

# TEMPERATURE CRITERIA ASSESSMENT

(Chinook Salmon and *Oncorhynchus mykiss*)

PROGRESS REPORT  
DON PEDRO PROJECT

FERC NO. 2299



Prepared for:  
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Modesto Irrigation District – Modesto, California

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# Temperature Criteria Study 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
SJRG	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.

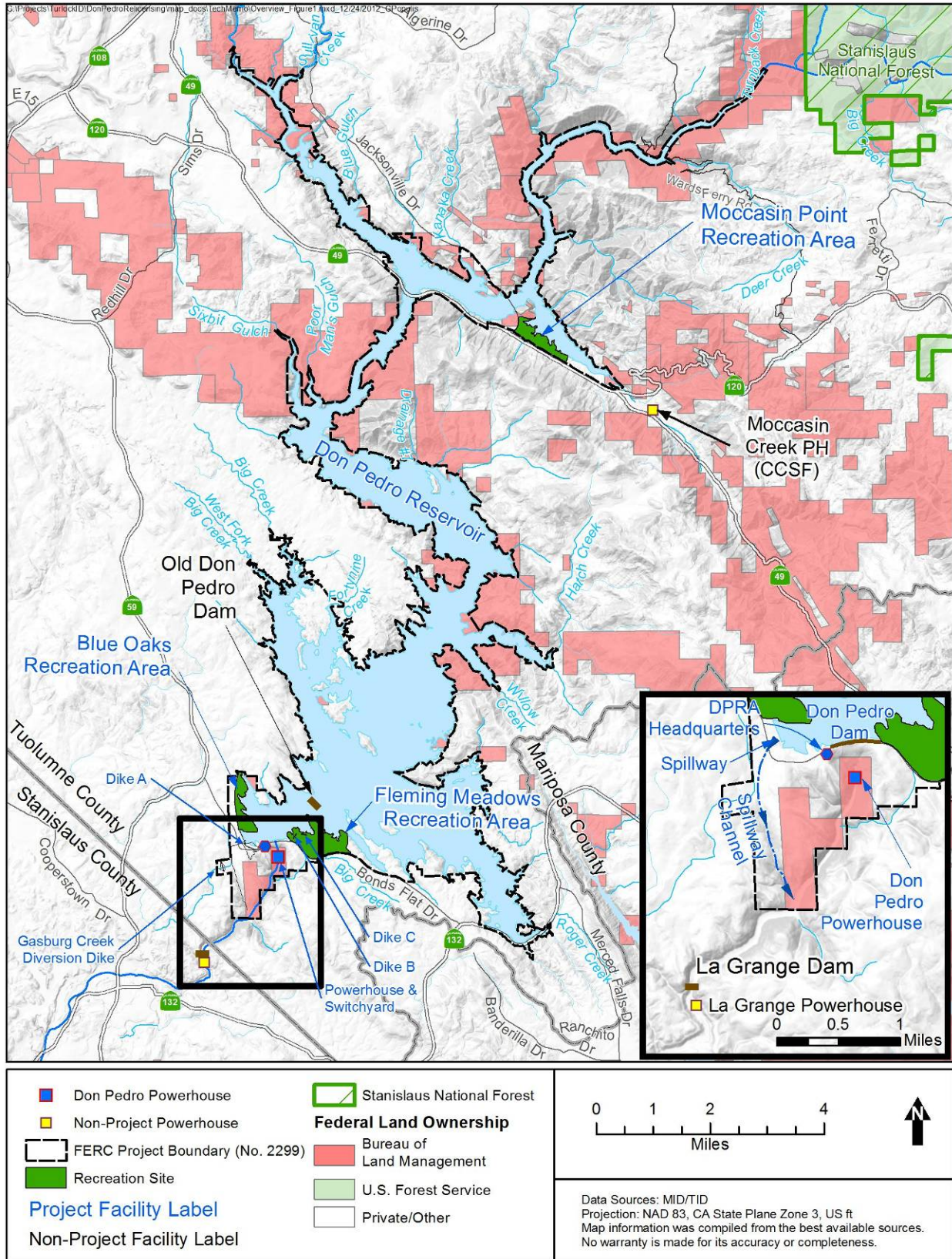


Figure 1.1-1. Don Pedro Project location.

