State of California
Department of Fish and Wildlife

Memorandum

Date: 20 May 2026

To: Leslie Call, Senior Environmental Scientist;
Sierra District Supervisor;
North Central Region Fisheries

From: Isaac Chellman, Environmental Scientist;
High Mountain Lakes;
North Central Region Fisheries

Cc: Region 2 Fish Files
Ec: CDFW Document Library

Subject: Amphibian monitoring in CDFW Region 2 – *Rana sierrae* capture-mark-recapture (CMR) in the northern Sierra Nevada

An adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*) basking on granite at the margin of a high elevation stream. (CDFW)

SUMMARY
For the past 25 years, the California Department of Fish and Wildlife (CDFW) has implemented the High Mountain Lakes (HML) project, which is an informal project designation that includes a few permanent CDFW staff assigned with managing high elevation aquatic ecosystems, including long-term monitoring to help determine the status and distribution of Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF), Southern Mountain Yellow-legged Frogs (*R. muscosa*; MYLF), Cascades Frogs (*R. cascadae*), Yosemite Toads (*Anaxyrus canorus*), introduced fish species, 'non-target' amphibian species (e.g., Southern Long-toed Salamanders [*Ambystoma macrodactylum sigillatum*] and Pacific Chorus Frogs [*Pseudacris regilla*]), and their habitat throughout the Sierra Nevada. CDFW HML—in close collaboration with other Sierra Fisheries staff, including district fisheries biologists (DFBs) and Heritage and Wild Trout (HWT) biologists—maintain working relationships with researchers, other resource agencies, and constituent groups to manage high elevation Sierra Nevada aquatic ecosystems. Using this information, HML staff report on findings through memoranda (hereafter "memo") and occasional development of, and updates to, long-term aquatic biodiversity management plans (ABMP) specific to hydrologic basins of the Sierra Nevada. The ABMPs do not reflect legal CDFW-mandated policy, but rather help guide management decisions for stabilizing and reversing negative effects of non-native fish introductions on native frog populations, while helping maintain viable recreational angling in a manner consistent with both the mission of CDFW and the guidelines set forth in the federal Endangered Species Act of 1973 (ESA) and California Endangered Species Act (CESA). Many of the areas discussed in this memo are included as management areas within existing ABMPs for various watersheds of conservation concern, and these ABMPs, along with memos detailing work therein, can be found on the **CDFW Document Library**.

This memo highlights the initial results of capture-mark-recapture (CMR) work at several different SNYLF populations in the northern Sierra Nevada. Surveys from 2022–2024 were funded through a State Wildlife Grant (SWG; Federal Award #F22AF01541) and surveys in 2025 were funded via a grant through Section 6 of the ESA (Federal Award #F25AP00356), both awarded to CDFW Region 2 HML staff, which are part of ongoing long-term monitoring of SNYLF in the northern Sierra Nevada.

Figure 1. An adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*) basking in a small pond in northern Sierra County. (CDFW)

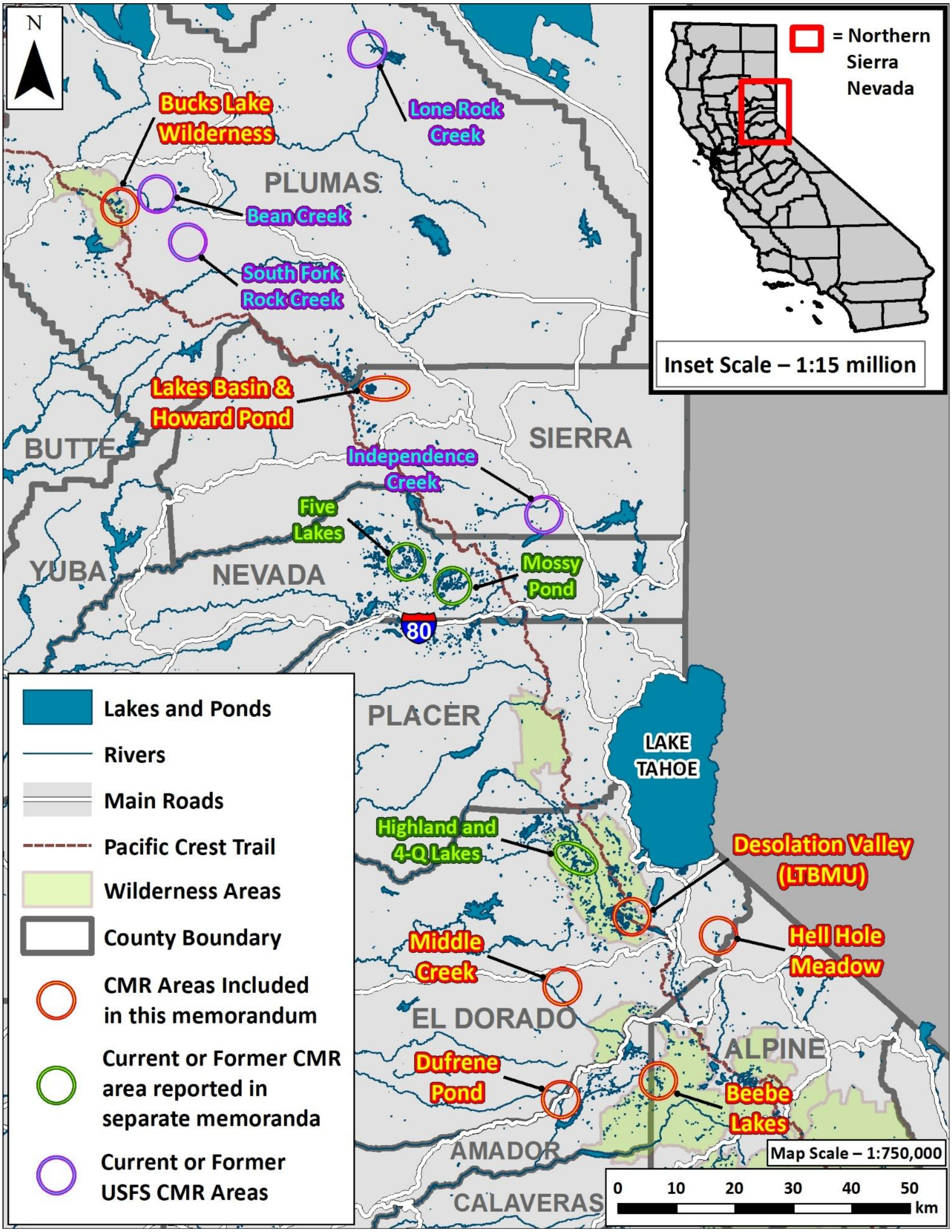


Figure 2. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) capture-mark-recapture (CMR) survey locations discussed in this memo (circled in yellow with red outlines). The map also displays three locations with current (4-Q Lakes, Five Lakes) and former (Mossy Pond) SNYLF CMR surveys conducted by CDFW (reported in other memos; in green), plus current and former locations of SNYLF CMR surveys conducted by the U.S. Forest Service (USFS; in light blue with purple outlines). "LTBMU" is the USFS Lake Tahoe Basin Management Unit.

ENVIRONMENTAL SETTING

The sites included in this memo are located in high elevation lake basins of the northern Sierra Nevada, in Plumas, Sierra, El Dorado, Amador, and Alpine Counties (**Figure 2**). These locations include the Gold Lake and Mount (Mt.) Pleasant areas, Plumas County (two small, adjacent drainages in Bucks Lake Wilderness, Plumas National Forest [PNF]); Lakes Basin, Sierra County (a small lake basin along the Gold Lake Highway corridor that spans Plumas and Tahoe National Forests); Howard Pond, Sierra County (a small pond on Tahoe National Forest [TNF]); the Jabu, Lucille, and Margery Lakes area, El Dorado County (a cluster of small lakes on the Lake Tahoe Basin Management Unit [LTBMU] at the eastern edge of Desolation Valley, Desolation Wilderness); Hell Hole Meadow, El Dorado County (a large meadow system on the LTBMU); Middle Creek, El Dorado County (a small stream on Eldorado National Forest [ENF] that flows into the Silver Fork American River); Dufrene Pond area, Amador County (a small, manmade pond and its connected streams that flow into the Little Bear River, on ENF); and the Beebe Lake area, Alpine County (a small lake basin in the Mokelumne Wilderness, ENF). These nine sites are located between approximately 4,950 feet (ft) (1,509 meters [m]) in elevation at the lower section of the Middle Creek drainage, and 8,500 ft (2,591 m) at the upper end of the Beebe Lake drainage. CDFW accesses all locations via a combination of vehicle and foot travel.

INTRODUCTION

Each site discussed in this memo includes its own subsection, each of which highlights specific attributes of the site, such as historic fish and amphibian distributions, and results of CMR surveys specific to those drainages. Prior to those site-specific subsections, this memo provides details on CMR methods used at all locations, plus information on threats common to all SNYLF populations discussed herein. This memo does not include information on three other locations where CDFW has recently conducted CMR for SNYLF in the northern Sierra Nevada. These include the Mossy Pond area (TNF, Nevada County), Five Lakes Basin (Grouse Ridge area; TNF, Nevada County), and 4-Q Lakes area (Desolation Wilderness, ENF, El Dorado County; **Figure 2**). CDFW no longer engages in active annual CMR in the Mossy Pond area, but details on previous surveys can be found in numerous memos from the Mossy Pond area (see the CDFW Document Library and use "Mossy Pond" in the search field). However, CDFW will be continuing annual SNYLF CMR at 4-Q Lakes and Five Lakes Basin for the foreseeable future, since CMR work at both sites is associated with ongoing SNYLF translocation projects, CDFW reports the detailed results of those surveys in separate memos, the most recent of which will include results from September 2025. Additionally, many of the sites discussed in this memo have received their own site-specific reporting associated with previous SNYLF visual encounter surveys (VES) conducted by CDFW staff. These can also be found on the CDFW Document Library, using the primary lakes names and/or author last names "Chellman" (2017–present memos) or "Mussulman" (2012–2016 memos) in the search field.

THREATS

Disease

The fungus *Batrachochytrium dendrobatidis* (*Bd*), also known as amphibian chytrid fungus, is a virulent pathogen that targets amphibians (Longcore et al. 1999). *Bd* can cause the disease chytridiomycosis, which can rapidly lead to severe illness and death in many amphibians, including SNYLF (Berger et al. 1998, Vredenburg et al. 2010). The disease causes severe disruptions to fluid and electrolyte balance, and other critical cutaneous functioning (Voyles et al. 2011, Voyles et al. 2012). In the 25 years since first being identified by scientists, *Bd* has been implicated in amphibian declines worldwide (Rachowicz et al. 2006, Skerratt et al. 2007, Rosenblum et al. 2010, Lambert et al. 2020). Within SNYLF populations, *Bd* infection intensity can vary, with occasionally no *Bd* being detected on some individuals, while others may have higher infection intensities (Ellison et al. 2019). However, studies indicate that recent metamorphs and subadults often have the highest *Bd* loads, and these life stages are the most susceptible to *Bd*-induced mortality (Rachowicz et al. 2006, Ellison et al. 2019). SNYLF populations in the northern Sierra Nevada are persisting despite presence of the pathogen. In these populations, CDFW generally considers *Bd* to be present in an enzootic state (i.e., the pathogen is persistent and epidemiologically "endemic"; Briggs et al. 2010). However, in other locations, in particular the southern Sierra Nevada, *Bd* has more recently been emerging in SNYLF and *R. muscosa* populations (considered together, the two species are hereafter referred to as "mountain yellow-legged frogs") that were previously naïve to the disease. When the disease first enters a mountain yellow-legged frog population, with few known exceptions, *Bd* emerges in an epizootic (epidemic) state (Briggs et al. 2010), leading to severe declines, and often extirpation of the population (Vredenburg et al. 2010, Knapp et al. 2022).

Locally, *Bd* has been detected in all northern Sierra Nevada SNYLF populations sampled by CDFW. Much of the testing conducted by CDFW in the northern Sierra Nevada occurred between 2008 and 2012, with staff conducting occasional swabbing at specific locations in more recent years. U.S. Forest Service (USFS) staff have also conducted occasional *Bd* testing at some SNYLF populations within CDFW Region 2, with most consistent monitoring occurring at small SNYLF populations in Plumas County (C. Dillingham and K. Weintraub, pers. comm.). To test for *Bd,* CDFW and partner biologists collect epithelial (outer skin) swabs in a standardized way, following established protocols (Knapp and Lindauer 2020). Partner scientists then screen the swab samples for presence of *Bd* DNA using real-time quantitative polymerase chain reaction (qPCR) analysis. The swab analyses can detect varying levels of infection intensity, which are expressed as "*Bd* loads" (either zoospore equivalents or, more recently, amplification of a region of the *Bd* "ITS1" gene region; Knapp and Lindauer 2020). Infection intensities on swabs collected from SNYLF populations vary, depending on the timing of sample collection, sample size, and population in question. In any one population of sampled populations in CDFW Region 2, swabs have returned anywhere from no *Bd* being detected up to relatively high *Bd* loads (particularly from recently metamorphosed and subadult frogs; Rachowicz et al. 2006). However, swabs collected from adult frogs at northern Sierra Nevada populations where *Bd* is known to have been present for many years have rarely revealed *Bd* loads high enough to suspect increased likelihood of mortality from severe chytridiomycosis.

