Study 7.11a

RADIO TELEMETRY STUDY OF SPRING- AND FALL-RUN CHINOOK MIGRATORY BEHAVIOR DOWNSTREAM OF NARROWS 2 POWERHOUSE

August 2013

1.0 Project Nexus

Yuba County Water Agency's (Licensee or YCWA) continued operation and maintenance (O&M) of the Yuba River Development Project (Project) has the potential to affect anadromous salmonid fish species in the Yuba River near the Project's Narrows 2 Powerhouse. The powerhouse is located approximately 400 feet (ft) downstream of the United States Army Corps of Engineers' (USACE) Englebright Dam.[1]

This study focuses on adult (≥300 millimeters in fork length [FL]) Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), and Central Valley fall-run Chinook salmon (*O. tshawytscha).*[2] Spring-run Chinook salmon is listed as threatened under the federal Endangered Species Act (ESA). Fall-run Chinook salmon is listed as a federal species of concern by the United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS).

2.0 Resource Management Goals of Agencies with Jurisdiction Over the Resource to be Studied

YCWA believes that four agencies have jurisdiction over fish that could be potentially affected in the geographic area included in this study proposal: 1) United States Department of Interior, Fish and Wildlife Service (USFWS); 2) NMFS; 3) California Department of Fish and Wildlife (CDFW);[3] and 4) State Water Resources Control Board, Division of Water Rights (SWRCB). Each of these agencies and their jurisdiction and management direction, as understood by YCWA at this time, is discussed below.

[1] Englebright Dam was constructed by the California Debris Commission in 1941; is owned, operated and maintained by the USACE. Englebright Reservoir is formed by Englebright Dam. The dam is about 260 feet high; was constructed by the California Debris Commission in 1941; is owned by the United States; and the dam, reservoir and associated recreation facilities are not included as Project facilities in FERC's license for the Yuba River Development Project. When the California Debris Commission was decommissioned in 1986, administration of Englebright Dam and Reservoir passed to the USACE. The primary purpose of the dam is to trap and contain sediment derived from extensive historic hydraulic mining operations in the Yuba River watershed. Englebright Reservoir is about 9 miles long with a surface area of 815 acres. When the dam was first constructed in 1941, it had a gross storage capacity of 70,000 ac-ft; however, due to sediment capture, the gross storage capacity today is approximately 50,000 ac-ft (USGS 2003).

[2] To attempt to achieve the desired tag pool size, fish as small as 300 mm will be tagged.

[3] CDFW was previously known as the California Department of Fish and Game, or CDFG.

USFWS
USFWS' jurisdiction and goals and objectives are described by USFWS on pages 1 through 3 of USFWS' March 7, 2011 letter to FERC that provided USFWS' comments on YCWA's Pre-Application Document, or PAD (YCWA 2010). USFWS' jurisdiction, goals and objectives are not repeated here.

NMFS
NMFS' statutory authorities and responsibilities are described by NMFS in Section 2.0 of Enclosure A in NMFS's March 7, 2011 letter to FERC providing NMFS's comments on YCWA's PAD. NMFS's jurisdiction and responsibilities are not repeated here.

CDFW
CDFW's jurisdiction is described by CDFW on page 1 of CDFW's March 2, 2011 letter to FERC providing CDFW's comments on YCWA's PAD. CDFW's goal, as described on page 2 of CDFW's letter is to preserve, protect, and as needed, to restore habitat necessary to support native fish, wildlife and plant species within the FERC boundaries and downstream of the Project as resources are affected by ongoing facility operations.

SWRCB
SWRCB has authority under the federal Clean Water Act (33 U.S.C. §11251-1357) to restore and maintain the chemical, physical and biological integrity of the Nation's waters. Throughout the relicensing process the SWRCB maintains independent regulatory authority to condition the operation of the Project to protect water quality and the beneficial uses of stream reaches consistent with Section 401 of the federal Clean Water Act, the Regional Water Quality Control Board Basin Plans, State Water Board regulations, California Environmental Quality Act (CEQA), and any other applicable state law.

3.0 Study Goals and Objectives

In its March 29, 2013 *Determination on Requests for Modifications to the Yuba River Hydroelectric Project Study Plan*, the Federal Energy Regulatory Commission (FERC or Commission) stated:

> Because the existing RMT acoustic-telemetry data is insufficient to achieve the goals and objectives of Study 7.11 *Fish Behavior and Hydraulics Near the Narrows 2 Powerhouse*, we recommend YCWA conduct a radio-telemetry study. YCWA should develop the radio-telemetry study after consultation with NMFS, FWS, and California Fish and Wildlife. YCWA should implement the study during the spawning/migration season(s). The telemetry study should be designed to radio-tag and track a statistically significant sample of anadromous salmonids, document their movements within the Yuba River between Daguerre Point dam and the Narrows 2 powerhouse and incorporate methods to obtain detailed fish movement data between the Narrows 1 & 2 powerhouses, and with an emphasis in the area of the Narrows 2 tailrace and bypass pool for the duration of the spawning/migration season.

In addition, YCWA should record all flow releases, including point of release (e.g., bypass facility, powerhouse, etc.) from the Narrows 2 project facilities on a 15-minute time step for the duration of the telemetry study.

YCWA should analyze the information from the radio-telemetry effort and flow release records to determine any correlation between the movement and behavior of tagged fish and project operations.

YCWA should incorporate the existing information from the 2009, 2010, and 2011 RMT acoustic study data into the final technical memorandum as requested by NMFS and provide an analysis of the number, origin, and length of time fish were in the general vicinity of the Narrow's 2 powerhouse.

We anticipate the cost associated with the development and implementation of the radio-telemetry study and associated analysis of operations and telemetry data to be $250,000.

During an April 5, 2013 conference call, NMFS and FERC agreed that Central Valley steelhead (*Oncorhynchus mykiss*) will not be included in the study because of its low population numbers.

Therefore, the goal of the study is to gain a better understanding of the relationship between operation of the Narrows 2 Powerhouse and spring-run and fall-run Chinook salmon movement and behavior and analyze existing RMT acoustic studies from 2009-2011. The objective is to document the movement and behavior of spring-run and fall-run Chinook salmon using radio telemetry.

4.0 Existing Information and Need for Additional Information[4]

Water from Englebright Dam and Reservoir is released either through Pacific Gas and Electric Company's (PG&E) Narrows 1 Powerhouse (up to 730 cubic feet per second, or cfs), the Project's Narrows 2 Powerhouse (up to 3,400 cfs), the Project's Narrows 2 Full-Bypass (up to 3,000 cfs), the Project's Narrows 2 Partial-Bypass (up to 650 cfs) or, if Englebright Reservoir is full, the dam spillway, which is uncontrolled. Narrows 1 and Narrows 2 powerhouses can release up to 4,130 cfs, combined.