## 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 Temperature Criteria Study (W&AR-14) 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's Scoping Document 2 identified potential effects of the Project on aquatic resources including anadromous fish. The continued operation and maintenance (O&M) of the Don Pedro Project (Project) may contribute to cumulative effects on habitat availability and production of in-river life stages of Chinook salmon and *O. mykiss* in the lower Tuolumne River. FERC's December 22, 2011 SPD did not recommend that the Districts conduct the W&AR-14 *Temperature Criteria Assessment (Chinook salmon and Oncorhynchus mykiss)*. FERC determined that documents provided by the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS) support the use of Environmental Protection Agency (EPA; 2003) temperature criteria for all life stages of salmonids in the lower Tuolumne

River. As such, FERC determined that the existing information concerning the effects of water temperature on specific life-stages of salmonids is sufficient (study criterion 4), and that while the Districts' temperature criteria assessment may have the potential to inform W&AR-05 *Salmonid Populations Information Integration and Synthesis Study*, FERC will continue to rely upon the temperature criteria in EPA (2003) for its evaluation of Project effects, unless empirical evidence from the lower Tuolumne River is provided that suggests different criteria are appropriate for salmonids in the lower Tuolumne River. As such, FERC does not see the need for the Districts to conduct this study.

The Districts are carrying out the temperature criteria study consistent with the study plan, including development of empirical evidence from the lower Tuolumne River that could suggest different criteria are appropriate for evaluating potential effects of temperature on salmonids in the lower Tuolumne River.

## 2.0 STUDY GOALS AND OBJECTIVES

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The Districts propose a study that would develop information on the influence of temperature on the in-river life-stages of Chinook salmon and *O. mykiss* found in the lower Tuolumne River. The specific study objectives include the following:

- Identify life stage-specific fisheries population effects related to water temperatures found in the lower Tuolumne River (e.g., effects on growth, disease susceptibility, predation risk, etc.);
- Identify life stage-specific water temperature evaluation parameters (i.e., effects associated with expected range of water temperatures);
- Assess and select an acceptable, informative approach to analyzing temperature regimes and their influences on Chinook salmon and *O. mykiss* in the lower Tuolumne River; and
- Evaluate the historical exceedance of identified water temperature criteria.

### **3.0 STUDY AREA**

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The study area includes the observed habitat use by Chinook salmon and *O. mykiss* in the Tuolumne River, extending from the La Grange dam (RM 52) downstream to the confluence with the San Joaquin River (RM 0). However, because this study plan addresses different Chinook salmon and *O. mykiss* life stages, these boundaries can vary by life stage.



## 4.0 METHODOLOGY

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The study is using literature and information, including previously conducted studies and ongoing Tuolumne River monitoring, to examine biologically relevant water temperature parameters for in-river life-stages of Chinook salmon and *O. mykiss*. Tasks in this study plan that address life stage-specific criteria for anadromous *O. mykiss* also would serve to address life stage-specific criteria for resident *O. mykiss* during freshwater life stages.

As confirmed by FERC in its December 2011 SPD, the development, evaluation and application of empirical evidence that would reduce uncertainties regarding temperature-related effects on Tuolumne River salmonids is a prime directive of this study. Acquisition and evaluation of information collected as part of previous and ongoing evaluations of salmonids in the LTR and in other Central Valley streams is a fundamental approach to this study. Additionally, FERC's emphasis on empirical evidence has further encouraged the Districts to identify and consider new evaluations that could contribute to more focused understanding of potential influences of temperature on LTR salmonids. As such, the Districts have updated and expanded the approach originally defined in W&AR 14 to include identification and consideration of evaluations that could build on existing information and potential original investigations of LTR salmonids to provide empirical evidence that could assist FERC in evaluating Project-related temperature influences on LTR Chinook salmon and *O. mykiss*. A major part of this effort has involved the Relicensing Participants in the review and comment on the identification and development of studies proposed to provide applicable, meaningful, empirical information to the temperature criteria evaluation.

The study is being conducted using the following steps defined in W&AR 14. Steps undertaken by the Districts upon initiation of this study that targeted acquisition and evaluation of additional empirical information are listed here and defined further in Attachment A – *Additional Study Plans for Acquisition and Evaluation of Information Supporting Development of Empirical Evidence Addressing Temperature Criteria for Salmonids in the Lower Tuolumne River*.