Biosecurity:

Recently, the topic of wearing disposable nitrile gloves as a biosecurity measure when handling amphibians has received more widespread emphasis in the herpetological research and management community (see Gray et al. 2017, Thomas et al. 2020, Bletz et al. 2023, and Noelker et al. 2024 for some related biosecurity and decontamination discussions), although research on this topic has been ongoing (Mendez et al. 2008, Greer et al. 2009). As a general rule, these recommendations are prudent and highly warranted, given concerns about amphibian declines (Stuart et al. 2004) and the presence of often virulent pathogens, which can be grouped into four main categories: 1) endemic (i.e., established; in the case of *Bd* throughout much of the Sierra Nevada; Briggs et al. 2010), 2) emerging (e.g., *Bd*'s first arrival into mountain yellow-legged frog populations naïve to the disease; Vredenburg et al. 2010), 3) potential (e.g., *B. salamandrivorans* [*Bsal*; Martel et al. 2013], the chytrid fungal pathogen first identified in Europe that has not yet been detected in wild amphibian populations in the United States; Gray et al. 2023), and 4) largely unknown (Bienentreu and Lesbarrères 2020; e.g., ranaviruses, particularly in their distribution and impact to amphibians in the Sierra Nevada, but see Smith et al. 2017).

In particular, the use of nitrile gloves may be especially important for handling amphibians in areas with high species diversity, greater risk of exposure to multiple pathogens, and/or high likelihood of invasion and devastating outcomes from novel pathogens (e.g., in the case of one recent analysis of *Bsal*, northern California [i.e., Cascades Range and north] and the Pacific Northwest had high environmental suitability and invasion potential for *Bsal*; also, notably, several California genera had high infection risk, including *Taricha* and *Ensatina*; Gray et al. 2023). However, Appalachia holds the highest salamander species diversity in North America, and many locations in the United States have high risk potential associated with hypothetical *Bsal* invasion (Connelly et al. 2023, Gray et al. 2023). High elevation habitats of the Sierra Nevada—with more limited amphibian species diversity and fewer known susceptible species—are arguably at lower risk for *Bsal* emergence than other areas with more susceptible species, higher species diversity, and more potential exposure pathways. However, *Bsal* has the potential to be pestilential for amphibians no matter where it may emerge in North America.

In isolated, geographically limited work areas, using a new pair of disposable gloves to handle each individual may be unnecessary, given known *Bd* presence, persistence of the population in the presence of disease, animal behavior, and logistical concerns. For example, in large SNYLF populations, frogs are regularly found in congregations, with individuals pressed directly together—and sometimes on top of—one another (**Figure 3**), behavior that provides ready opportunity for pathogen spread. Due in part to these behaviors (although many other factors are involved in *Bd* disease dynamics; see Wilber et al. 2022), *Bd* prevalence tends to be high in populations that are persisting despite continued presence of the pathogen (Briggs et al. 2010). However, *Bd*-induced mortality still plays a role in population dynamics, especially among recently metamorphosed frogs, which are particularly susceptible to chytridiomycosis (Rachowicz et al. 2006).

Figure 3. Examples of Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) congregations in a small stream in Nevada County (top) and a high alpine lake in El Dorado County (bottom). This clustering behavior is common, especially in higher density SNYLF populations. (CDFW)

During CMR, adult SNYLF are handled briefly to insert passive integrated transponder (PIT) tags (or scan for tags already in place) and collect morphological measurements. This process is made more difficult and time consuming while wearing gloves, especially when surveyors are working independently. There is a loss of dexterity, which is particularly important during the PIT tag insertion process. Therefore, at sites where the SNYLF populations has been persisting for years in the presence of *Bd*, staff have historically handled frogs bare-handed for CMR, given increased efficiency and decreased processing time without disposable gloves.

However, several important caveats should be noted: first, staff ensure their hands are free of sunscreen, bug spray, lotions, or any other topical substance that could harm frogs by being absorbed through their highly permeable skin. Second, staff vigorously rinse off their hands in lake water and substrate (e.g., organic matter at the lakeshore) at the beginning of surveys, and also rinse their hands and dip nets between each frog handled. These measures help ensure no unnatural materials are being introduced to the frogs. Additionally, given relatively low frog densities at 4-Q Lakes, there is often several minutes, or more, between each frog that is handled. Often, staff note their hands have sufficient time to dry completely between processing frogs, and bare hands that have dried completely would be less likely to spread *Bd* (Mendez et al. 2008; although, note that the authors specifically state, "*These experiments show that single use of disposable gloves is the only handling technique providing 100% confidence that* Batrachochytrium dendrobatidis *will not be transmitted between amphibians.*" However, in these experiments, which were conducted in a sterile lab environment, participants were specifically prevented from drying their hands, given that drying can kill *Bd* [Johnson et al. 2003], and thus confound their experiments [Mendez et al. 2008, pg. 99]).

Additionally, an important aspect of biosecurity involves decontamination of footwear, nets, and other equipment that has come in direct contact with aquatic substrate and amphibians. CDFW has protocols for decontaminating equipment between individual lake basins (e.g., **CDFW 2022a**), which staff have followed rigorously for over 20 years to prevent the spread of aquatic pathogens between field sites. The only exceptions involve specific circumstances, such as when staff directly translocate frogs between nearby lake basins, so decontaminating equipment would be nonsensical in those specific instances (**CDFW 2025**).

All these considerations and caveats stated, CDFW staff plan may incorporate the use of nitrile gloves for future SNYLF CMR at smaller populations and/or locations where less is known about disease dynamics. Since SNYLF populations in many of the CMR locations discussed in this memo tend to be small and more widely distributed on the landscape, wearing fresh nitrile gloves between individuals will reduce the chances of inadvertently transferring disease between frogs that do not regularly encounter as many conspecifics (at least outside of overwintering periods, during which frogs may aggregate at preferred overwintering locations; Wilber et al. 2022), when compared with sites that contain large, dense populations (**CDFW 2025**).

Introduced Fish

Introduced trout prey on SNYLF tadpoles and young frogs, compete with frogs for food, and severely reduce or eliminate SNYLF reproduction (Needham and Vestal 1938, Vredenburg 2004). Therefore, widespread introduction of fish into lakes and streams of the Sierra Nevada has been one of the primary contributors to the fragmentation and extirpation of many mountain yellow-legged frog populations (Bradford 1989, Bradford et al. 1993, Knapp and Matthews 2000, Knapp 2005). By 1915, mountain yellow-legged frogs (up until 2007, considered one species; Vredenburg et al. 2007) were rare or extirpated from lakes containing introduced fish, while often remaining abundant in many fishless lakes (Grinnell and Storer 1924). Subsequent long-term monitoring of mountain yellow-legged frogs throughout the Sierra Nevada and Transverse Ranges of southern California—conducted by CDFW, USFS, National Park Service (NPS), U.S. Geological Survey (USGS), and other researchers—have shown a steep decline in mountain yellow-legged frog populations compared with historic distributions (Vredenburg et al. 2007, **CDFG 2011**). This decline has been primarily attributed to the long-term and widespread introduction of trout (Bradford et al. 1993, Knapp and Matthews 2000) and the more recent emergence of disease (Rachowicz et al. 2006, Vredenburg et al. 2010). In addition to native frog declines, fish introductions have caused other negative ecological effects (Knapp et al. 2001). Introduced trout can indirectly impact native predators, such as gartersnakes (*Thamnophis* sp.), which primarily prey on amphibians, including mountain yellow-legged frogs (Matthews et al. 2002). Introduced trout also prey on large aquatic macroinvertebrates and zooplankton in lakes (Knapp 2005), and indirectly impact wildlife that rely on these organisms for food. This causes trophic cascades in aquatic food webs that may extend into the terrestrial environment (Finlay and Vredenburg 2007). As one specific example, the Gray-crowned Rosy Finch (*Leucosticte tephrocotis*; GCRF), a high elevation passerine that primarily feeds at lakes on adult mayflies, is less common at fish-containing versus fishless lakes (Epanchin et al. 2010). Evidence suggests this difference is caused by introduced trout, which severely reduce or eliminate mayfly emergence from lakes, resulting in less food availability for GCRF. Collectively, effects of introduced trout can have negative consequences for high elevation ecosystems.

Prior to the mid-1800's, most high elevation areas of the Sierra Nevada were naturally fishless, due to Pleistocene glaciation and steep topography that creates barriers to upstream fish passage (Moyle et al. 1996). As a result, fish were primarily restricted to low- or mid-elevation streams, depending on the watershed (Knapp 1996). Since that time, salmonids—and occasionally other families (including cyprinids, centrarchids, and ictalurids, among others; Moyle 2002)—have been widely stocking in high mountain lake ecosystems of the American west (Bahls 1992). In California, the first recorded stocking of introduced trout into high elevation lake basins began in the 1870's (Dill and Cordone 1997), and unrecorded stockings potentially occurred as early as the 1850's (Christenson 1977). Early stock efforts included non-native species, especially Brook Trout (*Salvelinus fontinalis*; BK), but also Brown Trout (*Salmo* *trutta*; BN) Lake Trout (*Salvelinus namaycush*), and others (Dill and Cordone 1997). Stocking also included species native to other parts of California, but not naturally found in high elevation lake basins, such as Rainbow Trout (*Oncorhynchus mykiss*; RT), Lahontan Cutthroat Trout (*O. clarkii henshawi*), and California Golden Trout (*O. m. aguabonita*; Dill and Cordone 1997). Initially, these stocking actions were variously carried out by the California Acclimatization Society, California Fish Commission (an early predecessor to CDFW), Sierra Club, private clubs (e.g., in Desolation Wilderness, the Mt. Ralston Fishing Club conducted many fish planting efforts), and mountaineers. In the early 20th century, the Division of Fish and Game (later California Department of Fish and Game, now CDFW; Leitritz 1970) conducted more concerted trout stocking efforts (CDFG 2012, Christenson 1977). These early trout stocking actions, from about the 1870's to the 1930's, were often informal or haphazard, and records from those earlier times are, at best, inconsistent, and often nonexistent (Dill and Cordone 1997, Pister 2001). Record-keeping of authorized backcountry fish stocking became more consistent following implementation of aerial stocking, which began in 1946 (Leitritz 1970). From about 1950 until 2000, CDFW stocked many waterbodies throughout the Sierra Nevada with trout, primarily through the use of aerial stocking (Pister 2001). In 2000, in response to range-wide declines of SNYLF and a departmental reassessment of stocking practices, CDFW halted aerial stocking at high elevation lakes and ponds (ICF Jones & Stokes 2010, Chapter 2, pgs. 7–8).

This moratorium on aerial stocking occurred concurrently with establishment of the CDFW High Mountain Lakes (HML) Project, which was created to better assess the current status and distribution of native species, determine status of high elevation fisheries, and allow more considered selection of areas where future stocking may be viable, while not negatively affecting native species, including SNYLF (see **CDFW 2020a** "Overview" section for details). Additionally, researchers, CDFW, USFS, and NPS began other direct management actions, including physical removal of introduced fish (using gill nets and backpack electrofishing units) throughout the high elevation aquatic ecosystems of California to benefit native aquatic species negatively affected by fish introduction. These fish removal efforts have occurred at a small fraction of fish-containing waterbodies in the high mountain ecosystems of California. Even the most ambitious introduced fish removal plan currently being implemented in California, at Sequoia and Kings Canyon National Parks (SEKI), involves long term work (i.e., 30+ years) that, if fully implemented, would only remove fish from about 15% of current fish-containing aquatic habitats in SEKI (NPS 2016). Fish removal work in other high elevation locations of California, such as Yosemite National Park and USFS lands, have removed fish from a much smaller fraction of fish-containing areas. In other locations, introduced fish have extirpated in the absence of stocking (e.g., without any active fish removal work), given the inability of those locations to naturally maintain self-sustaining fisheries.

