to meet Department of Fish and Game and NOAA Fisheries Service criteria. The new flat-plate "V"-shaped fish screen, head-gate structure, and enlarged bypass system will replace the existing diversion and will be complete in 2008.

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Reduce entrainment of juvenile fish into water diversions to increase survival and contribute to restoration goals	Work cooperatively with riparian diverters to install state-of-the-art fish screens where appropriate in the lower Mokelumne River between Camanche Dam and the San Joaquin River	EBMUD completed a preliminary assessment of riparian diverters that indicates 62 riparian diverters from Camanche Dam downstream to river mile 10. Most of these diversions provide agricultural water diversion during the late spring, summer, and early fall and divert from 0.4 to 10.0 cfs. It is estimated that the intake velocities of these diversions range from 2.5 to 12 ft/sec when operating at full capacity. EBMUD provided a prioritized list of riparian diversions that could be screened to USFWS (AFRP) in 2007.
	Work cooperatively with the North San Joaquin Conservation District to evaluate the installation of permanent fish screens on their diversions	The North San Joaquin Conservation District diversions are currently under review by the State Water Resources Control Board.
Manage flow releases to prevent stranding of juvenile fish and exposure of redds	Except in case of emergencies or when flood control releases are being made, average daily flow releases from Camanche Dam will not decrease by more than 50 cfs per day during the period October 16 through March 31, and by not more than 100 cfs per day at other times of the year	Except in emergencies or when flood control releases were being made, daily flow releases from Camanche Dam have not decreased by more than 50 cfs per day during the period October 16 through March 31, and by not more than 100 cfs per day at other times of the year since 1999.

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Improve anadromous fish passage at dams and diversions below Camanche Dam	Work cooperatively with the Woodbridge Irrigation District to improve fish passage at Woodbridge Dam	EBMUD has worked cooperatively with the Woodbridge Irrigation District (WID) since 1998 to support WID's Lower Mokelumne River Restoration Program to improve fish passage at WID dam while maintaining WID's access to its water rights. In 2004-05, WID replaced the existing Dam with a new adjustable weir dam immediately upstream. The new dam utilizes remotely operable Obermeyer gates, a downstream hydraulic control system to manage tailwater elevations at the entrances to the fish ladders, and a gated low-level outlet system. State-of-the-art fish passage facilities were also constructed at Woodbridge Dam, with improved design to attract fish to the ladder, fish ladders that operate when water levels in the lake are both high and low, and a fish-counting station and viewing area. Improvements to downstream fish-passage facilities included construction of a new bypass pipeline to transport fish migrating downstream from the existing fish screen to a location below the dam, and a smolt trap in the bypass pipeline.
	Work cooperatively with the Woodbridge Irrigation District and the City of Lodi to isolate the City of Lodi's Lake Lodi to improve salmon and steelhead passage and juvenile fish survival.	The predator isolation berm to isolate the City of Lodi's Lake Lodi was removed from the Woodbridge Irrigation District's Lower Mokelumne River Restoration Project due to a lack of data to justify its inclusion.

Goal: Contribute towards the state and federal fishery restoration goals as defined in the California Salmon, Steelhead Trout and Anadromous Fisheries Program Act and the Central Valley Project Improvement Act

Measure	Performance Criterion	Status
Reduce the loss of juvenile anadromous fish caused by hydraulic conditions created by man-made structures within or directly adjacent to the lower Mokelumne River	Modify and improve the fish bypass at the Woodbridge canal	In 2004-05, WID constructed improvements to downstream fish-passage facilities included construction of an 1,800 ft. long, 30-in diameter bypass pipeline to transport fish migrating downstream from the existing fish screen to a location below the dam, and a smolt trap in the bypass pipeline.
	Reduce the impact of predators on juvenile salmonids below Woodbridge Dam by modifying the stream channel below the dam and/or implementing a controlled recreational fishery	Woodbridge Irrigation District implemented predator-control measures below Woodbridge Dam to reduce predation on downstream-migrating smolts by regrading the riverbed below the dam to make the area less hospitable to predators and modifying the tailwater portion of the dam to help reduce the formation of a “hole” in the riverbed that would provide favorable habitat for predators.
	Construct a fish barrier separating recreational Lodi Lake from the river reach seasonally impounded behind Woodbridge Dam	The predator isolation berm to isolate the City of Lodi’s Lake Lodi was removed from the Woodbridge Irrigation District’s Lower Mokelumne River Restoration Project due to a lack of data to justify its inclusion.

