

**SALMONID REDD MAPPING  
PROGRESS REPORT  
DON PEDRO PROJECT  
FERC NO. 2299**



**Prepared for:  
Turlock Irrigation District – Turlock, California  
Modesto Irrigation District – Modesto, California**

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# Salmonid Redd Mapping Progress Report

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## List of Acronyms

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ac	acres
ACEC	Area of Critical Environmental Concern
AF	acre-feet
ACOE	U.S. Army Corps of Engineers
ADA	Americans with Disabilities Act
ALJ	Administrative Law Judge
APE	Area of Potential Effect
ARMR	Archaeological Resource Management Report
BA	Biological Assessment
BDCP	Bay-Delta Conservation Plan
BLM	U.S. Department of the Interior, Bureau of Land Management
BLM-S	Bureau of Land Management – Sensitive Species
BMI	Benthic macroinvertebrates
BMP	Best Management Practices
BO	Biological Opinion
CalEPPC	California Exotic Pest Plant Council
CalSPA	California Sports Fisherman Association
CAS	California Academy of Sciences
CCC	Criterion Continuous Concentrations
CCIC	Central California Information Center
CCSF	City and County of San Francisco
CCVHJV	California Central Valley Habitat Joint Venture
CD	Compact Disc
CDBW	California Department of Boating and Waterways
CDEC	California Data Exchange Center
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game (as of January 2013, Department of Fish and Wildlife)
CDMG	California Division of Mines and Geology
CDOF	California Department of Finance
CDPH	California Department of Public Health

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CDPR	California Department of Parks and Recreation
CDSOD	California Division of Safety of Dams
CDWR	California Department of Water Resources
CE	California Endangered Species
CEII	Critical Energy Infrastructure Information
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
CMAP	California Monitoring and Assessment Program
CMC	Criterion Maximum Concentrations
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
CORP	California Outdoor Recreation Plan
CPUE	Catch Per Unit Effort
CRAM	California Rapid Assessment Method
CRLF	California Red-Legged Frog
CRRF	California Rivers Restoration Fund
CSAS	Central Sierra Audubon Society
CSBP	California Stream Bioassessment Procedure
CT	California Threatened Species
CTR	California Toxics Rule
CTS	California Tiger Salamander
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
CWHR	California Wildlife Habitat Relationship
Districts	Turlock Irrigation District and Modesto Irrigation District
DLA	Draft License Application
DPRA	Don Pedro Recreation Agency
DPS	Distinct Population Segment
EA	Environmental Assessment
EC	Electrical Conductivity

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EFH.....	Essential Fish Habitat
EIR.....	Environmental Impact Report
EIS.....	Environmental Impact Statement
EPA.....	U.S. Environmental Protection Agency
ESA.....	Federal Endangered Species Act
ESRCD.....	East Stanislaus Resource Conservation District
ESU.....	Evolutionary Significant Unit
EWUA.....	Effective Weighted Useable Area
FERC.....	Federal Energy Regulatory Commission
FFS.....	Foothills Fault System
FL.....	Fork length
FMU.....	Fire Management Unit
FOT.....	Friends of the Tuolumne
FPC.....	Federal Power Commission
ft/mi.....	feet per mile
FWCA.....	Fish and Wildlife Coordination Act
FYLF.....	Foothill Yellow-Legged Frog
g.....	grams
GIS.....	Geographic Information System
GLO.....	General Land Office
GPS.....	Global Positioning System
HCP.....	Habitat Conservation Plan
HHWP.....	Hetch Hetchy Water and Power
HORB.....	Head of Old River Barrier
HPMP.....	Historic Properties Management Plan
ILP.....	Integrated Licensing Process
ISR.....	Initial Study Report
ITA.....	Indian Trust Assets
kV.....	kilovolt
m.....	meters
M&I.....	Municipal and Industrial
MCL.....	Maximum Contaminant Level
mg/kg.....	milligrams/kilogram