Minnows and other aquatic predators:

Although lakes and ponds with SNYLF populations discussed in this memo do not contain trout, several contain robust minnow populations, including species such as Speckled Dace (*Rhinichthys osculus*; DC-S) and Lahontan Redside (*Richardsonius egregius*; LRS). CDFW does not know what effect minnows may have on SNYLF breeding (e.g., potential for minnows to prey on, or damage, egg masses and early life stage tadpoles). However, European minnow species (*Phoxinus* spp.), which bear a close physiological resemblance to DC-S and LRS, have been shown to have detrimental effects on native amphibians in the Pyrenees mountains along the border of Spain and France (Miró et al. 2018), and researchers have shown that their removal can lead to rapid recovery of native amphibians (Miró et al. 2020). Blixie Lake, a site discussed further below in the section about Bucks Lake Wilderness (Plumas County), provides some circumstantial evidence that DC-S may be limiting SNYLF breeding because eggs and tadpoles have not been observed at that site. Conversely, Goose Lake, located at the southern edge of PNF in Sierra County, contains an abundant DC-S population sympatric with SNYLF. CDFW and PNF staff regularly monitor Goose Lake and the other waterbodies in the surrounding area. In addition to observations of SNYLF adults and subadults, CDFW and PNF staff often observe SNYLF egg masses in Goose Lake during early summer surveys. CDFW and PNF staff have not yet observed SNYLF breeding in other nearby locations that lack minnows, and the SNYLF population has persisted. Therefore, the presence of DC-S clearly does not preclude at least some SNYLF recruitment. However, little quantitative data are available regarding direct interactions between minnows and early life stage SNYLF.

There is some evidence that other cyprinids can cause reduced survival and growth in amphibians. For example, a mesocosm study found that Fathead Minnows (*Pimephales promelas*) reduced the survival and growth rates of salamander larvae through competition and inflicting injury (Pearson and Goater 2009). Another study examined the potential effects of introduced goldfish (*Carassius auratus*) on European Common Frogs (*Rana temporaria*) at a pond in Switzerland (Schmidt et al. 2021). Prior to goldfish introduction around 1989, the pond had been fishless. The researchers found that annual egg mass counts during the fishless period from 1975–1988 were significantly higher than the period 1989–2017, after goldfish introduction (Schmidt et al. 2021). Other small fish species have been linked with sublethal effects on amphibians, including Mosquitofish (*Gambusia* sp.; Pyke and White 2000; studies summarized in Kats and Ferrer 2003). Experimental evidence has shown that Three-spined Sticklebacks (*Gasterosteus aculeatus*) cause limb and tail damage in larval Western Toads (*Anaxyrus boreas*) identical to damage observed in the field (Bowerman et al. 2010). Undoubtedly, numerous fish species can affect amphibian larvae in different ways, and many of those effects may be deleterious, if not necessarily lethal (Wells 2007 pgs. 657–659).

The evidence for other common aquatic predators affecting larval amphibians further complicates isolating potential effects of minnows. For example, various species of dragonfly nymphs are voracious predators of amphibian larvae (See Table 14.2 in Wells 2007; Ballengée and Sessions 2009, Bowerman et al. 2010). Additionally, other amphibian larvae found in the northern Sierra Nevada are known to prey on conspecifics (e.g., *Ambystoma macrodactylum*; Wildy et al. 1998, Wildy et al. 2001).

Isolation and Loss of Genetic Diversity

Many SNYLF populations in the northern Sierra Nevada area are small and geographically isolated from one another. Isolated populations and small populations can suffer from similar negative genetic effects. Geographic isolation effectively eliminates gene flow between populations and increases risk for local extirpation. Isolated populations can suffer from inbreeding depression, genetic drift, fixation of deleterious alleles, and loss of genetic diversity, all of which are population genetic factors exacerbated when the population is small (Frankham et al. 2009). For the SNYLF populations discussed in this memo, only one (the Jabu, Margery, Lucille Lakes area) may have consistent gene flow with a nearby larger metapopulation of SNYLF: those in Desolation Valley, where SNYLF are widespread—albeit at relatively low densities—in fishless ponds and streams (**CDFW 2023a**). One other population discussed in this memo appears to be relatively large (Lakes Basin, Sierra County), although the true population size is currently uncertain (see Lakes Basin section below). For all other populations discussed in this memo, the nearest robust SNYLF populations are at least 15 km away, and no large SNYLF populations (i.e., ≥100 adults seen during any given survey) are currently known in Plumas County.

Marginal Habitat

Several of the SNYLF populations discussed in this memo are persisting in small, isolated ponds and their seasonally flowing tributaries. For example, Hell Hole Meadow currently retains shallow surface water and dispersed pothole pools throughout the year. These deep perennial pools likely provide crucial overwintering habitat for SNYLF. All other ponds surrounding Hell Hole Meadow are small and shallow, and most are ephemeral. Loss of meadow surface water earlier in summer, reduction in the water table, and lower pool levels (or complete desiccation of pools) for longer periods are potential threats to long term persistence of SNYLF. Another example, Middle Creek, contains a SNYLF population found in a small perennial stream, and any disturbances that threaten overwintering habitats or change flow regimes from the current perennial flows could present an extirpation risk. Similarly, the Dufrene Pond area SNYLF population primarily occupies small streams and two small, manmade ponds, the larger of which is slowly filling with silt over time, and smaller of which is ephemeral.

Threats to smaller, more isolated aquatic habitats may increase over time, particularly if the Sierra Nevada continues to experience consistently hotter and drier summers, more winter precipitation falling as rain, and loss of snowpack, as currently predicted by many climate models (Hatchett et al. 2017, Dettinger et al. 2018, Huang et al. 2018, Rhoades et al. 2018, Sun et al. 2019, Wahl et al. 2019, Coats et al. 2022). Other risks to these populations include habitat disturbance by humans, wildfire, possible exposure to severe winter conditions (i.e., scenarios of low snowpack and freezing temperatures leading to complete freezing of small waterbodies; Bradford 1983), and desiccation during drought conditions (e.g., the 2012–2015 and 2020–2022 drought periods, which lowered water levels in many small ponds throughout the Sierra Nevada), any one of which present potential extirpation risks to SNYLF populations restricted to marginal habitats.

Cattle Grazing

Studies investigating direct interactions between cattle and SNYLF populations have not been conducted. However, the USFS acknowledges potential cattle impacts to SNYLF; in one specific example, within an environmental assessment for the Bear River grazing allotment, which is adjacent to the Pardoe grazing allotment on which the Beebe Lake SNYLF population is located (USFS 2018, pgs. 26 and 27). Additionally, potential negative effects of livestock grazing on SNYLF habitat are discussed in the U.S. Fish and Wildlife Service (USFWS) final rule for listing SNYLF as a federally endangered species (USFWS 2014, pg. 24628–24630). USFWS concluded: "*Current livestock grazing activities may present an ongoing, localized threat to individual populations in locations where the populations occur in stream riparian zones and in small waters within meadow systems, where active grazing co-occurs with extant frog populations."*

The USFWS also concluded that, "*Livestock grazing that complies with forest standards and guidelines is not expected to negatively affect mountain yellow-legged frog populations in most cases, although limited exceptions could occur, especially where extant habitat is limited.*" (USFWS 2014, pgs. 24269–24270). One of these exceptions occurs at a small meadow pond near Beebe Lake (Alpine County), in which CDFW has documented SNYLF breeding. This site can receive heavy use by cattle. Additionally, CDFW field staff consistently observe cattle in several locations discussed in this memo, including the Beebe Lake area, Dufrene Pond area, and Middle Creek. In addition to observing cattle directly in SNYLF habitats, staff have observed abundant evidence of cattle use in some locations (e.g., the Beebe Lake area), in the form of tracks and manure all around waterbodies and throughout meadows (**Figure 4**).

Figure 4. A series of images showing cattle and cattle tracks in a meadow <1 km northwest of Beebe Lake, Alpine County. This meadow is occupied by Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) and contains a small pond where SNYLF breeding occurs. (CDFW)

CDFW is in discussion with ENF aquatic biologists to consider fencing off the aforementioned small meadow pond in which SNYLF breeding has occurred (including a portion of the small, braided meadow stream channels which flow into the pond) to prevent direct cattle access, trampling around the pond perimeter, and eutrophication and bacterial growth caused by cattle feces (**Figure 5**). Under current conditions, cattle appear to be negatively affecting SNYLF breeding at this location. These poor water quality conditions may be particularly acute during dry water years or late in the summer, when cattle are more often congregating at the fewer remaining water sources. Similar cattle exclusion efforts to benefit SNYLF have been conducted for many years in a large portion of Ladeux Meadow, which is in the adjacent drainage, west of the Beebe Lake area. However, in late July 2024, CDFW staff observed that the cattle exclusion fencing around Ladeux Meadow was uninstalled (i.e., left down on the ground, which the grazing allotment holders do overwinter to prevent snow load damage to the fencing), and cattle were grazing directly within the SNYLF habitat, so occasional grazing permit violations have been occurring in this area.

Figure 5. A small pond in a meadow <1 km northwest of Beebe Lake on 30 August 2022 (this pond is located in the meadow where cattle are shown in **Figure 4**). This small pond, which is the main water source in the upper meadow north of Beebe Lake, receives regular visitation from cattle. CDFW staff consistently observe cattle in this area, numerous cattle prints around this pond, and abundant manure at the pond margin and in the adjacent meadow. In August 2022, this pond contained thick algal growth, a phenomenon staff had not previously observed in the pond, which is one of only a few spots known to currently provide SNYLF breeding habitat in the Beebe Lake area. In past surveys, CDFW has observed numerous SNYLF tadpoles in this pond. However, in 2022, CDFW did not detect SNYLF tadpoles. The lack of detections may have been due to limited visibility from thick algal growth. CDFW suspects that algal growth may be facilitated by eutrophication caused by cattle manure. As noted by the USFWS (2014, pg. 24268), "*Livestock can increase nutrient-loading in water bodies due to urination and defecation in or near the water, and can cause elevated bacteria levels in areas where cattle are concentrated.*" Without intervention, these conditions may result in this pond becoming unsuitable for SNYLF breeding.

SNYLF CAPTURE-MARK-RECAPTURE (CMR): METHODS

At each site discussed in this memo, CDFW staff surveyed the area for SNYLF (maps in the Results and Discussion subsections below show the specific areas surveyed at each site), following the Region 2 High Mountain Lakes Project protocols (Attachment 1; survey methods modified from Fellers and Freel 1995). During surveys, field staff looked for SNYLF and captured any adults (individuals >40 millimeters snout-to-urostyle length [SUL]) detected using dip nets or hand capture. Field staff then scanned each adult frog for an implanted PIT tag (**Figure 6**), which provides a unique identifier for each individual. If the adult frog did not already have a PIT tag implanted, staff would use fine tip surgical scissors to cut a tiny incision through the skin of the frog's back (**Figure 7**), just wide enough to accommodate the 1.4 mm-wide PIT tag. Staff then placed the PIT tag beneath the skin (**Figure 8**) and gently slid the tag down the dorsum so it would rest above the urostyle. Then, staff used a PIT tag reader (i.e., "transponder") to scan the tag, which revealed the unique identifying code of that tag (**Figure 9**). Staff then measured SUL (in millimeters) (**Figure 10**), weight (in grams) (**Figure 11**), and documented sex of the frog. Adult female SNYLF have relatively thin arms and narrow thumbs (**Figure 12**), whereas adult males normally have notably more robust forearms and evident "nuptial excrescences" (more commonly known as "nuptial pads") on their thumbs (**Figures 13 and 14**). Although nuptial pads can be more prominent at different times of year (generally, nuptial pads are thought to be most pronounced during the breeding season; Duellman and Trueb 1994, pgs. 56–57), SNYLF males have conspicuous nuptial pads while active during the monitoring season, from at least ~May–October (Chellman, pers. obs.). The nuptial pads help males effectively grasp onto females while in the mating position known as "amplexus" in amphibians (**Figure 15**).