Step 1 – Review Relevant Literature. In order to successfully evaluate the influences of water temperature regimes on salmonid life history, relevant in-river life stages and life-history timing will be identified using existing river-wide monitoring and through coordination with fishery agency personnel. Evaluation will also include a literature review, including those already identified by RPs. The review and subsequent tasks to be conducted during this study will involve RP participation to be facilitated by convening coordination meetings once the study begins.

To identify appropriate water temperature evaluation parameters for the selected life stages and identified life history timing, the study will focus on effects of a range of temperatures that are beyond those identified as thresholds or benchmarks of optimum conditions (e.g., EPA 2003). The study is supported by a review of existing water temperature criteria guidance documents that will (1) provide logical and biologically sound rationale for each life stage definition and/or combination of life stages; (2) interpret the literature on the life stage-specific fisheries population effects (e.g., egg mortality, growth effects, disease incidence, predation risk, acute



lethal temperatures, etc.); and (3) consider the effects of exposure time at either constant or fluctuating temperatures.

The types of literature anticipated to be examined include scientific journals, Master's theses and Ph.D. dissertations, peer reviewed literature, and agency publications. To the extent available, data from recent unpublished or ongoing studies will be evaluated, including reported observations on water temperature-related effects, dose-response studies, and empirical relationships between water temperature and measures of fish biological performance (e.g., egg-retention percentage, fertilization percentage, embryo viability, pre-spawning mortality, onset of smolting, juvenile growth, increased incidence of disease, etc.).

The literature review will emphasize relevant laboratory and field experiments identifying water temperature-related effects on Chinook salmon and *O. mykiss* in a hierarchical manner. Literature that provides information from the Tuolumne River will be given the greatest emphasis, followed by information from the San Joaquin River system, and then followed by other Central Valley streams and rivers, as well as regulatory documents such as biological opinions from NMFS. Studies on fish from outside the Central Valley will be included, as appropriate, to augment the review.

Preliminary cursory literature review indicates that the application of temperature parameters to determine potential effects on targeted life stages varies and much of the literature on salmonid water temperature requirements refers to "stressful," "tolerable," "preferred or "optimal" water temperatures or water temperature ranges (e.g., McCullough 1999). Because of the variation in description of potential effects of elevated water temperatures on anadromous salmonids, care will be taken to identify an appropriate range of water temperature criteria that describe the range of effects that could occur. Water temperature criteria will be identified to represent a gradation of potential effects, from reported optimal water temperatures increasing to lethal water temperatures for each life stage from data gathered in both the laboratory and in the field so as to not bias the results by relying on a temperature recommendation developed using a single technique. In addition, care will be taken to verify the appropriateness of individual temperature criteria, and in particular, recommendations supported by references to other literature. For example, Hinze (1959) actually examines the effects of water temperature on incubating Chinook salmon eggs, yet Hinze (1959) is cited in Boles et al. (1988); Marine (1992); and NMFS (1997) in statements regarding the effects of water temperature on holding Chinook salmon adults. Boles et al. (1988) and Marine (1992) were then further cited by McCullough et al. (2001) in support of statements regarding how water temperature affects the viability of gametes developing in adults.

The results of information developed under Step 1 will identify:

- The relevant life history timing of Chinook salmon and *O. mykiss* in the Tuolumne River.
- The types of life stage-specific effects on Tuolumne River Chinook salmon and *O. mykiss* that could occur over a range of water temperatures.
- Life stage-specific effects of temperatures in the lower Tuolumne River on Chinook salmon and *O. mykiss*.

- The most robust approach to developing parameters applicable to characterizing effects of temperature conditions in the lower Tuolumne River on its Chinook salmon and *O. mykiss* populations.

The list of the references reviewed in this study is being maintained and some of the references have been provided to Relicensing Participants during preparation for W&AR 14 meetings. The list will be updated during the conduct of Step 1.

### Step 2 – Develop Water Temperature Evaluation Parameters.

Based upon the literature and information review conducted in Step 1, biologically defensible water temperature evaluation parameters will be developed. The criteria development will synthesize existing water temperature reviews and guidance documents (e.g., Marine 1992, Myrick and Cech 2001, EPA 2003) as well as approaches for criteria development (e.g., Baker et al 1995, Jager et al. 1997, Sullivan et al 2000, Pagliughi 2008, RMT 2010).