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mg/L	milligrams per liter
mgd	million gallons per day
mi	miles
mi <sup>2</sup>	square miles
MID	Modesto Irrigation District
MOU	Memorandum of Understanding
MSCS	Multi-Species Conservation Strategy
msl	mean sea level
MVA	Megavolt Ampere
MW	megawatt
MWh	megawatt hour
mya	million years ago
NAE	National Academy of Engineering
NAHC	Native American Heritage Commission
NAS	National Academy of Sciences
NAVD 88	North American Vertical Datum of 1988
NAWQA	National Water Quality Assessment
NCCP	Natural Community Conservation Plan
NEPA	National Environmental Policy Act
ng/g	nanograms per gram
NGOs	Non-Governmental Organizations
NHI	Natural Heritage Institute
NHPA	National Historic Preservation Act
NISC	National Invasive Species Council
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	U.S. Department of the Interior, National Park Service
NRCS	National Resource Conservation Service
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory

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NWIS	National Water Information System
NWR	National Wildlife Refuge
NGVD 29	National Geodetic Vertical Datum of 1929
O&M	operation and maintenance
OEHHA	Office of Environmental Health Hazard Assessment
ORV	Outstanding Remarkable Value
PAD	Pre-Application Document
PDO	Pacific Decadal Oscillation
PEIR	Program Environmental Impact Report
PGA	Peak Ground Acceleration
PHG	Public Health Goal
PM&E	Protection, Mitigation and Enhancement
PMF	Probable Maximum Flood
POAOR	Public Opinions and Attitudes in Outdoor Recreation
ppb	parts per billion
ppm	parts per million
PSP	Proposed Study Plan
QA	Quality Assurance
QC	Quality Control
RA	Recreation Area
RBP	Rapid Bioassessment Protocol
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	River Mile
RMP	Resource Management Plan
RP	Relicensing Participant
RSP	Revised Study Plan
RST	Rotary Screw Trap
RWF	Resource-Specific Work Groups
RWG	Resource Work Group
RWQCB	Regional Water Quality Control Board
SC	State candidate for listing under CESA
SCD	State candidate for delisting under CESA
SCE	State candidate for listing as endangered under CESA

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SCT	State candidate for listing as threatened under CESA
SD1	Scoping Document 1
SD2	Scoping Document 2
SE	State Endangered Species under the CESA
SFP	State Fully Protected Species under CESA
SFPUC	San Francisco Public Utilities Commission
SHPO	State Historic Preservation Office
SJRA	San Joaquin River Agreement
SJRGA	San Joaquin River Group Authority
SJTA	San Joaquin River Tributaries Authority
SPD	Study Plan Determination
SRA	State Recreation Area
SRMA	Special Recreation Management Area or Sierra Resource Management Area (as per use)
SRMP	Sierra Resource Management Plan
SRP	Special Run Pools
SSC	State species of special concern
ST	California Threatened Species under the CESA
STORET	Storage and Retrieval
SWAMP	Surface Water Ambient Monitoring Program
SWE	Snow-Water Equivalent
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TAF	thousand acre-feet
TCP	Traditional Cultural Properties
TDS	Total Dissolved Solids
TID	Turlock Irrigation District
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TRT	Tuolumne River Trust
TRTAC	Tuolumne River Technical Advisory Committee
UC	University of California
USDA	U.S. Department of Agriculture

USDOC .....	U.S. Department of Commerce
USDOI .....	U.S. Department of the Interior
USFS .....	U.S. Department of Agriculture, Forest Service
USFWS .....	U.S. Department of the Interior, Fish and Wildlife Service
USGS .....	U.S. Department of the Interior, Geological Survey
USR.....	Updated Study Report
UTM.....	Universal Transverse Mercator
VAMP.....	Vernalis Adaptive Management Plan
VELB .....	Valley Elderberry Longhorn Beetle
VRM .....	Visual Resource Management
WPT .....	Western Pond Turtle
WSA.....	Wilderness Study Area
WSIP .....	Water System Improvement Program
WWTP .....	Wastewater Treatment Plant
WY .....	water year
μS/cm .....	microSeimens per centimeter