Goal: Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River

Measure	Performance Criterion	Status
Continue operation of the Mokelumne River Fish Hatchery to meet the mitigation requirements to supplement natural production and sustain a viable commercial and recreational fishery	Reconstruct the hatchery in accordance with the 1996 Hatchery Master Plan and the final design in consultation with CDFG, USFWS and NMFS	The hatchery was reconstructed in accordance with the 1996 Hatchery Master Plan and the final design in consultation with CDFG, USFWS and NMFS. Reconstruction was completed in 2002.
	Operate the hatchery in accord with CDFG Best Management Practices	CDFG and EBMUD completed a new operation and maintenance agreement for the Mokelumne River Fish Hatchery in 2004. The new agreement clarifies and incorporates each party's roles and responsibilities into a single document (replacing several out-dated and obsolete agreements between the District and CDFG) and provides funding for operations and maintenance at the expanded hatchery. It will also ensure that operation of the hatchery meets EBMUD's Mokelumne River fishery mitigation requirements (for the Camanche Project) and provisions of the 1998 Mokelumne River Joint Settlement Agreement (JSA). Key elements of the new operations agreement include producing an annual report summarizing the adult salmon and steelhead returns, number of juvenile fish produced, the incidence of any diseases, water quality data, fish tagging and marking operations, and the number of visitors to the fish hatchery; and, developing an Annual Operations Plan that specifies the number of fish to be spawned, egg take goal, timing and release location of hatchery production, water quality monitoring, and operation of the fish ladder.

Goal: Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River

Measure	Performance Criterion	Status
Continue operation of the Mokelumne River Fish Hatchery to meet the mitigation requirements to supplement natural production and sustain a viable commercial and recreational fishery	Implement a protocol that will ensure notification of the parties of any abnormal losses and remedial actions taken	A protocol has been established to ensure notification of the parties of any abnormal losses and remedial actions taken at the Mokelumne River Fish Hatchery
	Monitor temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential, total and volitile suspended solids, total and dissolved phosphorous and nitrogen, and turbidity of the Mokelumne River Fish Hatchery water supply and effluent	Monitoring of temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential, total and volatile suspended solids, total and dissolved phosphorous and nitrogen, and turbidity at the Mokelumne River Fish Hatchery water supply and effluent was performed from December 1999 through May 2005. Based on the six-year review of the data collected, it was determined by the Partnership that monitoring temperature, pH, dissolved oxygen, conductivity, and oxidation-reduction potential of the Mokelumne River Fish Hatchery water supply and effluent would continue and monitoring the other constituents would be discontinued
	Operate the hatchery to provide the flexibility necessary to conduct focussed research to better integrate hatchery management practices with natural production	EBMUD has recommended that the Mokelumne River Fish Hatchery manager annually monitor the progress of the egg take and periodically during the run, determine the relationship between the projected egg take number, spawning guidelines established to ensure representation of the entire run, and the Goals and Constraints egg take target. If the projected number exceeds the target, the manager should, in order, (1) close the ladder on an interim basis, (2) return green fish to the river, or (3) truncate each egg lot by the percent exceeded

Goal: Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River

Measure	Performance Criterion	Status
Employ methods to limit straying of hatchery-produced fish and the possible reduction of the genetic integrity of naturally produced fish	Develop a cooperative program to evaluate the benefits of changing release locations in the Mokelumne River of salmon and steelhead produced at the Mokelumne River Fish Hatchery	EBMUD analyzed the efficacy of using coded-wire tags to evaluate various fall-run Chinook salmon hatchery release strategies such as changing release locations. Replicate groups of coded wire tagged (CWT) hatchery produced juvenile fall-run Chinook salmon were released in the lower Mokelumne River for nine years to evaluate relative survival and contribution to the ocean fishery from various release strategies. CWT recoveries for inland locations are incomplete to date. However, the recovery data associated with replicate experimental group recoveries in the ocean harvest suggests that CWT experiments lack the precision necessary to perform two-sample proportion comparison tests that would support hatchery management decisions such as changing release locations (Workman et al, 2005).
	Develop a plan to reduce the importation of eggs and fry from other hatcheries	The California Department of Fish and Game is working with NOAA Fisheries to develop a protocol for importation of eggs and fry from other hatcheries.