Spring-run Chinook salmon and fall-run Chinook salmon were reported to be historically present in the Yuba River Basin, and spring-run Chinook salmon spawning and holding habitat was believed to occur upstream of Englebright Dam's present location (Yoshiyama et al. 1996). Spring-run and fall-run Chinook salmon continue to be present in the Yuba River downstream of Englebright Dam. Each phenotypic run has specific life histories and lifestage periodicities. The critical periods of movement into and out of the river vary by run. A monthly summary of

[4] Much of the information presented in Section 4.0 is described in Technical Memorandum 7-11, *Fish Behavior and Hydraulics Near the Narrows 2 Powerhouse*.

lifestages and run timing from RMT (2013) shows that movement within the river occurs year-round (Table 4.1-1). Temporal life history data are variable by weeks, if not months, in some years. Therefore, the presented data are a general overview based on historical trends.

Table 4.1-1. Chinook Salmon life history periodicities in the Yuba River downstream of Englebright Dam (Source: RMT 2013).

Lifestage	Month																							
	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
FALL-RUN CHINOOK SALMON																								
Adult Immigration & Staging																								
Spawning																								
Embryo Incubation																								
Fry Rearing																								
Juvenile Rearing																								
Juvenile Downstream Movement																								
SPRING-RUN CHINOOK SALMON																								
Adult Immigration & Staging																								
Spawning																								
Embryo Incubation																								
Fry Rearing																								
Juvenile Rearing																								
Juvenile Downstream Movement																								
Smolt (Yearling+) Emigration																								

Previously, it has been reported that spring-run Chinook salmon in the lower Yuba River hold over during the summer in the deep pools and cool water downstream of the Narrows 1 and Narrows 2 powerhouses, or further downstream in the Narrows Reach (CDFG 1991; SWRCB 2003) where water depths can exceed 40 ft (YCWA et al. 2007). Congregations of adult Chinook salmon (i.e., approximately 30 to 100 fish) have been observed in the outlet pool at the base of the Narrows 2 Powerhouse, generally during late August or September when the powerhouse is shut down for maintenance. During this time period, the pool becomes clear enough to see the fish (M. Tucker, NMFS personal observation, September 2003; S. Onken, YCWA, pers. comm., 2004, both as cited in NMFS 2007). While it is difficult to visually distinguish spring-run from fall-run Chinook salmon in this situation, the fact that these fish are congregated this far up the river at this time of year indicates that some of them are likely to be spring-run Chinook salmon (NMFS 2007).

The Yuba River downstream of Englebright Dam is one of the more thoroughly studied rivers in the Central Valley of California. A description of existing information regarding salmonid populations downstream of Englebright Dam is provided as Attachment 7.8A to Technical Memorandum 7-8, *ESA and CESA Listed Salmonids Downstream of Englebright Dam* (YCWA 2013). The attachment describes available field studies and data collection reports, other relevant documents, and ongoing data collection, monitoring and evaluation activities. This includes the Lower Yuba River Accord Monitoring and Evaluation Program (M&E Program) and other data collection and monitoring programs. Specifically, the attachment summarily describes 30 available field studies and data collection reports, 28 other relevant documents (e.g., plans, policies, historical accounts and regulatory compliance), 14 ongoing data collection,

monitoring and evaluation activities for the M&E Program, and four other data collection and monitoring programs.

Of particular interest is the RMT's 3-year acoustic telemetry study of adult spring-run Chinook salmon tagged downstream of Daguerre Point Dam during the phenotypic adult upstream migration period, that occurred from 2009 through 2011. The dataset covered the monitoring area of the Yuba River from the Narrows 1 Powerhouse to proximally below Narrows 2 Powerhouse. The information was developed based on a cooperative effort between the RMT and CDFW. The monitoring station below Narrows 2 Powerhouse was located as close to Narrows 2 Powerhouse as practical for efficient transmitter detection.

Results from the acoustic telemetry study conducted during 2009 are available from the RMT (RMT 2009). The online link to that report is included in Section 11, References. Results of the acoustic telemetry study conducted during 2010 and 2011 are analyzed and summarized by the RMT (RMT 2013). The general methods employed from 2009 through 2011 were similar, but the timing of capturing and tagging individuals varied during each survey year, particularly during 2011 when spring-run Chinook salmon returned to the Yuba River, and other rivers in the Central Valley, later than usual.

The RMT used hook-and-line sampling in the Yuba River from near the confluence with the Feather River upstream to Daguerre Point Dam to capture and acoustically-tag a total of 90 adult Chinook salmon during 2009, 2010 and 2011 at various times between May and October (RMT 2013). Esophageal tag insertion was used to implant the tag into each individual's stomach. The transmitter was 36 mm x 13 mm, weighed 6 g (in water), and held a random ping interval between 30-90 seconds. The main purpose of the study was to examine phenotypic spring-run Chinook salmon holding and spawning behavior in the lower Yuba River (RMT 2013). However, eight individuals were caught and acoustically-tagged during the month of October of 2011 to examine migratory and spawning behavior of phenotypic fall-run Chinook salmon. A total of 74 out of 90 Chinook salmon tagged during the 2009, 2010 and 2011 acoustic-tagging studies passed upstream of Daguerre Point Dam (RMT 2013). With the exception of two tagged individuals that appeared to spawn downstream of Daguerre Point Dam, the remainder of the tagged fish from the studies either were not detected or moved out of the Yuba River (RMT 2013). Table 4.1-2 displays the number of adult Chinook salmon tagged, by tagging month and by month of passage upstream of Daguerre Point Dam for 2009, 2010 and 2011.

Table 4.1-2. Number of acoustically-tagged Chinook salmon that passed upstream of Daguerre Point Dam during 2009, 2010 and 2011 by tagging month and passage month. (Source: RMT 2013)

Passage Month		Tagging Month												Total
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Passage Month	Jan													
	Feb													
	Mar													
	Apr													
	May					4	--	--	--		--			**4**
	Jun					15	4	--	--		--			**19**
	Jul					5	1	--	--		--			**6**
	Aug					7	2	11	--		--			**20**
	Sep					4	2	10	1		--			**17**
	Oct					--	--	--	--		7			**7**
	Nov					--	--	--	--		1			**1**
	Dec					--	--	--	--		--			**--**
Total						**35**	**9**	**21**	**1**		**8**			**74**

Table 4.1-3 presents a summary of detection data for acoustically-tagged adult Chinook salmon captured and tagged by the RMT during 2009, 2010 and2011.

Table 4.1-3. Total number of unique detections from 2009 to 2011 by monitored reach for each month.