## 1.0 INTRODUCTION

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### 1.1 General Description of the Don Pedro Project

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are the co-licensees of the 168-megawatt (MW) Don Pedro Project (Project) located on the Tuolumne River in western Tuolumne County in the Central Valley region of California. The Don Pedro Dam is located at river mile (RM) 54.8 and the Don Pedro Reservoir formed by the dam extends 24-miles upstream at the normal maximum water surface elevation of 830 ft above mean sea level (msl; NGVD 29). At elevation 830 ft, the reservoir stores over 2,000,000 acre-feet (AF) of water and has a surface area slightly less than 13,000 acres (ac). The watershed above Don Pedro Dam is approximately 1,533 square miles (mi<sup>2</sup>).

Both TID and MID are local public agencies authorized under the laws of the State of California to provide water supply for irrigation and municipal and industrial (M&I) uses and to provide retail electric service. The Project serves many purposes including providing water storage for the beneficial use of irrigation of over 200,000 ac of prime Central Valley farmland and for the use of M&I customers in the City of Modesto (population 210,000). Consistent with the requirements of the Raker Act passed by Congress in 1913 and agreements between the Districts and City and County of San Francisco (CCSF), the Project reservoir also includes a “water bank” of up to 570,000 AF of storage. CCSF may use the water bank to more efficiently manage the water supply from its Hetch Hetchy water system while meeting the senior water rights of the Districts. CCSF’s “water bank” within Don Pedro Reservoir provides significant benefits for its 2.6 million customers in the San Francisco Bay Area.

The Project also provides storage for flood management purposes in the Tuolumne and San Joaquin rivers in coordination with the U.S. Army Corps of Engineers (ACOE). Other important uses supported by the Project are recreation, protection of the anadromous fisheries in the lower Tuolumne River, and hydropower generation.

The Project Boundary extends from approximately one mile downstream of the dam to approximately RM 79 upstream of the dam. Upstream of the dam, the Project Boundary runs generally along the 855 ft contour interval which corresponds to the top of the Don Pedro Dam. The Project Boundary encompasses approximately 18,370 ac with 78 percent of the lands owned jointly by the Districts and the remaining 22 percent (approximately 4,000 ac) is owned by the United States and managed as a part of the U.S. Bureau of Land Management (BLM) Sierra Resource Management Area.

The primary Project facilities include the 580-foot-high Don Pedro Dam and Reservoir completed in 1971; a four-unit powerhouse situated at the base of the dam; related facilities including the Project spillway, outlet works, and switchyard; four dikes (Gasburg Creek Dike and Dikes A, B, and C); and three developed recreational facilities (Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas). The location of the Project and its primary facilities is shown in Figure 1.1-1.

