Considerations for Conserving the Foothill Yellow-Legged Frog

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May 14, 2018

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Contents

The California Department of Fish and Wildlife (CDFW) developed this document to provide a review of the ecology of the foothill yellow-legged frog (Rana boylii) as well as considerations for avoiding or minimizing project-related impacts to the species. This document should not be interpreted as an order or mandatory standard for environmental review or permitting. The scientific information provided herein is intended to assist CDFW staff, project proponents, and consultants in conserving the species. While this document provides considerations and examples for avoiding or minimizing project-related impacts, practical applications must be based on the best available information and project- and site-specific conditions.

Introduction

CDFW staff, project proponents, and consultants routinely plan and implement projects that may affect stream breeding amphibians such as the foothill yellow-legged frog. Projects including seasonal bridge installation, bridge and culvert replacements, or dam removal can take days or years to complete and have temporary and/or permanent impacts within stream reaches. A season of operation that completely avoids foothill yellow-legged frog presence does not exist. If frogs are present and breeding, they may be encountered in various life-stages year round. Therefore, understanding the ecology and spatial distribution of the foothill yellow-legged frog is critical to implementing a project that minimizes impacts to the species, while achieving the desired outcome of the project in an efficient and cost effective manner[1]. The appendices provide examples of documented atypical behavior as well as examples of measures and practices that may help minimize impacts to foothill yellow-legged frogs.

Conservation Status

In December 2016, the Center for Biological Diversity submitted a petition to the California Fish and Game Commission (Commission) to list the foothill yellow-legged frog as threatened pursuant to the California Endangered Species Act (CESA; Fish & G. Code, § 2080 et seq.). The Commission followed CDFW's recommendation and voted to advance the species to candidacy on June 21, 2017, publishing its related findings on July 7, 2017 (Cal. Reg. Notice Register 2017, No. 27-Z, p. 986). During CESA candidacy, a species is afforded protections as a listed species and "take[2]" is prohibited

[1] It is the policy of the state of California and the intent of the California Endangered Species Act legislation that "reasonable and prudent alternatives shall be developed by the department, together with the project proponent and the state lead agency, consistent with conserving the species, while at the same time maintaining the project purpose to the greatest extent possible" (Fish & G. Code, § 2053).
[2] Pursuant to Fish and Game code section 86, "'take'" means hunt, pursue, catch, capture, or kill or attempt to hunt, pursue, catch, capture, or kill."

unless authorized by CDFW pursuant to Fish and Game Code section 2080.1, 2081, subdivision (a) or (b), 2089.6, or 2835, or by the Commission pursuant to Fish and Game Code section 2084.

As of July 7, 2017, projects within foothill yellow-legged frog habitat may need authorization for take if take cannot be avoided. Such authorization could take the form of an incidental take permit (ITP; Fish & G. Code § 2081, subd. (b); Cal. Code Regs., tit. 14, §§ 783.2-783.8), a consistency determination if federal incidental take has been authorized (CD; Fish & G. Code, § 2080.1), a safe harbor agreement (SHA; *Id.*, § 2089.6), or a natural community conservation plan (NCCP; *Id.,* § 2835). Take authorization issued pursuant to CESA requires project- and species-specific avoidance and minimization measures, as well as full mitigation for project related impacts.

Basic Ecology

Non-Breeding Habitat: Fall/winter refugia are generally characterized by small tributary streams with perennial water where frogs can forage and avoid mortality caused by flooding (Bourque 2008; Gonsolin 2010; Kupferberg 1996). Non-breeding habitat also includes adjacent terrestrial riparian habitat. Springs, seeps, pools or other moist habitats such as woody debris, root wads, undercut banks, clumps of sedges, and large boulders occurring at high water-lines adjacent to pools may serve as refugia during periods of high stream flow in winter (Rombough 2006; Van Wagner 1996). Wheeler and Welsh (2008) observed adult frogs in breeding and non-breeding habitats regardless of season, providing evidence of a dispersed distribution during both seasons. Overwintering is the least understood aspect of foothill yellow-legged frog habitat use (Hayes et al. 2016).

Breeding Habitat: Adult frogs congregate at suitable breeding habitat and females select oviposition sites. Breeding and rearing habitat is generally characterized by wider, more sunlit mainstem channels. Breeding sites are generally, but not always, located in low-gradient edge water often at point bars or depositional areas near tail-ends of pools and runs (Kupferberg 1996; Wheeler and Welsh 2008). Kupferberg (1996) found successful frogs selected historically used breeding sites associated with tributary confluences, with distinctive channel morphologies, and with boulders that created microhabitats with below-ambient flow velocity. Breeding sites with greater than average width-to-depth

ratios had above-average survival (Ibid.). Thalwegs are rarely suitable for breeding due to greater depths and higher velocities.

Movement: Adult frogs congregate at breeding sites during the reproductive season and then disperse following reproductive activity. Seasonal movements occur among breeding, post breeding summer, and overwintering habitats. Movement data on foothill yellow-legged frogs is limited to a few studies at this time; it is likely that frogs are more mobile than commonly believed and likely utilize a wide range of watershed features including different order tributaries. One study in Tehama County found frogs rarely go beyond 12 m from the channel during any time of the year (Bourque 2008). However, during the same study, Bourque observed a female move up a dry tributary and over a ridge to an adjacent watershed, a distance of over 7 km from her original location, although much of this was in wetted channels. And Nussbaum et al. (1983) reported finding frogs 50 m away from water under debris. Cook (2012) described frequent observations of foothill yellow-legged frogs far (16 m to 331 m, average distance of 71.3 m) from natal streams and in urban settings, near Ukiah, Mendocino County. Instream travel rates vary from tens to hundreds of meters per day, with the longest recorded distance being 1,386 m per day (Thomson et al. 2016).

Foothill yellow-legged frog upland habitat use and movement are poorly understood. However, anecdotal observations suggest that foothill yellow-legged frogs utilize upland habitat in relative proximity to streams, at least in more mesic parts of California (see Appendix A). Seasonality also likely plays a key role as explained throughout this document.

Breeding Season: Foothill yellow-legged frog breeding is correlated with the seasonal timing of streamflow and increasing air and water temperature. Generally, breeding occurs in the spring after winter runoff has subsided. Timing of breeding is variable and may depend on:

- Latitude - Southern populations breed earlier than northern populations (Zweifel 1955).
- Water and/or air temperature - Breeding may start as early as May in warm coastal locations and as late as July in snowmelt-dominated watersheds.
- Rainfall/discharge - Breeding may occur earlier and during a shorter time period during drought years compared to years with rainy oviposition periods (Kupferberg 1996). Frogs initiate breeding to coincide with warmer temperatures and cessation of winter rains (Ibid.). Frogs commence ovipositioning later when base flow is high, and earlier in low-flow years. This plasticity may be driven by temperature cues as well as by precipitation (Ibid.).

Predicting breeding season variability is important for effective avoidance and project-related mitigation. As a rule-of-thumb, in coastal (rain-fed) systems, breeding occurs between May to mid-June. In Sierra Nevada and Klamath-Siskiyou (snowmelt-fed) systems, breeding occurs between late April to early July[3] (generally May to early June).

Duration of breeding varies by population with some breeding intervals as short as two weeks (Storer 1925; Zweifel 1955), others lasting up to 31 days (Van Wagner 1996). Breeding is more protracted during cold, rainy springs than warm, dry ones (Kupferberg 1996; Wheeler and Welsh 2008). In addition, male frogs may remain near the breeding area for months after breeding activity ends (Wheeler et al 2006).

Oviposition, Tadpoles, and Subadults (Metamorphs): Eggs occur in a mass, attached to cobble, boulder, bedrock and occasionally wood and vegetative substrates[4] in the shallow, slow moving (i.e., <5 cm/sec) portions of the stream. See Hayes et al. 2016, Table 1 for an overview in variation in physical conditions (elevation, water temperature, depth, and velocity) at oviposition. Approximately 10^{o}C may be the minimum temperature required for oviposition (See Hayes et al. 2016, Table 1). Rates of embryonic development (5 to 30+ days) are highly temperature-dependent (Zweifel 1955). Length of the tadpole period is 3-4 months (Zweifel 1955) and varies in relation to both temperature and the quantity and quality of algal food (Catenazzi and Kupferberg 2013; Kupferberg et al. 2011), with cooler water temperatures lengthening the time to metamorphosis. Successful tadpoles select temperatures between 16.5^{o}C and 22.2^{o}C (Catenazzi and Kupferberg 2013). Tadpole rearing sites require some degree of protection from unpredictable scouring flows. Lower water velocity and shallower water depth habitats are more suitable for tadpole rearing sites (Bondi et al. 2013). However, shallower sites are more vulnerable to stranding and desiccation.

For an expanded discussion of foothill yellow-legged frog life history, see:

Thomson, R. C., A. N. Wright and H. B. Shaffer. 2016. California Amphibian and Reptile Species of Special Concern. 390 pp. University of California Press.

[3] Breeding on the Stanislaus River below New Melones Reservoir can occur as late as July, likely owing to the relatively low temperature of water released (Hayes et al. 2016).

[4] Foothill yellow-legged frog egg masses were documented laid on sedges, woody debris, and other vegetation from 2007 to 2016 within the Pit 4 Reach of the Pit River, Shasta County (PG&E 2017). The Federal Energy Regulatory Commission issued a license to Pacific Gas and Electric Company during this time period which increased the minimum instream flow releases. Discharge and water depth increased and consequently, suitable breeding habitat was pushed into the riparian zone, where frogs used live vegetation and woody debris as attachment substrate. See Appendix B for photos.

Hayes, M.P., C.A. Wheeler, A.J. Lind, G.A. Green and D.C. Macfarlane (Technical Coordinators). 2016. Foothill Yellow-Legged Frog Conservation Assessment in California. Gen. Tech. Rep. PSW-GTR-248. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 193 p. https://www.fs.fed.us/psw/publications/documents/psw_gtr248/psw_gtr248.pdf



Avoidance Considerations

Generally, some projects may be strategically planned and implemented to avoid take of listed or candidate species. Although such projects might not require take authorization, these projects may require other environmental permits (e.g., Lake or Streambed Alteration Agreement; Fish & G. Code, § 1600 et seq.). Project proponents may seek to consult with CDFW to determine appropriate measures that could be implemented for purposes of avoiding take. If take could still occur, authorization for incidental take such as an ITP, CD, SHA, or NCCP are options to discuss with CDFW. The following considerations may be useful when determining whether a project could avoid take of foothill yellow-legged frogs.

