

APPENDIX F
SPECIFIC SAMPLING PROTOCOLS AND PROCEDURES FOR VAKI
RIVERWATCHER MONITORING

VAKI RIVERWATCHER MONITORING

Background

Underwater video monitoring provides a non-invasive method for gathering information on salmon migration in streams (Kucera and Orme 2007). Underwater video monitoring can often be hampered by high flow events and turbidity. The Vaki Riverwatcher infrared systems, produced by Vaki Aquaculture Systems Ltd., of Iceland, provide a tool for monitoring fish passage year-round without need for continuous video feeds. The Vaki Riverwatcher system records both silhouettes and electronic images of each fish passage event. By capturing silhouettes and images, fish passage can be accurately monitored even in under turbid conditions. Data for each fish passage event is downloaded directly to an on-site PC for further analysis.

Fish passage monitoring of adult Chinook salmon and steelhead on the lower Yuba River will be conducted using two Vaki Riverwatcher systems, in conjunction with digital photography located in the north and south fish ladders at Daguerre Point Dam (DPD). The data collected by the Vaki Riverwatcher systems for Chinook salmon and steelhead will be used in conjunction with data from redd surveys, carcass surveys, and angler surveys. The combined datasets will be used to generate abundance estimates, help evaluate habitat use, and examine trends in fish passage.

Goals of the Vaki Riverwatcher monitoring include: (1) estimate the abundance of spring-run, fall-run, and late fall-run Chinook salmon and steelhead above DPD; (2) examine the temporal distribution of immigration of the total run, and natural origin spring-run, fall-run, and late fall-run Chinook salmon and steelhead immigrating past DPD; (3) examine the size structure of salmonids using length-frequency distributions; (4) examine the age structure of salmonids by examining the modalities of length-frequency distributions; (5) examine the annual and multi-year trends in timing of immigrating salmonids past DPD; (6) examine the annual and multi-year trends in timing of different sizes of immigrating salmonids past DPD; (7) use Vaki Riverwatcher data in conjunction with redd survey data to estimate the abundance of steelhead below DPD; and (8) use Vaki Riverwatcher data in conjunction with water temperature and flow

data to evaluate potential relationships between water temperatures and flows, and the timing of adult salmonid immigration.

1.0 Survey Location

The Yuba River watershed drains 3,468 km² along the western slope of the Sierra Nevada. The Yuba River's confluence with the Feather River is located in Marysville, California. Between the mouth of the Yuba River and Englebright Dam, the first impassable barrier to anadromous fish migration on the Yuba River, there are approximately 39 km of habitat potentially used by salmonids. Daguerre Point Dam is approximately 19 km upstream from the mouth of the Yuba River and has two fish ladders (located on the north and south side of the river) to allow fish passage. Each ladder is outfitted with a Vaki Riverwatcher system.

2.0 Survey Period

Both of the Vaki Riverwatcher systems are operated year-round for monitoring fish migration in the lower Yuba River. The Vaki Riverwatcher systems are anticipated to be operated continuously at least through 2014.

3.0 Sampling Frequency

Passage data from each Vaki Riverwatcher systems will be downloaded every Monday. Files will be transferred onto a universal serial bus (USB) flash drive. These files will be subsequently uploaded to the database computer. The uploaded data will be analyzed weekly and reviewed for quality assurance and quality control. All data will be routinely backed-up to an external hard drive. Routine updates and annual reports on fish passage will be provided to supervisors and the River Management Team.

4.0 Sample Size

All fish passage events are recorded by the Vaki Riverwatcher systems. All positively identified and unknown fish passing the Vaki Riverwatcher systems will be recorded.

5.0 Monitoring Protocols and Procedures

5.1 Preseason Planning - Lead Biologist Responsibilities and Coordination Activities

The lead biologist is responsible for supervising the Vaki Riverwatcher system technician, for carrying out the annual logistics to prepare for the next monitoring period (Section 6.0), for pre-season data management needs, and for preparing the previous year's annual report to focus on the next monitoring period.