Month	2009–2011 Unique Detections by Monitored Reach (River Mile, or RM)										Total by Month
	RMs 0.0-3.1	RMs 3.1-8.0	RMs 8.0-11.0	Daguerre Point Dam	RMs 11.0-13.3	RMs 13.3-17.6	RMs 17.6-21.1	RMs 21.1-22.3	RMs 22.3-23.1	Englebright Dam	
May	14	5	358		4	4	2	0	0		387
June	18	29	793		22	63	57	38	0		1,020
July	6	33	981		8	13	98	34	26		1,199
Aug	8	28	1,201		54	42	126	71	59		1,589
Sep	4	16	470		62	119	345	359	155		
Oct	1	3	68		37	37	160	69	47		422
Nov	0	0	39		20	20	26	31	0		136
Dec	0	0	0		0	0	0	0	0		0
Total	**51**	**114**	**3,910**		**207**	**298**	**814**	**602**	**287**		**6,283**

The RMT's acoustic telemetry study showed that fish tagged during the spring-run Chinook salmon period were detected in the river through November (Table 4.1-2). However, the RMT's (2013) examination of the acoustically-tagged phenotypic spring-run Chinook salmon data indicated that almost all of the tagged individuals spawned by the first week in October. Therefore, acoustic tag detections observed during November likely represented tagged fish that had already spawned and died. The greatest number of tag detections occurred during August (n=1,589) and the most by location was at RM 8.0 – 11.0 (n=3,910), which is downstream of Daguerre Point Dam. The site closest to the Narrows 2 Powerhouse (RM 22.3–23.1) represented only 4.6 percent of total detections in the lower Yuba River (n=287). Detections within or proximal to the Narrows region (RM 21.1 to RM 23.1), from June through October (period of tagging), accounted for 13 percent of the total population. At RM 22.3–23.1, the earliest detection of an acoustically-tagged fish was during July 2009, but the majority of the detections occurred during September (Figures 4.1-1 and 4.1-2). At RM 21.1–22.3, detections were

observed into November, but detections did not occur at the furthest upstream monitoring location (RM 22.3-23.1) after October.

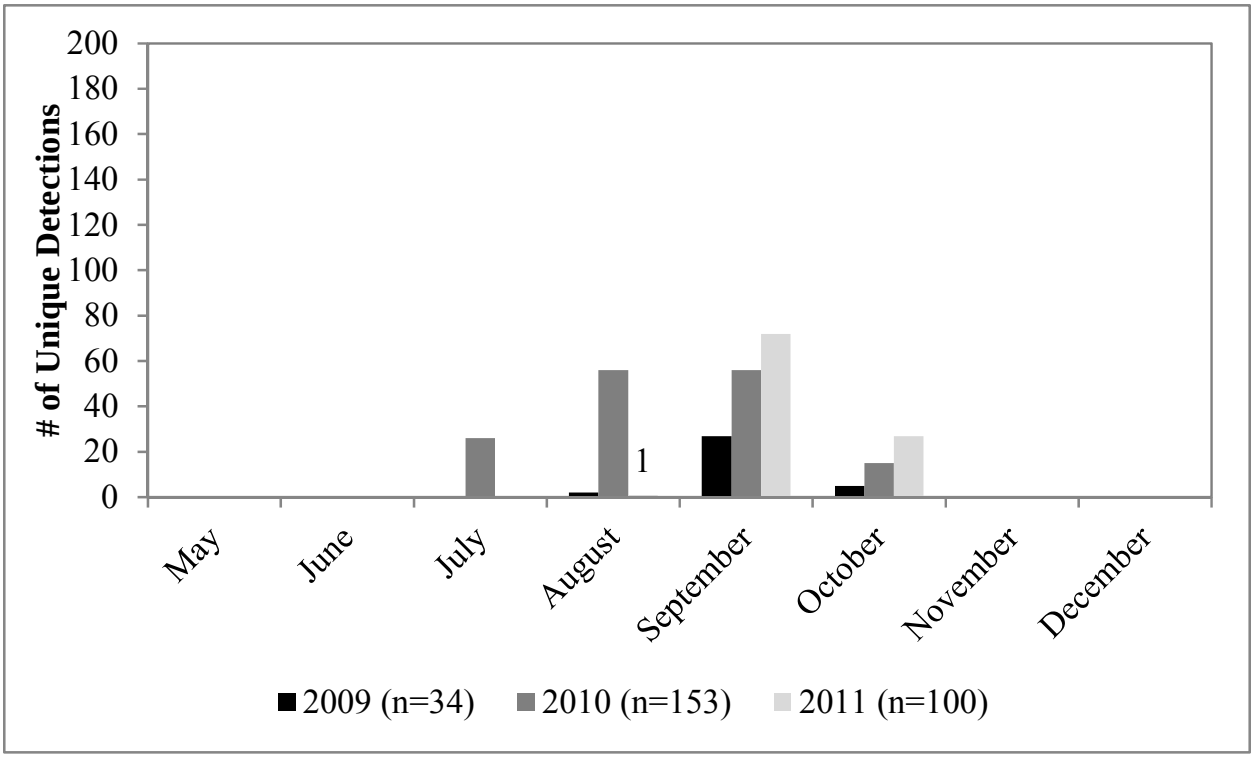

Figure 4.1-1. Unique spring-run Chinook salmon detections by year and month from RM 22.3 through RM 23.1. Note: detections below Narrows 2 Powerhouse do not include detections below Narrows 1 Powerhouse.