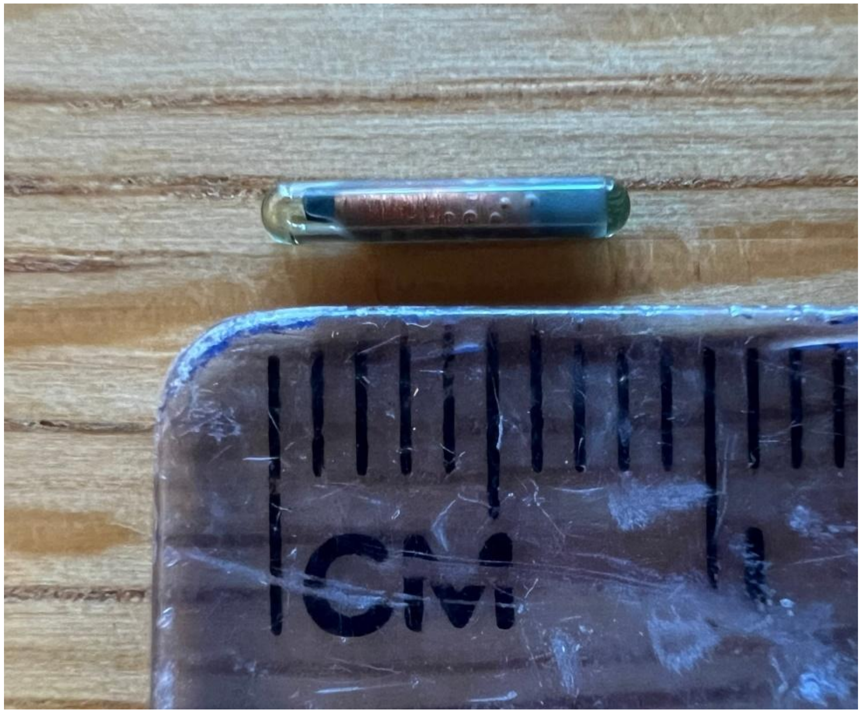


Figure 6. Up-close photo of a “Mini HPT8” passive integrated transponder (PIT) tag made by Biomark®. The PIT tag is 8 mm long x 1.4 mm wide. Tags are inert and encapsulated in biocompatible glass. At sites where CDFW is undertaking capture-mark-recapture (CMR) population assessments, staff place these tiny PIT tags (about the size of a grain of rice) beneath the skin of adult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) to provide a unique identifying code for each individual captured. Staff use a PIT tag reader to scan for tags (see **Figure 9**). If a tag is present, the reader will detect it and display a unique identification code. Unless expelled (which is rare), the tags remain beneath the frog’s skin for the remainder of its life. (CDFW)

Figure 7. A CDFW staff member using surgical scissors to make a small incision into the dorsal skin of a Sierra Nevada Yellow-legged Frog (*Rana sierrae*). Staff then place a 1.4 mm wide passive integrated transponder (PIT) tag through the skin to provide a unique identifying code for that individual. (CDFW)

Figure 8. A CDFW staff member inserting a passive integrated transponder (PIT) tag into an adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*). (CDFW)

Figure 9. A CDFW staff member scanning the recently inserted PIT tag of an adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*). (CDFW)

Figure 10. A CDFW staff member preparing to measure the snout-to-urostyle (SUL) length of an adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*). (CDFW)

Figure 11. A CDFW staff member using a spring scale to weigh an adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*). (CDFW)

Figure 12. An adult female Sierra Nevada Yellow-legged Frog (*Rana sierrae*). Note the smooth thumbs (red arrow) and thin arms (blue arrow) when compared with the male in **Figure 13**. (CDFW)

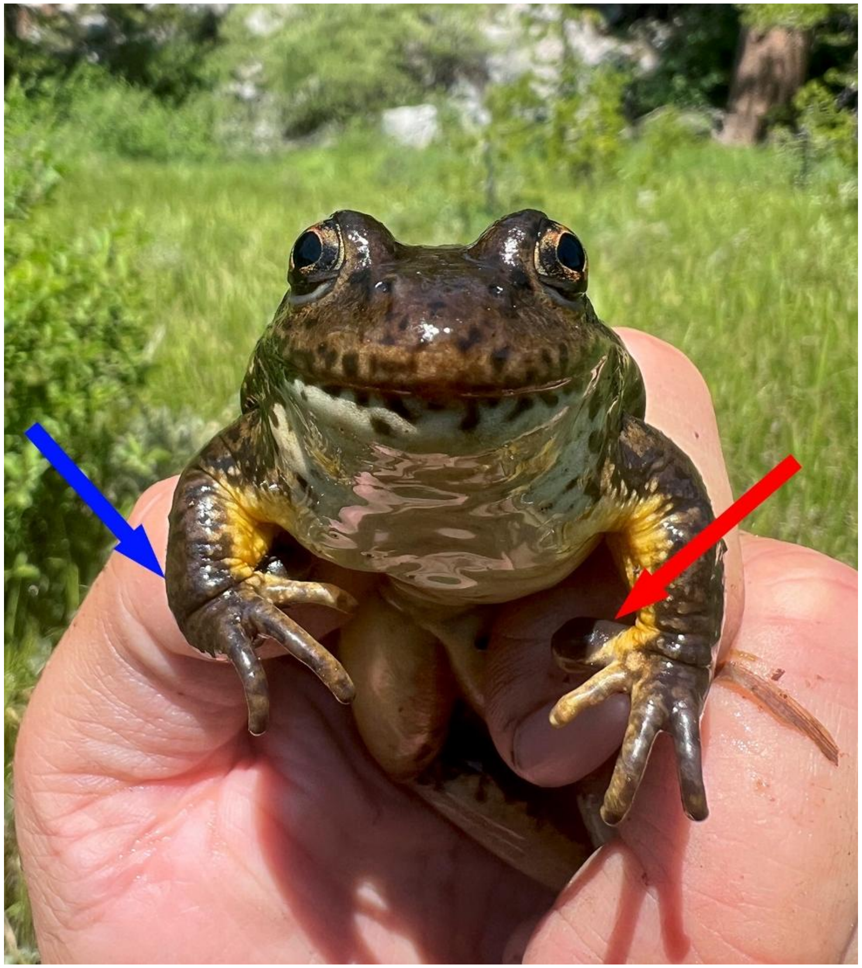


Figure 13. An adult male Sierra Nevada Yellow-legged Frog (*Rana sierrae*). Note the enlarged nuptial pad on the thumbs (red arrow) and more robust arms (blue arrow) when compared with the female in **Figure 12**. (CDFW)

Figure 14. Zoomed-in photo of the nuptial pad (red arrow) on the thumb of an adult male Sierra Nevada Yellow-legged Frog (*Rana sierrae*). Nuptial pads help the male more effectively hold onto females during amplexus (see **Figure 15**). (CDFW)

Figure 15. A male Sierra Nevada Yellow-legged Frog (*Rana sierrae*) grasping onto the back of a female, in the mating position called amplexus. (CDFW)

Although PIT tags are the primary method of individual identification, staff also took photographs of chin spot patterns for all adult SNYLF captured. Chin patterns of at least some ranid frogs—including SNYLF, *R. boylii*, and *R. muscosa*—are unique to the individual and do not change in shape over time, so the pattern can be used as a secondary form of individual identification (Marlow et al. 2016). PIT tags can occasionally be expelled from frogs (Brannelly et al. 2014), most often from newly tagged individuals. In SNYLF, known tag loss usually occurs when the tag makes its way back up to the incision and gets expelled before the incision has time to heal. However, PIT tag loss is rare, particularly in mountain yellow-legged frogs (Hammond et al. 2022), and appears to primarily happen when too large of an incision has been made (San Francisco [SF] Zoo, unpubl. data). However, since tag loss can happen, CDFW collects chin pattern photos on each captured adult, especially because photo collection is a fast, easy, and noninvasive way to obtain a backup method for identifying individuals. There is a high amount of variability in chin patterns between individuals, with some frogs having almost no pattern (**Figure 16**, left image), some with very bold patterns (**Figure 16**, middle image), and others with more muted contrast in their patterns (**Figure 16**, right image). Additionally, the intensity/contrast of an individual frog's chin pattern can change due to things like background substrate, environmental temperature, light exposure, and humidity (Hoffman and Blouin 2000), and those changes can sometimes occur very rapidly (Wheeler et al. 2005).

After collecting PIT tag-related data, morphological measurements, and chin pattern photos, staff then released the frogs back to their original point of capture. For locations where CDFW surveyed the same site(s) more than once during the same trip, staff would not recollect morphological data on any frogs that had already been captured. For frogs recaptured during the same trip, staff would only collect date, time, Site ID, PIT tag number, sex, and location coordinates of the frog. For most sites discussed in this memo, CDFW staff only visited each location once annually, but CDFW did visit a few locations more than once. Details of those visits are provided in the Results and Discussion subsections below.

Figure 16. Three different adult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) showing differences in the quantity, contrast, and blotch arrangements of their chin patterns. (CDFW)

SNYLF CAPTURE-MARK-RECAPTURE (CMR): RESULTS and DISCUSSION

Bucks Lake Wilderness, Plumas County

Bucks Lake Wilderness Summary

CDFW is focusing on two areas in Bucks Lake Wilderness (**Figure 17**), the Gold Lake area and the Mt. Pleasant area, to benefit state threatened and federally endangered Sierra Nevada Yellow-legged Frogs (*Rana sierrae*, SNYLF). The Gold Lake area includes Gold Lake, Rock Lake, Mud Lake, and tributaries (**Figure 18**). Gold Lake is a site from which CDFW removed introduced Brook Trout to benefit SNYLF (**CDFW 2019a**). The Mt. Pleasant area, which includes several small ponds, is located about 2 kilometers (km) northwest of the Gold Lake area (**Figure 18**). CDFW has designated both areas as Native Species Reserves (NSRs) in the Aquatic Biodiversity Management Plan for the Bucks Lake Wilderness Management Unit (ABMP; **CDFW 2015**).

Amphibian monitoring data from 2004–2025 reveals small, persisting SNYLF populations in both areas. However, the population sizes have remained low for years, and biologists have consistently observed a small number of dead SNYLF in the Mt. Pleasant area. Additionally, SNYLF populations in Bucks Lake Wilderness, like many populations at the northern extent of the species' range, are small and isolated, resulting in high risk of extirpation. Therefore, these populations are of conservation concern to CDFW.

The Interagency Conservation Strategy for Mountain Yellow-legged Frogs in the Sierra Nevada (hereafter "Strategy"; MYLF ITT 2018) highlights reintroductions as a principal method for SNYLF recovery. As a result, in September 2018, PNF staff from the Mt. Hough Ranger District collected 64 larval and metamorphic SNYLF for captive rearing at the San Francisco (SF) Zoo. SF Zoo staff raised the SNYLF to maturity, and PNF and CDFW staff released frogs large enough for PIT-tagging back into the Gold Lake and Mt. Pleasant areas on 28 June 2019. In October 2019, PNF staff collected an additional 42 larval SNYLF from the Mt. Pleasant area for captive rearing at the SF Zoo. On 19 June 2020, PNF and CDFW staff released a subset of these frogs (those large enough for PIT-tagging), including all remaining individuals from the 2018 cohort. On 25 June 2021, CDFW and PNF released the remaining captive-reared SNYLF housed at the SF Zoo back into the wild. In 2023, PNF staff collected portions of SNYLF egg masses from Rock Lake (Gold Lake NSR; 93 eggs total) and Dot Lake (Mt. Pleasant NSR; 172 eggs total). These individuals were raised to maturity at the SF Zoo. In July 2024, CDFW and PNF staff released the adult SNYLF back into Rock Lake (129 adults released) and Dot Lake (128 adults released). A portion of the released adults at both sites were held in *in situ* for 10 days and fed crickets daily as a "soft release" experiment to see if temporary holding on site before full release increases post-release survival (more details below). At present, no Bucks Lake Wilderness SNYLF remain at the SF Zoo.

CDFW and PNF staff will continue annual amphibian monitoring to document SNYLF response to reintroductions and BK removal.