Goal: Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River

Measure	Performance Criterion	Status
Employ methods to limit straying of hatchery-produced fish and the possible reduction of the genetic integrity of naturally produced fish	Continue coded-wire tagging representative lots of chinook salmon released from the Mokelumne River Fish Hatchery and expand or modify the program if a statewide strategy is developed to constant fractional mark or coded-wire tag all salmon released from California fish hatcheries in cooperation with commercial salmon trawlers, the Resource Agencies and the California Fish and Game Commission	Over 5 million hatchery-produced fall-run Chinook salmon have been coded-wire tagged by EBMUD and released from the Mokelumne River Fish Hatchery since brood year 1992. In 2006, CALFED funded implementation of the Central Valley Constant Fractional Marking (CFM) program for marking/tagging production releases of fall-run Chinook salmon. The program is a cooperative effort of the California Department of Fish and Game, California Department of Water Resources, U.S. Fish and Wildlife Service, Pacific States Marine Fisheries Commission, U.S. Bureau of Reclamation and EBMUD. In spring 2007, 1,547,575 (24.98% of total production) fall-run Chinook salmon produced at the Mokelumne River Fish Hatchery were tagged and released.
	Develop a cooperative plan to reduce impacts of imported fish released in Camanche and Pardee reservoirs	Since 2005 EBMUD requires planting non-viable rainbow trout in Camanche Reservoir. CDFG continues to plant viable rainbow trout in Camanche Reservoir.
Develop harvest management strategies that allow naturally produced fish to increase their reproductive potential	Implement enforcement efforts to reduce or eliminate illegal salmon and steelhead harvest in the lower Mokelumne River	The Partnership funded $15,000 in FY01, $15,000 in FY03 and $10,933 in FY04 for increased CDFG enforcement patrols in the lower Mokelumne River. CDFG policy precluded expenditures of overtime enforcement in FY05. EBMUD also funds ($45K annually) enforcement efforts for watershed rules/regulations at the Mokelumne River Day Use Area

Goal: Sustain the long-term viability of the salmon and steelhead fishery while protecting the genetic diversity of naturally producing populations in the lower Mokelumne River

Measure	Performance Criterion	Status
Develop harvest management strategies that allow naturally produced fish to increase their reproductive potential	Mark and tag all hatchery-produced steelhead and establish a selective fishery in the lower Mokelumne River	Since 1998 CDFG is required to and does mark (adipose fin clip) all hatchery-produced steelhead.

3.0 RECOMMENDATIONS

Based on the review of the JSA flow and non-flow measures implemented since 1998 as described in the Water Quality and Resource Management Program (WQRMP), the Partnership Steering committee recommends implementing the following strategies and measures, designed to make significant progress towards meeting the JSA goals and measuring progress:

Strategy 1.0

Operate Camanche and Pardee reservoirs to maintain best available water temperatures in the lower Mokelumne River for salmonid spawning, incubation, rearing and over-summering based on temperature model simulations and water availability.

Measures

1.1 Develop an integrated reservoir/stream network temperature simulation model for the Mokelumne River to predict temporal water temperatures in the lower Mokelumne River.

1.2 Operate Camanche and Pardee reservoirs to maintain the best available water temperatures for all salmonid life stages in the lower Mokelumne River based on temperature model simulations and water availability.

Strategy 2.0

Provide flows in the lower Mokelumne River to enhance natural production of Chinook salmon and steelhead based on life history stage needs and water availability

Measures

2.1 Operate the Lower Mokelumne River Project in accordance with the flow requirements specified in Attachment 1 of the JSA.

2.2 Increase instream flows beyond the flows specified in Attachment 1 of the JSA by an amount equal to 20% of the actual yield (up to 20,000 acre-feet) of additional water supplies developed by EBMUD from new facilities. Said gainsharing water shall be available in accord with Section F.2 of the JSA.

Strategy 3.0

Replenish gravel suitable for salmonid spawning habitat.

Measure

3.1 Provide annual spawning gravel supplementation using the Spawning Habitat Integrated Rehabilitation Approach (SHIRA) developed by the University of California, Davis and EBMUD.

Strategy 4.0

Enhance and maintain the riparian corridor to improve streambank and channel rearing habitat for juvenile salmonids.

Measures

4.1 Work cooperatively with local landowners along the lower Mokelumne River to implement the conservation practices and restoration and enhancement projects identified in the San Joaquin County Resource Conservation District's Lower Mokelumne River Conservation Handbook.

4.2 Implement the Mokelumne River Day Use Area Recreation and Resource Management Plan as funding becomes available.

Strategy 5.0

Operate the Mokelumne River Fish Hatchery to maintain the genetic characteristics of the local, natural populations of fall-run Chinook salmon and California Central Valley steelhead and reduce the genetic risks that hatchery-origin fish may pose to naturally spawning populations.

Measures

5.1 Develop and implement a Hatchery and Genetics Management Plan for California Central Valley Steelhead and Fall-run Chinook salmon in cooperation with NOAA Fisheries.

5.2 Continue the Central Valley Constant Fractional Marking (CFM) program at the Mokelumne River Fish Hatchery.

Strategy 6.0

Evaluate the effects of the measures on Chinook salmon and steelhead in the lower Mokelumne River.

Measures

6.1 Continue the annual estimate of Chinook salmon and steelhead escapement by video monitoring at Woodbridge Dam, carcass surveys, or other appropriate methods.