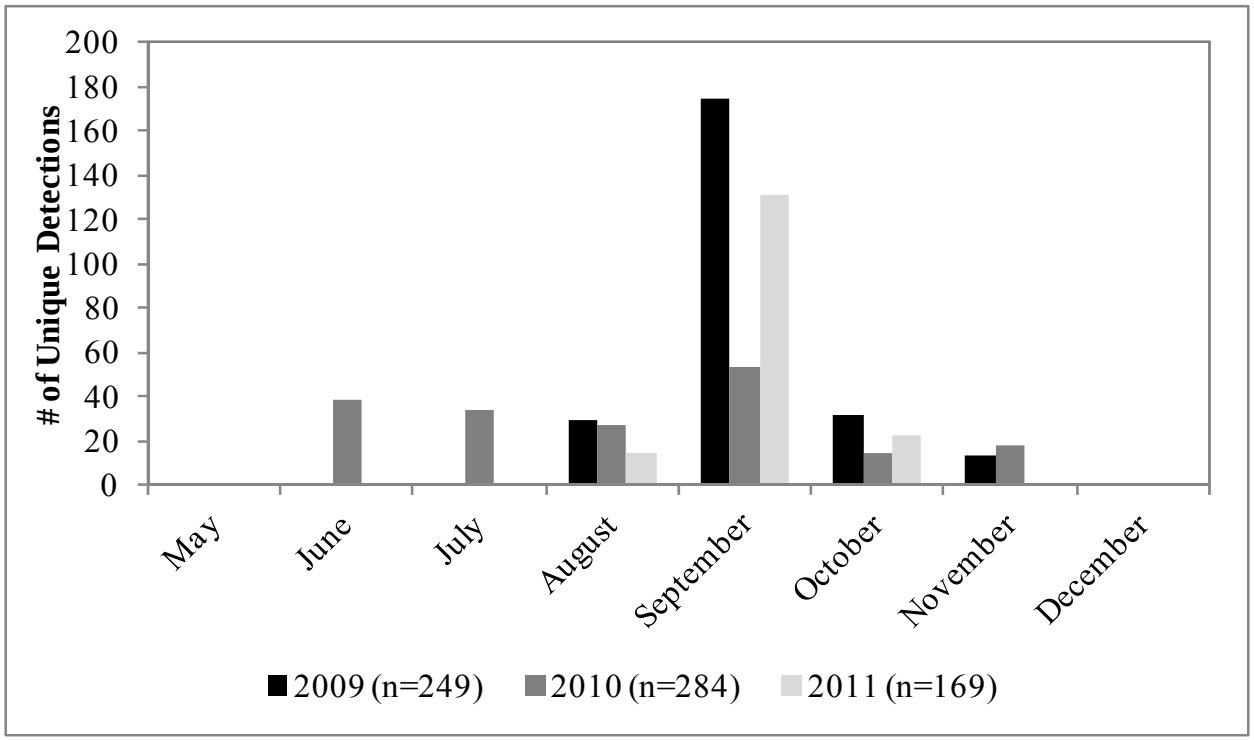

Figure 4.1-2. Unique spring-run Chinook salmon detections by year and month from RM 21.1 to RM 22.3. Note: Includes detections below Narrows 1 Powerhouse.

The acoustic tag detection technologies utilized in the RMT studies were challenged by background interference (noise) of the power generation facilities at the Narrows 1 and Narrows 2 powerhouses, which at times limited detection range and efficiency. In addition, the acoustic technology that the RMT used is non-directional - essentially, any detection recorded by a receiver can only be said to be generally proximate to that receiver (i.e., within the detection range of the receiver upstream or downstream). Nevertheless, the data from the RMT's 2009, 2010 and 2011 studies showed that phenotypic spring-run Chinook salmon exhibited variable and extended durations of holding below Daguerre Point Dam, followed by rapid movements into upstream areas (upper Timbuctoo, Narrows and Englebright reaches) during September, followed by an approximate 1-week period indicative of spawning events, which ended by the first week in October (RMT 2013). Fish detections in upstream reaches then decreased in frequency as spawning was completed.

5.0 Study Methods and Analysis

The study is divided into two phases. In Phase 1, YCWA will evaluate telemetry technologies that best provide behavioral information in proximity to the Narrows 2 Powerhouse outfall area. Phase 1 will occur in November 2013 after spawning has been completed, but before extended winter storms are expected that might spill over Englebright Dam. This timeframe will prevent harassment of migrating and spawning fall-run Chinook salmon that may be in the area in the

previous months. For these reasons, YCWA anticipates that no permits/approvals will be required to perform Phase 1**.**

Phase 2 will include tagging and tracking both the phenotypic spring-run and fall-run Chinook salmon, and will occur in 2014, assuming that necessary permits can be obtained. Phase 2 will require obtaining permits. Phase 2 fieldwork will coincide with the spawning migration timing of the two runs (Table 4.1-1). Specifically, adult spring-run fish will be tagged during capture efforts that occur on at least a monthly basis beginning in June and continuing through mid September to allow a minimum of 4 to 6 weeks of tracking after the last group is tagged. Sampling will occur in the river below Narrows 1 Powerhouse and in the Narrows Pool. Telemetry monitoring would extend from as early as June when the first fish are tagged (depending upon arrival time to the sample area) throughout the spawning/migration period ending in December. From July 2014 until the conclusion of the study, spring- and fall-run Chinook salmon will both be present within the Yuba River. As a result, fish tagged within this period may be of either run. While timing of migration and holding location may vary between runs, no data suggests individual behavioral difference due to a different run-type within a species. Both runs will be monitored during this period, but documented as Spring/Fall. See Section 7 for additional detail regarding the study schedule.[5]

5.1 Study Area

The study area is the lower Yuba River from the Narrows Pool to the Narrows 2 Powerhouse, with emphasis on the area between the Narrows 1 and Narrows 2 powerhouses, and in the area of the Narrows 2 Powerhouse tailrace and Narrows 2 Bypass pool. Collection of fish for tagging will be conducted in and around the Narrows Pool downstream of Narrows 1 Powerhouse. Detailed tracking will be focused in the area immediately below the Narrows 2 Powerhouse (Figure 5.1-1).

[5] It is not the intent of the study to determine the run of the fish being tagged, but rather to tag during times that offer the potential to represent both Chinook salmon runs.