Assessing Habitat and Evaluating Presence

Habitat assessments are conducted to evaluate the likelihood that a site supports foothill yellow-legged frogs. Foothill yellow-legged frogs have a wide geographic range in California. The species is strongly associated with shallow, low-gradient channels with riffles that have unconsolidated coarse substrates (see Hayes et al. 2016 for a recent literature review on this topic)[5]. They occupy habitat ranging from sea level to

[5] However, the range of aquatic habitat in which foothill yellow-legged frog have been found in is diverse; frogs have been observed in permanent and intermittent streams with low to relatively high gradients, alluvial and bedrock channels (Leidy et al. 2009), stream-associated backwaters and isolated pools (Hayes and Jennings 1988), and slow-moving rivers with mud-substrates (Fitch 1938).

approximately 5,800 feet[6]. Suitable habitat may be seasonal refugia (non-breeding habitat), breeding and rearing sites, or movement corridors.

Project proponents and CDFW staff should consult the California Natural Diversity Database (https://www.wildlife.ca.gov/Data/CNDDB) or other similar sources for any observations of foothill yellow-legged frog within or adjacent to the project site. Note that an absence of observations does not rule out presence and CDFW recommends that a trained and experienced biologist conduct additional follow-up surveys.

Surveys

Surveys provide information needed to determine potential effects of proposed projects and activities on foothill yellow-legged frogs, and to avoid or minimize take of frogs. Project site surveys are the best method for assessing whether foothill yellow-legged frogs are present where suitable habitat is present (see Basic Ecology above). There is no standard protocol for surveying foothill yellow-legged frog, and the survey method selected may vary depending on time of year and the intended life-stage. Timing of surveys may vary depending on watershed location and characteristics, regional snow pack, timing and rate of spring runoff, day length, average ambient air and water temperatures, and local and seasonal weather conditions. Current scientific literature suggests surveys for presence will be most accurate if conducted during and immediately following the breeding season (spring-summer). Recommended visual encounter survey (VES) methods are described below.

VES conducted during the late summer are often the easiest method for determining presence; subadults and occasionally adults are often observed along river margins, and subadult and adult frogs will likely also be observed in tributary streams (Crump and Scott 1994). This survey period has a high probability of detecting foothill yellow-legged frogs. To increase the likelihood of detection, two or more surveys are recommended, one including a tadpole survey in the late spring/early summer followed by a second survey for subadults and adults in the late summer. It is important to understand that frogs are ectothermic, so ambient temperature affects the likelihood of detection. Whether the life form is larval or subadult, both stages will shelter in place under substrate and emerge and become active with warmth (i.e., detection probability increases with temperature). If a survey fails to detect foothill yellow-legged frogs within suitable habitat, a follow-up survey should be conducted two to four weeks after the initial survey.

[6] There is one record from 6,400 feet (Hemphill 1952).

Peek et al. (2017) provide a useful VES protocol. Seltenrich and Pool (2002) recommend conducing one or two surveys for adult frogs followed by a tadpole survey, then a second survey for juveniles/subadults:

- Conduct one or two adult frog VES during the breeding and/or oviposition period (generally, April-June). VES during the spring breeding period usually provide the best opportunities for observing adults and egg masses, but timing can be difficult as many adults do not remain for extended periods at breeding locations.
- Conduct a tadpole survey four to eight weeks after completing breeding survey(s) (usually from June through early August).
- Conduct a subadult survey during the latter part of the summer or during early autumn (generally late August to early October).

While surveys conducted during and immediately following the breeding season are considered most effective, surveys may fail to detect existent foothill yellow-legged frogs; some project proponents may choose to assume presence and rely on habitat as an indicator of presence in lieu of, or in addition to, surveys.

Evaluating Avoidance Methods

Measures to avoid incidental take must be developed on a site- and project-specific basis. For example, measures may vary based on the type and extent of disturbance, duration and timing of disturbance, and influence of environmental factors. The following measures and those in Appendix C are intended to illustrate how a project proponent may avoid incidental take. CDFW does not recommend using these measures as a de facto standard or employing them without a habitat assessment and field-surveys.

A season of operation that completely avoids foothill yellow-legged frog presence does not exist; if frogs are present and breeding, they may be encountered in various life-stages year round. However, in locations having periodic dry conditions, especially prolonged dry conditions, foothill yellow-legged frogs are unlikely to be encountered. Under dry conditions, foothill yellow-legged frogs seek refuge in wetted tributaries (or any wetted feature), and cooler riparian habitat, and may be capable of aestivation, although this adaptation is not described in the literature. Any form of surface water will likely attract foothill yellow-legged frogs.

Conducting site inspections prior to conducting work may allow project proponents to avoid incidental take. If frogs in any life stage are found during inspections, work should be suspended, and the project proponent should notify CDFW for the purpose of developing coordinated conservation measures prior to recommencing work. For example:

- Within 3-5 days prior to entering or working near stream/riparian habitat within the foothill yellow-legged frog range, CDFW recommends a biologist survey the project site for foothill yellow-legged frogs (adults, subadults, tadpoles or egg masses) within the project area and at least 500 feet upstream and downstream. If the project activities are expected to result in effects extending beyond 500 feet downstream (e.g., heavy sedimentation that could bury egg masses or tadpole rearing sites), CDFW recommends the survey area be expanded to encompass the expected affected area.

- If surface water is present during the work period, CDFW recommends a biologist inspect the work area daily, before work begins and during construction.

Prior to beginning construction where equipment or materials may come in contact with water, gravel bars, riparian areas, or any other foothill yellow-legged frog habitats, CDFW recommends a biologist educate personnel, explaining site-specific protective measures to equipment operators and construction personnel. This should include species identification, life history descriptions, habitat requirements during various life stages, and the species' protected status. Education should include clear instructions that if any workers encounter a foothill yellow-legged frog within or near the project site, work should halt and the biologist and project proponent should be informed.

Minimization Considerations

The following considerations and measures may help minimize impacts to foothill yellow-legged frogs.

Seasonal Restrictions:

Restricting work within the stream and riparian habitat to periods outside of the breeding season may reduce impacts to individual foothill yellow-legged frogs. As previously noted, a season of operation that completely avoids foothill yellow-legged frog presence does not exist in habitats that maintain perennial surface water.

Excluding Frogs From the Project Area:

Other ranid frogs, such as California red-legged frogs (*R. draytonii*) have strong breeding site fidelity and are capable of climbing (Rathbun et al. 1997, Semonsen 2017). Recent observations by a species expert suggest that sub-adult foothill-yellow-legged frogs can climb wetted-vertical concrete walls (J. Wilcox, Managing Ecologist at Sonoma Mountain Ranch Preservation Foundation. Personal communication, 12/18/2017).

The effect of excluding frogs from their historical breeding sites is unknown. Exclusion fencing is expected to be an effective technique provided it is properly installed; both trenched in and vertically stout, and regularly maintained. Another species expert suggests exclusion fencing should be at least three feet high and the top few inches should be folded over to curtail climbing frogs (J. Alvarez, Wildlife Biologist. Personal communication, 12/14/2017). This approach was also reported by Semonsen (2017) who proposed a simple fix for climbing by folding over the top few inches of wire (with silt fence) away from the construction area. The proposed design would allow frogs to climb up and out of the impact zone but would prevent them from climbing in (Ibid.).

When exclusion is required in flowing water, exclusion fencing should be installed up- and downstream of the work area. The fence should consist of ¼-inch mesh or smaller opening material, preferably consisting of wire, or alternatively fabric netting if capable of withstanding flow. Fencing must be sufficiently anchored to the streambed to prevent immigration of frogs and tadpoles.

Examples of products that have been used for excluding wildlife from construction sites include:

- https://animexfencing.com/
- http://ertecsystems.com/Applications/Wildlife-Exclusion-Fence---Special-Status-Species-Protection

Relocating Adults and Eggs Outside of the Project Area:

The following measures may minimize direct mortality of individual frogs or egg masses; however, they would only be authorized through an ITP, SHA or NCCP. When CDFW consults with project proponents, the primary approach is to identify measures designed to ***avoid*** impacts, both to individuals and habitat. This is particularly important when it comes to breeding habitat and more specifically oviposition sites. Foothill yellow-legged frogs select specific abiotic features within the stream channel such as instream morphology, depth, velocity, and thermal exposure, among others. Oviposition sites are very important and should be avoided when possible. If avoidance is not possible and surveys confirm egg masses occur in high numbers (e.g., more than 100 egg masses/km), then oviposition sites may be less genetically significant and egg mass relocation may be a feasible option to minimize take of individuals[7].

In main stem rivers such as those on the north coast where foothill yellow-legged frogs appear to be relatively abundant, the most effective method for reducing individual mortality may be to relocate egg masses, rather than relocating subsequent larvae or subadult frogs from a project area. Foothill yellow-legged frogs lay a single clutch or egg mass of 200-300 eggs on average, but egg masses can contain up to 3,000 eggs (Kupferberg et al. 2009). Egg masses are relatively conspicuous to an experienced surveyor and egg masses are relatively persistent, lasting for about 2-3 weeks prior to hatching and larvae emergence, although this is variable and based on water temperature (Zweifel 1955). Egg masses are usually attached to the leeward side of cobble, bedrock, and occasionally wood (see Appendix B for atypical substrate examples). Egg mass relocation requires planning and adequate site surveys both in and beyond the project area. Egg mass relocation should not be a last minute exercise. The following methods are based on CDFW biologist experience.

[7] Avoidance should be tied to extinction risk at the population level; if foothill yellow-legged frogs and oviposition sites are rare in a given stream based on surveys, then the level of avoidance should be designed to preserve as many egg masses as possible. Minimizing take of individuals by relocating egg masses may not be advisable in such cases and measures should be developed to fully avoid take of egg masses (e.g., limiting in-stream work to outside of the breeding season).