The study will use the term “index” as a metric characterizing temperature data (measured or modeled) over specific time periods of interest (i.e., a life stage); examples include daily or seasonal average temperatures, daily or annual maximum temperatures, 7-day average of daily maximum temperatures (7DADM), and the annual maximum weekly average temperature (MWAT) among others. Temperature “thresholds” are identified in Step 1 above, and are defined as the value of a selected index that temperature must remain below to avoid specified (i.e., adverse) impacts. Temperature “Criteria” are defined as a combination of an index and associated threshold(s).

Acute Criteria. Acute temperature criteria refer to “lethal” conditions (often reported as the upper incipient lethal temperature, or UILT) and will be based primarily on laboratory studies with adjustments for acclimatization and other factors (e.g., Myrick and Cech, 2001) using the appropriate indices reflecting short term exposure (e.g., daily maximum water temperature). It may also be possible to set acute temperature standards at lower temperatures using a longer term exposure approach (e.g., MWAT) approach if supported by available literature or survey data reliably documenting life-stage presence/absence at conditions corresponding to the selected index.

Chronic and Sub-lethal Criteria. There are a variety of chronic and sub-lethal effects that can adversely affect anadromous salmonid populations (EPA 2003). These chronic and sub-lethal effects include reduced juvenile growth, increased incidence of disease, reduced viability of gametes in adults prior to spawning, increased susceptibility to predation and competition, and suppressed or reversed smoltification. Sub-lethal criteria will be based upon the effects assessment developed in Step 1 above, including reduced growth, increased susceptibility to disease, predator avoidance, or other identified effects on individual fish. Literature-based criteria for juvenile life stages developed from literature sources may be adjusted by application of bioenergetics approaches proposed by Sullivan et al (2000). Adaptation of this approach will require (1) review of existing estimates of food consumption and ration size (TID/MID 1997, Report 96-9), (2) identification of biologically relevant growth criteria (e.g., percent reduction from optimal, size at date, etc.), and (3) bioenergetic growth modeling as functions of

temperature and fish size (i.e., length or weight). Depending upon the suitability of existing data, criteria specific to the Tuolumne River will be developed and compared with those reviewed in Step 1.

The results of information developed under Step 2 will identify:

- In-river temperatures that would be protective of Chinook salmon and *O. mykiss* at each identified in-river life-stage.
- Indices, or metrics, that should be used to assess individual and population-level effects of a specific water temperature regime on Chinook salmon and *O. mykiss* in the Tuolumne River.
- Appropriate water temperature evaluation criteria for the Tuolumne River.

Step 3 – Relate Baseline Water Temperature Conditions to Population. Following the literature review and identification of water temperature and population-level fisheries parameters in Steps 1 and 2 above, the criteria will be applied to water temperatures recorded at various locations in the lower Tuolumne River. Exceedance probability distributions will be developed for the various criteria (e.g., optimum, stressful) from ranked and sorted water temperature data and the proportion of time that each of the water temperature evaluation parameter is exceeded will be calculated. Based on these exceedance probabilities, the potential effects on anadromous salmonids will be summarized and discussed.

The results of information developed under Step 3 will identify:

- How often each of the life stage-specific water temperature evaluation parameters are met under baseline conditions.
- How often various water temperature evaluation parameters were met, and the likely sub-lethal and population-level effects on Tuolumne River Salmonids.

## 5.0 RESULTS

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In response to FERC's SPD stating that FERC would consider empirical evidence from the lower Tuolumne River in addressing modification of temperature criteria for evaluation of Project effects on salmonids, the Districts initiated an investigation of potential sources of empirical evidence that could be integrated into Study W&AR 14. Conduct of the four steps comprising W&AR 14, defined above, is ongoing and will continue concurrent with the additional empirical studies identified in this progress report.

Eight studies identified as potentially yielding empirical evidence on temperature effects in the Tuolumne River were discussed with Relicensing Participants during the April 11, 2012 meeting on W&AR-14 - Temperature Criteria Assessment Study. During the workshop, questions were raised concerning data availability and utility to conduct the five studies considered "desktop" studies, since they would involve evaluation of existing field data. The studies and their status was discussed with relicensing participants at the November 16, 2012 progress meeting, and are briefly described in the following sections. Three additional studies also discussed during the meetings would require additional data collection. These studies are no longer being considered for implementation.

