Placer County Water Agency
Middle Fork American River Project
(FERC Project No. 2079)

FOOTHILL YELLOW-LEGGED FROG MONITORING PLAN

Placer County Water Agency
P.O. Box 6570
Auburn, CA 95604

February 2011

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List of Acronyms

CDFG	California Department of Fish and Game
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
Commission	Federal Energy Regulatory Commission
FERC	Federal Energy Regulatory Commission
FYLF	Foothill yellow-legged frog
FYLFMP	Foothill Yellow-legged Frog (Rana boylii) Monitoring Plan
GPS	Global Positioning System
km	kilometer
m	meters
MFP	Middle Fork American River Project
^{o}C	degrees Celsius
^{o}F	degrees Fahrenheit
PCWA	Placer County Water Agency
Project	Middle Fork American River Project
SD	Supporting Document
State Water Board	State Water Resources Control Board
USDA-FS	United States Department of Agriculture-Forest Service
USFWS	United States Fish and Wildlife Service
WTMP	Water Temperature Monitoring Plan
YOY	young-of-the-year

1.0 INTRODUCTION

This Foothill Yellow-legged Frog (*Rana boylii*) Monitoring Plan (FYLFMP) was developed for the Placer County Water Agency's (PCWA) Middle Fork American River Project (MFP or Project) located on the west slope of the Sierra Nevada range primarily in Placer County, California. Foothill yellow-legged frog (*Rana boylii*) (hereafter, FYLF), is a United States Department of Agriculture-Forest Service (USDA-FS) Sensitive Species and California Species of Special Concern.

The goal of the FYLFMP is to periodically characterize populations of FYLF in selected bypass and peaking reaches associated with MFP during implementation of the new license. Information collected as part of the FYLFMP will be presented along with the historical FYLF population data collected during MFP relicensing (AQ 12 – Special-Status Amphibian and Aquatic Reptile Technical Study Report 2007 [AQ 12 – TSR] PCWA 2011a; Supporting Document [SD] B).

2.0 FYLFMP ORGANIZATON

The FYLFMP is organized into the following sections:

Section 3.0 FYLFMP Objective: This section defines the purpose of the FYLFMP.

Section 4.0 Monitoring Approach: This section describes the approach for monitoring FYLF populations over the term of the new license, including monitoring locations and schedule and sampling and analyses methods. The section also includes a description of special purpose monitoring studies.

Section 5.0 Reporting and Consultation: This section outlines reporting that will be required over the term of the new license and describes agency consultation that would be conducted following the completion of each monitoring period.

Section 6.0 Literature Cited: This section provides a list of documents or other resources that are referenced in the FYLFMP.

3.0 FYLFMP OBJECTIVES

The FYLFMP describes monitoring and reporting of FYLF populations at select sites in the bypass and peaking reaches associated with the MFP over the term of the license. This information will be used to characterize FYLF populations (abundance and distribution) associated with the MFP. Specifically, the objectives of the FYLFMP are to:

- General Purpose Monitoring
    - Monitor FYLF species abundance (egg masses, tadpoles, and young-of-the-year [YOY]) in select locations in the bypass and peaking reaches, including tributaries;

- Document the approximate upstream distribution of FYLF in the Rubicon River and the Middle Fork American River (upstream of Ralston Afterbay); and

- Determine the approximate timing of the initiation of FYLF breeding season in the Rubicon River and Middle Fork American River (upstream of Ralston Afterbay).

- Special Purpose Monitoring

  - Monitor FYLF initiation of breading timing in relation to the pulse flow releases during the initial implementation years (Middle Fork American River and Rubicon River);

  - Monitor FYLF in relation to flows during the annual fall maintenance outage during the initial implementation years (Middle Fork American River and Rubicon River); and

  - Monitor FYLF in relation to potential flow changes during emergency power outages.

4.0 MONITORING APPROACH

This section describes the approach for general and special purpose monitoring of FYLF populations.

4.1 GENERAL PURPOSE MONITORING

The general purpose monitoring field sampling methods and analyses are consistent with those conducted in 2007 for the AQ 12 – TSR (PCWA 2011a; SD B). The monitoring locations and schedule, sampling methods, and analysis methods are discussed below.

4.1.1 Monitoring Locations and Schedule

FYLF monitoring sites in the bypass and peaking reaches and comparison river reaches are provided in FYLFMP Table 1 and depicted on FYLFMP Map 1. FYLF populations at these locations were sampled in 2007 as part of the MFP relicensing studies (AQ 12 – TSR [PCWA 2011a; SD B]).