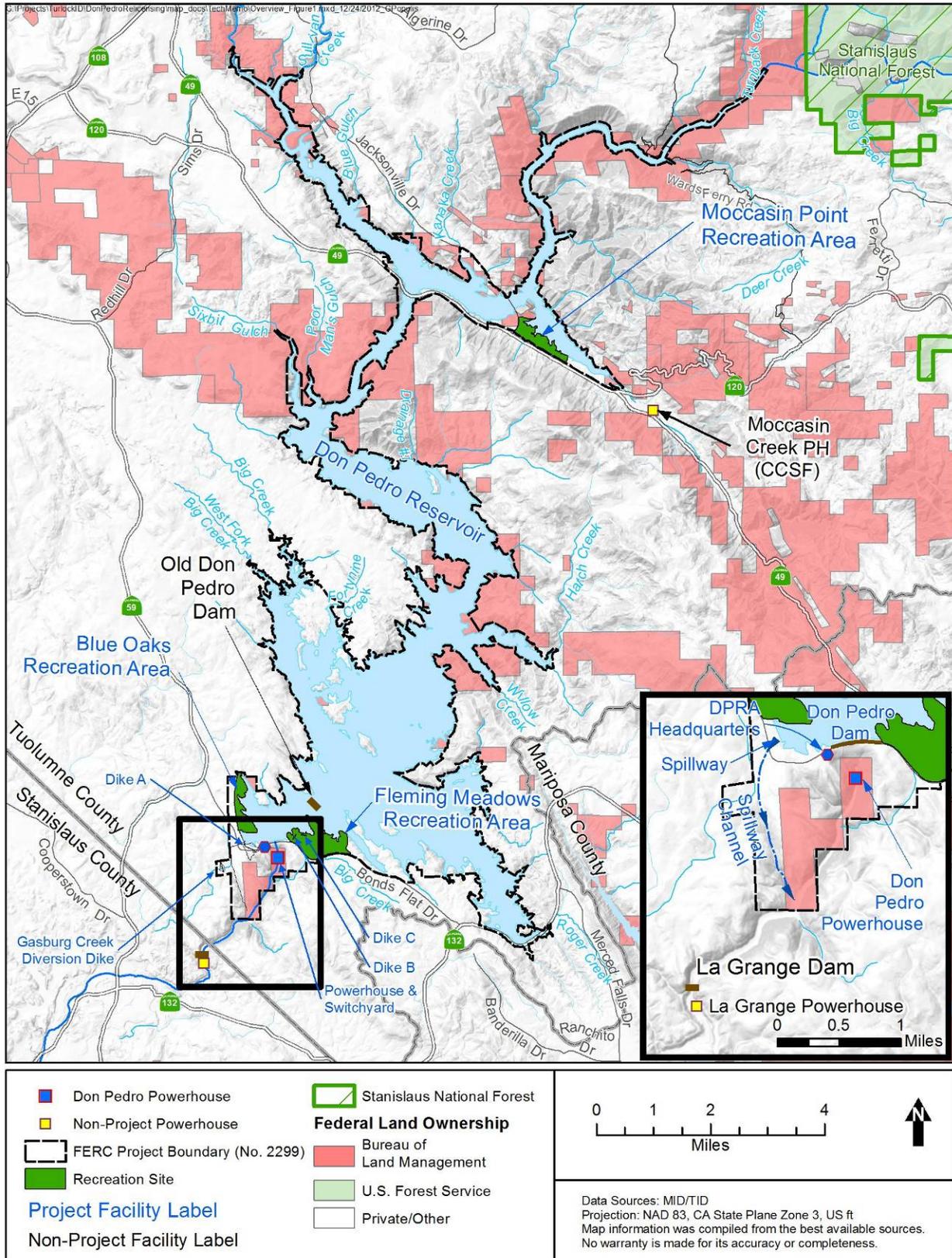


Figure 1.1-1. Don Pedro Project location.

## 1.2 Relicensing Process

The current FERC license for the Project expires on April 30, 2016, and the Districts will apply for a new license no later than April 30, 2014. The Districts began the relicensing process by filing a Notice of Intent and Pre-Application Document (PAD) with FERC on February 10, 2011, following the regulations governing the Integrated Licensing Process (ILP). The Districts' PAD included descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project area resources. The PAD also included ten draft study plans describing a subset of the Districts' proposed relicensing studies. The Districts then convened a series of Resource Work Group meetings, engaging agencies and other relicensing participants in a collaborative study plan development process culminating in the Districts' Proposed Study Plan (PSP) and Revised Study Plan (RSP) filings to FERC on July 25, 2011 and November 22, 2011, respectively.