5.2 Data Collection and Sampling Techniques

Data collection for individual fish passage events are automatically recorded by the Vaki Riverwatcher systems. Each data record is reviewed by personnel to: (1) identify the fish species; (2) examine if Chinook salmon have an adipose fin, and (3) identify non-fish passage events (i.e., debris). The Vaki Riverwatcher systems record the time/date of each fish passage event, the upstream or downstream direction of passage, the speed of the fish moving through the system (m/sec), the fish's body depth (mm), and logs water temperature every hour. The body depth of a fish is converted to a length measurement (cm) by the program software (Winari v. 4.16) utilizing a body length-to-depth ratio (e.g., steelhead body length-to-depth ratio is 4.7:1) (D. Massa, CDFG, pers. Comm. 2009). The morphometric body ratios were obtained by measuring 36 fall-run Chinook salmon in 2003 and 119 fall-run Chinook salmon in 2005 from the Feather River Hatchery and 168 steelhead from the lower Yuba River (D. Massa, CDFG, pers. Comm. 2009). To maximize the accuracy of passage estimates generated by the Vaki Riverwatcher systems, a full-time technician will be employed to monitor the systems and minimize system off-line events.

5.2.1 Vaki Riverwatcher Specifications

The Vaki Riverwatcher system consists of: (1) a digital camera (takes photographs); (2) lighting systems; (3) two infrared scanning plates (takes silhouette images); and (4) a temperature probe. The equipment is submerged underwater and installed in a modified weir (measuring 18" x 24") within each fish ladder. The fish weir confines fish passage over the scanner plates for recording a silhouette and recording an image with the digital camera. The south Vaki Riverwatcher system has an exposed camera, and the north ladder has a camera contained in an aluminum box with a white background to provide contrast. The north side is additionally outfitted with an LED light bar. Each Vaki Riverwatcher system has a computer used for data storage, system maintenance, and monitoring. Power for both north and south Vaki Riverwatcher systems is provided by a bank of four 6-volt batteries. Photovoltaic panels (solar panels) are used to recharge the batteries.

5.2.2 Quality Assurance/Quality Control for Fish Passage Events

The Vaki Riverwatcher systems' infrared scanning plates detect passage and capture a silhouette of fish passing in either an upstream or downstream direction. The minimum body depth to activate the scanning plates is 40mm. The passage of an upstream migrating fish, past the scanning plates, activates the digital camera and flash. For each upstream passage event the digital camera records one to five digital color images. Currently, the Vaki Riverwatcher systems are set to record five images to maximize the potential for capturing a reliable image. For downstream passage events, the systems can only record silhouettes due to the placement of the cameras upstream of the scanning plates.

The technician will review all passage records and make a species identification after reviewing silhouettes and photos (see **Figures 1 and 2**). Each species has specific physiological characteristics identifiable in the silhouettes and photos. Good examples of physiological characteristics are adipose fins of salmonids and the hooked jaw of male Chinook salmon.

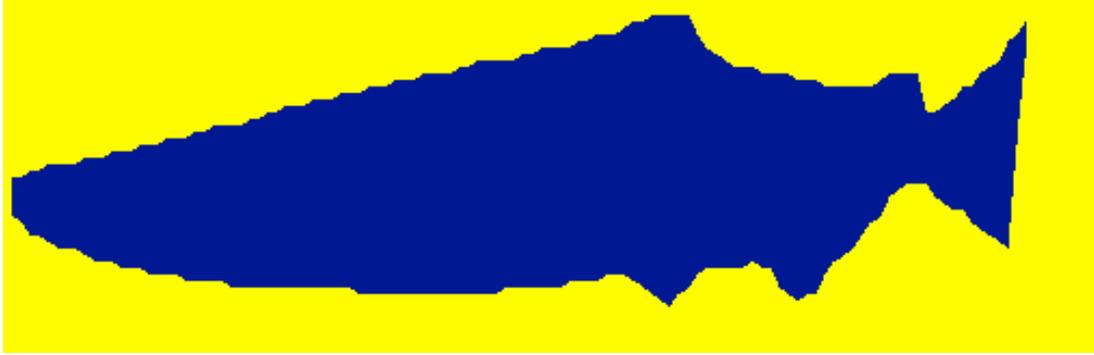


Figure 1. Chinook salmon silhouette from Vaki Riverwatcher



Figure 2. Photographs of a Chinook salmon passage recorded by the Vaki Riverwatcher

5.2.3 Vaki Field Maintenance Protocol

Under ideal operational conditions, field maintenance of the Vaki Riverwatcher system occurs each week on Monday, Wednesday, and Friday. Duties include:

- Daily maintenance log
- Ladder and camera equipment maintenance
- Power supply equipment maintenance
- Data download and computer reset
- Equipment safety and high flow monitoring.