6.2 Continue annual Chinook salmon and steelhead redd surveys in the lower Mokelumne River between Camanche Dam and the Elliott Road bridge.

6.3 Continue the annual estimate of juvenile Chinook salmon and steelhead outmigration by operation of the rotary screw traps or other appropriate methods.

LITERATURE CITED

Merz., J.E. and M.S. Saldate. 2004. Lower Mokelumne River Fish Community Survey. 1 January 1997 through 30 June 2004. East Bay Municipal Utility District, Lodi, CA.

Merz, J.E. and J.D. Setka. 2004a. Riverine Habitat Characterization of the Lower Mokelumne River, California. East Bay Municipal Utility District, Lodi, CA.

Merz, J.E., and J.D. Setka. 2004b. Evaluation of a Spawning Habitat Enhancement Site for Chinook Salmon in a Regulated River. North American Journal of Fisheries Management 24(2): 397-407.

Merz, J.E., J.D. Setka, G.B. Pasternak and J.M. Wheaton 2004. Predicting Benefits of Spawning-Habitat Rehabilitation to salmonid (*Oncorhynchus* spp.) Fry Production in a Regulated California River. Canadian Journal of Fisheries and Aquatic Sciences. 61:1433-1446.

Ochikubo-Chan, L.K. 2003. Use of Macroinvertebrates as an Indicator of Chinook Salmon (*Oncorhynchus tshawytscha*) Spawning Habitat Quality in the Lower Mokelumne River, California. MS. Thesis. California State University, Sacramento.

Pasternak, G.B., C.L. Wang, and J.E. Merz. 2004. Application of a 2D Hydrodynamic Model to Design of Reach-Scale Spawning Gravel Replenishment on the Mokelumne River, California. River Research and Applications. 20:205-225.

Reeves, K.A., and J.S. Jones. 2004a. Terrestrial Vegetation Communities along the Lower Mokelumne River, California. East Bay Municipal Utility District, Lodi, CA.

Reeves, K.A., and J.S. Jones. 2004b. Lower Mokelumne River Small Mammal Inventory. East Bay Municipal Utility District, Lodi, CA.

Reeves, K.A., and J.S. Jones. 2004c. Non-native Invasive Plant Communities along the Lower Mokelumne River, California. East Bay Municipal Utility District, Lodi, CA.

Reeves, K.A., and J.R. Smith. 2004. Surveys of Falcons, Kites, Hawks and Owls along the Lower Mokelumne River Watershed, Sacramento and San Joaquin Counties, California. East Bay Municipal Utility District, Lodi, CA.

Setka, J.D. 2004. Summary of Fall-Run Chinook Salmon and Steelhead Trout Spawning in the Lower Mokelumne River, California 1996-2003.

Smith, J.R. 2004. Lower Mokelumne River Riparian Bird Surveys. East Bay Municipal Utility District, Lodi, CA.

Wheaton, J.M. 2003. Spawning Habitat Rehabilitation. MS Thesis. University of California, Davis.

Wheaton, J.M., G.B. Pasternak, and J.E. Merz. 2004a. Spawning Habitat Rehabilitation – II. Hypothesis Testing in Design on the Mokelumne River, California, U.S.A. International Journal of River Basin Management. 2 (1): 21-37.

Wheaton, J.M., G.B. Pasternak, and J.E. Merz. 2004b. Spawning Habitat Rehabilitation – I. Conceptual Approach and Methods. International Journal of River Basin Management. 2(1): 3-20.

Workman, M.L., and J.R. Smith. 2004. Lower Mokelumne River Amphibian and Reptile Inventory. East Bay Municipal Utility District, Lodi, CA.

Workman, M.L., J.R. Smith, and J.J. Miyamoto. 2005. Coded-Wire Tag Recoveries of Replicate Groups of Hatchery Produced Fall-run Chinook Salmon. East Bay Municipal Utility District, Lodi, CA.

Zimmerman, C.E., G. Edwards, and K. Perry. 2008. Maternal Origin and Migratory History of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California. California Department of Fish and Game (Contract P0385300), Sacramento, CA.

APPENDIX A

CHINOOK SALMON TRAP AND TRUCK PROGRAM: 1998-2007

Introduction

The Lower Mokelumne River Joint Settlement Agreement (JSA) parties agree that a trap and truck program could have some benefit to the fishery resource and recommends that trapping and trucking of anadromous salmonids take place during critical years upon approval of the Partnership Steering Committee. Outmigrating salmon smolts captured at the Woodbridge Irrigation District Dam were trapped and trucked in 2001, 2002 and 2007. Although 2003 was a dry water year type, instream temperatures did not warrant initiation of a trapping and trucking program.