On December 22, 2011, FERC issued its Study Plan Determination (SPD) for the Project, approving, or approving with modifications, 34 studies proposed in the RSP that addressed Cultural and Historical Resources, Recreational Resources, Terrestrial Resources, and Water and Aquatic Resources. In addition, as required by the SPD, the Districts filed three new study plans (W&AR-18, W&AR-19, and W&AR-20) on February 28, 2012 and one modified study plan (W&AR-12) on April 6, 2012. Prior to filing these plans with FERC, the Districts consulted with relicensing participants on drafts of the plans. FERC approved or approved with modifications these four studies on July 25, 2012.

Following the SPD, a total of seven studies (and associated study elements) that were either not adopted in the SPD, or were adopted with modifications, formed the basis of Study Dispute proceedings. In accordance with the ILP, FERC convened a Dispute Resolution Panel on April 17, 2012 and the Panel issued its findings on May 4, 2012. On May 24, 2012, the Director of FERC issued his Formal Study Dispute Determination, with additional clarifications related to the Formal Study Dispute Determination issued on August 17, 2012.

This progress report describes the objectives, methods, and results of the Salmonid Redd Mapping Study (W&AR-08) as implemented by the Districts in accordance with FERC's SPD and subsequent study modifications and clarifications. Documents relating to the Project relicensing are publicly available on the Districts' relicensing website at [www.donpedro-relicensing.com](http://www.donpedro-relicensing.com).

## 1.3 Study Plan

FERC approved the Districts revised study plan, with modifications, in its December 22, 2011 Study plan Determination. FERC directed the Districts to modify their study to not only quantify the current spawning capacity and redd/recruitment relationships in the Tuolumne River, but to also evaluate potential changes to redd distribution and superimposition with changes in flow and gravel availability.

## 2.0 STUDY GOALS AND OBJECTIVES

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The purpose of the salmonid redd mapping study is to document the spatial distribution of Chinook salmon and *O. mykiss* redds and redd superimposition in order to assist with quantifying the current spawning capacity and redd/recruit relationships of the Tuolumne River. Specific information obtained by this study will be:

- identify locations of Chinook salmon and *O. mykiss* spawning redds,
- document redd superimposition at current spawning population levels,
- model whether redd superimposition is currently limiting salmon production, and
- Compare redd counts and densities at recent gravel augmentation sites and nearby control sites.

FERC's SPD approved with modifications the Districts' Salmonid Redd Mapping study plan. In its SPD, FERC recommended that the Districts (1) collect flow data during the redd surveys and (2) expand their assessment of redd distribution and superimposition by integrating the results of this study with results from the Spawning Gravel Study Plan (W&AR-04) and the ongoing IFIM study required by FERC's July 2009 Order on Rehearing to produce a "synthesized description of the effects of gravel availability and flows upon redd distribution and superimposition."

The Districts have been undertaking the Salmonid Redd Mapping study consistent with these directions.

### **3.0 STUDY AREA**

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The study area includes the Tuolumne River from the La Grange Dam (RM 52) downstream to Santa Fe Bridge (RM 22), which captures Chinook salmon spawning activity in riffles documented in recent annual spawner surveys conducted by CDFG. The study area has been divided into four reaches (Figure 3.0-1):

- Reach 1: La Dam (RM 52.0) to Basso Bridge (RM 47.4)
- Reach 2: Basso Bridge (RM 47.4) to Turlock Lake State Recreation Area (TLSRA) (RM 42.0)
- Reach 3: TLSRA (RM 42.0) to Hickman Bridge (RM 31.6)
- Reach 4: Hickman Bridge (RM 31.6) to Santa Fe Bridge (RM 22.0)