Egg Relocation Methods:

Identifying receiving habitat for relocated eggs. In order to identify suitable receiving habitat (i.e., breeding patch) for egg masses relocated from the project site, CDFW recommends conducting one or more VES along the margins of the stream both upstream and downstream of the project area in the spring prior to project initiation. For large-scale projects, completing the VES a year prior to construction can aid in planning and logistics and may be critical to minimizing impacts to foothill yellow-legged frogs. If the project area is large and/or linear, or breeding patches are scarce, it may be necessary to survey greater than a kilometer each way to locate enough receiving habitat. During a VES, observers walk and/or wade along the margins of the stream visually inspecting and noting the location of all suitable habitat for egg masses. A VES is most effective as well as safer for the surveyors when done in tandem with each surveyor covering opposite sides of the stream.

Moving egg masses. It is critical to identify the onset of breeding because egg masses mature and hatch quickly (approximately 2-3 weeks). If the project proponent elects to move egg masses to minimize impacts, CDFW recommends conducting visual encounter surveys for egg masses within the project area every 7-10 days for the duration of the breeding season. When an egg mass is observed within the project area, the biologist should gently place the egg mass and its rock into a bucket with fresh stream water and immediately transport the eggs upstream (upstream initially and downstream if needed) above the affected reach to the previously identified receiving habitat. Two or three egg masses, depending on rock size, will fit in one bucket. Egg masses should be submerged at all times. Aeration is not required, assuming bucket retention time is brief. Within the receiving habitat, the biologist will gently place the egg mass and its rock in appropriate depth and velocity edge water. Other egg masses will likely already be present in the receiving habitat so it is important to note their location and avoid disturbing them during relocation procedures. If any egg masses become detached from their cobble, they should be enclosed with cobble in the sheltered low-flow receiving habitat.

It is good practice to collect a GPS waypoint for each egg mass and also the age of the egg mass based on embryonic development (i.e., Gosner Stage). Gosner stage is

useful life history data and can assist with determining breeding phenology in a given stream segment.

Larvae Relocation Considerations:

Newly hatched larvae are immobile and spend several days grazing on egg mass accumulated algae/diatoms before they begin to move away from the egg mass remnants. Larvae are most susceptible to desiccation or project related impacts at this life phase as they are incapable of any substantial movement. As larvae mature, they become stronger swimmers but even then, they tend to travel short distances with bursts of speed only to seek cover among interstitial spaces in stream substrate or in algal cover. Due to this behavioral trait, relocating larvae is difficult. If the project can be delayed, relocating post-metamorphic frogs may be easier and more feasible than relocating larvae. Larvae are more fragile than post-metamorphic frogs.

If larval foothill yellow-legged frogs must be moved to avoid direct mortality, the methodology is for surveyors to move upstream with small aquarium nets and buckets, covering the wetted channel equidistance from each other. Larvae may flush but they may also hide under or between substrate, depending on temperature, time of the day, etc., so “rubble rousing” and algae displacement can be important. Larvae are likely to be concentrated in and around former oviposition sites, so edge habitat is most likely occupied; the thalweg or deeper areas are less likely to be occupied by larvae. Several passes will be required, and captures should decrease with each pass. Block netting the upper and lower portions of the impact area may be important to reduce recruitment of individuals into the area being cleared.

Water Diversion Considerations:

Streams and rivers are used as a water source for many activities, including but not limited to, domestic water supply, timber harvesting operations, cannabis cultivation, wildfire suppression, and revegetation projects. Diverted water may be used immediately or stored and may be used in combination with additives such as fertilizers or dust palliatives for unpaved roads. Some of these additives may have direct or indirect impacts to frogs and other aquatic species.

The following are best management practices for minimizing impacts of water diversion on foothill yellow-legged frogs. For low-volume water diversion projects, water intake screening and water diversion rate should be assessed regarding potential impacts to foothill yellow-legged frogs. High-volume water diversion projects may require project-specific consultation with CDFW engineering staff[8].

Intake screening. To minimize entrainment of foothill yellow-legged frog larvae during water diversion, all pump intakes should be fitted with a screen-type device consisting of, at minimum, a water intake strainer. Water intake strainers are most appropriate for low-volume diversion projects. For high-volume water diversion projects or other diversion activities that may warrant greater protection, pump intakes should be fitted with screens made of woven mesh, perforated plate, or wedge wire. The screen medium must be able to withstand forces related to pumping and be of sufficient size to prevent foothill yellow-legged frog larvae from entering the intake and being pumped along with diverted water. As mentioned previously, high-volume water diversion projects may require project-specific consultation with CDFW engineering staff.

For water diversions involving water trucks, operators should move drafting hoses with attached screens in and out of the water after each drafting operation. The screen should be brushed clean and inspected each time it is placed into the water. This practice will usually prevent screens from accumulating significant amounts of debris and essentially replicate the function of a self-cleaning screen. Where a stationary pump is used, the screen should be checked frequently to ensure it is kept clean and free of debris.

Diversion rate. Water diversion rates may cause adverse impacts to foothill yellow-legged frogs if the flow in source streams is reduced to levels insufficient to support eggs, tadpoles, and subadults. For these cases, a site-specific water diversion plan and measures such as these may minimize impacts in smaller streams:

- For small streams, maintain flow in the source stream during water diversion at a minimum rate of 2.0 feet^3/second or greater
- If diverting from a pool, do not reduce pool volume by more than 10 percent
- Do not exceed a diversion rate of 10 percent of the surface flow from the source stream

[8] CDFW developed fish screen criteria to protect fry-sized salmonids from water diversion activities. Those screen criteria will likely protect foothill yellow-legged frogs. See the California Salmonid Stream Habitat Restoration Manual, Appendix S for more details.

- Do not exceed an instantaneous diversion rate of 350 gallons per minute (0.78 $feet^3$/second)

Water storage facility. Diverted water may be stored in artificially constructed water storage facilities. These include off-stream reservoirs, bladders, and tanks. All water storage facilities, including secondary containment structures, should be regularly inspected for leaks and to ensure integrity; repairs should be made immediately. To prevent rupture or overflow and runoff, water storage facilities should be equipped with a float valve, or equivalent device, to shut off diversion when storage facilities are full. The following design criteria may minimize impacts to foothill yellow-legged frogs:

Reservoirs

- Designed by a licensed professional.
- Designed so that reservoir may be routinely drawn down and left in a dry state for an extended period.
- No hydrologic connectivity to upstream surface waters (i.e., not located on-stream).
- Overflow outlet designed and located to prevent erosion in case of overtopping.
- Constructed and operated in a manner that enables wildlife to exit the waterbody.

Bladders

- Include a secondary containment structure that will contain 110 percent of water volume in case of bladder failure, and that will enable wildlife to escape the structure.
- Designed and properly installed to store water and sited to minimize the potential for water to flow into a watercourse in the event of a catastrophic failure.
- Not encouraged for long-term use.

Tanks

- Enclosed (no open top).
- Made of rigid material, such as metal or high-density polyethylene, designed to hold water.
- Installed according to manufacturer's specifications and placed on properly compacted soil that is free of rocks and sharp objects, capable of bearing the weight of the tank and its maximum contents with minimal settlement.
- Piping includes backflow prevention devices to minimize backflow and cross contamination, for example, from tanks used to mix chemicals.
- Located outside of any stream channel or riparian vegetation.

APPENDIX A. Upland Movement Examples

The following images depict upland observations made by M. van Hattem in Humboldt County of foothill yellow-legged frog movement. The actual path traveled is unknown; the red line in each image depicts the shortest distance from the location where the frog was found to the stream course. Elevation change along that distance is included for each image.

In both Mad River examples, no stream connection existed with the location where the frogs were found, demonstrating both summer and winter overland movement. In two of three examples, the frog's location was adjacent to a large wetland complex. These observations suggest that foothill yellow-legged frogs, especially subadults, will move overland and movement may not be directly tied to a stream course.

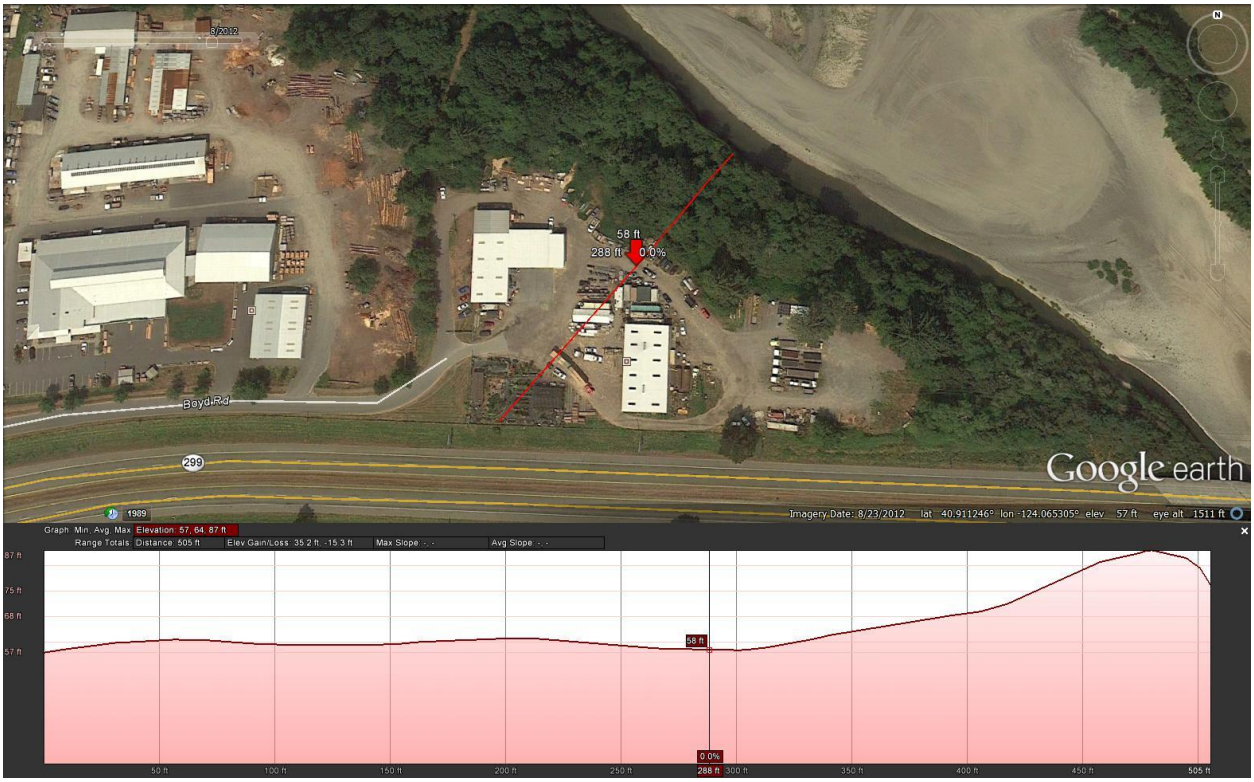


Figure 1. Six adult foothill yellow-legged frogs were observed, August 2011, utilizing decorative nursery ponds during the summer months, post breeding, on the lower Mad River, approximately four miles from the Pacific Ocean. The ponds were approximately 500 feet from the wetted channel. To reach the ponds from the river, the frogs had to cross a developed retail zone adjacent to a highway.