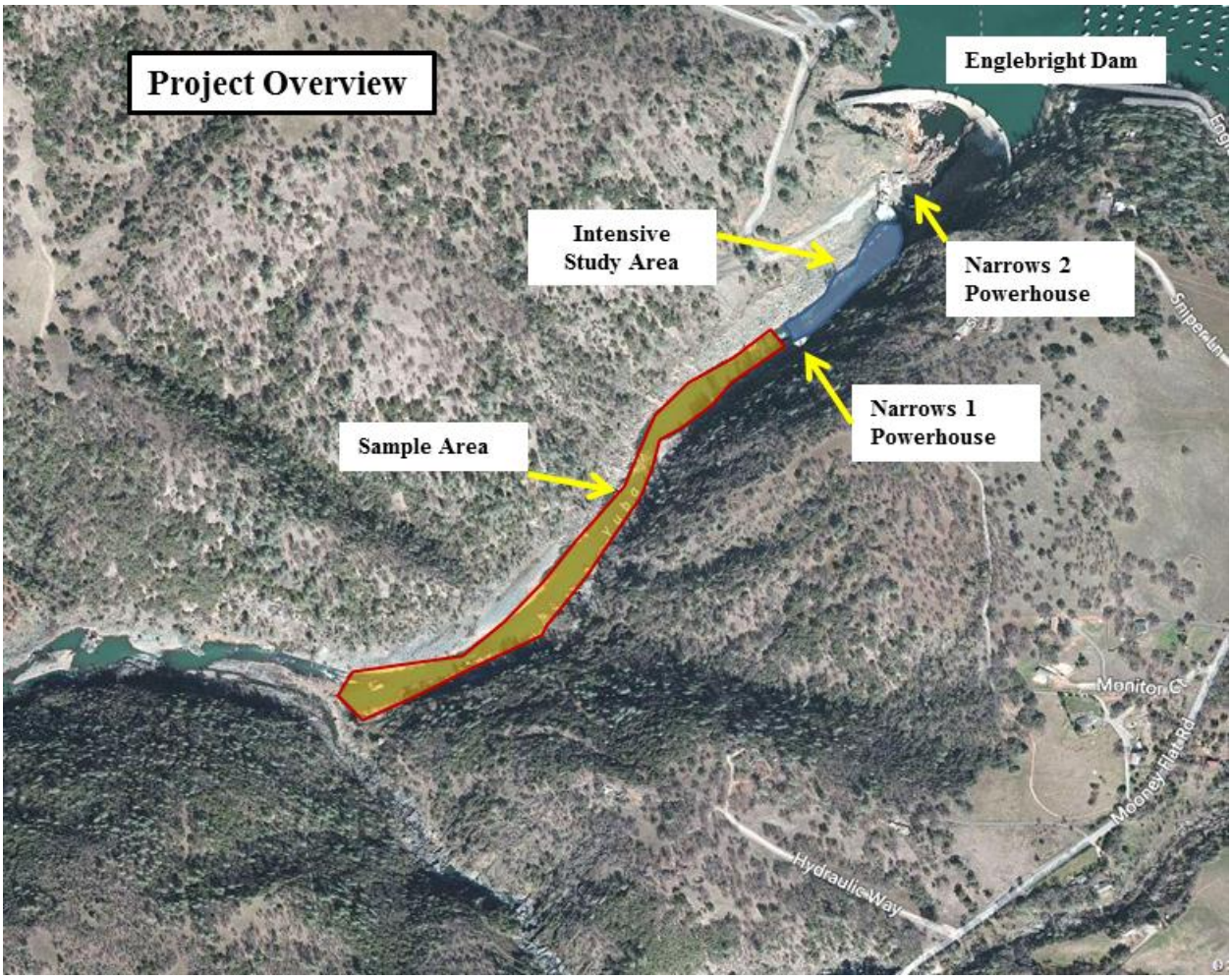

Figure 5.1-1. Study and sampling area for monitoring Chinook salmon migration behavior below Narrows 2 Powerhouse on the Yuba River. Placement and density of telemetry stations in the intensive study area will be determined during Phase 1 field testing. Mobile tracking will determine tagged fish location outside of the intensive study area.

5.2 General Concepts and Procedures

The following general concepts and practices apply to the study:

- Personal safety is the most important consideration of each fieldwork team.
- YCWA's field crews may make minor variances to the FERC-approved study in the field to accommodate actual field conditions and unforeseen problems. When minor variances are made, YCWA's field crew will follow the protocols in the FERC-approved study.
- When YCWA becomes aware of major variances to the FERC-approved study, YCWA will issue an e-mail to the Relicensing Contact List describing the variance and reason for the variance. YCWA will contact by phone the NMFS, USFWS, SWRCB and CDFW to provide an opportunity for input regarding how to address the variance. YCWA will

issue an e-mail to the Relicensing Contact List advising them of the resolution of the variance. YCWA will summarize in the final study technical memorandum any variances and resolutions.

- YCWA's performance of the study does not presume that YCWA is responsible in whole or in part for measures that may arise from the study.
- Global Positioning System (GPS) data will be collected using either a Map Grade Trimble GPS (sub-meter data collection accuracy under ideal conditions), a Recreation Grade Garmin GPS unit (3 meter data collection accuracy under ideal conditions), or similar units. GPS data will be post-processed and exported from the GPS unit into Geographic Information System (GIS) compatible file format in an appropriate coordinate system using desktop software. The resulting GIS file will then be reviewed by both field staff and Licensee's relicensing GIS analyst. Metadata will be developed for deliverable GIS data sets. Upon request, GIS maps will be provided to agencies in a form, such as ESRI Shapefiles, GeoDatabases, or Coverage with appropriate metadata, that is useful for interactive data analysis and interpretation. Metadata will be Federal Geographic Data Committee (FGDC) compliant.
- YCWA's field crews will record incidental observations of aquatic and wildlife species observed during the performance of this study. All incidental observations will be reported in the appropriate YCWA technical memorandum. The purpose of this effort is not to conduct a focused study (i.e., no effort in addition to the specific field tasks identified for the particular study) or to make all field crews experts in identifying all species, but only to opportunistically gather data during the performance of the study.
- Field crews will be trained on and provided with materials (e.g., Quat) for decontaminating their boots, waders, and other equipment between study sites. Major concerns are amphibian chytrid fungus, and invasive invertebrates (e.g., zebra mussel, *Dreissena polymorpha*). This is of primary importance when moving: 1) between tributaries and mainstem reaches; 2) moving between basins (e.g., Middle Yuba River, Yuba River, and North Yuba River); and 3) moving between isolated wetlands or ponds and river or stream environments.

5.3 Study Methods

5.3.1 Phase 1 – Evaluation of Telemetry Technologies

Phase 1 will occur in three steps, each of which is described below.

5.3.1.1 Step 1 – Office Evaluation of Up To Six Telemetry Systems

An office-based collaborative assessment will be conducted involving NMFS, USFWS, CDFW, SWRCB and researcher experience to evaluate up to six telemetry systems for the most appropriate for monitoring Chinook salmon behavior downstream of Narrows 2 Powerhouse, based on the physical environment and river characteristics in the study reach and the precise positional data sought.

YCWA will consult with NMFS, USFWS, CDFW, SWRCB and established vendors of telemetry systems (e.g., HTI, Lotek, ATS and Vemco) to determine the best two to three systems to compare in the field. The attributes and limitations of radio telemetry or acoustic telemetry systems will be evaluated in the Yuba River below Narrows 2 Powerhouse. Generally, acoustic telemetry does not perform well in turbid environments with air bubbles. Radio telemetry performs well in shallow water systems and allows real time tracking from the surface or shore, but does not easily provide fine scale positioning. The pros and cons of each system will be documented and their performance on accurately detecting locations of test tags in the study reach will be documented.

Acoustic telemetry systems such as those from HTI can provide 3-dimensional positioning of tagged fish within a study area where an array of multiple hydrophones are deployed. These types of set-ups rely on overlapping detection ranges so that tagged fish are detected simultaneously on multiple hydrophones and using the known fixed positions of the hydrophones the fish's position can be triangulated. Other acoustic telemetry systems use hydrophone data-loggers in self contained autonomous units that can provide similar data, but are limited to 2-dimensional positioning. The third dimension of depth, using such systems, can be obtained by using tags that have built in pressure sensors that provide the depth data.