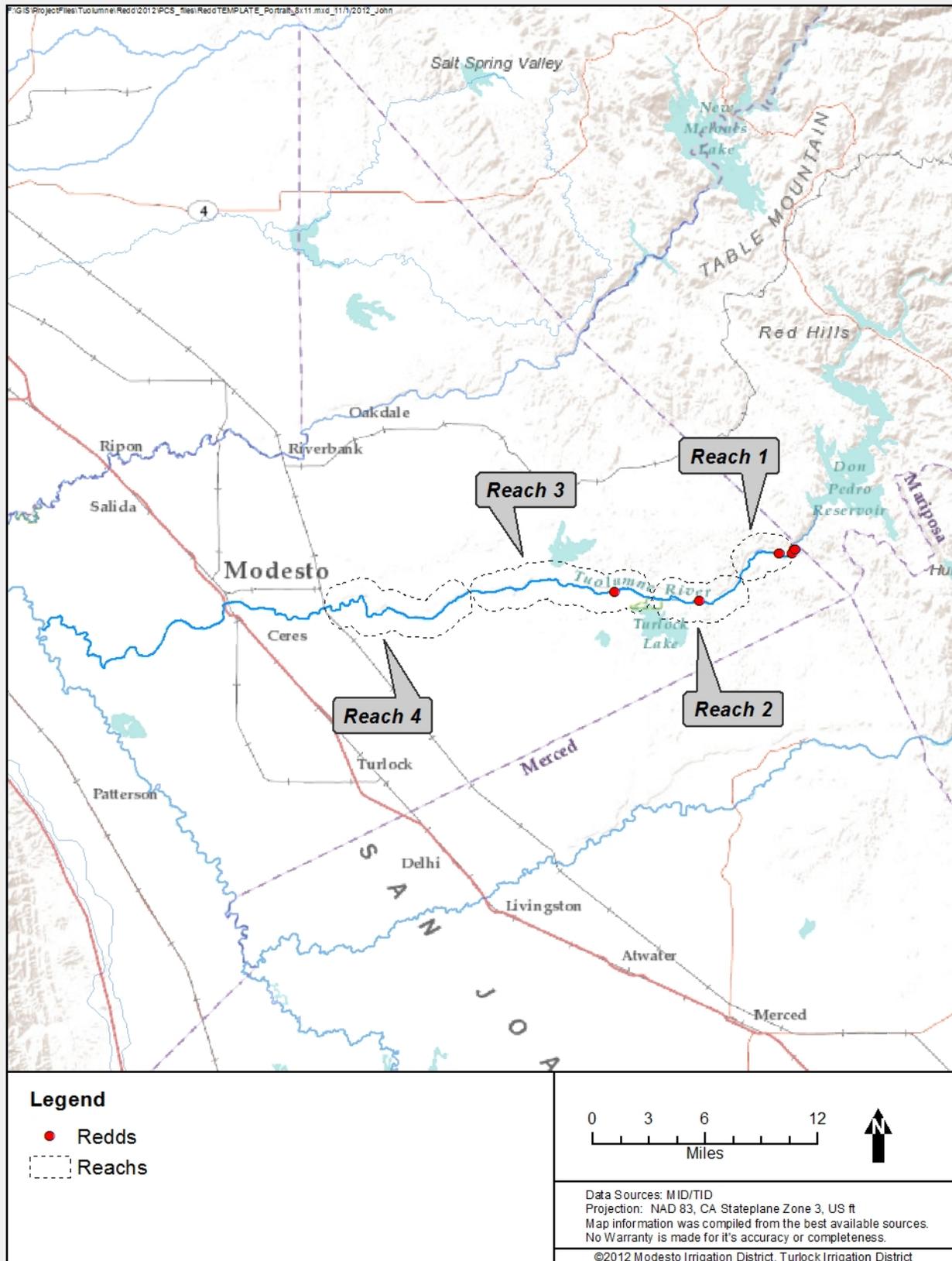


Figure 3.0-1. Map of the study area.

## 4.0 METHODOLOGY

### 4.1 Redd Mapping

Bi-weekly redd mapping surveys have been conducted starting October 1, 2012. A crew consisting of one biologist and one fisheries technician floated the entire study area during each survey week. Reaches 1 and 2 were surveyed from a 12-foot inflatable raft equipped with a rowing frame. Reaches 3 and 4 were surveyed from a 14-foot canoe equipped with a battery powered trolling motor to assist moving through the long slow-water sections of these reaches. One crew member stood at the front of the boat and observed for spawning activity as the boat maneuvered downstream. When the single person could not view the entire river width, the boat was stopped and both individuals surveyed on foot.