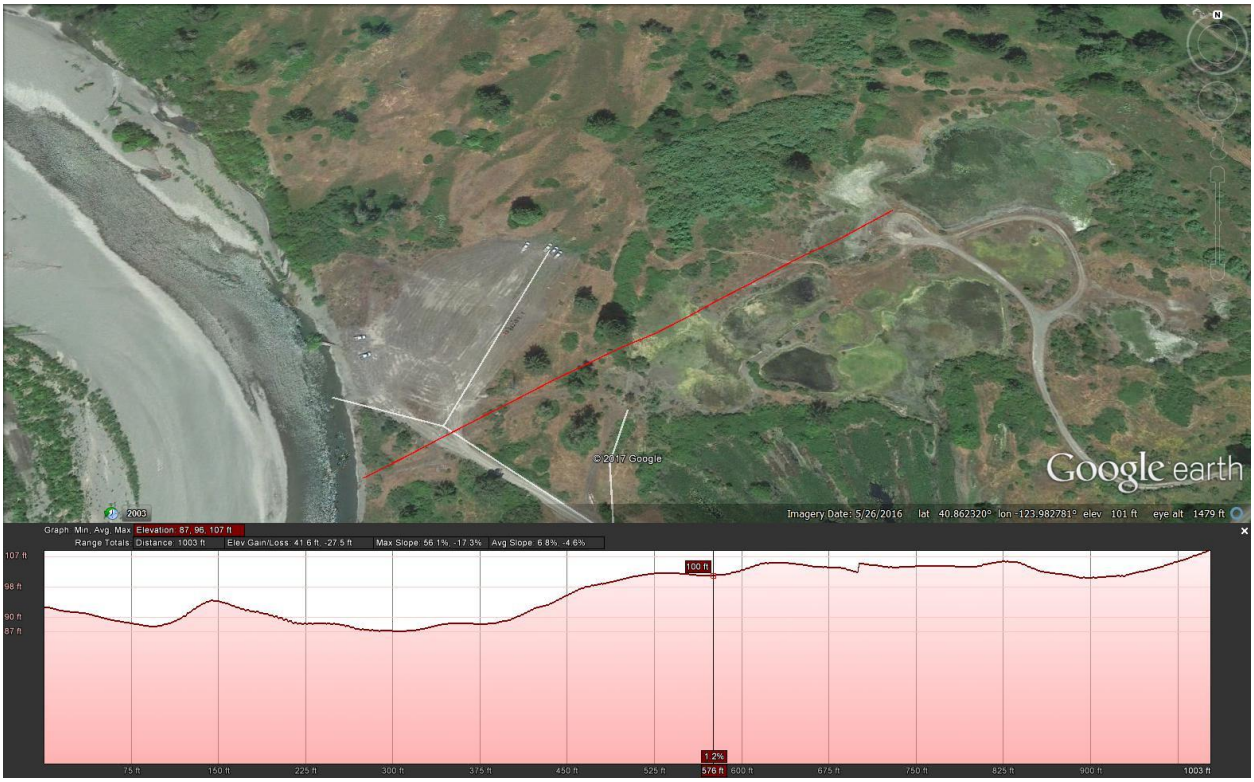


Figure 2. A single subadult foothill yellow-legged frog was observed with two northern pacific treefrogs (*Pseudacris regilla*) under a piece of bark refugia approximately 1,000 feet from the wetted edge of the Mad River, and approximately 9 miles from the Pacific Ocean. The frogs were observed January 12, 2017, during cold temperatures and all three frogs were sluggish. The location was on a high floodplain adjacent to an old gravel mine and resulting pond.

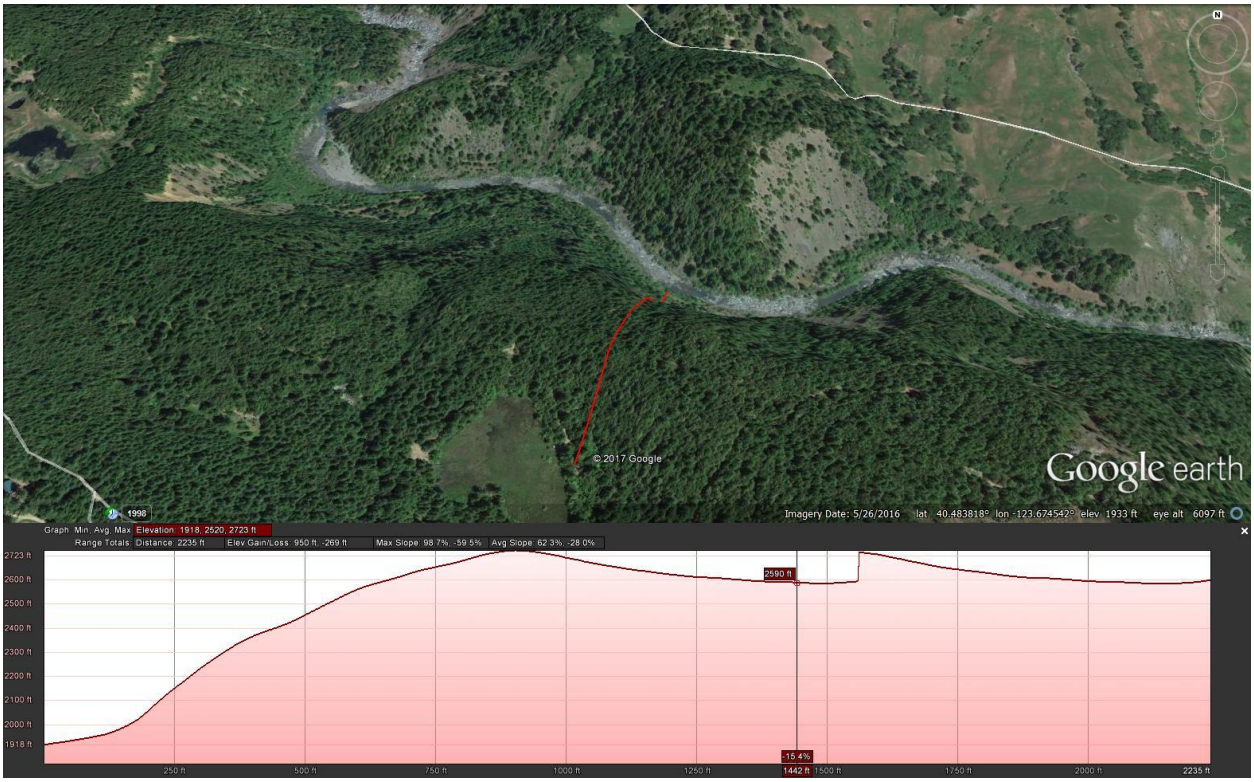
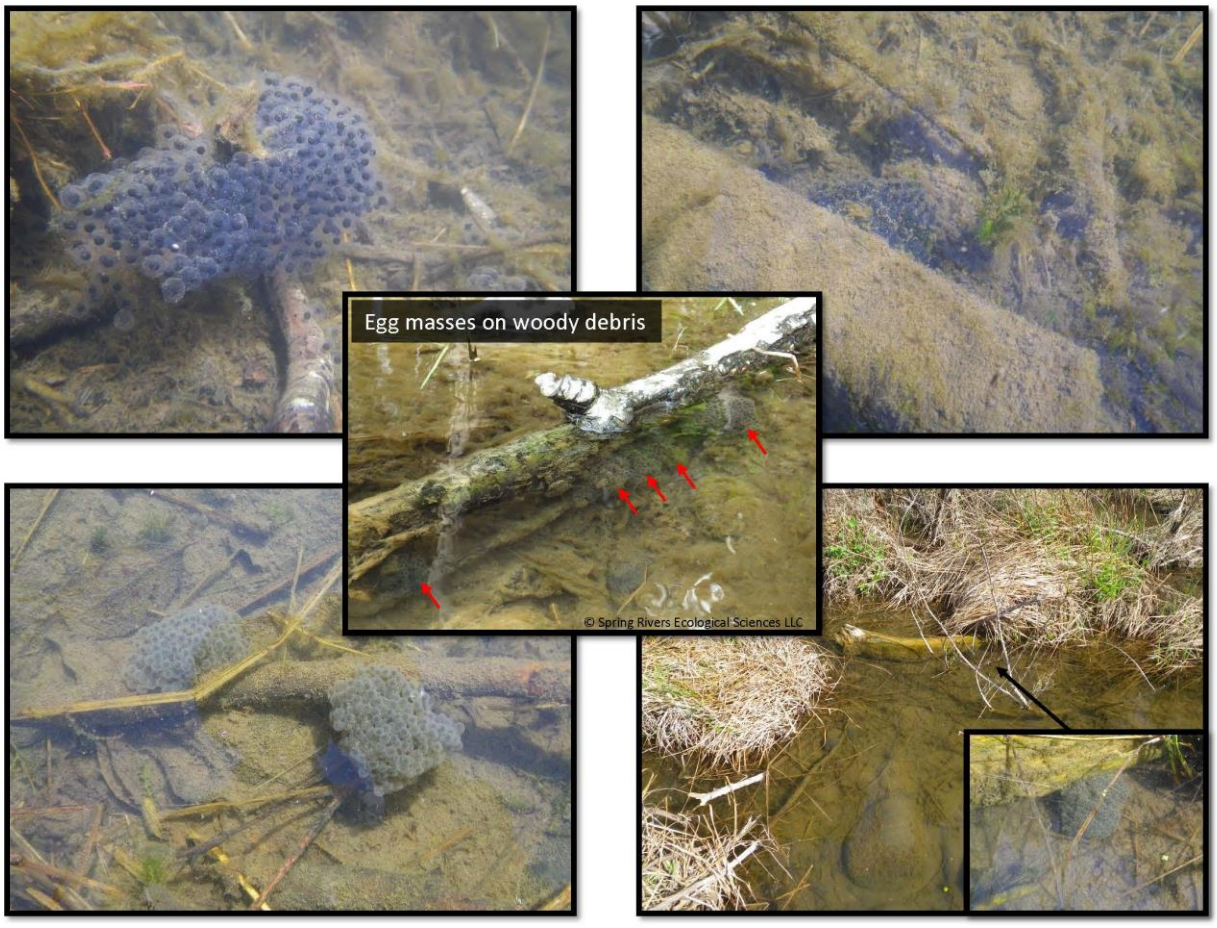