For radio telemetry to provide autonomous positional data, underwater antennas would be set up in a grid pattern. Each antenna would be tuned to detect tags only within a defined detection radius of less than 10 m. By recording the detection history of each fish on the grid of antennas, movement patterns, and residence timing can be discerned.

At the conclusion of Step 1, YCWA will meet with NMFS, USFWS, CDFW and SWQCB to seek collaborative agreement regarding which two to three evaluated systems will be field tested in the next step. If collaborative agreement is not reached, the matter will be referred to FERC for resolution.

5.3.1.2 Step 2 – Field Evaluation of Up To Three Telemetry Systems

Depending on the willingness of vendors to provide the necessary equipment, YCWA will field test up telemetry systems. The field effort will not necessarily test both radio and acoustic telemetry. If vendor and agency consultation does not suggest an acoustic system due to known limitations, then one will not be tested.

Using a small boat and GPS, test tags will be moved through the study area at known depths and positions and the accuracy and reliability of the various telemetry systems will be evaluated. In addition to performance, the equipment and operational costs will also be a factor in determining a preferred system.

5.3.1.3 Step 3 – Interim Technical Memorandum

At the conclusion of Step 2, YCWA will prepare and issue an interim technical memorandum that includes the following sections: 1) Study Goals and Objectives; 2) Methods and Analysis; 3) Results; 4) Discussion; and 5) Description of Variances from the FERC-approved study, if any.

The interim technical memorandum will contain relevant summary data, tables and graphs that provide the results of Steps 1 and 2, and YCWA's recommendation for a telemetry system for use in Phase 2. No earlier than 15 days or later than 30 days after issuance of the technical memorandum, YCWA will meet with NMFS, USFWS, CDFW and SWRCB to seek agreement on the telemetry system. If collaborative agreement is not reached, the matter will be referred to FERC for resolution.

5.3.2 Phase 2 – Tagging and Tracking Fish

Phase 2 will occur in six steps, each of which is described below.

5.3.2.1 Step 1 – Obtain Necessary Permits

The YCWA study team will obtain the permits/approvals listed below prior to performing Phase 2, which includes the potential for handling live fish which may be indistinguishable from those listed as threatened under the ESA. YCWA considered the need of an ESA Section 10 permit or an ESA 4(d) Rule Research Authorization. Both permits provide coverage for handling ESA protected species. YCWA concluded the most expeditious pathway was the Section 4(d) Rule Research Authorization, as suggested by NMFS, and presents that process pathway below.

YCWA intends to attach this study plan, once approved by FERC, to its ESA 4(d) Rule Research Authorization application and scientific collecting permit application. If the permits issued by the agencies differ from the FERC-approved study, YCWA will notify FERC to discuss how to resolve differences.

ESA 4(d) Rule Research Authorization

Certain activities, including research and enhancement, that may result in the take of certain threatened species may be approved under ESA Section 4(d), which was previously used to obtain permission to conduct RMT telemetry studies on spring-run Chinook salmon from 2009-2011. The permit is issued by NMFS and has a fixed window for online application. The permit provides an authorization for only 1 year, with the option of an annual renewal. The online permitting application period hosted by CDFW is between mid-September and mid-October. The major steps in this process are: 1) CDFW must provide for NMFS' review and approval a list of scientific research activities planned for the coming year. CDFW screens research applications and then works with NMFS to ensure authorized research does not over utilize the resource; 2) NMFS conducts an ESA Section 7 and Magnuson-Stevens Fishery Conservation and Management Act consultation on the proposed issuance of the approval of the research program, resulting in a biological opinion; 3) NMFS advises CDFW whether the submittal has been approved or rejected within 6 weeks of the date a complete submittal is received; and 4) researchers are covered under the research limit as soon as CDFW receives a letter from NMFS' Northwest Regional Administrator that their submittal has been approved. The permit will require specific identified experienced biologists to conduct the work.

Based on YCWA's previous experience, if YCWA submits an application for a 4(d) Rule Research Authorization by mid-October 2013, the permit is likely to be issued no earlier than March 2014.

Scientific Collection Permit

This permit is issued by the CDFW under Fish and Game Code Section 1002 and Title 14 Sections 650 and 670.7. The permit allows for take, collection, capture, mark, or salvage of fish for scientific purposes. The permit can be applied for at any time and takes a minimum of 26 weeks to process. In addition, a Memorandum of Understanding is required when handling state listed species. This permit would be required in addition to protections afforded by the Section 4d Rule Research Authorization. A Memorandum of Understanding (MOU) could be developed within the month of issuance depending on the availability of the regional biologist to issue it.

Based on YCWA's previous experience, if YCWA submits an application for a scientific collecting permit by mid-October 2013, the permit is likely to be granted by November 2013. A MOU would be developed by the end of December 2013.

5.3.2.2 Step 2 - Deployment of Telemetry Array

To evaluate upstream migration behavior in the Yuba River below Narrows 2 Powerhouse, the telemetry system selected in Phase 1 will be deployed. Receivers will be placed in order that detection ranges cover the river from just downstream of Narrows 1 Powerhouse upstream to the pool above Narrows 2 Powerhouse. The area immediately below Narrows 2 Powerhouse will have additional receivers in order to provide positional data of tagged fish in that area to discern movement behavior (Figure 5.1-1). Specific placement of additional receivers within the study area will be based on feasibility and operation. YCWA will attempt to place detection units in the bypass pool and transition riffle, so long as the detection station is able to perform satisfactorily. Each antenna or hydrophone's detection field would constitute a location or zone where fish presence would be recorded. If a tag is detected simultaneously on two neighboring receivers, it would be assigned to the one that had the highest power level recorded.

Telemetry receivers and data loggers will be set up to operate autonomously and powered on site using batteries and solar panels. Installation of the units will require landowner permission, which may influence the exact position of the monitoring locations. Once the system is fully deployed, it will be tested using test tags prior to commencing fish tagging.

Detection range testing will be conducted to configure the telemetry array to maximize detection efficiencies at each of the routes and locations. The operation of the system will be confirmed throughout the study period with the use of beacon tags. The beacon tags will be stationed at strategic locations within the detection range of either multiple or single stations and will emit a signal at scheduled time intervals. These signals will be detected by the receivers and used to record the functionality of the system throughout the study period. Data will be downloaded weekly during mobile tracking surveys.