5.2.3.1 Daily Maintenance Log

The maintenance log will be filled out every time the technician visits the ladder, and is kept in the PC box. The following data will be recorded: (1) date and time; (2) name of the person taking data; (3) battery voltage; (4) solar output; (5) weather conditions; (6) debris load (i.e., light, medium or heavy); (7) number of up and down fish movements; (8) data download status (i.e., yes/no); (9) previous data reset (i.e., yes/no); and (10) any comments. Comments should include: (1) abnormal flow or weather events; (2) system complications such as broken equipment; (3) any new installed equipment, (4) changes to setting in the Winari system; (5) any salmon carcasses removed from the ladder; and (6) any other relevant information. When the

maintenance log is full (approximately bi-monthly), the technician will bring the log into the office and enter the information into the database. The technician will leave a new maintenance log in the PC box.

5.2.3.2 Ladder and Camera Equipment Maintenance

The ladder can be serviced with or without lowering the gate that controls the water flow through the ladder. Approximately from June through October, the camera/scanner unit can be inspected and thoroughly cleaned underwater by two technicians equipped with proper exposure gear (i.e., minimum 0.5 mm wetsuit, gloves, and boots). During the winter or during high flow events, the gate valve regulating flow into the ladder must be closed. Water entering the fish ladder will be diverted, and two technicians can service the equipment using waders. *Omit steps in protocol for lowering gate for ladder if not necessary.* Specific maintenance steps include the following.

- 1) Open the PC box and turn the System OFF before starting any maintenance. The Winari program will open automatically on the PC monitor when the PC box is opened. The OFF icon is in the upper right corner of the monitor.
- 2) If the gate needs to be lowered to block water from entering the ladder, use a generator (Honda) and large drill (with an attached special slotted bit) to lower the gate. Haul the generator and drill out to the dam above the gate valve. Start the generator and plug in the drill. Record the water level height and the gate valve height (for reference when raising the gate). Lower the gate valve using the drill. If the drill is non-operable the technician can lower the gate manually with the crank tool. *Note: some water will come through the gate, but the flow will be minimal.* Raising the gate is done by performing the above operations, but cranking the gate the opposite way. Take care to adjust the gate to achieve the proper water level/flow (there is a gauge located on the dam next to the diversion gate on the North side).
- 3) Unlock the metal security grate (where the scanner unit/camera is located) and open the grate with a come-along. Attach a safety cable from the hatch top to the adjacent grate.
- 4) Clean debris from the fish ladders and Vaki Riverwatcher scanner plates and lights. Use a rake to pull out any debris in the fish ladder, being careful not to catch or disturb any wires. Use the pole brush to clean the camera from algae/periphyton. On the north side, use the brush to clean the LED light bar and white board (the south side does not have a LED light bar). On the south side, use the brush to clean the scanners. Diving is required to clean the scanner plate on the north side. During the summer, dive once a week to clean the scanner plated on the north side. Algae/periphyton growth is reduced during the winter, so cleaning the scanner plates is required less often. During the winter when river conditions permit diving, clean the scanner plates when cleaning is needed or when an obstruction is blocking the scanners. Lower the metal security grate and lock the grate when finished servicing the ladder.
- 5) Open the PC box and reset the Winari program to the ON position. Ensure that “connected” flashes in the bottom left corner of the screen in the Winari program.

- 6) Scanner visibility should be checked every time the Vaki Riverwatcher system is serviced. Click on the SCANNER icon. A small window pops up that shows two vertical bars with yellow dots. If there are any flashing black/yellow dots there is an obstruction in the scanner box. Any obstruction should be removed immediately.
- 7) The upper two pools of the fish ladder may periodically require gravel extraction by siphoning the gravel into downstream pools.
- 8) If significant gravel has accumulated in lower pools of the ladder contact the Army Corp of Engineers for servicing at (530) 432-6427 ext 11.

5.2.3.3 Power Supply Equipment Maintenance

Solar Panels

The north and south Vaki Riverwatcher systems are each powered by two photovoltaic (solar) panels. These solar panels are used to recharge the bank of batteries. Access to the south Vaki Riverwatcher system's panels is from the dam and the north Vaki Riverwatcher system's panels must be accessed using an extension ladder from below the ladder. Solar panels will be periodically maintained due to dust/dirt and bird droppings, which can reduce power output by the panels.