The study team has further evaluated the availability and utility of data to conduct the five "desktop" studies and have determined that there are sufficient data to conduct all or part of three studies (2, 3 and 7 below), but are insufficient to conduct all or part of three studies (3, 6 and 8 below). Additionally, the Districts will proceed with proposed Study 1, but have determined that Studies 4 and 5 will not be pursued further. Further detail on each study is summarized below.

### ***Study 1 - Local Adaptation of Temperature Tolerance of *O. mykiss* Juveniles in the Lower Tuolumne River***

**Objective:** Determine the temperature tolerance of juvenile and subadult *O. mykiss* captured from the lower Tuolumne River (LTR) to assess any local adaptation to warmer temperatures occurring in the southern extent of *O. mykiss* range.

**Status:** The Districts propose to conduct this study during 2013 and have initiated discussions with the National Marine Fisheries Service (NMFS) in order to obtain a Section 10 permit required to conduct this study. A study plan is included in Attachment A.

### ***Study 2 – Spatial distribution juvenile *O. mykiss* in response to temperature***

**Objective:** Identify temperature thresholds that define rearing temperature tolerances for juvenile *O. mykiss* rearing.

**Status:** Data availability and utility have been determined to be sufficient to support conduct of this study. A study plan is included in Attachment A.

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***Study 3 – Influence of temperature on growth of *O. mykiss* and Chinook salmon***

**Objective:** Identify temperature thresholds that support “acceptable/expected” growth of juvenile *O. mykiss* and juvenile Chinook salmon in the lower Tuolumne River.

**Status:** Evaluation of the availability and utility of data to support this study has shown that data are not available to conduct an evaluation of the observed influence of temperature on growth of *O. mykiss*. Therefore, the Districts will not pursue this aspect of the study. However, data are available and suitable for conducting an evaluation of observed temperature influences on growth of Fall-run Chinook salmon. Therefore, the Districts will pursue this aspect of the study.

***Study 4 – Effect of temperature observed as changes in condition/health of Chinook salmon***

**Objective:** This study would evaluate the influence of the temperature regime of the Tuolumne River on Chinook salmon survival potential, measured as specific temperature-related affects to health and condition of smolt or smolt-sized Chinook salmon. The study would evaluate quality of Chinook salmon smolt rearing in the Tuolumne River using methods previously applied by CDFG (Rich and Loudermilk 1991) and USFWS (Nichols and Foote 2002) to assess Chinook salmon condition in the San Joaquin River system

**Status:** The Districts will not pursue implementation of this study

***Study 5 – Influence of temperature on location, movement, survival potential of *O. mykiss*.***

**Objective:** Acoustic tagging *O. mykiss* during early summer in various locals with various temperature expectations and monitor movement and survival to emigration.

**Status:** The Districts will not pursue implementation of this study

***Study 6 – Influence of temperatures during the early Chinook salmon spawning period on egg survival.***

**Objective:** Identify the relationship between temperature and egg-fry survival in the lower Tuolumne River. Study would evaluate the influence of observed temperature conditions during spawning on Chinook salmon spawning (egg to emergence survival).

**Status:** The Districts will not pursue implementation of this study. Data required to conduct this study are not available. Data on emergence of Chinook salmon fry from redds within the Tuolumne River are available, but those data are not associated with temperature conditions, were not complete, or were too few to allow evaluation of influences of temperature on redd survival.

***Study 7 – Influence of temperature on timing of initial spawning of Chinook salmon***

**Objective:** Identify adult Chinook salmon response to temperatures that exceed optimum, per EPA (2003) in the lower Tuolumne River in the early portion of the spawning period. Evaluation of inter annual timing of spawning will be compared with temperatures during early spawning

period using redd surveys or carcass survey results to identify temporal distribution of early spawning, and pre-spawning mortality, potentially measured as egg retention during carcass surveys.

**Status:** Data availability and utility have been determined to be sufficient to support conduct of this study. A study plan is included in Attachment A.

***Study 8 – Chinook salmon production related to precedent temperature conditions***

**Objective:** Identify effects of early temperature regime influence on Chinook salmon production measured as the relationship between spawner population and juvenile emigration from the natal stream reach.

**Status:** The Districts will not to pursue implementation of this study

## **6.0 DISCUSSION AND FINDINGS**

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Results of the temperature criteria evaluation will be available in 2013.

## **7.0 STUDY VARIANCES AND MODIFICATIONS**

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There are no study variances for W&AR-14. The study has been modified to include the updates to the study and additional, empirical evaluations, described in Attachment A.



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