FYLF monitoring will be conducted in three of the first five years to represent different water year types and then in Years 7, 8, 13, 14, and thereafter for two consecutive years during every ten-year period for the term of the license. The schedule for FYLF monitoring is consistent with the other aquatic monitoring (water temperature, fish populations, geomorphology, and riparian resources). The goal of sampling three years in the first five years of new the License is to represent the three different categories of water year types: (1) wet/above normal; (2) below normal; and (3) dry/critical. If all three categories do not occur within the first five years, then PCWA will conduct surveys

during the first occurrence of any outstanding water year type(s) until all three categories have been represented.

4.1.2 Sampling Methods

The sampling methods include abundance surveys, distribution surveys, timing of initiation of FYLF breeding surveys, and hydrology / water temperature data monitoring.

4.1.2.1 Abundance Surveys

Abundance surveys will be conducted four times during each monitoring year, including twice in the spring/early summer to detect eggs and early tadpoles, once in the summer to detect tadpoles, and once in the late summer/early fall to detect YOY juveniles.

The first spring visit will be conducted when river temperatures reach a daily average of approximately 11–12ºC (51.8–54.6^{o}F) and when breeding is verified at one of the monitoring sites in the bypass or peaking reaches (refer to Timing and Initiation of Breeding Season Surveys below). These surveys will follow the Visual Encounter Protocol described in *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians* (Heyer et al. 1994; Attachment A) and incorporate United States Fish and Wildlife Service (USFWS) decontamination guidelines (Appendix B of USFWS 2005) or their successors. Surveyor and sampling bias will be reduced by using following procedures:

- Using only highly experienced survey personnel;
- Using the same protocols for all surveys through the license term[1]; and
- Training all personnel on the survey protocols prior to each field season.

At each monitoring location, two surveyors will search the stream banks, back channel areas, and potential instream habitats for FYLF by progressing in a slow, methodical fashion. To aid in the detection of eggs and tadpoles, surveyors will use a viewing box in shallow margin areas and snorkel in deeper water where feasible. Chin photographs will be taken of any adult FYLF captured.

At each sampling location, a minimum of 1,000 meters (m) will be surveyed. For sites located at tributary confluences, a minimum of 1,000 m will be surveyed in the mainstem, as well as 1,000 m up the tributary where possible. The actual distance surveyed will be recorded and the approximate area surveyed for tadpoles will be recorded. During each survey, data (time of the survey, Global Positioning System [GPS] locations, weather conditions, and water and air temperatures at the channel margin and within the channel) will be collected to describe the sampling site and document observations (lifestage, sex, size, developmental Gosner stage

[1] The survey protocol will only be modified through mutual agreement between PCWA, CDFG, and USDA-FS.

[Gosner 1960], and GPS location) of FYLF. A California Native Species Field Survey form for FYLF detections will be prepared and submitted to the California Natural Diversity Database (CNDDB) following successful detections of FYLF.

4.1.2.2 Distribution Surveys

To document the extent of the FYLF upstream distribution in the Rubicon River and Middle Fork American River between Ralston Afterbay and Middle Fork Interbay, distribution surveys will be completed once in the late summer during each monitoring period. Distribution surveys will be presence/absence surveys that will extend no farther upstream than the current known elevation limit of FYLF in the Sierra Nevada, 4,500 feet. The surveys will be conducted in early fall to detect juvenile and adult frogs. Five habitat areas (with suitable breeding and rearing habitat) within approximately 3 miles upstream of the current documented FYLF extent will be surveyed. Habitat areas will be selected from mapping conducted previously (PCWA 2011a) and aerial photography. The habitat areas will be distributed approximately with equal spacing. A minimum of 1,000 m of stream will be surveyed at each area. If FYLF populations become established at the monitoring sites on the Middle Fork or North Fork American rivers in the peaking reach, then distribution surveys will be extended to include the peaking reach.

4.1.2.3 Timing of Initiation of Breeding Season Surveys

To determine the timing of the initiation of breeding season, repeat reconnaissance level surveys will be conducted at MF26.2, MF14.1 (Otter Creek), and R3.5 on the Middle Fork American River and Rubicon River, respectively, prior to and up to the initiation of breeding (FYLFMP Table 1; FYLFMP Map 1). If road access is not available to Otter Creek (MF 14.1), this site will not be used for initiation of breeding surveys and an alternative site, MF 9.3 (Gas Canyon Creek) will be used. The surveys will begin in late March–May, depending on when daily average water temperatures are estimated to be approaching 11–12^{o}C (e.g., spot field measurements). At least two surveyors will conduct a visual search for egg masses in the most likely breeding habitats (<1,000 m of stream). The Gosner stage of any egg masses will be identified. Surveys will continue on a weekly basis until the start of breeding has been confirmed at each of the study sites (e.g., one or more egg masses are observed).