Clean the solar panels' bullet proof covers on a bi-weekly basis or as needed. Do NOT use the pole brush, squeegee, or any alkaline chemical cleaners on the polycarbonate solar covers. The polycarbonate covers can be cleaned using a jet of water from a water pump or by hand. Soap and water or the 409 brand product can be used to clean the covers with a cellulose sponge. Do NOT clean the panels or covers at a hot time of day as this may cause water spots. Dry the covers with a chamois or cellulose sponge. Apply Rain-Ex to the covers according to the package directions for window use. A full-body safety harness is required if a 6-ft ladder is used where there is no safety railing.

Batteries

The Vaki Riverwatcher systems each have a bank of four, 6-Volt (V) batteries located in a metal box next to the PC box. During summer months, batteries can become fully charged and attain a maximum of about 15 V. The Vaki Riverwatcher systems can run on 1V, but cannot be maintained for prolonged periods at that voltage. Normal demand for the system is approximately 3-5 V. Winter conditions (i.e., cloudy) do not fully charge the batteries and the batteries quickly exhaust their power. The batteries must be manually charged to keep the system running during these conditions. Specific maintenance steps include the following.

- 1) The batteries should be checked on a monthly basis. Apply anti-corrosion terminal cleaner to all terminals as needed.

- 2) Manually charge the batteries when needed. Specific steps to manually charge the batteries include the following.
- a. Disconnect the Vaki Riverwatcher system from power sources and then turn off the computer system.
 - b. Turn off the charge controller to prevent any power surges from reaching the computer terminals.
 - c. Now disconnect the 12V power connection from the computer system for safety.
 - d. Disconnect the solar wire from the solar (+) terminal on the charge controller and cover the exposed wiring using electrical tape.
 - e. Disconnect the positive (+) wire from the battery terminal on the charge controller and tape the disconnected wire, using electrical tape, to the metal box housing the system (arrange the wire so the exposed wiring is not touching anything).
 - f. Disconnect the ground (-) wire from the battery terminal on the charge controller. **DO NOT ALLOW THE EXPOSED WIRES TO TOUCH.** Tape the disconnected wire, using electrical tape, to the metal box housing the system (arrange the wire so the exposed wiring is not touching anything).
 - g. Start the power generator.
 - h. Once the generator is powered, plug the battery charger into the generator. Make sure that the charger is set on the following functions before continuing (functions may vary pending on the charger being used): (1) Deep Cycle; (2) Charge; and (3) 12V Automatic (preferably 10-15A option).
 - i. Connect the battery charger clamps/terminals to the appropriate battery wires. **DO NOT ALLOW THE BATTERY CLAMPS TO TOUCH WHILE CHARGING.** The positive (+; red) clamp connects to the exposed portion of the positive disconnected battery wire. The ground (-; black) clamps to the exposed portion of the grounded disconnected battery wire.
 - j. While charging, watch the gauge on the battery charger to ensure one does not overcharge the battery series.
 - k. Once the battery series is charge to desired level, turn off the charger.
 - l. Disconnect the clamps after the charger is off.
 - m. Reconnect the ground (-) wire to its appropriate terminal on the charge controller.
 - n. Reconnect the positive (+) wire to its appropriate terminal on the charge controller.

- o. Reconnect the positive (+) solar wire to the solar input terminal on the charge controller.
- p. Reconnect the 12 V power connection to the appropriate computer terminal.
- q. Turn on the charge controller.
- r. Review the charge controller readings for the battery series to ensure the needed charge has been reached.
- s. Ensure there is a reading for the solar input to the controller.
- t. If everything appears to be functioning correctly, restart the computer.
- u. If any problems arise, contact the lead biologist immediately.

5.2.3.4 Data Download and Computer Reset

On Monday of each week, all data saved onto the Vaki Riverwatcher PC must be downloaded onto a USB flash drive, by implementing the following procedure.

- 1) Open the PC box and turn the System OFF before downloading data. The Winari program opens automatically on the PC monitor when the PC box is opened. The OFF icon is in the upper right corner of the monitor. Press the SAVE icon (to create unique files for the data set). Insert the USB flash drive and save all data from the previous week onto the drive. Eject the drive.
- 2) Reset the Winari program by pressing the RESET icon. A prompt will indicate that all data will be erased, press OK (data has been saved). Re-connect the PC by pressing the ON icon. Confirm that “connected” is flashing in the lower left hand corner. Close and lock box.

6.0 Logistics

6.1 Personnel

6.1.1 Qualifications

The Vaki Riverwatcher system technician will be responsible for downloading data and maintaining equipment described in this protocols and procedures. The Vaki Riverwatcher system technician will be expected to maintain complete survey field notes described in this protocols and procedures.