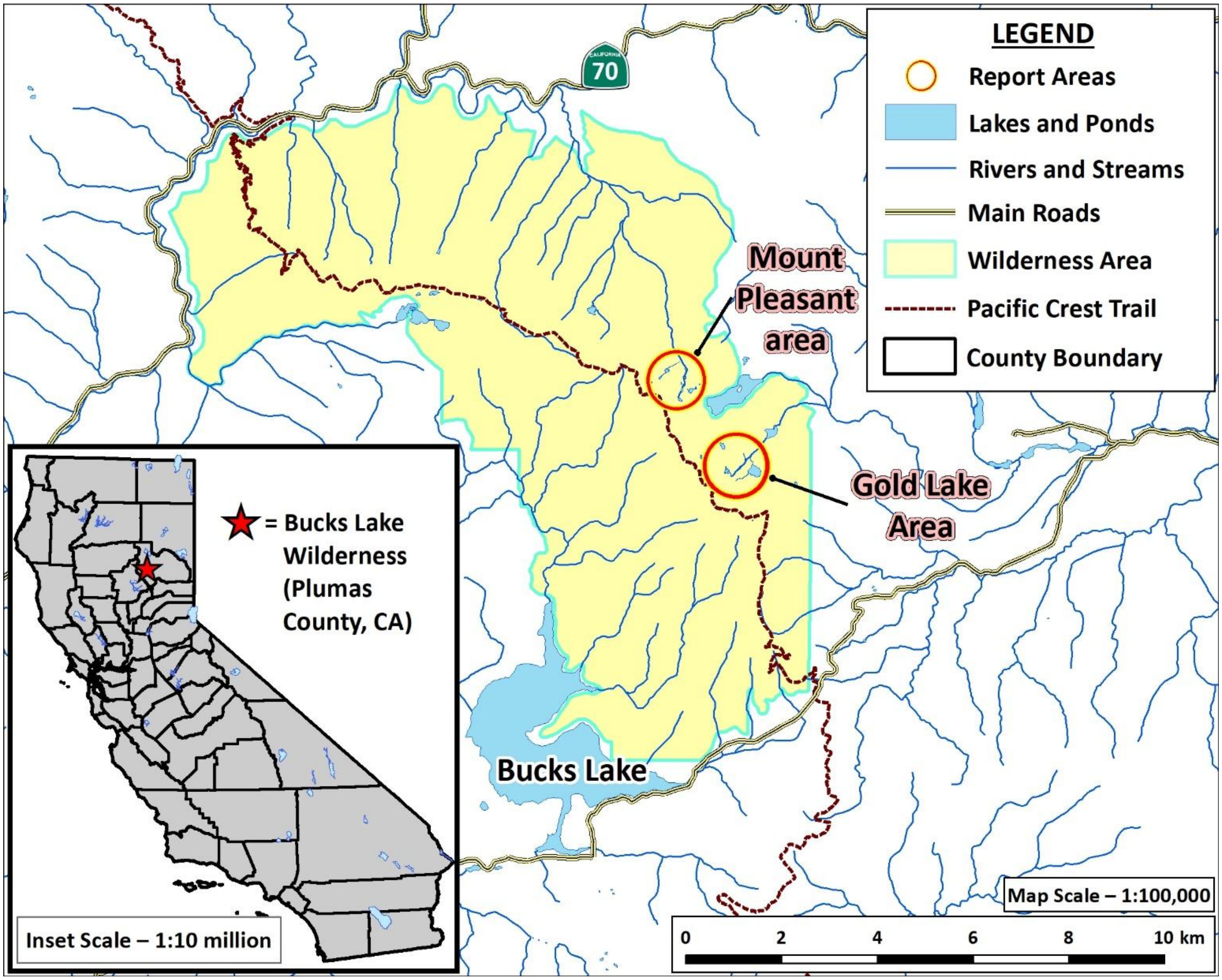


Figure 17. Bucks Lake Wilderness, Plumas County, CA. The areas discussed in this section are circled.

Background for Bucks Lake Wilderness CMR

Surveys for SNYLF (**Figure 18**) in Bucks Lake Wilderness focus on the Mt. Pleasant and Gold Lake area NSRs (**Figure 19**). These two populations are located in separate drainages, but their proximity (approximately 2 km apart) may allow rare instances of connectivity and gene flow. However, thus far, no frogs PIT-tagged in one NSR have been recaptured in the other.

PIT-tagging of SNYLF in Bucks Lake Wilderness began in 2015, during which a USFS researcher was conducting a short-term population study. The initial tagging efforts were subsequently halted due to changes in research direction and personnel. More recent PIT-tagging work undertaken by current PNF and CDFW staff, beginning in 2017 and expanding in 2018, seeks to PIT tag all newly captured (untagged) adults in the Gold Lake and Mt. Pleasant areas. Data summarized here focuses on 2018 onward, which is the period during which there has been more consistent surveying and tagging effort. PIT-tagging allows CDFW and PNF to more accurately keep track of SNYLF population demographics through time. Additionally, PIT-tagging allows biologists to learn more about the potential benefits of the recent SNYLF headstarting work, discussed below.

More details regarding SNYLF population monitoring in Bucks Lake Wilderness are also documented by USFS personnel in annual summary reports of activities required under a 10(a)(1)(A) recovery permit (#ES40087B, exp 4/20/2028) with the U.S. Fish and Wildlife Service. What follows is a summary of the SNYLF management work conducted since 2015, with particular emphasis on the most recent long-term tagging efforts by PNF and CDFW staff, included in a recent SWG (Federal Award #F22AF01541) that funded CDFW work during the 2022–2024 field seasons (~June–Sept annually) and a Section 6 of the ESA grant (Federal Award #F25AP00356) that funds current CDFW monitoring work (2025 through 2027).

Figure 18. An adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*) at Rock Lake (Site ID 12069) in August 2022. (CDFW)

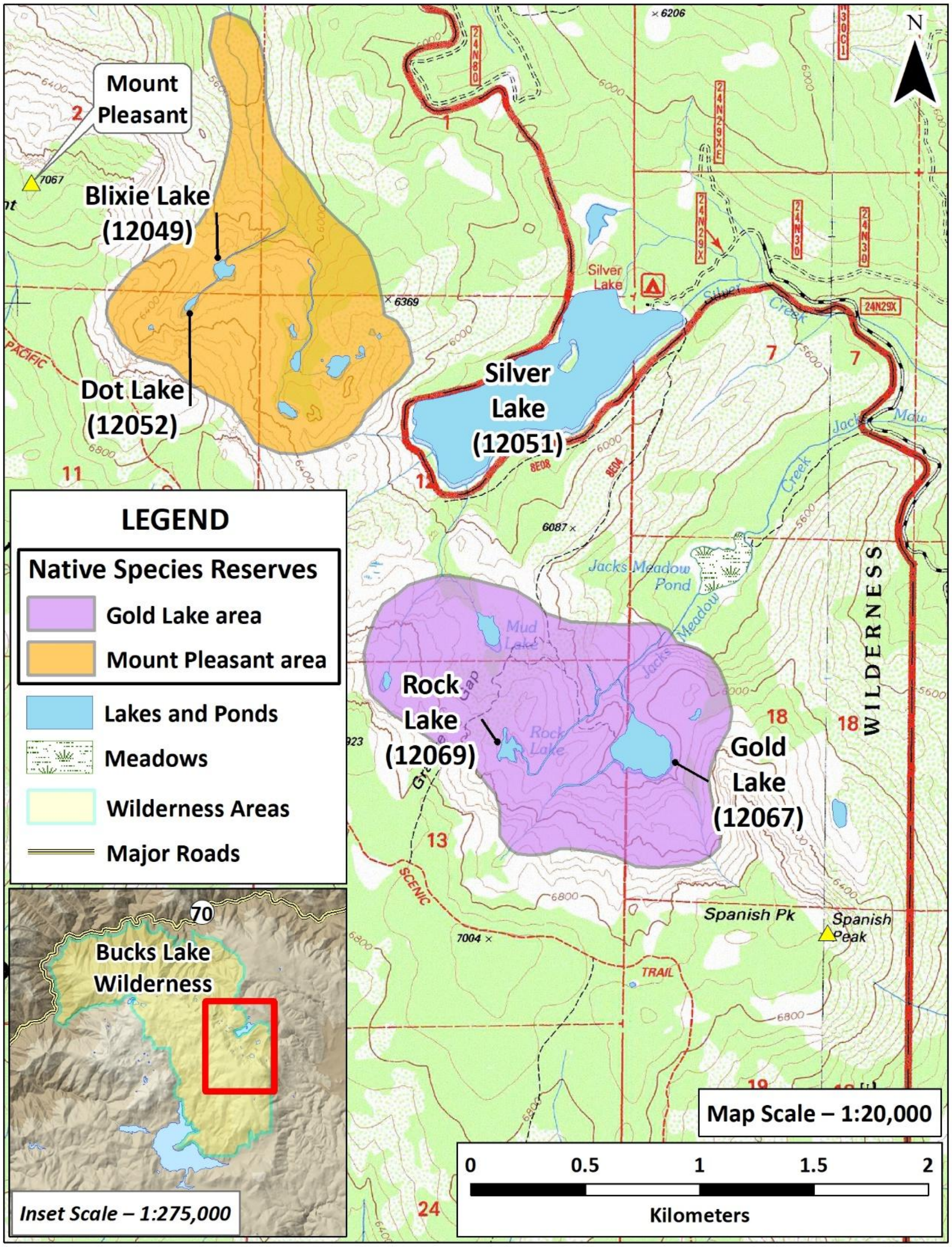


Figure 19. Focal areas for Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) management by California Department of Fish and Wildlife (CDFW) and Plumas National Forest in Bucks Lake Wilderness, Plumas County, CA. The orange area highlights the Mt. Pleasant Native Species Reserve (NSR), and the purple area highlights the Gold Lake NSR. CDFW and PNF biologists from the Mt. Hough Ranger District regularly monitor the SNYLF populations in both areas. Numbers displayed are CDFW Site IDs.

Bucks Lake Wilderness Results

Since consistent monitoring of SNYLF populations in Bucks Lake Wilderness began in the early 2000's, SNYLF detections in the Mt. Pleasant and Gold Lake areas have been relatively low, particularly since 2010 (for detailed background on SNYLF visual encounter surveys and management in Bucks Lake Wilderness, see **CDFW 2023b** and earlier survey memos found on the **CDFW Document Library**). These low counts have concerned both CDFW and PNF. During VES in August 2018, CDFW field staff observed very few SNYLF in both the Mt. Pleasant and Gold Lake areas. Although observer bias and variation in survey conditions can affect the number of SNYLF detected during any given visual survey, the low numbers were troubling, especially when observed in already threatened populations.

In response to these observations and long-term trends, PNF personnel, in collaboration with CDFW, the U.S. Fish and Wildlife Service (USFWS), and SF Zoo, undertook a collection of early life stage SNYLF from Rock Lake (Site ID 12069; **Figure 20**) and Dot Lake (Site ID 12052; **Figure 21**) for captive rearing (a.k.a., "headstarting") at the SF Zoo. The Strategy highlights captive rearing as one of the primary actions to restore SNYLF populations (MYLF ITT 2018, pgs. 17–19). CDFW also mentions the potential for translocations (which are one of the methods, along with captive rearing, broadly considered under "Reintroductions" in the Strategy) in the Mt. Pleasant area in the Bucks Lake Wilderness ABMP (**CDFW 2015**, pg. 20).

Figure 20. Rock Lake (Site ID 12069) in 2022. Rock Lake is the primary site in the Gold Lake NSR at which Plumas National Forest and CDFW staff have collected early life stage Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) for captive rearing at the San Francisco Zoo, and later release of mature adult SNYLF back into the wild. (CDFW)

Figure 21. Dot Lake (Site ID 12052) in 2022. Dot Lake is the primary site in the Mt. Pleasant NSR at which Plumas National Forest and CDFW staff have collected early life stage Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) for captive rearing at the San Francisco Zoo, and later release of mature adult SNYLF back into the wild. (CDFW)

Table 1 displays the summarized results from CMR, collections of early life stage SNYLF (eggs, larvae, or recent metamorphs), and releases of captive-reared SNYLF in the Gold Lake NSR. **Table 2** displays the same information for SNYLF in the Mt. Pleasant NSR.

In total, between 2015 and 2025, USFS, CDFW, and SF Zoo staff have PIT tagged 538 SNYLF that have been wild caught as adults (n = 181), or captured as early life stages, captive-reared to maturity, and released (n = 357). Of those 538 frogs, staff have recaptured 228 (42%) at least once since initial capture or release. Of the 228 SNYLF that staff have recaptured at least once, staff captured 58 (25% of recaptured frogs; or 11% of all PIT-tagged frogs) after the passage of at least one winter.

Overall, among the zoo-reared SNYLF that PNF and CDFW staff have released between 2019 and 2024 (40 released in 2019, 38 released in 2020, 22 released in 2021, and 257 released in 2024), recapture rates have been low. The lack of recaptures have been especially striking when attempting to relocate frogs that have survived at least one winter following release back into the wild. Of the 40 captive-reared adults released in 2019, staff only recaptured one in 2020 (a frog observed in Rock Lake in late June 2020), and another during surveys in 2021. Staff have not recaptured any of the captive-reared frogs released in 2020 or 2021 following the initial summer of release. Of the 257 captive-reared adults released in 2024, PNF and CDFW staff have only detected one, at Rock Lake, following winter 2024–2025 (an individual that staff captured twice in 2025). Unfortunately, none of the zoo-reared frogs released at Dot Lake have been recaptured following the winter. In sum, only three captive-reared individuals of the 357 released (<1%) over a seven-year period are known to have survived at least one winter.

Staff have recaptured more PIT-tagged wild frogs that have survived at least one winter. Since 2015, USFS and CDFW staff have PIT-tagged 181 wild SNYLF in the Mt. Pleasant and Gold Lake NSRs. Of those 181 wild-caught and PIT-tagged individuals, staff have recaptured 55 individuals (30% of PIT-tagged wild frogs) that survived at least one winter. Of those 55 wild frogs that survived at least one winter, staff recaptured 21 only once following the overwintering period. Of the 34 remaining recaptured wild frogs that staff recaptured more than once after a winter, staff recaptured 18 more than twice.