4.1.2.4 Hydrology and Water Temperature Data Monitoring

Hydrology (at existing gages) and water temperatures (continuous, 15-minute) will be monitored from March 1 through October 31 during the years when surveys are completed. Water temperatures will be monitored at 26 locations on the bypass and peaking reaches and on comparison river reaches (Water Temperature Monitoring Plan [WTMP] [PCWA 2011b; SD A]).

4.1.3 Analysis Methods

Analysis methods for the general purpose monitoring abundance surveys, distribution surveys, and timing of initiation of breeding season surveys are described below.

4.1.3.1 Abundance Surveys

The number of observations by life stage (egg mass, tadpoles, juveniles, adults), by monitoring site, and by survey date will be summarized in tabular format. FYLF densities (average number of observations per kilometer [km]) at each monitoring site will be calculated. In addition, tadpole density per area (numbers/m^2) will be calculated. The life stage density monitoring data will be presented along with the data collected as part of the AQ 12 – TSR (PCWA 2011a; SD B) and data from any of the previous FYLF monitoring surveys to identify trends in relative abundance and age distributions. Hydrology (i.e., spring accretion flows, recent spill history and timing), water temperature, and other data collected as part of the overall monitoring program for the MFP will be reviewed, summarized, and presented with the abundance data. Any FYLF that are captured and chin photos are taken will be compared to FYLF captured previously to identify FYLF movement patterns.

4.1.3.2 Distribution Surveys

The distribution survey data from the Middle Fork American River and Rubicon River and the data from each of the sampling sites in the bypass and peaking reaches will be used to update the distribution map for FYLF. The distribution map will be presented along with the data collected during previous monitoring surveys (including data collected in the AQ 12 – TSR [PCWA 2011a; SD B]). Recent hydrology, water temperature, and other data collected as part of the surveys, will be reviewed, summarized, and presented with the observed distribution patterns, as appropriate.

4.1.3.3 Timing of Initiation of Breeding Season Surveys

The timing of initiation of breeding observed at the bypass, peaking, and comparison river monitoring sites will be presented relative to water temperature and hydrology data. The timing of oviposition will be estimated and presented in tables and figures along with observed water temperature and flow data. Breeding timing observations will be presented along with the data collected during previous monitoring surveys and data collected as part of the AQ 12 – TSR (PCWA 2011a; SD B) to illustrate initiation of breeding trends.

4.2 SPECIAL PURPOSE MONITORING

Special purpose monitoring includes supplemental initiation of breeding season monitoring, annual fall maintenance outage monitoring, and emergency outage monitoring.

4.2.1 Supplemental Initiation of Breeding Season Monitoring

Supplemental initiation of breeding season surveys will be used to monitor the timing of initiation of breeding in relation to the timing of pulse flow releases.

4.2.1.1 Monitoring Locations and Schedule

Initiation of breeding season surveys will be conducted in the first two years that pulse flow releases are implemented. These supplemental surveys will be conducted at MF26.2 and R3.5 (FYLFMP Table 1; FYLFMP Map 1) on the Middle Fork American River and Rubicon River, respectively.

4.2.1.2 Sampling Methods

The surveys will begin in late March–May, depending on when daily average water temperatures are estimated to be approaching 11–12^{o}C. At least two surveyors will conduct a visual search for egg masses in the most likely breeding habitats within the study site (<1,000 m of stream). The Gosner stage of any egg masses will be identified. Surveys will continue weekly until breeding has been confirmed (e.g., one or more egg masses are observed).

4.2.1.3 Analyses Methods

The timing of initiation of breeding will be presented along with relevant water temperature and hydrology data. Oviposition timing will be presented in a table and figure along with the observed water temperature and discharge data. Breeding timing information will be presented along with the data collected during any of the previous monitoring surveys, including data collected as part of the AQ 12 – TSR (PCWA 2011a; SD B).

4.2.2 Annual Fall Maintenance Outage Monitoring

Annual fall maintenance outage monitoring will be used to characterize FYLF populations in relation to flow changes in the bypass reaches during the maintenance outage.