To successfully complete data collection associated with the Vaki Riverwatcher systems, the Vaki technician conducting the work will have the following minimum qualifications: a related 4-year college degree (e.g., fisheries biology or biology) and a minimum of 2 years of professional experience in fisheries biology. Specifically, staff members will have experience with:

- ❑ Use of various fish and fish habitat sampling techniques
- ❑ Identification of freshwater water fish including salmonids
- ❑ Use of underwater photography
- ❑ Use of computers and database software
- ❑ Understanding of biological field studies

For field data collection and equipment maintenance, the work will be conducted by two people to facilitate safe and efficient data collection, and at least one person will have the minimum qualifications as stated above.

6.1.2 Training

This protocols and procedures will be made available to the technician in charge of monitoring the Vaki Riverwatcher systems. The technician will be trained on maintenance procedures, data transferring, and data analysis prior to working with the Vaki Riverwatcher systems. Fish identification training will include working with experienced staff on multiple trail data sets. To promote consistency and to address safety concerns, new hires assisting in the maintenance and operation of the Vaki Riverwatcher systems should be scheduled to work with experienced staff and receive training in the field. Safety training for field personnel should include first aide, swift water rescue training, and operating four-wheel drive vehicles. Specialized training with other related equipment will occur as needed. Data management and analysis may require additional specialized training.

6.2 Schedule

North and south Vaki Riverwatcher systems will be serviced on Monday, Wednesday, and Friday of each week. All fish passage data will be downloaded to the editing computer, backed up, and analyzed on Tuesdays and Thursdays of each week. Situations may arise when the Vaki Riverwatcher systems must be serviced at different intervals from the aforementioned days. The technician is responsible for determining when the systems need to be checked and/or serviced under special conditions.

6.3 Annual Cost

Yearly Yuba River VAKI System Monitoring Costs							
<u>LABOR (Field maintenance: Data download, cleaning and maintaining equipment)</u>							
	days/week	total days	hrs/day	total hrs	labor rate/hr	# of personnel	
VAKI Tech	3	156	8	1248	\$27.88	1	\$34,794.24
<u>LABOR (data analysis)</u>							
	days/week	total days	hrs/day	total hrs	labor rate/hr	# of personnel	
VAKI Tech	2	104	8	832	\$27.88	1	\$23,196.16
<u>LABOR (Monthly Supervisor visits: Includes reports and admin. work)</u>							
	days/month	total days	hrs/day	total hrs	labor rate/hr	# of personnel	
	2	24	8	192	\$39.24	1	\$7,534.08
							Subtotal
							\$65,524.48
<u>Equipment and Repair costs</u>							
Maintenance	winch replacement, system overhauls, computer repairs	Rate Per Year \$					
		\$1,000					\$1,000.00
Annual VAKI repairs/modifications	CDFG screen shop employees	total days/year				# of personnel	
		3				4	\$2,007.60
							Subtotal
							\$3,007.60
<u>TRANSPORTATION</u>							
	days/week	total days	miles/day	total miles	rate/mile	# DFG vehicles	
Four-wheel Drive Vehicle	3	156	110	17160	\$0.59	1	\$10,124.40
							Subtotal
							\$10,124.40
							Grand Total:
							\$78,656.48

6.4 Equipment Lists

Vaki Riverwatcher Monitoring	
• Honda EU 2000i Generator	• Electrical Tape
• Milwaukee 3/4" Drill	• Lg. Spool Black Coaxial Cable
• Hand Ratchet Winch	• Lg. Spool Blue Bennex Cable
• Rake(s)	• Heavy Duty Extension Cord
• Brush poles	• Multi-Purpose Lithium Grease
• Soft Truck Brushes	• Dielectric Grease
• Hand Brushes	• Grease Gun
• Commercial Sponges	• 600 ft 1/2" Truck Rope
• Gaff	• USB Flash Drive
• Wetsuit, Hood, Booties, Gloves	• Chemical Gloves
• Mask and Snorkel	• Tool Kit
• Ultra Torch	• Absorbent Wipes
• Micro Torch	• Insecticide
• Insulated Solder less Terminal Kit	• Data Forms
• Heat Shrinkable Insulation Kit	• Watch
• Cable Ties	• Digital Camera
• Staple Gun	• Pens, Pencils, Sharpies
• Meter Tape	• Flagging
• Survey Protocol	• Food and Water

7.0 Data Management

7.1 Data Entry and Data Processing

Each week, the north and south Vaki Riverwatcher systems' raw data files will be transferred from the Vaki Riverwatcher system to a USB flash drive and then transferred to the office and saved onto the designated Vaki PC for processing. All data records will be saved to an external hard drive for archiving on the 1st of each month. All records of fish passage will be categorized by species by the Vaki technician. Quality control of fish identification will be done Tuesdays and Thursdays of each week by the Vaki technician. Every file record will be reviewed and any changes will be recorded in the QA/QC log and will also be re-categorized manually in the Winari program. A supervisor will review the QA/QC log for additional quality assurance of the data.