Table 1. Summary of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) captures, early life stage collections, and captive-reared adult frog releases in the Gold Lake NSR from 2015 to 2025. The numbers shown represent the number of newly marked ("NEW"), recaptured ("RECAP"), collected, and released ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which would include SNYLF individuals caught >1x in the same year).

YEAR	NEW	RECAP	RECAP NOTES	EARLY LIFE STAGES COLLECTED FOR CAPTIVE REARING	RELEASED	GENERAL NOTES
2015	12	10		0	0	USFS *R. sierrae* population study.
2016	0	1		0	0	
2017	2	2		0	0	
2018	11	7		60	0	
2019	1	4		0	19	All captive-reared frogs released at Rock Lake.
2020	10	9	One recap was a zoo-reared frog released in 2019; Four recaps were zoo-reared frogs released in June.	0	19	All captive-reared frogs released at Rock Lake.
2021	2	7	One recap was a zoo-reared frog released in 2019. (Not the same individual as the recap in 2020.)	0	11	All captive-reared frogs released at Rock Lake.
2022	10	9		0	0	
2023	11	14		93	0	PNF staff also detected nine unique PIT tags at Rock Lake with Biomark PIT tag probe, but frogs not seen. Eight of the nine tags belonged to zoo-reared frogs (one was from a wild frog tagged in 2017).
2024	1	74	61 of the recaps were zoo-reared frogs released in July.	0	129	All captive-reared frogs released at Rock Lake. 57 of the captive-reared frogs were "soft-released" by holding temporarily (nine days) inside *in situ* baskets to get acclimated to the site before full release. PNF staff also found one loose tag with Biomark PIT tag probe.
2025	0	5	One of the recaps was a zoo-reared frog released in July 2024	0	0	PNF staff also detected 24 unique PIT tags at Rock Lake with Biomark PIT tag probe: seven were loose tags (i.e., not inside frogs; frogs presumed dead), the other 17 were detected, but no frog or tag was seen directly, so status of the frog was not known.

Table 2. Summary of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) captures, early life stage collections, and captive-reared adult frog releases in the Mt. Pleasant NSR from 2015 to 2025. The numbers shown represent the number of newly marked ("NEW"), recaptured ("RECAP"), collected, and released ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which would include SNYLF individuals caught >1x in the same year).

YEAR	NEW	RECAP	RECAP NOTES	EARLY LIFE STAGES COLLECTED FOR CAPTIVE REARING	RELEASED	GENERAL NOTES
2015	47	33		0	0	
2016	0	0		0	0	
2017	1	1		0	0	
2018	7	4		4	0	
2019	12	5	1 recap was a zoo-reared frog released in June	42	21	All captive-reared frogs released at Dot Lake.
2020	8	16	3 recaps were zoo-reared frogs released in June	0	19	All captive-reared frogs released at Dot Lake.
2021	2	9	6 recaps were zoo-reared frogs released in June	0	11	All captive-reared frogs released at Dot Lake.
2022	3	10	1 recap was found dead on the lake bottom	0	0	
2023	17	4		172	0	
2024	12	60	45 of the recaps were zoo-reared frogs released in July. 5 of the recaps were found dead (4 of which had been eaten by gartersnakes)	0	128	All captive-reared frogs released at Dot Lake. 57 of the captive-reared frogs were "soft-released" by holding temporarily (9 days) inside *in situ* baskets to get acclimated to the site before full release.
2025	10	9	None of the recaps were zoo-reared frogs.	0	0	Most frogs were detected underwater.

Soft Releases in 2024

In July 2024, PNF and CDFW staff tried a soft release approach (e.g., Klocke et al. 2023) for a subset of the most recent cohort of captive-reared SNYLF (**Figure 22**). In this case, "soft release" means that staff held a subset of captive-reared frogs (114 of 257 [44%]; 57 at Rock Lake and 57 at Dot Lake) within *in situ* pens for nine days (**Figure 23**). Staff released the other 144 captive-reared frogs immediately after reaching the release sites (here after referred to as "hard release"; 72 frogs at Rock Lake and 72 frogs at Dot Lake), in the method traditionally undertaken when releasing captive-reared frogs (**Figure 24**). The *in situ* pens were laundry baskets modified with screen mesh hot-glued in place to cover holes in the side walls, and a sheet of screen mesh over the top, held in place with clothespins to prevent frogs from escaping and gartersnakes or other small predators from entering the baskets. Staff placed laundry baskets in shallow areas of each lake, so the frogs had constant access to fresh lake water (**Figure 23**). Staff also placed several rocks within each basket before placing frogs inside, to allow the baskets to stay in place, and provide cover and basking areas for the frogs. During the entire nine-day soft release period at each site, at least one staff member remained on site to monitor the *in situ* frogs, ensure baskets remained in place, prevent any wildlife or humans from interfering with the baskets, and feed the frogs. Staff regularly fed the frogs being held *in situ* with a supply of live crickets provided by the SF Zoo.

The idea behind a soft release is that the subset of frogs held *in situ* may better acclimate to the wild release site and may better recover from potential stress resulting from the transport process. Possible benefits could be the frogs having better site fidelity and higher likelihood of feeding on wild prey (i.e., if the frogs are less stressed and more inclined to forage on final release). However, these ideas are speculative, and thus an experimental approach was undertaken by only including a portion of the frogs in the soft release group. If staff end up recapturing more soft-released frogs when compared with frogs released immediately, it could indicate possible benefit of this soft release approach. However, additional surveys in subsequent years will be needed to gain an initial understanding of potential benefits that may have been conferred by soft releasing captive-reared SNYLF.

In addition to the soft release process, staff also outfit 13 SNYLF (six at Rock Lake—one soft release and five hard release; and seven at Dot Lake—two soft release and five hard release) with radio telemetry belts, using methods similar to those of other studies of mountain yellow-legged frogs involving telemetry (Matthews and Pope 1999, Matthews 2003, Brown et al. 2019). Belts were comprised of beaded chains with ball-connector clasps to which staff adhered radio transmitters with epoxy (**Figure 25**). Staff then radio-tracked these frogs for several weeks after release. Unfortunately, problems with transmitter belts failing to remain on frogs (poor belt sizing and difficulty in engaging clasps) and poor adherence of transmitters to belts (i.e., epoxy failure) resulted in limited information being obtained from the radio-tracking process. Most transmitters were later found separate from frogs (often in emergent vegetation at lake margins). As of fall 2024, ten of the transmitters have been recovered by PNF staff, but three transmitters remained missing, due to loss of signal after battery depletion. Two of the radio-tracked frogs are known to have died: one was found dead at Dot Lake three days after the transmitter had been attached (a small branch from shoreline vegetation was stuck underneath the transmitter belt) and another was eaten by a gartersnake. Only one frog, a hard-released individual at Rock Lake, retained its tracking belt for the entire planned tracking period and was alive when the tracker was removed. This frog retained the tracking belt from 10 July to 5 September 2024.

Given these results, CDFW and PNF will not reattempt radio tracking using the same methods. Different methodology will be necessary to potentially attempt future tracking of SNYLF, including different belting materials and alternative methods for attaching transmitters to belts (Altobelli et al. 2022). Additionally, different transmitter types may be preferable (e.g., more modern, smaller transmitters with shorter antennas that are less likely to snag on vegetation or otherwise potentially impede frog movements).

Figure 22. Several captive-reared Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) at the San Francisco Zoo.

Figure 23. Biologists from California Department of Fish and Wildlife (CDFW) and Plumas National Forest, Mt. Hough Ranger District scanning the passive integrated transponder (PIT) tags of captive-reared Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) sitting within their transport containers before being placed into *in situ* pens during the “soft release” process at Rock Lake, Bucks Lake Wilderness, in July 2024. (CDFW)

Figure 24. A Sierra Nevada Yellow-legged Frog (*Rana sierrae*) being released soon after transport from the San Francisco Zoo to Rock Lake, Bucks Lake Wilderness, in July 2024 (CDFW).

Figure 25. A Sierra Nevada Yellow-legged Frog (*Rana sierrae*) wearing a radio tracking belt affixed to a beaded waist belt soon after release into Rock Lake, Bucks Lake Wilderness, in July 2024 (CDFW).

Bucks Lake Wilderness Discussion

Although recaptures have so far been highly limited among the zoo-reared frogs, CMR work with SNYLF in other locations (e.g., Mossy Pond in TNF [**CDFW 2019b**] and Desolation Valley in ENF [**CDFW 2022b**]) has demonstrated that SNYLF can go undetected and later be available for detection in following years. Such an example is also provided among wild frogs from Bucks Lake Wilderness. For example, an adult female marked at Dot Lake in October 2015 was not recaptured again until October 2019. Another individual tagged at Dot Lake in 2015 was not subsequently detected until 2018, after which staff consistently recaptured that individual each year until the most recent capture event in June 2023. As one additional example: of the seven wild frogs PIT-tagged in the Mt. Pleasant area in 2018, five were not observed during surveys in 2019. However, all five frogs were recaptured during surveys in 2020. These examples help demonstrate that more zoo-reared SNYLF may still be extant on the landscape and detected during future surveys in Bucks Lake Wilderness.

As of 2025, the Gold Lake and Mt. Pleasant NSR SNYLF populations remain small, with consistent, but limited reproduction. Although PNF and CDFW have not observed any conspicuous recruitment pulses in either drainage in response to captive rearing and release, staff have still been detecting egg masses in late spring and early summer annually during the past several years.

Based on similar efforts with SNYLF in other parts of the Sierra Nevada, the slow start to population augmentation is not surprising. SNYLF are long-lived and tadpoles often take at least two years to metamorphose. Under the right conditions, captive rearing work has demonstrated that SNYLF can metamorphose in one year, but the timeline for SNYLF development in the captive environment likely represents an upper limit on growth rates. Any individual component of captive rearing conditions (e.g., controlled climate, constant supply of high-quality food, lack of predators, active disease mitigation, etc.), let alone all factors, is often not present in the wild. However, SNYLF may naturally experience rapid development in relatively low elevation populations like Bucks Lake Wilderness (~6,000 ft. [~1,830 m]), particularly during drought periods with long growing seasons and relatively mild winters (e.g., the 2012–2016 and 2020–2022 drought periods). Despite some longer warm periods in recent years, most SNYLF in the Bucks Lake Wilderness populations likely overwinter at least once before metamorphosis. Therefore, more time may be needed to observe potential benefits of headstarting.

Population augmentation—in the form of conservation efforts such as headstarting, translocations, or *in situ* rearing—can take years to manifest, or may require many separate augmentations, before there is a detectable increase in abundance (Joseph and Knapp 2018). Delays in population growth can be the result of many factors, including limited recruitment. Low recruitment appears to be a consistent attribute of SNYLF populations in the northern Sierra Nevada, in which many populations are stream-based (Brown et al. 2020). Current SNYLF research in Yosemite, being conducted by University of California, Santa Barbara (UCSB) scientists, suggests that recruitment is often rare and episodic, despite reproduction (T. Smith, pers. comm.). *Bd*-induced mortality, particularly among highly susceptible early life stages, is one factor often leading to low recruitment in SNYLF populations (Rachowicz et al. 2006). However, other factors can also affect recruitment, including severe winters (Bradford 1983, Joseph and Knapp 2018), snake predation (Jennings et al. 1992, Matthews et al. 2002; T. Smith, pers. comm.), and non-native fish (Knapp and Matthews 2000).

Although the potential benefits of population augmentation through captive rearing can take years to manifest, the lack of success in efforts undertaken from 2018 to 2025 in Bucks Lake Wilderness are evident. CDFW and PNF do not know the full reasons for the apparent lack of overwinter survival among zoo-reared frogs. The reasons may be multifold, including *Bd*-induced mortality, predation, and behavioral differences among captive-reared frogs (e.g., although speculative, examples include difficulty foraging independently, greater susceptibility to predators, potentially moving greater distances than wild frogs, and inability to locate proper overwinter habitat). Observer bias and poor detectability may also play a role in the low number of recaptured SNYLF at these locations. Dense emergent vegetation and wetland shrubs are present in many of the stream channels and lake margins in Bucks Lake Wilderness (**Figure 26**).

Continued CMR work is needed to obtain a better understanding of survival among the captive-reared and wild-caught SNYLF. This work will also provide useful information on abundance, growth, and movement of SNYLF within the Gold Lake and Mt. Pleasant areas. Therefore, CDFW and PNF staff plan to continue this work annually.