2001 Operations

East Bay Municipal Utility District (EBMUD) operated under a dry water year type for the period of April through September of 2001. The JSA Partnership Coordinating Committee (PCC) developed operational criteria for the trap and truck program at it's April, 2001 meeting (the first dry water year type since JSA implementation). A temperature trigger of >18^{o} C daily mean water temperature at the Frandy gauging station (RKM 46) was agreed upon to initiate trapping and trucking. The temperature trigger of >18^{o} C was met on April 24, 2001. Trapping and trucking of juvenile fall-run Chinook salmon began on April 26, 2001. A transport tank with two 75-gallon compartments equipped with mechanical aerators was used to haul fish. Tanks were filled from the high stage fish ladder at Woodbridge Irrigation District Dam using a submersible pump. Water was treated with Novaqua®, ice made from Mokelumne River water, supplemental O_2, and salt to minimize stress to fish. A recommended concentration of salt for fish transport of a 0.1 to 0.3% salt solution was used in transport (Piper et al 1992). Oxygen levels in transport tanks were initially set at 9.00 ppm to accommodate high oxygen consumption associated with stress. Transport levels were kept at > 7.00 ppm. Each tank was supplied with a 1-gallon container of frozen Mokelumne River water to maintain constant temperatures during transport (Workman 2002a).

Fish were released at Wimpy's Marina, Lighthouse Marina, B&W Resort and Korth's Pirate's Lair. Release site determination was based on appropriate water temperatures, tides, predation activity and human activity at the site. All fish were acclimated to within 1.0^{o} C of release water in the transport tanks by introducing release water into the tanks before release.

Trapping and trucking occurred from April 26, 2001 through July 24, 2001. During this period 56,229 fish were transported and released alive. A 1.2% mortality rate was attributed to handling and transport stress. Release location temperatures varied from within 0.1^{o} C of trapping location to a high of 5.3^{o} C. Average difference between release and trap temperatures was 3.0^{o} C.

The average daily water temperatures at Frandy varied from 17.8 ^{o} C (May 2nd) to 30.9 ^{o} C (July 3rd). Water temperatures at capture (Woodbridge Irrigation District Dam) varied from 16.5 ^{o} C (May 15th, 29th) to 22.8 ^{o} C (July 3rd) and at the release sites from17.7 ^{o} C (May 3rd) to 25.7 ^{o} C (June 21st). There was no correlation between ΔT (^{o} C), release temperatures, capture temperatures, or number of captures and mortalities.

2002 Operations

Although the April through September time period was not designated as a dry water year type, the temperature criteria developed by the PCC was reached in June and trapping and trucking was conducted from July1st through July 14th. The same transport protocols listed above for 2001 operations were again employed. Fish were released at Brannan Island State Park. Release site determination was based on appropriate water temperatures.

During the 2002 trap and truck operation, 577 smolt-sized fall-run Chinook salmon were trapped, and transported, with 575 released alive. The two mortalities were due to handling and transport stress. Release location temperatures were higher than trapping location temperatures by a range of 1.2^{o} C - 3.3^{o} C. Average difference in release and trap temperatures was 2.4^{o} C. All fish were acclimated to within 1.0^{o} C of release site water temperature in the transport tanks by introducing river water into the tanks.

2007 Operations

On April 6, 2007, the PCC agreed to the following revised criterion for trap and truck activities (mean average daily water temperature at Frandy gauge exceeds 24° C during April, May and June). The criterion change was based on recent published literature which indicates salmon growth and survival still occurs at 24^{o} C (Marine and Cech 2004).

The trigger temperature of 24^{o}C at Frandy was reached on June 4, 2007. Trap and truck operations were implemented on July 6, 2007 after approval from the Partnership Steering Committee, and amendment to scientific collector's permits were received on July 5, 2007. Trap and truck operations continued through July 11th at which time the agreed upon trigger to end the effort, < 50 fish per day for a 5 day period, was reached (Workman et al 2008).

During the 2007 operations, 295 fish were transported with 2 mortalities during transport (0.01% mortality rate). The two release locations were Lighthouse Marina and Korth's Pirate's Lair Marina on the Mokelumne River.