All visible redds were geo-referenced (marked) using a using a sub-meter GPS (Trimble; GeoXH 6000) equipped with an external antenna (Trimble; Tornado), the external antenna improved satellite reception and accuracy potential of post processed data. GPS coordinates for each redd were recorded at the estimated egg pocket location. For areas appearing to contain multiple redds with no clear boundaries, total dimensional area was delineated with the GPS. Care was taken to avoid impacting redds during the survey. Surveyors also documented redd age (Table 4.1-1), presence of fish, fish species, evidence of superimposition, and whether the redd appeared to be complete or incomplete.

**Table 4.1-1. Criteria for describing redd age.**

Redd Age	Description
New	Signs of fresh digging activity, well developed pit and tail spill
Old	Redd fading, algae and or redd flattening out but still visible
Incomplete	Not well developed, no defined pit or tail spill

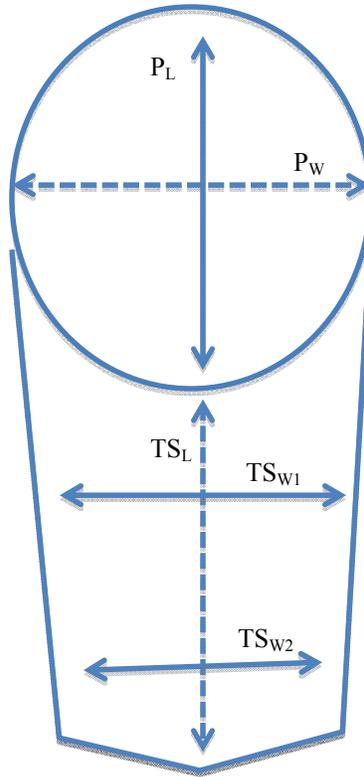
For each redd marked, physical dimensions were recorded as described in Gallagher et al. (2009) (Figure 4.1-1). Redd measurements included pit length, pit width, tail spill length, and tail spill width (Table 4.1-2). Measurements were recorded the nearest 0.1 foot using a stadia rod.

Depth and velocity measurements were recorded immediately upstream of the pit. Velocity measurements were taken using a FH950 portable velocity meter (Hach Company; Loveland, CO) at 60% of the depth and recorded in feet per second (ft/sec). Median grain-size was visually estimated on the substrate immediately upstream of the pit.

Whether redds were constructed by Chinook salmon or *O. mykiss* will be determined by:

- Redd construction timing: Chinook salmon typically construct redds between November–January, while anadromous *O. mykiss* typically spawn in January–March.
- Redd location: Chinook salmon usually construct redds in the middle of a riffle, while *O. mykiss* redds are usually nearer cover such as cut banks and overhanging trees).
- Redd protection: Chinook salmon generally defend their redds for 1-2 weeks after being built, while *O. mykiss* do not. Monitoring frequency may not allow reliable species association to be determination by this observation.

- Gravel size: Chinook salmon construct redds in larger gravel sizes than *O. mykiss*.
- Redd size: Chinook salmon redds are larger than *O. mykiss* redds.



**Figure 4.1-1 Schematic of the redd measurement locations.**

**Table 4.1-2. Description of redd dimension measurements.**

Measurement	Description
Pit Length ( $P_L$ )	Total Length of the pit parallel to streamflow, measured from the top to bottom edge.
Pit Width ( $P_W$ )	Maximum width of the pit perpendicular to the stream flow or pit length. When the pit is irregularly shaped, estimate the total width as accurately as possible.
Tail Spill Length ( $T_{S_L}$ )	Total length of the tail spill perpendicular to the stream flow. Measured from the top edge of the middle of the pit to the bottom edge of the tail spill.
Tail Spill Width 1 ( $T_{S_{W1}}$ )	Maximum width of the tail spill perpendicular to the stream flow or pit length. Measured about one-third of the distance down from the top edge of the tail spill
Tail Spill Width 2 ( $T_{S_{W2}}$ )	Maximum width of the tail spill perpendicular to the stream flow or pit length. Measured about two-thirds of the distance down from the top edge of the tail spill