5.3.2.3 Step 3 – Fish Tagging

Target Population Sizes

The estimated number of phenotypic spring-run and fall-run Chinook salmon annually passing upstream of Daguerre Point Dam from 2004 to 2011 was obtained from the RMT (RMT 2013). These numbers were averaged to obtain a single estimate to use as a population estimate for calculating a sample size that would be needed to obtain a desired statistical confidence level. For spring-run Chinook salmon, the average annual number was 1,415. For fall-run Chinook salmon, the annual average was 4,343. As described in Section 4.0 above, past telemetry studies have shown that 13 percent of tagged fish located above Daguerre Point Dam migrated up to Narrows 1 and 2 powerhouses. For this study, that percentage was used to estimate the number of fish from the population above Daguerre Point Dam that would be expected in the study area. The spring-run Chinook salmon annual estimate of the population that reach Narrows 1 and 2 powerhouses is therefore 13 percent of 1,415 which is 184 fish, and for fall-run Chinook is 565. This population estimate for only the proportion of fish that typically make it up to Narrows 1 and 2 powerhouses was used for calculating sample size for this study.

The formula used to calculate a sample size given the confidence interval parameters was from Creative Research Systems online tools for creating scientific surveys and is as follows:

$$N = \frac{Z^2*(p)*(1-p)}{C^2}$$

where:

Z = 1.96 (for 95% confidence level; alpha = 0.05)
p = parameter (percentage as a decimal – 0.5 used in this case as response is unknown and the fish will either migrate up or it will not)
c = confidence interval (expressed as decimal e.g. +/-5% = .05)

This formula is for an unknown large population, the sample size was corrected for a finite population (the mean annual escapement) using:

$$N_2 = \frac{N}{1+\frac{N-1}{P}}$$

where:

P = the known population (annual mean).
N is calculated in the previous equation

Table 5.3-1 provides the results of the calculations.

Table 5.3-1. Estimated required sample sizes for spring-run and fall-run Chinook salmon based on Schaefer mark-and-recapture phenotypic population estimates from 2004-2011 in the Yuba River.

Chinook Salmon Run Type	5% Confidence Interval	10% Confidence Interval[1]
Spring and Fall Run (based on mean annual population estimate of 184 + 565 = 749)	254 fish	85 fish

[1] Recommended level of confidence by YCWA as a practical effort due to challenges with collecting unique fish and not biasing the study with recaptures.

The 10 percent confidence interval sample size estimate provides a practical number of fish that could be captured and tagged while maintaining reasonable statistical rigor. Excessively high tag requirements (i.e., such as 254 fish needed for a 5% confidence range) may unnecessarily impact the ESA protected spring-run Chinook. Unless otherwise directed, YCWA will use the 10 percent confidence interval as the tag pool number goal.

Fish Capture

Hook-and-line sampling will be used to capture and tag adult spring and fall-run Chinook salmon from the Yuba River downstream of the study area below Narrows 1 and in Narrows Pool with the aid of a professional guide service. YCWA considered other sampling methods but upon evaluation determined that hook-and-line would be the best approach. Reasons that led to this determination include: 1) sampling could be performed in proximity to the study area; 2) no fish transport is required to decrease stress and possible bias; and 3) method was previously endorsed for permitting requirements.

Sampling will occur in a phased approach. Spring-run Chinook salmon will be tagged beginning approximately in June, and continuing in July 2014, near the Narrows Pool. Fall-run Chinook salmon will be tagged in August and September 2014. Due to the potential mixing of runs, August and September 2014 tagging events may also collect additional spring-run Chinook salmon. Based on this approach, four sample events would occur. Each sample event will last up to 10 days in length or conclude when at least 25 fish are tagged, whichever occurs first. Consideration will be made to apply additional effort (i.e., catch up) if the tagging crew is behind desired tag numbers.

Due to the variation in run size, tagging a total 25 adult Chinook salmon during each of the four tagging efforts (i.e., total of 85 fish) may not be feasible. YCWA will make a good faith effort to meet the target goal for each tagging effort. If after 10 days of effort at a site the target number of fish are not collected and tagged, YCWA will consult with FERC regarding the need for additional effort.

Tagging Procedures

Minimizing fish stress is important to reduce the effects of handling and tagging on study results and thereby ensure the most accurate data. Best practice techniques to minimize this stress will be employed. Water temperature and dissolved oxygen levels are key components for maintaining low stress levels in fish. The water used for holding fish will be continuously

aerated using air pumps and air stones, and the water in the tanks and tubs will be changed after each tag insertion event. To minimize holding times, less than 5 fish will be processed within each tag insertion event. Handling methods can have cumulative effects on fish stress levels; therefore, fish will be handled as little as possible.

A tagging station will be set up on the side of the river or on a boat and will have portable holding tanks that contain river water. One tank will be used for anesthetizing fish before tagging, and the other for recovery. The tagging operation will be set up efficiently so that it is easy to handle the fish and immediately place them in an anesthetic bath. Fish will be anesthetized to loss of equilibrium with tricaine methanesulfonate (MS-222) at a concentration of 80 milligrams per liter (mg/L) of freshwater. This mixture is approved by the Food and Drug Administration (FDA) as an anesthetic for fishes and other cold-blooded animals and neutralized MS-222 (pH 7) is the most effective chemical for anesthetizing salmonids.

Regardless of which telemetry system is selected for the study, all fish will be gastrically tagged. Gastric-tagging techniques will be similar to those described by Adams et al. (1998). Once the fish is anesthetized (i.e., displays loss of equilibrium), it will be removed from the anesthetic bath. While immobile, fish will be weighed to the nearest 0.1 gram (g), measured to the nearest millimeter (mm), and the transmitter code confirmed and recorded using a portable receiver. The unique code will be documented on the datasheet so that the collected data will be associated with the unique identifier code for each transmitter. All metrics associated with each fish will be input into the computer data record. The fish will then be placed on a wet foam operating table. The transmitter will then be inserted into the stomach of the fish through the mouth using a plastic rod with a 4 mm diameter to gently press the tag down the throat. If radio tags are used, the radio tag antenna will remain protruding out the side of the mouth and be crimped so that it trails posteriorly alongside the body of the fish. The fish will then be placed in the recovery holding tank with aerated freshwater for observation during a 4 to 6 minute recovery period. The fish will be observed to evaluate short-term tagging effects, tag retention, and post-tagging mortality. Once the fish is deemed fully recovered it will be released nearby where it was collected and documented with a GPS mark. Fish mortality during the tagging procedure will be recorded. YCWA will determine appropriate action in the event of excessive fish mortality through the permitting process with CDFW and NMFS.

5.3.2.4 Step 4 – Data Monitoring

Stationary Receivers

Data from the telemetry stations will be downloaded onto a field laptop once per week, likely coinciding with mobile tracking efforts. The data will have information that will include a time stamp and when a uniquely identified transmitter was detected by the station. The detection log will be compiled in a Microsoft Excel™ database and backed up after each upload.