Figure 26. View looking toward Gold Lake (Site ID 12067; see **Figure 19** for spatial reference) from the southern inlet. Like many streams in Bucks Lake Wilderness, dense vegetation is present throughout much of this inlet.

Bucks Lake Wilderness Concluding Remarks

CDFW, in close partnership with PNF, will continue monitoring the Gold Lake and Mt. Pleasant area SNYLF populations every year to assess population status (i.e., determine relative abundance, look for signs of continued breeding and recruitment, and assess distribution of SNYLF on the landscape). CDFW and PNF will also continue PIT-tagging adult SNYLF to obtain more detailed abundance and survival data on wild and SF Zoo-reared frogs. Additionally, staff will focus on locating additional SNYLF that may be moving out of Rock Lake and into Gold Lake or its tributaries. These efforts will require thorough surveys in challenging terrain, such as stream channels with dense willow growth and steep, rocky substrates with abundant refugia for SNYLF.

At this time, CDFW and PNF will not collect any additional early life stage SNYLF from Rock Lake or Dot Lake for future captive rearing efforts. Any future population supplementation that may occur will likely involve collecting early life stage SNYLF for captive rearing from other populations in the northern Sierra Nevada with higher abundance and greater potentially genetic diversity (Frankham et al. 2019). Alternatively, CDFW may consider future direct translocation of wild adult SNYLF from northern Sierra Nevada populations that are persisting despite the presence of Bd (Knapp et al. 2024). However, any direct translocations would require donor population where recent survey results indicate high abundance (i.e., >200 adult frogs observed during VES). The closest areas with higher SNYLF abundance that could accommodate collection of adults without potentially risking the long-term persistence of the source population are further south, 50–80 miles southeast, and would require separate coordination with USFS and USFWS to undertake. However, those more distant populations are well within the same northern Sierra Nevada population genetic cluster of SNYLF (Byrne et al. 2024), and the additional genetic diversity potentially provided by a more distant population with greater abundance would likely benefit the small, genetically isolated SNYLF populations in the Gold Lake and Rock Lake NSRs (Frankham et al. 2019).

Future success of these alternative captive rearing and translocation efforts would be determined in several ways, including staff observing, 1) released adult SNYLF persisting after the first winter following release, 2) additional signs of breeding (higher counts of egg masses, tadpoles, and/or recently metamorphosed frogs), and 3) evidence of new recruitment into the adult population. In addition to the successful removal of introduced trout that has already taken place, augmenting these populations through captive rearing of frogs sourced from other populations and direct translocation of adults may have higher potential to increase the likelihood of long-term SNYLF persistence in Bucks Lake Wilderness.

Lakes Basin and Howard Pond, Sierra County

Lakes Basin and Howard Pond Summary

CDFW monitors the Lakes Basin and Howard Pond areas (**Figure 27**) because they contain two of the few known extant SNYLF populations remaining in Sierra County.

In Lakes Basin (for this memorandum, "Lakes Basin" refers to the cluster of small lakes and ponds east of Gold Lake and centering around Haven Lake; **Figure 27**), CDFW conducted baseline VES in 2001, during which crews observed post-metamorphic SNYLF in several areas, including Goose Lake (Site ID 12273), Haven Lake (Site ID 12291), Site ID 50122, and Site 50123 (**Figure 28**). Since 2021, PNF and CDFW have been conducting CMR monitoring of the Lakes Basin SNYLF population.

At Howard Pond, SNYLF have been observed since at least 2001. In the past 25 years, TNF staff have conducted most surveying at the site (USFS 2016). However, beginning in 2019, CDFW has been collaborating with TNF on surveying the site.

PNF staff began CMR in Lakes Basin in 2021. Since that time, CDFW and PNF have continued marking new adults and recapturing any tagged adult SNYLF observed during surveys of the basin. In the past seven years, SNYLF egg mass counts at Goose Lake have varied between 21 and 117 egg masses detected. In May 2021, CDFW and PNF staff collected portions of 10 different SNYLF egg masses, which CDFW brought to the SF Zoo for captive rearing. SF Zoo staff raised up the frogs to maturity, after which CDFW and PNF staff released 164 captive-reared SNYLF back into Goose Lake in June 2022. Before release, all captive-reared SNYLF were PIT-tagged at the SF Zoo.

Since 2021, PNF and CDFW staff have captured and released 306 adult SNYLF in Lakes Basin (142 wild frogs originally marked on-site, and 164 zoo-reared frogs). Staff have recaptured 90 wild frogs and 62 zoo-reared frogs at least once. Of the 90 recaptured wild frogs, 67 individuals have been recaptured after the passage of at least one winter. Of the 62 recaptured zoo-reared frogs, 21 individuals have been recaptured after the passage of at least one winter. Staff observed six of these 21 overwintered zoo-reared individuals in 2025 (one of which was alive in July, but found dead in September). Those six individuals survived three overwinter periods.

CDFW and TNF staff have been conducting CMR at Howard Pond since 2022. In that time, staff have marked 31 new adult SNYLF and recaptured only one. Additionally, CDFW staff have detected up to 34 SNYLF egg masses in one relatively small area at the eastern side of Howard Pond, and additional egg masses were likely not detected, given habitat complexity and a subset of egg masses being placed in cryptic locations (e.g., staff found a subset of egg masses by reaching deep under cover and feeling them attached to submerged objects). These initial results suggest a larger SNYLF population than previously known, but long-term monitoring will be needed to better determine the population dynamics of the Howard Pond SNYLF population.

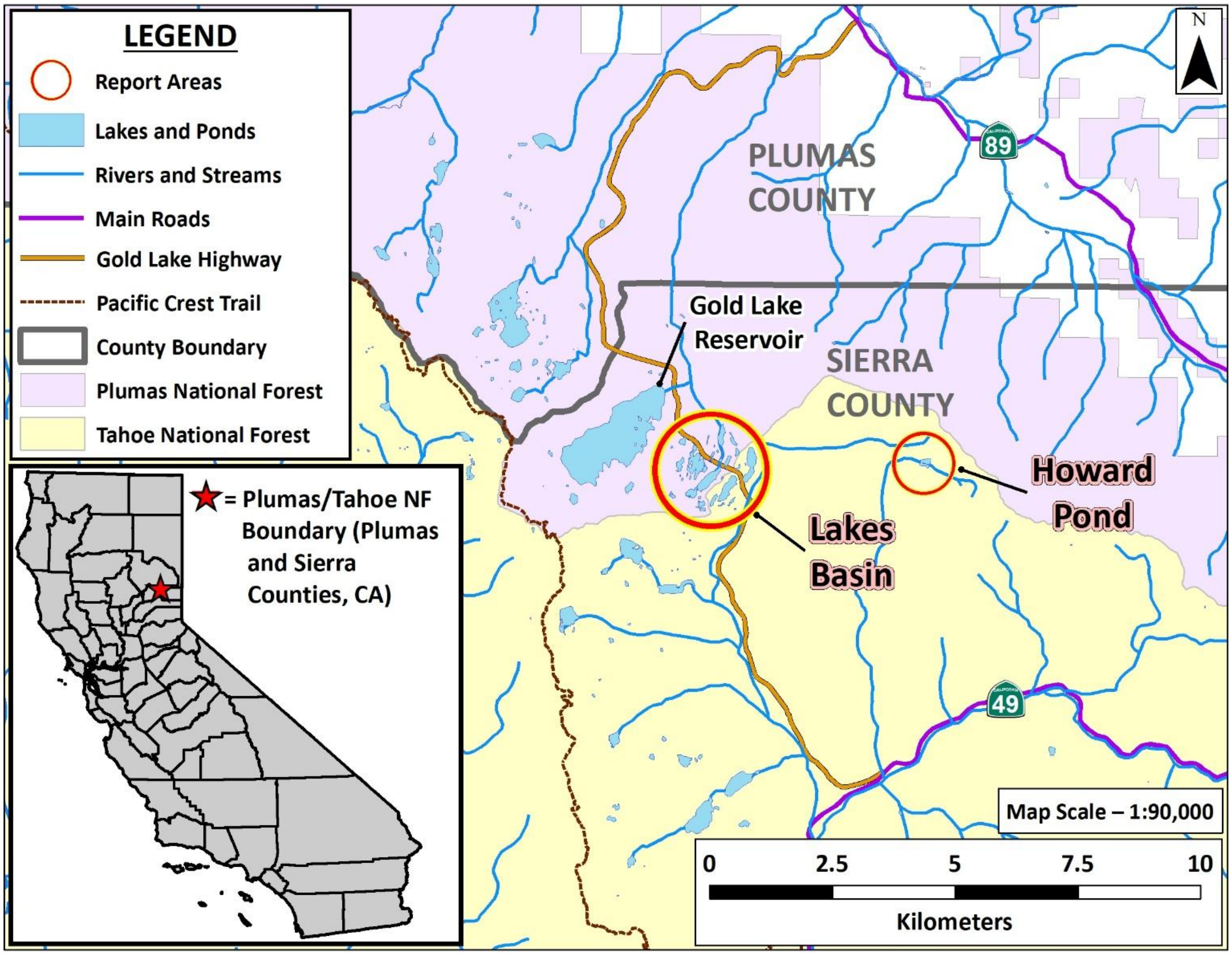


Figure 27. Gold Lake Highway area, Sierra County, CA. Plumas National Forest is shown in light purple and Tahoe National Forest is shown in light yellow. Gold Lake Highway is displayed in orange. The areas discussed in this section are circled.

Lakes Basin

Background: VES in the Lakes Basin area

CDFW performed baseline VES in the Lakes Basin area in 2001, during which staff encountered a small breeding SNYLF population occupying four ponds. Twenty-five years of occasional monitoring data suggest the Lakes Basin area SNYLF population is currently stable, despite being relatively small when compared with populations in the core of the species range (i.e., in the central Sierra Nevada; Knapp et al. 2016).

However, the population is still faced with consistent threats, including *Bd* (USFS, *unpubl. data* from epithelial swab monitoring, showing widespread prevalence of *Bd* among sampled SNYLF), which may be a consistent source of additive mortality for the Lakes Basin population. For example, CDFW and PNF staff have often detected dead adult SNYLF in the area, particularly during late spring/early summer surveys, with the number of dead frogs observed each season varying between no detections and up to four dead adults seen at Goose Lake in June 2019 (**CDFW 2023c**). However, CDFW does not know the ultimate cause of these mortalities. Overwinter conditions, *Bd*, or some combination of factors may be the cause. However, given the long-term presence of *Bd* in the northern Sierra Nevada, and the widespread prevalence of *Bd* at this site (revealed by the extensive swab sampling by PNF staff), *Bd* seems to be a likely culprit in the observed mortalities.

The primary locations of interest for SNYLF conservation are Goose and Haven Lakes (**Figure 28**), in which CDFW and PNF personnel have consistently observed SNYLF egg masses (**Figure 29**) and/or tadpoles. SNYLF detections remained relatively consistent, albeit low, between 2001 and 2020 (**CDFW 2023c**). However, observer bias, variation in survey effort, weather conditions, habitat complexity, and the low number of detections made deriving trends difficult. (For example, in 2019, CDFW surveyed 17 ponds in the Goose Lake area [**Figure 30**], compared to only three ponds in 2017.) Therefore, PNF staff began PIT-tagging adult SNYLF in Lakes Basin in 2021, and CDFW staff began assisting with these efforts in 2022.

As with the Bucks Lake Wilderness SNYLF population discussed above, data regarding SNYLF population monitoring in Lakes Basin are also summarized by USFS personnel in annual summary reports of activities required under a 10(a)(1)(A) recovery permit (#ES40087B, exp 4/20/2028) with the U.S. Fish and Wildlife Service. This memo summarizes the SNYLF management work conducted since 2021 by PNF and CDFW staff, included in a recent SWG (Federal Award #F22AF01541) that funded CDFW work during the 2022–2024 field seasons (~June–Sept annually) and a Section 6 of the ESA grant (Federal Award #F25AP00356) that funds current CDFW monitoring work (2025 through 2027).

CDFW and PNF plan to continue SNYLF CMR in the Lakes Basin area to monitor population trends over time. CDFW plans to next survey the Lakes Basin area in 2026.