4.2.2.1 Monitoring Locations and Schedule

PCWA will monitor FYLF during the annual maintenance outage in Years 1, 2, and 3 after license issuance. The study locations will be MFR26.2, R3.5, and R20.9 (FYLFMP Table 1; FYLFMP Map 1). These are representative study sites in the bypass reaches with known FYLF populations that may be affected by changes in flows during the outages.

4.2.2.2 Sampling Methods

PCWA will monitor FYLF, water temperature, and hydrology (e.g., river stage, flow) during the annual fall maintenance outage. In particular, the monitoring will focus on determining the life stages of the FYLF present during this period and identifying the specific locations within the study areas that are being occupied. Surveys will occur on three occasions associated with the annual maintenance outage: (1) within one week prior to the initiation of increased maintenance outage flows; (2) immediately following outage flow stabilization (as measured at the stream gages in the Middle Fork American

river upstream of Ralston Afterbay and the Rubicon River upstream of Ralston Powerhouse); and (3) immediately following the end of the outage and resumption and stabilization of normal minimum instream flow releases. The surveys will focus on enumerating and determining the life stage (tadpole, juvenile, adult) of FYLF present and mapping their location relative to the stream channel (e.g., stream margin, mid-channel bar, etc.). The FYLF locations and channel margins (at each observed flow) will be mapped on aerial photographs or topography maps. Water temperature and hydrology data from the nearest temperature and flow monitoring sites will be collected. Stage-discharge relationships developed for the gage nearest to the monitoring locations or developed as part of the relicensing studies will be used to help analyze the stage changes during the outage.

4.2.2.3 Analyses Methods

The pre-, during, and post-outage flow numbers and life stages of FLYF observed will be presented along with relevant water temperature and river stage/flow data. The maps of FYLF locations and channel margins (at each observed flow) will be presented. Qualitative observations of the effects of flow changes on FYLF during the monitoring be will reported, as appropriate.

4.2.3 Emergency Outage Monitoring

FYLF monitoring will be used to characterize FYLF populations if a large flow event occurs as a result of an emergency outage at a PCWA facility in the bypass reaches.

4.2.3.1 Monitoring Locations and Schedule

PCWA will survey for FYLF if an emergency outage at a PCWA facility occurs that substantially alters flows in the Middle Fork American River between Middle Fork Interbay and Ralston Afterbay and the Rubicon River below Hell Hole Dam. If an emergency outage occurs between May and September that alters flow by more than 100 cfs[2] (approximately 1.0-foot-stage change) in one of these reaches, PCWA will notify the USDA-FS, State Water Resources Control Board (State Water Board), and California Department of Fish and Game (CDFG), as soon as possible, and will consult with them to determine if monitoring needs to occur.

4.2.3.2 Sampling Methods

Sampling methods will be determined in coordination with the USDA-FS, State Water Board, and CDFG.

[2] As measured at the streamflow gage in the Middle Fork American River downstream of Middle Fork Interbay and in the Rubicon River downstream of Hell Hole Reservoir.

4.2.3.3 Analyses Methods

Analysis methods will be determined in coordination with the USDA-FS, State Water Board, and CDFG.

5.0 REPORTING AND CONSULTATION

General Purpose Monitoring and Special Purpose FYLF Monitoring reports will be prepared and distributed to the USDA-FS, State Water Board, and CDFG for review and comment within 120 days following the completion of each monitoring year. The reports, where appropriate, will follow the general presentation layout for the FYLF data provided in the AQ 12 – TSR (PCWA 2011a; SD B). A 60-day review period will be provided to the agencies. Based on the results of the monitoring and comments received during the review process, PCWA and the agencies may hold a meeting to discuss the results or modify the monitoring program. Within 60 days of receipt of comments, or within 60 days following any meeting, comments will be addressed and the final report will be filed by PCWA with the agencies (USDA-FS, State Water Board, USFWS, and CDFG) and the Federal Energy Regulatory Commission (FERC or Commission).

6.0 LITERATURE CITED

Gosner, K.L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16:183–190.

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PCWA. 2011a. AQ 12 – Special-Status Amphibian and Aquatic Reptile Technical Study Report (2007). Available in PCWA's Application for New License – Supporting Document B.

____. 2011b. Water Temperature Monitoring Plan. Available in PCWA's Application for New License – Supporting Document A.

United States Fish and Wildlife Service (USFWS). 2005. Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog, August 2005.

TABLES

FYLFMP Table 1. Foothill Yellow-Legged Frog Monitoring Site Locations.