Figure 3. A subadult foothill yellow-legged frog was observed 2,723 feet (with approximately 1,000 foot elevation gain) away from the wetted edge of the Van Duzen River, and approximately 35 miles from the Pacific Ocean. The frog's location was adjacent to a large wetland complex (11/17/2015).

APPENDIX B. Egg Masses on Woody and Vegetative Substrates Examples

Foothill yellow-legged frog egg masses were documented laid on atypical substrates such as sedges, woody debris, and other vegetation from 2007-2016 within the Pit 4 Reach of the Pit River, Shasta County (PG&E 2017). The Federal Energy Regulatory Commission issued a license to Pacific Gas and Electric Company during this timer period which increased the minimum instream flow releases. Discharge and water depth increased and consequently, suitable breeding habitat was pushed into the riparian zone, where frogs used live vegetation and woody debris as attachment substrate. The following photos are copyright of Koen G. H. Breedveld of Spring Rivers Ecological Sciences, LLC. Used with permission.


Egg mass on willow stem
Egg masses on willow stem and roots
Egg masses on sedges and alder/willow roots
© Spring Rivers Ecological Sciences LLC


Egg masses on woody debris
© Spring Rivers Ecological Sciences LLC

APPENDIX C. Example Avoidance and Minimization Measures

The following are examples of foothill yellow-legged frog avoidance and minimization measures prescribed in past CESA ITPs and Lake and Streambed Alteration Agreements issued for construction and restoration projects, with additional measures recommended in the scientific literature. This appendix only restates past mitigation approaches and should not be interpreted as having any determinative or binding effect on future mitigation recommendations or requirements by CDFW. These measures may be used and adapted or modified based on site- and project-specific conditions.

Habitat Assessment and Delineation:

Prior to initiating Covered Activities, the Biologist shall conduct and submit to CDFW a habitat assessment to determine the likelihood (low, moderate, or high) of foothill yellow-legged frog occurring within and adjacent to the Project Area. The habitat assessment shall consider historical and existing land uses of the Project Area, presence of invasive species, proximity to known or potential instream foothill yellow-legged frog breeding sites, existing quality of riparian habitat, proximity to tributaries, barrier(s) to foothill yellow-legged frog movement between suitable riparian/upland and/or aquatic habitat and the Project Area, and other conditions pertinent to foothill yellow-legged frog presence.

Pre-Construction Survey Plan:

Permittee shall develop a Pre-Construction Survey Plan for foothill yellow-legged frog and submit it to CDFW for approval prior to ground-disturbing activities. The Plan shall include what life-stage(s) shall be surveyed for, survey method(s), and timing of survey(s). The Plan shall provide justification for timing and methodology of survey design (e.g., watershed characteristics, regional snow pack, timing and rate of spring runoff, day length, average ambient air and water temperatures, local and seasonal conditions). For sites with suitable breeding habitat, two consecutive seasons of negative egg mass/larval surveys are recommended to support a negative finding.

Pre-Construction Surveys:

Within 3-5 days prior to entering or working at the Project Site, the Biologist shall perform a pre-construction survey, as specified in the Pre-Construction Survey Plan, within the boundaries of the Project Area plus a 500-foot buffer zone upstream and downstream of the construction area. The survey shall include a description of any standing or flowing water. Permittee shall provide Pre-Construction Survey notes and observations to CDFW prior to commencing Covered Activities.

If foothill yellow-legged frog are found during the Pre-Construction Survey, Permittee shall:

1) Consult CDFW immediately by either telephone or email and provide a short description of observations, including a count of individuals and the life stage(s), condition at the site, and other aquatic species observed; and
2) Either propose site-specific measures that Permittee shall use to avoid take, or consult with CDFW to obtain an Incidental Take Permit (ITP) if take of foothill yellow-legged frog may occur during project activities. Permittee shall not commence instream work until CDFW has provided written approval of the proposed avoidance measures or issued an ITP.

If no foothill yellow-legged frogs are found during the Pre-Construction Survey and no surface water is present in the Project Area, work may commence without further surveys.

If no foothill yellow-legged frogs are found but surface water is present during the Pre-Construction Survey, or if surface water becomes present at any time during the work period, the Biologist shall survey the work site each day before commencement of work activities where equipment and/or materials may come in contact with foothill yellow-legged frogs, streams, or riparian habitat.

If foothill yellow-legged frogs are observed at any time during Covered Activities, Permittee shall halt work in the immediate area and immediately contact CDFW. Permittee may propose site-specific measures that Permittee shall use to avoid take, or consult with CDFW to obtain an Incidental Take Permit (ITP) if take of foothill yellow-legged frog may occur during project activities. Permittee shall not resume Covered Activities until CDFW has provided written approval of the proposed avoidance measures or issued an ITP.

<u>Seasonal Work Restriction:</u>

Permittee shall ensure that Covered Activities involving construction and heavy equipment use (such as excavation, grading, and contouring) that are conducted in streams, ponds, and riparian areas are limited to the period from July 15 to October 15[9]

[9] Time period is geographic- and precipitation-specific (generally, fall-winter) to avoid the breeding season (generally, spring) as well as the period when larval and subadults are in the stream and stream margins (generally, summer). Note this measure is for minimization of impacts, not avoidance.

of each year (Dry Season) until the expiration of this ITP. Any work outside of the Dry Season shall be subject to approval of CDFW.

Exclusion-Fencing:

Prior to commencing Covered Activities, Permittee shall install exclusion fencing to prevent foothill yellow-legged frog from dispersing into the Project Area. Permittee shall submit the design to CDFW for approval no less than 30 days prior to the proposed start of Covered Activities. Permittee shall place the exclusion fencing around the construction footprint and the exclusion fencing shall be maintained by the Permittee throughout all construction activities. The Biologist shall inspect the area prior to installation. The Biologist shall inspect the exclusion fencing daily and after storm events. The Permittee shall maintain and repair the exclusion fencing immediately to ensure that it is functional and without defects. The exclusion fencing shall be:

- Properly installed, both trenched in and vertically stout, and regularly maintained to be effective.
- At lease three-feet in height.
- The top few inches of the exclusion fencing must be folded over and away from the construction area.

To avoid potential entanglement of foothill yellow-legged frog, the Permittee shall not use plastic monofilament netting.

The exclusion fencing shall remain in place until the Permittee completes all Covered Activities and removes all construction equipment from the site. The Biologist shall relocate any foothill yellow-legged frog found along the fence[10]. Permittee shall provide refuge opportunities such as natural cover objects (e.g., fallen logs, leaf litter, and branches), or artificial cover boards[11] along or near the outside of the exclusion fence. The Permittee shall avoid damage to small mammal burrows to the maximum extent possible during installation of the exclusion fencing.

[10] It may be beneficial to have the Biologist walk along the fence line each morning. Foothill yellow-legged frogs are in the same family as California red-legged frogs. California red-legged frogs are nocturnal and move in a linear manner – they will not usually turn and walk along a fence line like other amphibians (e.g., California tiger salamanders). Rather, they will remain in place or try to climb the fence and may desiccate (Jeff Alvarez, personal communication, May 01, 2013).

[11] Refuge opportunities need to provide shade. Cover boards are commonly used as a trapping method as amphibians use them as shelter (Enge, 1997).

If exclusion fencing is required in flowing water, Permittee shall install exclusion fencing up- and downstream of the work area. The fence shall consist of 1/4-inch mesh or smaller opening material, preferably of wire, or alternatively fabric netting if capable of withstanding flow. Fencing must be sufficiently anchored to the streambed to prevent immigration of frogs and tadpoles.

Foothill Yellow-Legged Frog Relocation Plan:

Permittee shall develop a Relocation Plan for foothill yellow-legged frog and submit it to CDFW for approval prior to ground-disturbing activities. The Relocation Plan shall include what life stage(s) will be relocated (e.g., adults or egg masses) and specific protocols for each life stage. The Relocation Plan shall quantify the amount, location, and quality of suitable receiving habitat (e.g., breeding and dispersal habitat). The Relocation Plan shall include capture and handling methods specific to each life stage.

Foothill Yellow-Legged Frog Observation:

During all phases of Project construction operation and maintenance, all workers shall inform the Biologist if they encounter foothill yellow-legged frog within or near the Project site. All Covered Activities with potential to take the foothill yellow-legged frog shall cease until the animal moves from the construction area on its own accord. The Biologist may relocate the animal outside the area of construction, in accordance with the Relocation Plan, if the Biologist determines that relocation is necessary.

The Biologist shall submit all observations of the foothill yellow-legged frog to CDFW's California Natural Diversity Database (https://www.wildlife.ca.gov/Data/CNDDB within 60 calendar days of the observation and the Biologist shall include copies of the submitted forms with the next Monthly Compliance Report or Annual Status Report, whichever is submitted first relative to the observation.