The field maintenance log will be photocopied and entered into the Vaki computer bi-monthly (approximately-depending on when it is completely filled out). The sheets will be filed properly at the office.

7.1.1 Data Editing in the Winari Program

Procedures for uploading and analyzing passage data include the following.

- 1) After the Riverwatcher data files are transferred to the editing computer, they are to be added into Winari program. Open the Winari program and select the appropriate counter ladder/year and go to "add/delete files" to select the new data files.
- 2) In the Winari program, create categories by clicking "settings" and go to "categories." Type in category names and complementary length-to-depth ratios. The category names and respective ratios are as below:
 - Unidentified, 4.39
 - Debris, 4.39
 - Chinook Salmon Non-clipped, 4.39
 - Chinook Salmon Adipose Clipped, 4.39
 - Chinook Salmon Adipose Undetermined, 4.39
 - Steelhead trout, 4.7
 - Sacramento Pikeminnow, 4.39
 - Sacramento Sucker, 4.39
 - Hardhead, 4.39
 - American Shad, 4.39
 - River Otter, 6
 - Needs Review, 4.39

- 3) The silhouette and corresponding photo of a newly added file set should be closely examined for species identification and categorization. Identification of fish reviewed for each passage event is based upon the adequacy the silhouettes and digital photo images in combination with associated passage event data (i.e., passage time, etc.). Accurate passage identification of Chinook salmon and steelhead is assumed for classifications based on a full complement of silhouettes, digital photos, and associated data. In addition, accurate identification of Chinook salmon is assumed for the identification of records that contained a partial set of data attributes or single attribute, (i.e. a clear photo or silhouette can still allow for an accurate identification). Contrary to identifying Chinook salmon with a single attribute, the identification of a steelhead trout is not possible with the absence of either a defining silhouette or clear digital photo. When the digital photo and silhouette is not recorded and only associated data is available, no attempt is made to identify the record as a steelhead.
- 4) For Chinook salmon the condition of the adipose fin also will be identified from passage images. If labeling the salmon as “adipose clipped” or “not clipped” is not possible from images, then the salmon will be categorizes as “adipose undetermined”.
- 5) All non-salmonid species are categorized to the appropriate species designation.
- 6) Individual data records that are identified as non-fish passage events are selected to the descriptive category of “debris”.

7.1.2 Quality Assurance/Quality Control Processes in the Winari Program

The technician will be responsible for initial data quality assurance and control. The technician will maintain an electronic database of the Vaki Riverwatcher data and summarize fish counts. After initial quality control, all data including reports and summaries will be transmitted electronically to Mr. Colin Purdy (cpurdy@dfg.ca.gov), and Mr. Duane Massa (DMASSA@dfg.ca.gov).

7.2 Data Storage and Archival Procedures

All original data will be well organized, clearly labeled, and archived. Reports will be prepared annually and archived. Digital versions of the data sets, as well as hardcopies of reports, will be submitted to the RMT Planning Group.

- ❑ Raw Data Electronic Storage Format (Software): Winari/Microsoft Excel
- ❑ Processed Data Electronic Storage Format (Software): Winari/Microsoft Excel

Electronic files and print copies of the field data sheets will be located at:

Yuba County Water Agency
1220 F Street
Marysville, CA 95901-4226

And

California Department of Fish and Game
629 Entler Ave. #12
Chico, CA 95928

Data Retrieval Contact: Duane Massa
Telephone Number: (530) 570-3474
Email Address: duane@psmfc.org

REFERENCES

Kucera, P. A., Orme, R. W. (2007). Chinook salmon (*Oncorhynchus tshawytscha*) Adult Escapement Monitoring in Lake Creek and Secesh River, Idaho in 2006. Annual Report January 2006 – December 2006.

Navicky, James. 2003. CDFG. Personal communication. (916) 358-2926. Yuba River Vaki Riverwatcher.