## 4.2 Data Collection and Storage

To ensure consistency in field data collection, data dictionaries were constructed using GPS Pathfinder Office software (Trimble; Sunnyvale, CA) with fields outlining each required redd parameter. Data dictionaries were transferred to the GPS unit and opened within TerraSync Software (Trimble; Sunnyvale, CA). A minimum of 10 GPS points were required to record each

redd position. GPS data were downloaded from the GPS unit to a desktop computer and post-processed using GPS Pathfinder Office software. To account for positional error due to various sources (e.g., atmospheric conditions, satellite distributions, GPS clock errors) GPS data was differentially corrected using the nearest reliable base data provider (CORS, Modesto COOP (CMOD), California). The GPS files were then exported to shapefile format and opened within ArcGIS software (ESRI; Redlands, CA) where data from previous events was appended to a single master file and stored within a personal geo-database.

### **4.3 River Conditions**

Provisional daily average flow data for the Tuolumne River at La Grange was obtained from USGS at [http://waterdata.usgs.gov/ca/nwis/uv/?site\\_no=11289650&agency\\_cd=USGS](http://waterdata.usgs.gov/ca/nwis/uv/?site_no=11289650&agency_cd=USGS). Water temperature data were obtained from hourly recording Hobo Pro v2 water temperature data loggers (Onset Computer Corporation) maintained at eight sites from La Grange powerhouse (RM 52) to Santa Fe Bridge (RM 22).

## 5.0 RESULTS

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### 5.1 Redd Counts

Redd surveys began on October 1, 2012, and were conducted bi-weekly through the week of October 29. For the weeks of November 5 through November 26, surveys were conducted weekly to capture the peak Chinook salmon spawning period. Surveys were again conducted bi-weekly starting December 10 and are on-going through April 2013. Data collected after December 1, 2012 will be provided in the final report scheduled for issuance in 2013.

A total of 626 Chinook salmon redds were observed through November 29, 2012. Peak observations for all survey reaches occurred during the week of November 12, when 187 new Chinook salmon redds were identified. The highest abundance of observed Chinook salmon redds occurred in Reach 1 (RM 52.0 to RM 47.4), accounting for 48.9 percent of the redds identified to date (Table 5.1-1).

**Table 5.1-1. Table detailing new redds identified by reach during the first seven survey periods in 2012.**

Week	Survey Dates	Reach				Grand Total	Percent
		1	2	3	4		
1	10/1- 10/4/12	7	1	1	0	9	1.4%
3	10/15- 10/18/12	1	0	0	0	1	0.2%
5	10/29- 11/2/12	28	10	30	5	73	11.7%
6	11/5- 11/9/12	87	48	35	10	180	28.8%
7	11/12- 11/15/12	87	49	37	14	187	29.9%
8	11/18- 11/21/12	82	15	37	8	142	22.7%
9	11/26- 11/29/12	14	8	4	8	34	5.4%
<b>Grand Total</b>		306	131	144	45	626	--
<b>Percent</b>		48.9%	20.9%	23.0%	7.2%	--	--

## **6.0 DISCUSSION AND FINDINGS**

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This section will be developed after field sampling has been completed in April 2013.

## **7.0 STUDY VARIANCES AND MODIFICATIONS**

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There have been no variances to the study plan. No modifications to the study are proposed.

## **8.0 REFERENCES**

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Gallagher, S.P., P.K.J. Hahn, and D.H. Johnson. 2009. Redd counts. American Fisheries Society Protocols 1953: 197-234.