Capture and Handling:

Foothill yellow-legged frog shall be handled using methodology described in the Restraint and Handling of Live Amphibians (Appendix D), and in accordance with the Fieldwork Code of Practice (Appendix E).

Decontamination:

Permittee shall ensure all project personnel adhere to the current version of the California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol for all field gear and equipment that will be in contact with water or foothill yellow-legged frogs. Heavy equipment and other motorized or mechanized equipment that comes in contact with water should generally follow watercraft decontamination protocols found in the Decontamination Protocol.

No Night Work or Lighting:

Permittee shall not use night lighting in the Project Area. All project activity shall terminate 30 minutes before sunset and shall not resume until 30 minutes after sunrise. The Permittee shall use sunrise and sunset times established by the U.S. Naval Observatory Astronomical Applications Department for the geographic area where the project is located (http://aa.usno.navy.mil/data/docs/RS_OneDay.php).

Water Diversion:

Permittee shall develop a Water Diversion Plan for foothill yellow-legged frog and submit it to CDFW for approval prior to in-stream activities. The Water Diversion Plan shall do the following:

1. Specify water intake screening (e.g., screen material, size, cleaning method, etc.).
2. Identify the proposed instantaneous flow reduction and duration of reduction from the source stream.
3. Disclose potential impacts associated with both the instantaneous flow reduction and cumulative flow reduction and total volume removed from the source stream.
4. Identify proposed recommendations for minimizing adverse impacts such as reduced hose diameter, decrease in pumping rates, use of alternative sites and/or restrict number of water withdrawals from one location.

Water Storage Facilities:

Permittee shall regularly inspect all water storage facilities, including secondary containment structures, for leaks and to ensure integrity; Permittee shall make repairs immediately. To prevent rupture or overflow and runoff, Permittee shall ensure water storage facilities are equipped with a float valve, or equivalent device, to shut off diversion when storage facilities are full.

Season of Diversion:

Permittee shall confine the period of diversion to December 15 through March 31. Permittee shall plug, cap, block (e.g., with a shut-off valve), or remove all intakes at the end of each diversion season.

Bypass Flow:

Permittee shall ensure that diversion facility passes sufficient flow at all times to keep fish and wildlife resources below the facility in good condition. If at any time the diversion rate identified in the Water Diversion Plan cannot be maintained, Permittee

shall cease diversion and all natural flow shall be allowed to bypass the point of diversion.

Diversion Materials:

Permittee shall not use or construct the diversion structure with materials deleterious to fish or wildlife, including, but not limited to, particle board, plastic sheeting, bentonite, pressure treated lumber, creosote, concrete, or asphalt.

Diversion Monitoring:

Permittee shall install and maintain an adequate measuring device for measuring the instantaneous and cumulative rate of diversion. The device shall be installed within the flow of diverted water. Permittee shall maintain records of diversion with the date and time diversion occurred.

APPENDIX D. Restraint and Handling of Live Amphibians

Citation:
Green, D. E. 2001. Restraint and handling of live amphibians. Amphibian Research and Monitoring Initiative Standard Operating Procedure, No. 100. National Wildlife Health Center. Available from http://www.nwhc.usgs.gov/publications/amphibian_research_procedures/handling_and_restraint.jsp (accessed Month Year).

STANDARD OPERATING PROCEDURE
ARMI SOP No. 100
Revised, 16 February 2001

I. PURPOSE:

Provide guidelines for humane handling of amphibians so that injury and distress to the amphibian are minimized.

II. SCOPE:

These guidelines apply to larvae and tadpoles, as well as adult frogs, toads, salamanders and neotenes. Because of their anatomically different and very delicate skin, tadpoles and larvae must be handled differently than post-metamorphic amphibians.

III. EQUIPMENT and SUPPLIES:

a. Standard capture equipment (seine nets, dip nets, minnow traps)
b. Clear plastic bags (half liter or full liter size)

IV. BACKGROUND:

There are three main hazards associated with handling live amphibians: two to the amphibian and one to the handler. To amphibians, the main dangers of being handled are skin damage that could result in secondary skin infections, and bone and muscle injuries caused by struggling when being held. For the handler, the main danger comes from toxic skin secretions produced by some amphibians (in the USA, this is mostly newts and the introduced giant/marine toad).

Tadpoles and larvae have thin delicate skin that is very easily damaged by the slightest handling. The skin of larvae lacks keratin and has fewer cell layers than adult amphibian skin. Therefore, direct contact handling of tadpoles and larvae is to be avoided; instead, these amphibian stages are examined through clear flexible plastic bags containing water. Although the skin of adult (post-metamorphic) amphibians has keratin and is less delicate than larval skin, their skin is still much more delicate than the skin of reptiles,

birds and mammals. Rough handling of adult amphibians can easily result in skin abrasions, small tears, punctures, erosions and ulcers; normally, minor skin wounds heal quickly, but if contaminants, sewage or high levels of microorganisms are present in the pond or other environment, then wound infections are possible.

Frogs and Toads: All amphibians can be expected to struggle following capture. For anurans, there is a danger that vigorous kicking with the hind limbs can cause joint dislocations or a broken (fractured) back; broken backs are a well-documented and major problem in another species that moves by hopping--rabbits. Therefore, proper restraint of anurans, first and foremost involves inhibiting their ability to kick.

Salamanders: For salamanders, there are three major dangers associated with handling: 1) loss (automizing) of the tail, 2) damage to the very delicate external gills (in neotenes), and 3) back injury during whip-like thrashing movements.

V. METHODS OF PHYSICAL RESTRAINT:

a. Anurans: Medium and large size frogs and toads (those about 5 grams and larger) should be grasped around the waist with the hind limbs fully extended. The animal should not be allowed to bend (flex) its hip and knee joints, since this would allow it to kick.
b. Caudates: Medium and large size salamanders (those about 5 grams and larger) should be grasped in the middle of the body between the forelimbs and hind limbs. Larval and neotenic salamanders should never be grasped around the head or neck, because the gills can be easily damaged. Under no circumstances should salamanders be grasped by the tail or picked up by the tail.
c. Larvae: All larvae (including tadpoles) should be handled with nets or scoops. For examinations, the larvae should be placed in a clear plastic bag with a mild amount of water. Alternatively, larvae may be sedated with an anesthetic and examined in a dish or bowl of water. As much as possible, larvae should be examined only while they are in water. Larvae should not be grasped with bare hands.

VI. MISHAPS:

a. Skin wounds: If an amphibian suffers a skin wound during handling, it is recommended that the wound be sprayed with the over-the-counter product, Bactine® (See the SOP on Toe Clipping of Frogs and Toads, NWHC ACUC Protocol 2001-004). All other topical antiseptics and disinfectants (sprays and ointments) are CONTRAINDICATED in amphibians. If possible, the animal should then be released on land rather than into water, since the antiseptic spray would be quickly washed off in water.

b. Broken back: If a frog or toad suffers a broken back during capture or handling, it should be promptly euthanized. It would be inhumane to release such a crippled animal. An animal with a broken back will have serious damage to the spinal cord and should show almost immediate paralysis of the hind limbs and tail. Recommended methods of humane euthanasia include (see NWHC ACUC Protocol 1999-009, Methods of Euthanasia):
    i. Pithing
    ii. Overdosing in anesthetic solutions of MS222 or benzocaine
    iii. Application of a benzocaine-based topical ointment (as used by humans to relieve toothaches) to the top or the head and dorsum of the body.
c. Broken leg: If a major bone of a limb is broken during capture or handling, the animal should be euthanized or taken to a wildlife rehabilitation center or veterinarian for treatment. A broken leg bone typically is recognized as an abnormal bend in the leg where there is no joint; other signs of a broken leg bone are protrusion of a bone fragment through the skin, inability of the animal to move a limb or position a leg in its normal resting posture. After treatment, amphibians with broken bones might be given to a zoo or placed in a captive breeding program. Only if the injured amphibian is kept isolated from all other fish, amphibians and reptiles (e.g., in a separate cage) during treatment, can it later be considered for release at the point of capture. Injuries to digits (toes and fingers) generally are not life threatening; if the skin of the injured toe also is wounded, then treatment with Bactine® prior to immediate release is acceptable. If a toe bone is broken and protruding through the skin, the affected toe may be amputated just proximal to the site of the fracture, the stump should be sprayed with Bactine®, and the animal may be released.
d. Automized tail: If a salamander automizes (detaches) its tail during capture or handling, the stump should be treated (sprayed) with Bactine®; the salamander can then be promptly released.
e. Crushing injuries to head and body: Amphibians that have serious injuries to skin, muscles and bones should be promptly euthanized. Crushing injuries that are limited to a limb or tail will require treatment at a wildlife rehabilitation center or a veterinary clinic; alternatively, the animal may be euthanized, but it would be inhumane to release a seriously injured amphibian.
f. Snout abrasions: Amphibians that are held in glass or clear plastic containers may jump headfirst into the glass, or may rub their snout

against the container in attempts to burrow out. If amphibians are held for more than an hour in a clear container (bottle, aquarium, etc.), they should be examined for evidence of skin injury at the tip of the snout and elsewhere around the head prior to release. If abrasions are detected, they should be sprayed with Bactine® prior to release.

g. Toxic skin secretions: All amphibians have glands in their skin that secrete a vast number of chemicals; some of which are merely noxious and repellant-like, while others may cause skin or eye irritation, and some may actually kill. The poison-dart frogs of Central America are an example of a frog with toxic secretions that can kill a human. Among the native amphibians of the United States, the two amphibians of greatest concern are giant toads (also called cane toads, marine toads, aga toads; *Bufo marinus*) and western newts of the genus, *Taricha*.

Giant toads secrete a potent white mucoid substance from their parotid glands (large warts just behind the eyes) that affects the heart, but it is not absorbed through the intact human skin; however, the toxin is readily absorbed through the eyes and mouth. Hence, the best way to prevent poisoning is to carefully avoid rubbing the eyes or putting fingers in the mouth after handling a giant toad. If skin secretions of giant toads contact the eye or mouth, then flush promptly with generous amounts of clean fresh water or contact lens wetting solution, and then seek emergency care at a clinic or hospital if stinging or numbness of the eye or mouth develops.