River and Monitoring Sites[1] (River Mile)	Reach Type			Monitoring Site Type	Tributary Confluence Site	Relation to Monitoring Plan Objective			
	Bypass Reach	Peaking Reach	Comparison Reach			General Purpose Monitoring	Special Purpose Monitoring		
							Supplemental Initiation of Breeding	Annual Fall Maintenance Outage	Emergency Outage
Middle Fork American River									
AMPH MF6.4		●		Tributary/Mainstem	American Canyon Creek	●			
AMPH MF9.3		●		Tributary/Mainstem	Todd Creek Gas Canyon Slug Canyon	●			
AMPH MF14.1		●		Tributary/Mainstem	Otter Creek	●	●		
AMPH MF24.1		●		Tributary/Mainstem	North Fork of the Middle Fork American River	●			
AMPH MF26.2	●			Mainstem	No	●	●	●	●[2]
AMPH MF29.4	●			Mainstem	No	●			●[2]
Rubicon River									
AMPH R1.2	●			Mainstem	No	●			●[2]
AMPH R3.5	●			Mainstem	Long Canyon Creek	●	●	●	●[2]
AMPH R5.2	●			Mainstem	Pilot Creek	●			●[2]
AMPH R14.3	●			Mainstem	No	●			●[2]
AMPH R20.9	●			Mainstem	No	●		●	●[2]
North Fork American River									
AMPH NF21.1		●		Tributary/Mainstem	Middle Fork American River	●			
AMPH NF35.7			●	Comparison	Shirttail Creek	●			
North Fork of the Middle Fork American River									
AMPH NFMF2.3	●		●	Comparison	No	●			

[1] All study sites will be surveyed a minimum of 1,000 m in stream length. Tributary site surveys will also include a minimum of 1,000 m upstream on the tributary where possible.

[2] These are the bypass reach locations that may be affected by an emergency outage.

MAPS

ATTACHMENT A

Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians (Heyer et al., 1994)

STANDARD VES (HEYER et al. 1994) WITH AUGMENTED FIELD DATASHEETS

YARNELL, S. 2007.

This Visual Encounter Survey (VES) protocol and associated datasheet are for use in stream reaches up to several thousand feet in length where information on all lifestages and the micro-habitat associations of each individual is desired. The data from this survey protocol is intended to (1) describe the abundance, distribution and micro-habitat associations of *R. boylii*, and (2) provide the data necessary to coordinate with other stream reach study efforts, such as instream flow studies where hydrodynamic modeling will be used.

The VES protocol is as described in Heyer et al. (1994), and is summarized for stream habitats as follows. Habitats are searched along a several meter wide transect parallel to the stream at the water's edge, and the number of animals encountered over a period of time is recorded. Using a moderate level of search effort, individuals active on the surface of the ground, on rocks, or at the water's edge are identified, and captured and measured if possible. Rocks, logs and other surface cover objects are also overturned in search of individuals, then returned to their original position to minimize disturbance to the habitat. Habitats are not systematically destroyed in order to find animals, and voucher specimens are not collected unless absolutely necessary for identification. In shallow water habitats, hand dip nets are used to capture individual adults and sub-adults, and to seine the channel bottom to collect tadpoles. This search effort in shallow water habitats is balanced to minimize habitat disturbance, but adequately sift through any silt, gravel or vegetation where individuals may be hiding. Use of a viewing box in shallow, wadable areas to help in detection of egg and tadpole lifestages is recommended. Likewise, where safe and possible, snorkeling in deeper water (0.5–2 m deep) adjacent to good breeding habitat (e.g., edges of cobble bars) can greatly aid in detection of egg masses, and is recommended during spring surveys. To effectively survey stream segments, both banks are walked with a minimum of two surveyors. Wherever possible, surveys are completed walking upstream so that as individuals seek cover in the stream, often swimming downstream, they are not counted twice. In addition, eggmasses are generally attached to the downstream side of cobbles and are easier to detect when walking upstream. However, surveys could proceed in the downstream direction if surveyors are well-practiced in identification, are manually feeling and checking behind cobbles and boulders for eggmasses, and can adequately keep track of any downstream migrating individuals.

A list data to be included on data sheets is provided below. A list of field equipment required to complete the surveys is attached at the end of this protocol. In general, equipment should be selected to be lightweight and compact enough to fit within a daypack so that surveyors can be fully mobile.

General Data

Site: Name of stream and reach to be surveyed. If sub-reaches are used, clarify which sections are to be surveyed. For example: South Yuba River, Reach A-1, river mile 12.5–13.5.