Literature Cited

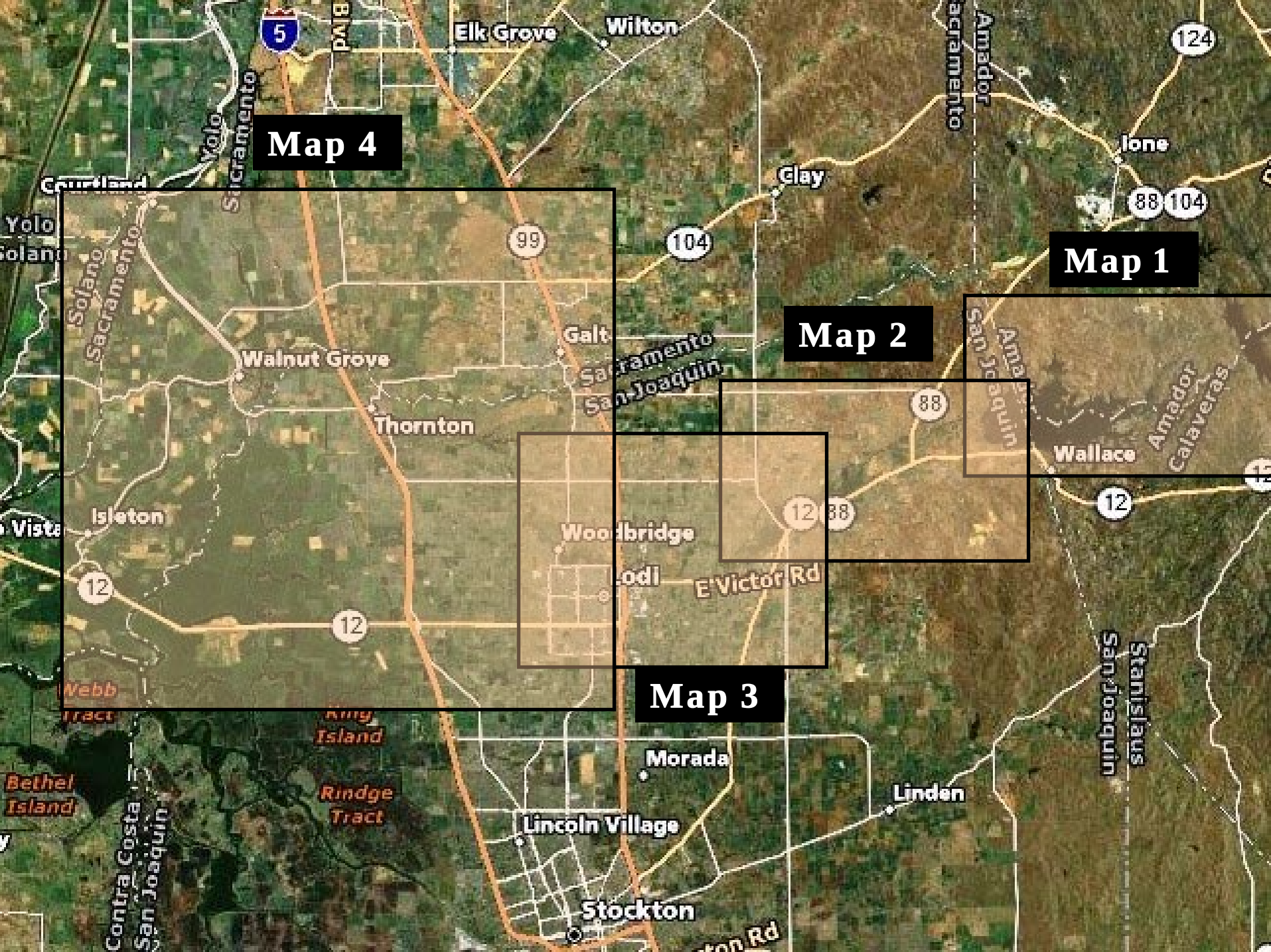
Marine, K.R., and J.J. Cech Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River Chinook Salmon. NAJFM. 24:198-2110.