Newts of the genus, *Taricha*, also secrete toxins from their skin; it is presumed that the entire body of these newts secretes toxins (newts and other salamanders do not have parotid glands). Their skin secretions are very irritating to the eyes and mouth. Temporary blindness (lasting about 24 hrs) has been reported by field biologists that handled newts and then rubbed their eyes. If sensations of blurred vision, or burning or stinging of the eyes occur after handling any genus or species of newt, wash the eyes with copious amounts of fresh clean water (or contact lens wetting solutions) and promptly seek medical care. Persons with newt skin secretions in their eyes are advised not to drive a vehicle or operate other dangerous or heavy equipment.

Finally, it is possible that other amphibian species in the USA besides giant toads and newts, could produce skin secretions that are irritants to the eyes. Furthermore, amphibians may carry some bacteria in their intestines and feces that are human pathogens, such as the bacteria, Salmonella and Leptospira. Hence, it is always best to practice good personal hygiene after handling any amphibian (namely, thoroughly wash your hands with soap and water).

VII. CITED LITERATURE:

1. MARTIN, D., and H. HONG. 1991. The use of Bactine® in the treatment of open wounds and other lesions in captive anurans. Herpetol Rev 22: 21.

APPENDIX E. The Declining Amphibian Task Force Fieldwork Code of Practice

[This] code of practice, [was] prepared by the Declining Amphibian Task Force (DAPTF) to provide guidelines for use by anyone conducting fieldwork at amphibian breeding sites or in other aquatic habitats. Observations of disease and parasite-infected amphibians are now being frequently reported from sites all over the world. This has given rise to concerns that releasing amphibians following a period of captivity, during which time they can pick up unapparent infections of novel disease agents, may cause an increased risk of mortality in wild populations. Amphibian pathogens and parasites can also be carried in a variety of ways between habitats on the hands, footwear, or equipment of fieldworkers, which can spread them to novel localities containing species, which have had little or no prior contact with such pathogens or parasites. Such occurrences may be implicated in some instances where amphibian populations have declined. Therefore, it is vitally important for those involved in amphibian research (and other wetland/pond studies including those on fish, invertebrates and plants) to take steps to minimize the spread of disease and parasites between study sites.

1. Remove mud, snails, algae, and other debris from nets, traps, boots, vehicle tires, and all other surfaces. Rinse cleaned items with sterilized (e.g., boiled or treated) water before leaving each study site.
2. Boots, nets, traps, etc., should then be scrubbed with 70% ethanol solution (or sodium hypochlorite 3 to 6%) and rinsed clean with sterilized water between study sites. Avoid cleaning equipment in the immediate vicinity of a pond or wetland.
3. In remote locations, clean all equipment as described above upon return to the lab or “base camp.” Elsewhere, when washing machine facilities are available, remove nets from poles and wash with bleach on a “delicates” cycle, contained in a protective mesh laundry bag.
4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolated species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps, and other equipment to each site being visited. Clean and store them separately at the end of each field day.
5. When amphibians are collected, ensure the separation of animals from different sites and take great care to avoid direct contact between them (e.g., via handling, reuse of containers) or with other captive animals. Isolation from un-sterilized plants or soils which have been taken from other sites is also essential. Always use disinfected/disposable husbandry equipment.

6. Examine collected amphibians for the presence of diseases and parasites soon after capture. Prior to their release or the release of any progeny, amphibians should be quarantined for a period and thoroughly screened for the presence of any potential disease agents.

Used cleaning materials (liquids, etc.) should be disposed of safely and if necessary taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

APPENDIX F. Invasive Non-Native Control and Eradication

Foothill yellow-legged frogs have been lost from over 50 percent of their historic range in California for a variety of reasons (see Hayes et al. 2016). Removing, controlling, and ultimately eradicating invasive non-native species know to predate foothill yellow-legged frogs would be beneficial and could be a form of mitigation for take and project related activities. Site-specific information based on surveys will inform whether this option is viable or needed and the following information is intended to assist with creating an effective Bullfrog Management Plan.

The following is an example of a bullfrog monitoring and management plan that was part of a Lake or Streambed Alteration Agreement for Region 1. These measures may be used and adapted or modified based on site- and project-specific conditions.

Bullfrog Monitoring and Management Plan Example

General Bullfrog Information

The American bullfrog (*Lithobates catesbeianus* = *Rana catesbeiana*); hereafter bullfrog, is an invasive non-native species in California and poses a significant threat to California's native fish and wildlife resources. Bullfrogs were introduced in California over 100 years ago from eastern parts of the United States as a food supply, but have since caused substantial ecological consequences. Bullfrogs are considered highly invasive and are well documented predators upon a variety of fish and wildlife species, including some that are rare, threatened, and endangered. Human modifications to the environment provide favorable conditions to bullfrogs such as artificially created agricultural ponds, canals and ditches where warm still water occurs. As a result bullfrogs have spread throughout California.

Efforts to control bullfrogs have been met with varying degrees of success because: 1) bullfrogs can be difficult to detect and go dormant from fall through winter, 2) bullfrogs often take cover in difficult areas to manage (e.g., dense vegetation), 3) they can travel long distances to colonize and re-colonize areas, 4) they have high reproductive output, 5) they are weary and readily flee perceived threats, and 6) they can survive physical trauma remarkably well. CDFW scientific staff recognizes there is an urgent and immediate need to develop improved bullfrog management strategies to protect

California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. Public support and implementation of bullfrog control in California is an important conservation strategy that will help protect natural resources for future generations.

Monitoring

Aquatic features (e.g., stream, ponds, oxbows mining ponds, etc.) shall be monitored for bullfrog presence on an annual basis with a minimum of five total surveys, no less than two weeks apart, throughout the months of May-July

- All pond survey effort must be made by a person knowledgeable in bullfrog identification (see reference photos);
- Survey efforts shall include listening for bullfrog calls and slowly walking the complete perimeter of the pond at night* (dusk or later) while shining a flashlight to detect movement and eye-shine.

If bullfrogs are not detected upon completion of five total surveys, or at any other time of the year incidentally, removal efforts are not required that year.

*Day time monitoring can also be conducted to aid detection but is not required under this plan.

Success Criteria

The level of effort needed to successfully manage bullfrog populations varies with infestation levels. This plan shall be considered successfully implemented if sufficient effort is provided to prevent adult bullfrogs from reproducing in the aquatic feature each year, and no bullfrog life-stages can be detected. Bullfrogs are capable of traveling long distances over-land, and on-going efforts will be required to ensure dispersing bullfrogs do not colonize the aquatic feature at a future time.

Options for Management

Two removal methods may by employed for controlling bullfrogs under this plan and include:

- Manual direct removal
- Aquatic feature de-watering (Hydro-modification)

Implementing both reservoir de-watering and manual direct removal is currently believed to be the most effective method of managing bullfrog infestations. For aquatic features that are heavily infested with juvenile bullfrogs and/or tadpoles, the draining of aquatic features will be necessary to break the bullfrog’s reproductive life cycle and

prevent on-going reproduction. Prior to conducting aquatic feature dewatering activities, please coordinate with CDFW Environmental Scientist XXXXXXX XXXXXXX by phone at (XXX) XXX-XXXX or via email at: XXXXXXXXXXXX

Direct Removal

All direct removal efforts must be made by the **Biologist**.

- Removal efforts must occur during, but are not be limited to the active/breeding season, occurring May – July;
- A minimum of ***five*** efforts throughout the season are considered necessary;
- Direct removal efforts are typically most effective when conducted at night with use of lights but can also be conducted during the day;
- Direct removal must include working the entire perimeter of the reservoir;
- A rubber raft or small boat may be necessary to successfully remove some individuals;
- A team of two individuals or more is often helpful, one person for shining lights and/or operating a boat and the other person to perform removal efforts;
- Bullfrog tadpoles must be removed and dispatched and must not be relocated or kept as pets.

Management Authorization

Take of bullfrogs is specifically allowed in the California Code of Regulations, title 14, section 5.05, subdivision (a)(28), under the authority of a sport fishing license. There is no daily bag limit, possession limit, or hour restriction, but bullfrogs can only be taken by hand, hand-held dip net, hook and line, lights, spears, gigs, grabs, paddles, bow and arrow or fish tackle.

Alternatively, Fish and Game Code section 5501 allows CDFW, as limited by the Fish and Game Commission, to issue a permit to destroy fish that are harmful to other wildlife. Title 14 regulations have addressed this under section 226.5, Issuance of Permits to Destroy Harmful Species of Fish in Private Waters for Management Purposes. This allows CDFW to issue free permits to destroy harmful aquatic species by seining and draining.

Pond Dewatering

Pond dewatering may be appropriate if the aquatic feature can be successfully dewatered without adversely affecting stream resources. Careful planning and coordination with CDFW, is necessary to ensure potential impacts to stream resources

can be addressed, prior to commencing with pond draining. Discharge of polluted water to Waters of the State may require permitting from other agencies with permitting authority, such as the Regional Water Quality Control Board.

In general, bullfrog larvae require two years to develop into frogs, whereas native amphibians only require one year. Therefore, draining the aquatic feature every year is intended to interrupt bullfrog larval development, dramatically decrease bullfrog populations and allow for reduced efforts as a measure of adaptive management. Typically in Northern California, reservoir draining should occur in September through October to avoid impacts to sensitive native amphibian and fishery resources. While draining occurs, direct removal efforts should be employed as described above if possible.

Reporting

A written log shall be kept of monitoring and management efforts and shall be provided to CDFW **each year** by December 31. The written log shall include: 1) date and time of each monitoring and management effort, 2) approximate number of each bullfrog life stage detected and/or removed per effort, and 3) amount of time spent for each monitoring and management effort.

BULLFROG REFERENCE PHOTOS

This is a photo of a large bullfrog tadpole, in its second year.

The photos shows a medium sized adult bullfrog that was removed from Tenmile Creek, Mendocino County. Note the bullfrog has a large tympanum, (circular eardrum shown with an arrow) and **does not** have distinct ridges along its back (dorsolateral folds).