The detection data will be filtered to eliminate false detections and noise. Detections that fall below the background noise threshold; occur prior to the tagged fish release; or those that occur in a time sequence that would be impossible for the tagged fish, will be removed from the data set. The database of valid detections will be used to determine migration rates, timing, and

frequency of upstream and downstream movements, and residence times. Data from the underwater antennas will be used to compile patterns of use within 300 ft below the Narrows 2 Powerhouse outfall. Monitoring will continue through December 15, 2014, or until flow conditions make data recovery or mobile tracking unsafe, whichever occurs earlier.

Mobile Tracking

Fixed-station array data will be supplemented by weekly mobile tracking surveys from the time of first tag implantation until the end of the tracking season, December 15, 2014, using a portable receiver from a small boat such as a kayak or on foot from shore. For each tag detected by mobile tracking, the tag identification code, time of day, date, and GPS coordinates will be recorded. Mobile tracking would provide more detailed movement and location data outside the focal area below Narrows 2, as well as help locate and determine fates of the tagged fish. Results of mobile tracking will be compared to fixed station arrays to corroborate census numbers. If it is determined that either kayak or foot-based census approach is significantly more effective, then the more effective approach will be prioritized for the remainder of the sampling season.

5.3.2.5 Step 5 – Data QA/QC

All collected and entered data will be reviewed for accuracy. Data sheets will be reviewed at the end of each field day by the lead field scientist to ensure all required data cells are populated appropriately. Finalized datasheets will be entered into Microsoft Excel™ or Access™ database and then reviewed for entry accuracy. Database quality assurance and quality control (QA/QC) will consist of a technician reading off the original datasheet information to a second technician affirming appropriate database entry. Only finalized data will be analyzed and presented within the Study technical memorandum.

5.3.2.6 Step 6 – Report and Analysis

At the conclusion of the study, YCWA will prepare a final technical memorandum for Phase 1 and 2 that includes the following sections: 1) Study Goals and Objectives; 2) Methods and Analysis; 3) Results; 4) Discussion; and 5) Description of Variances from the FERC-approved study, if any. The technical memorandum will contain relevant summary data, tables and graphs, and will be a stand-alone document, though it will address relevant information developed by other studies, including Study 7.11. An electronic database of all tracking data will be provided as an appendix.

The technical memorandum will generally describe Chinook salmon movements within the lower Yuba River between Daguerre Point Dam and the Narrows 2 Powerhouse and provide detailed fish movement data between the Narrows 1 and 2 powerhouses, and the area of the Narrows 2 Powerhouse tailrace and bypass pool. A description of flow releases from the Narrows 2 Powerhouse facilities on a 15-minute time step for the duration of the telemetry study will be included, as will mean daily flow at the United States Geological Survey's Smartsville and Marysville streamflow gaging stations. Existing information from the 2009, 2010, and 2011 RMT acoustic study will be generally compared to newly collected data.

6.0 Study-Specific Consultation

The study includes two study-specific consultations:

- An office-based collaborative assessment will be conducted involving NMFS, USFWS, CDFW, SWRCB and researcher experience to evaluate which of up to six telemetry systems is most appropriate for monitoring Chinook salmon behavior downstream of Narrows 2 Powerhouse based on the physical environment and river characteristics in the study reach and the precise positional data sought. (Phase 1, Step 1.)
- YCWA will consult with NMFS, USFWS, CDFW, SWRCB and established vendors of telemetry systems (e.g., HTI, Lotek, ATS and Vemco) to determine the best two to three systems to compare in the field (Phase 1, Step 1).
- At the conclusion of Step 1, YCWA will meet with NMFS, USFWS, CDFW and SWQCB to seek collaborative agreement regarding which of the evaluated systems will be field tested in the next step. If collaborative agreement is not reached, the matter will be referred to FERC for resolution. (Phase 1, Step 1.)
- The interim technical memorandum will contain relevant summary data, tables and graphs that provide the results of Steps 1 and 2, and YCWA's recommendation for a telemetry system to use in Phase 2. No earlier than 15 days or later than 30 days after issuance of the technical memorandum, YCWA will meet with NMFS, USFWS, CDFW and SWRCB to seek agreement on the telemetry system. If collaborative agreement is not reached, the matter will be referred to FERC for resolution. (Phase 1, Step 3.)
- YCWA will notify FERC to discuss how to resolve differences if the permits issued by agencies differ from the FERC-approved study (Phase 2, Step 1).
- YCWA will make a good faith effort to meet the target goal of tagged adult Chinook salmon (i.e., 25) in each of the four tagging efforts or until all 85 fish are tagged. If after 10 days of effort during any of the four tagging efforts the target number of fish are not collected and tagged, YCWA will consult with FERC regarding the need for additional effort. (Phase 2, Step 3.).
- YCWA will provide routine notification to NMFS, USFWS, CDFW and SWRCB regarding planned field events.

7.0 Schedule

YCWA anticipates the study will occur in two phases from 2013 to early 2015. A schedule for the study is provided below.[6] The proposed schedule assumes finalization of the study plan by FERC in August 2013. The schedule may shift depending upon finalization and the first month indicated below (currently August 2013) should be considered the month the study plan is final.

[6] The study schedule for Phase 2 is contingent on obtaining the necessary permits and approvals from NMFS and CDFW by the end of March 2014.

YCWA is committed to delivering the study in a timely manner and will work within the constraints allowed.

Phase 1 – Evaluation of Telemetry Technologies

Office Evaluation of Up to Six Telemetry Systems (Step 1) .....August – September 2013
Field Evaluation of Up to Three Telemetry Systems (Step 2)[7] .....October – November 2013
Interim Technical Memorandum (Step 3)..... December 2013 - January 2014

Phase 2 – Tagging and Tracking Fish

Obtain Necessary Permits (Step 1) .....September 2013 - March 2014
Deployment of Telemetry Array (Step 2).....May - June 2014
Fish Tagging (Step 3)..... June – September 2014
Data Monitoring (Step 4).....June – December 15, 2014
Data QA/QC (Step 5)..... July – December 2014
Report and Analysis (Step 6) .....January – March 2015

8.0 Consistency of Methodology with Generally Accepted Scientific Practices

The methods presented in this study plan are consistent with other generally accepted scientific study methods concerning anadromous salmonid population assessments, including those conducted by the resource agencies in California.

9.0 Level of Effort and Cost

YCWA estimates the cost to complete this study in 2013 dollars is $450,000.

10.0 Attachments

This study plan includes one attachment:

- Attachment 7-11aA Documentation of Transmittal of Draft Study Plan to NMFS, USFWS, SWRCB and CDFW for 21-Day Review and Comment
- Attachment 7-11aB Comments from NMFS and USFWS.[8]
- Attachment 7-11aC YCWA's Response to NMFS' and USFWS' Comments

[7] This assumes the vendor provides tags and necessary equipment to perform the field tests.
[8] CDFW and SWRCB did not provide us with comments.

11.0 References Cited

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