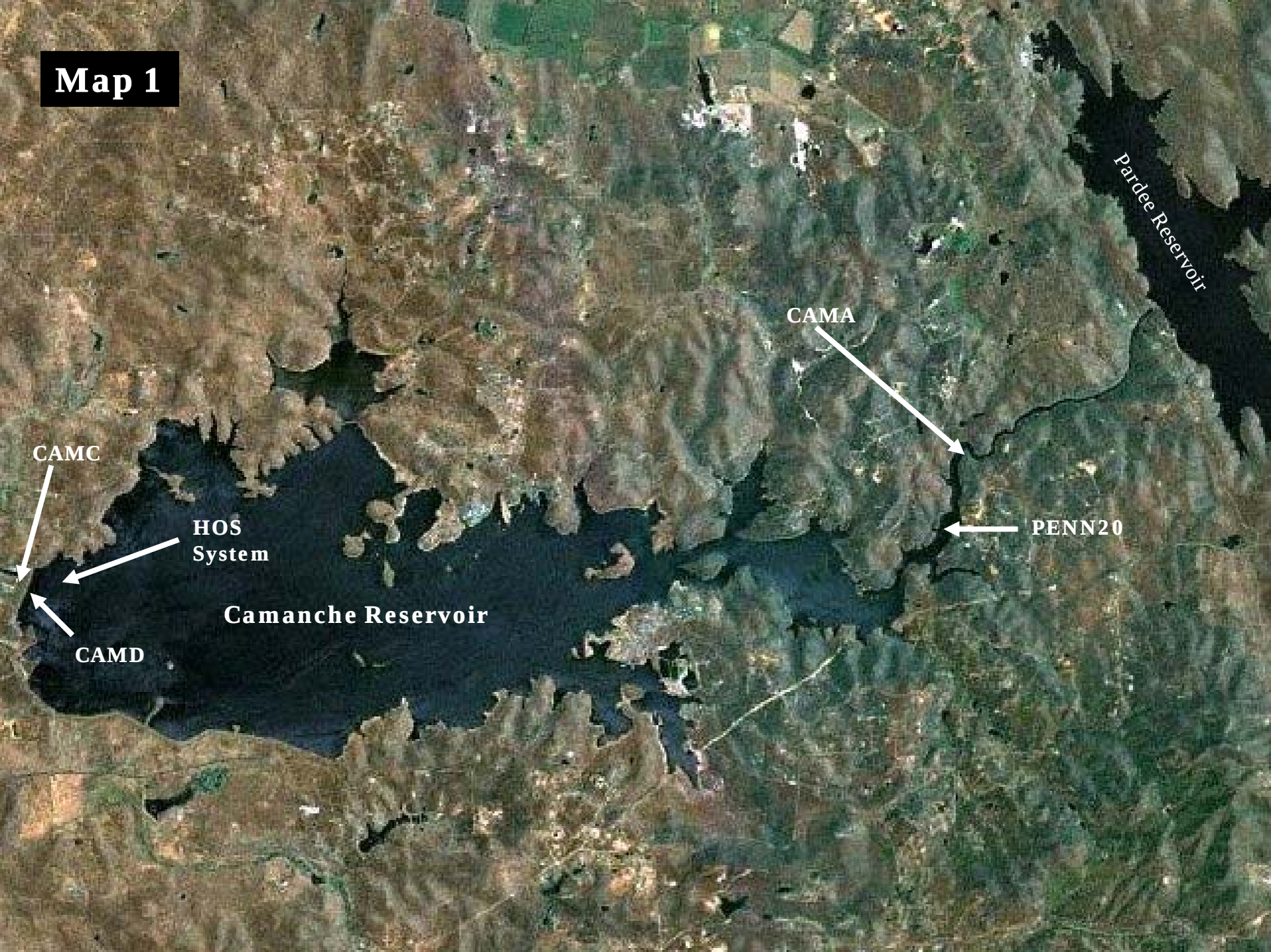
Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, J.R. Leonard. 1992. Fish Hatchery Management. USDI. Fish and Wildlife Service. Washington D.C. 517pp.