This bullfrog has somewhat distinct mottling and the underside of the bullfrogs hind legs are not shaded pink, red or yellow.

APPENDIX G. Riparian Enhancement

Foothill yellow-legged frog are highly aquatic but use riparian/upland habitat for overwintering. California has lost more than 90 percent of its riparian habitat and most riparian habitat types are considered Sensitive Natural Communities by CDFW. Improving riparian condition, both in area and diversity, would be beneficial to foothill yellow-legged frogs. Adding complexity, such as downed large wood within the planting area matrix will provide cover and both summer and winter refugia. Riparian enhancement that benefits foothill yellow-legged frog could be a form of mitigation for take and project related activities. The following describes the preparation of a Riparian Restoration Planting Plan.

Last Revision: June 27, 2017

A successful plan will include at minimum the information described below:

1. **Location of the restoration site(s):** This section should include a regional map, general map illustrating planting locations (polygons), location or any other existing or proposed restoration actions in the general vicinity, ownership information, and directions to the site.

2. **Site suitability evaluation:** Provide the rationale behind selecting the restoration site including information on the soils, hydrology (including risk of scour by high flows, characterization of water table depths and water availability for irrigation if proposed), and riparian species present at a nearby reference site(s). This information should be based on field work completed during the planning and design phases for the project. Any reports, data, and other information that support site suitability decisions should be included in the plan.

3. **Site Preparation and installation methods:** Provide a description of the methods that will be used to install the plants with a detailed discussion for each plant species and type of planting stock (container, stem cutting, pole cutting, bare-root stock, etc.), time of the year during which the planting will occur, and any other pertinent information regarding implementation of the project, any necessary site preparation work (i.e., heavy equipment work, stabilization, soil work, etc.) should be described in this section of the plan. Other restoration work to be completed during project

implementation should also be described in sufficient detail to allow for proper evaluation.

4. **Materials:** Provide the list of plant species to be utilized, size of specimens to be used for each species, number of plants, the source of plant materials to be used, fertilizers to be used, if any, and irrigation materials, if necessary. Information regarding the need for plant protection and the materials necessary to accomplish protection should be included. If fertilizer or irrigation are proposed, discuss the rationale behind the proposal including the pros/cons of fertilizer use and a discussion of how irrigation would be used, the type, and the pros/cons of use.

5. **Schematic:** Include a detailed planting design that depicts exactly where the plants will go in the restoration area, including the number of plants and which species to be planted in each location, spacing between plants, and total acreage planned for revegetation.

6. **Maintenance of plants:** Include a description of methods that will be used to maintain plants in good condition, to control non-native vegetation, and prevention of herbivory to the plantings, including a discussion of how maintenance actions will be triggered by changes in plant health over time. If the planting will be irrigated, include an irrigation plan that describes the type of irrigation system that will be used and the watering regime that will be used to successfully establish the plantings. The irrigation plan should be designed to discourage the growth of invasive plants while encouraging deep rooting of planted materials to ensure maximum survival following the plant establishment period.

7. **Success criteria:** Include the performance criteria that will be used to evaluate project success. Performance criteria should be developed for species diversity, structural diversity, overall vegetative cover by species (if important) and how cover will be measured (absolute vs. relative); density (by species); plant vigor; and survivorship. In addition, intermediate thresholds (incremental progress toward performance criteria) should be developed in conjunction with an adaptive management plan that triggers remedial activities that would be implemented if intermediate thresholds are not being met. This will allow the revegetation specialist to increase the likelihood that performance criteria are met by the end of the monitoring period.

8. **Monitoring methods:** Include a detailed description of how the project will be monitored to evaluate whether performance criteria are being met. Include a detailed description of the methods used for data collection, sample size, data entry and storage, statistical analyses to be performed, photo point locations, and a description of the monitoring report format.

9. **Adaptive management and contingency measures:** Describe the projects' adaptive management strategies and what actions shall be implemented if the monitoring data indicates that the performance criteria may not be met. Identify the party responsible for implementing remedial measures and the source(s) of funding to complete actions.

REFERENCES

Bondi, C. A., S. M. Yarnell, and A. J. Lind. 2013. Transferability of habitat suitability criteria for a stream breeding frog (*Rana boylii*) in the Sierra Nevada, California. Herpetological Conservation and Biology. 8(1): 88–103.

Bourque, R. 2008. Spatial ecology of an inland population of the foothill yellow-legged frog (*Rana boylii*) in Tehama County, California. Arcata, CA: Humboldt State University. 93 p. M.S. thesis.

Catenazzi, A. and S. J. Kupferberg, 2013. The importance of thermal conditions to recruitment success in stream-breeding frog populations distributed across a productivity gradient. Biological Conservation. 168: 40–48.

Cook, D. G. 2012. *Rana boylii* (Foothill yellow-legged frog). Upland Movement. Herpetological Review 43(2): 325.

Crump, M. L. and N. J. Scott, Jr. 1994. Visual encounter surveys. 84-92 *in* Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.-A.C., & M.S. Foster, (eds.): Measuring and monitoring biological diversity. Standard methods for amphibians. Washington & London, Smithsonian Institution Press, 364 p.

Enge, K. M. 1997. A standardized protocol for drift-fence surveys. Florida Game and Fresh Water Fish Commission, Tallahassee, FL.

Fitch, H. S. 1938. *Rana boylii* in Oregon. Copeia. 1938: 148.

Flosi, G. F., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 2010. California Salmonid Stream Habitat Restoration Manual, Volume 1, 4th edition. California Department of Fish and Game. Sacramento, CA.

Gonsolin, T. E. 2010. Ecology of foothill yellow-legged frogs in upper Coyote Creek, Santa Clara County, CA. San Jose, CA: State University of California. 119 p. M.S. thesis.

Hayes, M. P. and M. R. Jennings. 1988. Habitat correlates of the distribution of California red-legged frog (*Rana aurora draytonii*) and foothill yellow-legged frog (*Rana boylii*): implications for management. In: Szaro, R.C.; Severson, K.E.; Patton, D.R., tech. coords. Proceedings of a symposium on the management of amphibians, reptiles, and small mammals in North America, Gen. Tech. Rep. RM-GTR-166. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 144–158.

Hayes, M. P., C. A. Wheeler, A. J. Lind, G. A. Green and D. C. Macfarlane (Technical Coordinators). 2016. Foothill Yellow-Legged Frog Conservation Assessment in California. Gen. Tech. Rep. PSW-GTR-248. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 193 p.

Hemphill, D. V. 1952. The Vertebrate Fauna of the Boreal Areas of the Southern Yolla Bolly Mountains, California. PhD Dissertation. Oregon State University, Corvallis. 341 p.

Kupferberg, S. J. 1996. Hydrologic and geomorphic factors affecting conservation of a river-breeding frog (*Rana boylii*). Ecological Applications. 6: 1332–1344.

Kupferberg, S. J., A. Catenazzi, and M. E. Power. 2011. The importance of water temperature and algal assemblage for frog conservation in northern California rivers with hydroelectric projects. CEC-500-2014-033. Sacramento, CA: California Energy Commission, Public Interest Energy Research Program. 96 p.

Kupferberg, S. J., A. Lind, and W. Palen. 2009. Pulsed flow effects on the foothill yellow-legged frog (*Rana boylii*): population modeling. Sacramento CA: California Energy Commission. 80 p.

Leidy, R. A., E. Gonsolin, and G. A. Leidy. 2009. Late-summer aggregation of the foothill yellow-legged frog (*Rana boylii*) in central California. The Southwestern Naturalist. 54(3): 367–368.

Nussbaum, R. A., E. D. Brodie, Jr., and R. M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Moscow, ID: University of Idaho Press. 332 p.

Peek, R. A., S. M. Yarnell, and A. J. Lind. 2017. Visual encounter survey protocol for *Rana boylii* in lotic environments. Center for Watershed Sciences, University of California, Davis. 9 p.

Pacific Gas & Electric (PG&E). 2017. Pit 3, 4, and 5 Hydroelectric project foothill yellow-legged frog monitoring report, 2007-2016 summary report. Prepared by Spring Rivers Ecological Sciences LLC. 193 p.

Rathbun, G. B., N. J. Scott, Jr., and T. G. Murphey. 1997. *Rana aurora draytonii* (California red-legged frog). Behavior. Herpetological Review 28: 85-86.

Rombough, C. J. 2006. Wintering habitat use by juvenile foothill yellow-legged frogs (*Rana boylii*): the importance of seeps [Abstract]. Northwestern Naturalist. 87: 159.

Seltenrich, C. P. and A. C. Pool. 2002. A standardized approach for habitat assessment and visual encounter surveys for the foothill yellow-legged frog (*Rana boylii*). Report prepared for Pacific Gas and Electric Company. 11 p.

Semonsen, V. J. 2017. *Rana draytonii* (California Red-legged Frog). Climbing Ability. Herpetological Review 48(1): 169.

Storer, T. I. 1925. A synopsis of the amphibia of California. University of California Publications in Zoology. 27: 1–343.

Thomson, R. C., A. N. Wright, and H. B. Shaffer. 2016. California Amphibian and Reptile Species of Special Concern. 390 pp. University of California Press.

Van Wagner, T. J. 1996. Selected life-history and ecological aspects of a population of foothill yellow-legged frogs (*Rana boylii*) from Clear Creek, Nevada County, California. Chico, CA: California State University. 143 p. M.S. thesis.

Wheeler, C. A. and H. H. Welsh, Jr. 2008. Mating strategy and breeding patterns of the foothill yellow-legged frog (*Rana boylii*). Herpetological Conservation and Biology. 3: 128–142.

Wheeler, C. A., H. H. Welsh, Jr., and T. Roelofs. 2006. Oviposition site selection, movement, and spatial ecology of the foothill yellow-legged frog (*Rana boylii*). Final report. Sacramento, CA: California Department of Fish and Game. 20 p.

Zweifel, R. G. 1955. Ecology, distribution, and systematics of frogs of the *Rana boylei* group. University of California Publications in Zoology. 54: 207–292.