Start/End UTM: Coordinates of start and end survey locations on the stream in NAD27 datum (designate other datum if needed). Record saved waypoint (wypt) number accuracy of point (in meters).

Elevation: Record from Topo map or GPS and circle source (note range of error)

Photo numbers: Record digital photo ID numbers for photos taken throughout survey. Include photos of the start and end locations, typical mid-channel habitat, typical edgewater and backwater habitats, examples of breeding habitat (occupied or otherwise), example individuals where possible (adults, juveniles, eggs and tadpoles) and any other interesting or unique habitat features.

Observers(s): Names of surveyors

Date: Month, Day, Year

Survey Start/End Time: Record start/end times of survey (note time of breaks for lunch, etc on bottom of sheet if necessary). This should reflect actual survey/search time.

Weather: Describe general cloud cover; enter code from list:

C Clear

PC Partly Cloudy

MC Mostly Cloudy

O Overcast

R Rainy

Start/End Temp (C): Record temperature of air (in the shade) and water (thalweg and edgewater) at start, mid-day (if applicable) and end of survey. Edgewater temp should be within 0.3 m of shore in a shallow slow-moving location.

Bullfrogs? Fish? Note presence/absence of bullfrogs, fish or crayfish anywhere in survey reach. If needed, add notes at bottom of page.

Field sketch completed? At the bottom of the page, note whether a rough field sketch was completed on the back of the datasheet. The sketch serves as rough indicator of habitat throughout the survey reach and can be used to delineate which portions of the reach may *not* have been surveyed (e.g., very deep or fast areas near a steep heavily vegetated bank).

Life Stage/Sex: Note life stage of individual; enter code from list:

AF	Adult Female
AM	Adult Male
AU	Adult Unknown
J	Juvenile/Sub-adult
Y	Young of Year/metamorph (newly emerged – fall only)
T	Tadpole
E	Egg mass

Length (mm): Snout to vent length for adults/sub-adults; Total length for tadpoles; Diameter for egg masses

Developmental Stage: Gosner stage for egg masses and tadpoles. If categorized, then note categories on back of datasheet.

Location of Observation: Code or some identifier of location in survey reach where observation was recorded. Could be a GPS waypoint number or an associated meso-habitat number correlating to another study.

Comments: Include here any information on local habitat condition, species condition, presence of non-natives, photo description, etc.

LITERATURE CITED:

Heyer, W. R., M. A. Donnelly, R. W. McDiarmid, L. C. Hayek and M. S. Foster, Eds. 1994. Measuring and monitoring biological diversity: Standard methods for amphibians. Biological Diversity Handbook Series. Washington D.C. Smithsonian Institution Press.

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Seltenrich, C.P. and Pool, A.C. 2002. A Standardized Approach for Habitat Assessments and Visual Encounter Surveys for the Foothill Yellow-legged Frog (*Rana boylii*). Pacific Gas & Electric Company.

Yarnell, S. M. 2005. Spatial Heterogeneity of *Rana boylii* Habitat: Physical Processes, Quantification and Ecological Meaningfulness. PhD Dissertation. Hydrologic Sciences, University of California, Davis.

USFSR5 meso-habitat types

Field Equipment List

Required:

Field notebook

Datasheets (w/copy of survey protocol) and clipboard

Clean copies of study site aerial/topo maps (for sketching habitats, etc.)

Pencil, pen, sharpie

Stopwatch

Flagging

Thermometer

Binoculars

Dip net or small handheld net for scooping tadpoles and catching individuals

Clear see-thru rulers (marked in metric) to measure individual length

Small clear plastic vial or wide-mouth bottle to capture tads for identification

Camera – extra batteries, memory card

Scale for pictures (ruler, pencil of known length, etc.)

Handheld GPS – extra batteries

Waders

First Aid kit

Personal – water, food, sunscreen, bug juice, etc.

Recommended:

Viewing box (ideal if made of plexiglass, but could be lightweight plastic with clear plastic affixed to hole in bottom)

Snorkeling gear – drysuit, mask/snorkel, shoes

Rope to tie off and use in swift water

Hand lens (aid in identifying mouth parts on tadpoles)

30m tape – w/metric markings

Optional:

Range finder – to record large scale distances (river width, length of bar, etc.)

Compass

Walkie talkies

Inflatable kayak, inner tube, or some means of floating river if needed – includes lifejackets, drybags, paddles, ropes, etc.