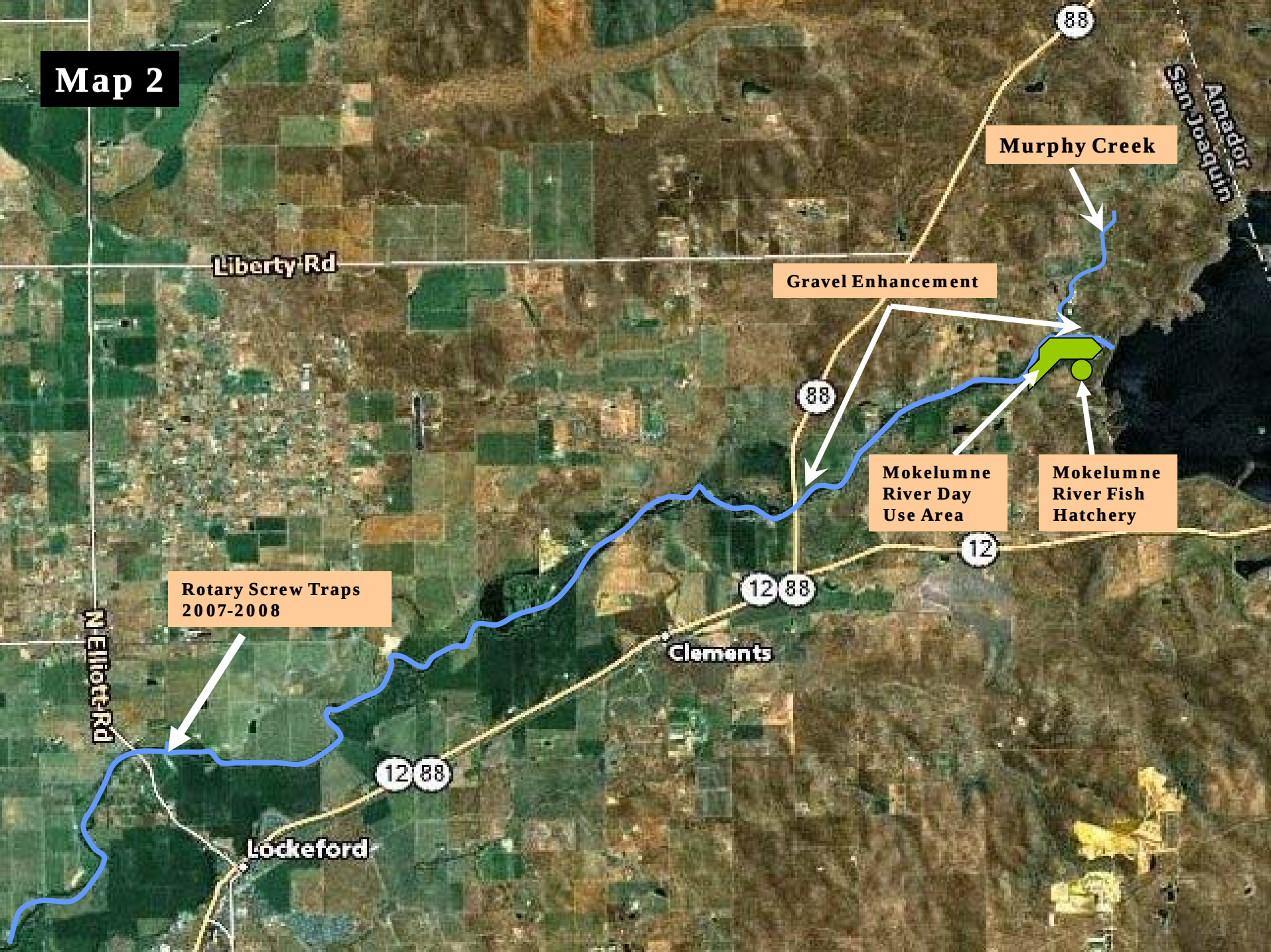
Workman, M.L. 2002a. Downstream Migration Monitoring at Woodbridge Dam on the Lower Mokelumne River, Ca. December 2000 through July 2001. EBMUD unpublished report.

Workman, M.L. 2002b. Downstream Migration Monitoring at Woodbridge Dam on the Lower Mokelumne River, Ca. December 2001 through July 2002. EBMUD unpublished report.

Workman, M.L, C.E. Hunter, M.S. Saldate, and J.L. Shillam. 2008. Downstream Migration Monitoring at Woodbridge Dam on the Lower Mokelumne River, Ca. December 2006 through July 2007. EBMUD unpublished report.


Map 4
Map 1
Map 2
Map 3
Elk Grove
Wilton
Courtland
Yolo
Sacramento
Clay
Ione
Walnut Grove
Galt
Thornton
Isleton
Woodbridge
Lodi
E Victor Rd
Wallace
Morada
Lincoln Village
Linden
Stockton
Bethel Island
Rindge Tract
Webb Tract
Contra Costa
San Joaquin
Stanislaus
Amador
Calaveras
99
104
88
12
5
124


Map 1
Pardee Reservoir
CAMA
CAMC
HOS
System
PENN20
Camanche Reservoir
CAMD


Map 2
Murphy Creek
Amador
San Joaquin
Liberty Rd
Gravel Enhancement
88
Mokelumne
River Day
Use Area
Mokelumne
River Fish
Hatchery
12
12 88
Rotary Screw Traps
2007-2008
N Elliott Rd
Clements
12 88
Lockeford


Map 3
99
J12
E Peltier Rd
N Elliott Rd
Acampo
Hoffman Property
WID Fish Screen
Woodbridge Irrigation District Dam
Video Monitoring
Lockeford
Woodbridge
Calvary Bible Church
NSJCD Diversions
N Ham Ln
S Ham Ln
Lake Lodi
Victor
12
E Victor Rd
Lodi
99
88


Map 4
Courtland
Paintersville
Sacramento
Vorden
Grand Island
Ryer Island
Solano
Sacramento
Walnut Grove
Sacramento
San Joaquin
Cosumnes River
Galt
Wimpy's Marina
Andrus Island
Thornton
Gill Creek
Walker Landing
Eagle Tree
J8
Frandy Gage
J12
Tyler Island
Acampo
Isleton
Rotary Screw Traps 1990-2008
Woodbridge
B&W Marina
Lighthouse
San Joaquin River Confluence
Korth's
Terminous
Lodi
Bouldin
99
220
160
12
5