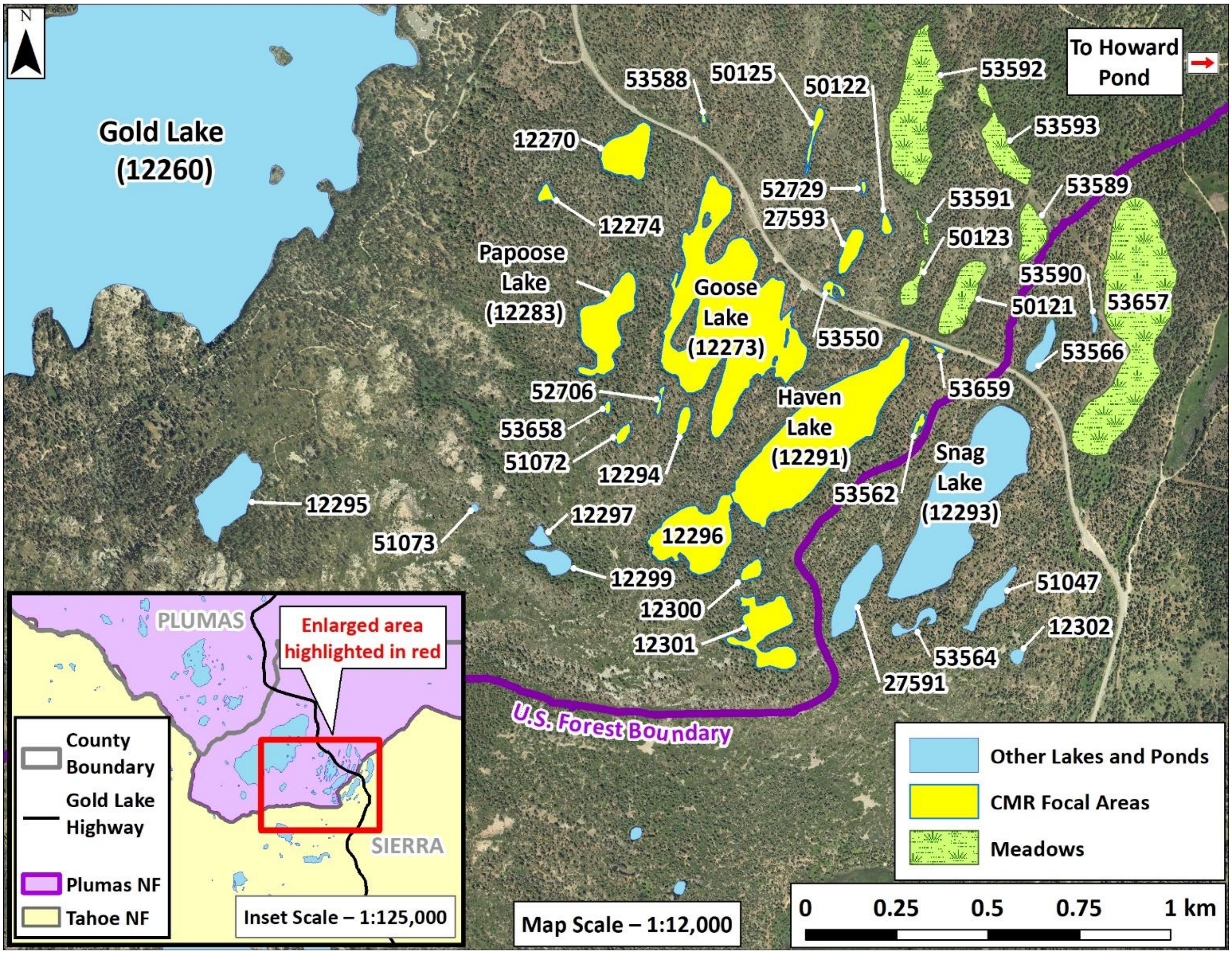


Figure 28. Lakes Basin area ponds in Plumas and Tahoe National Forests, Sierra County, CA. The purple boundary line demarcates PNF (to the west and north) and TNF (to the east and south). Focal areas for Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) capture-mark-recapture (CMR) surveys from 2021–present are displayed in yellow. California Department of Fish and Wildlife (CDFW) and PNF staff occasionally monitor all other ponds and meadows shown on this map, but the areas in yellow receive most survey attention. Goose and Haven Lakes are breeding sites for SNYLF. Minnows are present in most of the larger ponds in the area, and a high-density Brown Bullhead (*Ameiurus nebulosus*) population is also present at Snag Lake. CDFW regularly stocks Gold Lake reservoir with trout. Numbers are CDFW Site IDs.

Figure 29. A Sierra Nevada Yellow-legged Frog (*Rana sierrae*) egg mass with developing tadpoles, observed at Goose Lake (Site ID 12273) in June 2019. (CDFW)

Figure 30. Goose Lake (Site ID 12273) in June 2024. (CDFW)

Lakes Basin SNYLF Population Supplementation:
In recent years, CDFW and PNF staff have observed relatively large numbers of SNYLF egg masses (2019–2025 range is 21 to 117 egg masses detected). These detections were in stark contrast to post-metamorphic frog detections, which had historically been highly limited in the Goose Lake area (2001–2017 range of observed adults was 0 to 10). However, habitat composition in the area results in challenging survey conditions, particularly in late spring and early summer, when SNYLF breeding typically occurs. During that time of year, water levels in the local lakes and ponds are often high, causing the water levels to fall within dense, shrubby shoreline vegetation. In part due to these challenging survey conditions, staff often detect few adult SNYLF. However, during more consistent surveys of the Goose Lake area from 2019–2022, PNF and CDFW staff detected comparatively large numbers of SNYLF egg masses (**Figure 31**). These results demonstrate that more SNYLF are present in the area than staff detect through standard VES. These egg mass detections were part of the catalyst for initiating CMR, which provides the opportunity to gain a better understanding of SNYLF abundance, growth, movement, and other population demographic factors. Additionally, detecting multiple SNYLF egg masses provided an opportunity to collaborate with partner scientists at the SF Zoo to collect portions of egg masses for captive rearing SNYLF.

Figure 31. A cluster of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) egg masses at Goose Lake on 19 May 2021. (CDFW)

On 19 May 2021, staff from PNF Beckwourth Ranger District and CDFW collaborated on an effort to collect portions of SNYLF egg masses observed in Goose Lake (**Figure 30**). Staff collected approximately 20 eggs from each of 10 different egg masses, for a total of approximately 200 SNYLF eggs (**Figure 32**). Staff collected, housed, and transported eggs using methods similar to those recommended by Grasso (2017). In brief, staff housed the SNYLF eggs and water collected from the site in food grade containers modified to accommodate portable aerators (**Figure 33**). Staff securely stored these containers within a cooler packed with insulation and ice. CDFW staff then drove for approximately five hours to deliver the eggs to the SF Zoo. Once at the SF Zoo, staff placed the eggs within prepared aquaria used for captive rearing (**Figures 34 and 35**). From the original cohort of approximately 200 SNYLF eggs, SF Zoo staff raised a total of 164 SNYLF through metamorphosis. Once large enough (~40 mm SUL), SF Zoo staff inserted a PIT tag beneath the dorsal skin of each frog.

On 13 June 2022, CDFW staff collected all 164 captive-reared SNYLF from SF Zoo staff and drove to Goose Lake to release the frogs back to their natal habitat. Once arriving at the site, CDFW met up with PNF staff from the Beckwourth and Mt. Hough Ranger Districts (**Figure 36**). CDFW and PNF staff divided up the SNYLF into three groups (with equal divisions of males and females), and released these three groups of frogs into three separate areas of Goose Lake.

Figure 32. Staff from the Plumas National Forest Beckwourth Ranger District collecting Sierra Nevada Yellow-legged Frog (*Rana sierrae*) eggs at Goose Lake on 19 May 2021. (CDFW)

Figure 33. A subset of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) eggs, collected from Goose Lake on 19 May 2021, housed within a food grade plastic transport container filled with water collected from the natal site. (CDFW)

Figure 34. Staff from the San Francisco Zoo gently placing Sierra Nevada Yellow-legged Frog (*Rana sierrae*) eggs collected from Goose Lake into early life stage rearing aquaria on 19 May 2021. (CDFW)

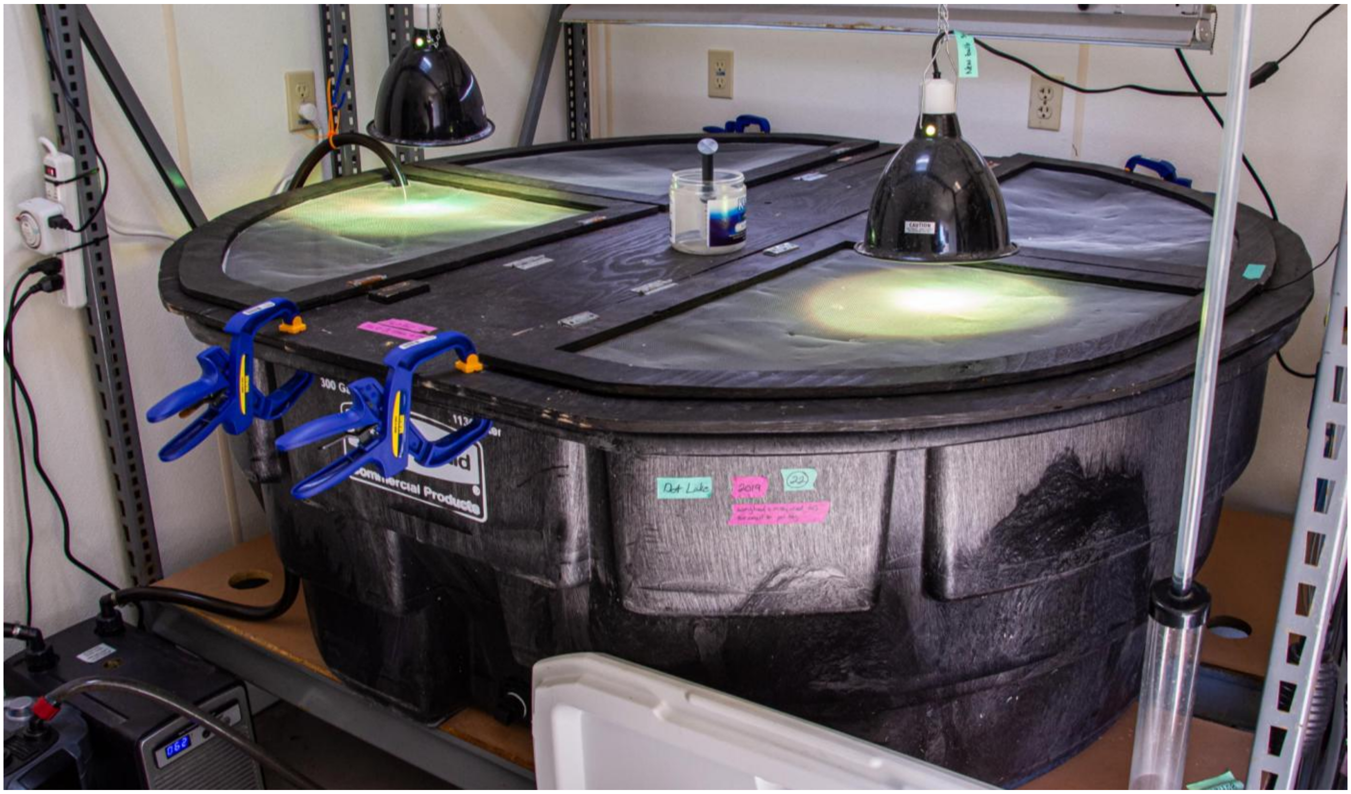


Figure 35. A 300-gallon stock tank modified to house post-metamorphic Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) at the San Francisco Zoo. (CDFW)

Figure 36. The team of biologists from Plumas National Forest (Beckwourth and Mt. Hough Ranger Districts) and California Department of Fish and Wildlife who collaborated to release captive-reared Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) back into Goose Lake on 13 June 2022. (CDFW)

Figure 37. Plumas National Forest staff organizing containers housing captive-reared Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) soon before releasing the frogs back into Goose Lake on 13 June 2022. (CDFW)

Lakes Basin Results

For additional background on SNYLF visual encounter surveys and management in Lakes Basin, see **CDFW 2023c** and earlier survey memos found on the **CDFW Document Library**. Data summarized here include collaborative work between CDFW and PNF, plus independent surveys by PNF staff. PIT-tagging allows CDFW and PNF to more accurately keep track of SNYLF population demographics through time by using CMR analyses. Additionally, PIT-tagging allows biologists to learn more about the potential benefits of the recent SNYLF headstarting work, discussed above, in the Lakes Basin SNYLF Population Supplementation section.

A summary of PIT-tagging effort by PNF and CDFW from 2021 to 2025 is below (**Table 3**).

Overall, among the SNYLF that have been marked and released since 2021, recapture rates have been relatively high. CDFW and PNF staff have recaptured 62 of the 164 SF Zoo-reared frogs at least once (i.e., staff have recaptured 38% of SF Zoo-reared frogs during follow-up surveys). Of those 62 recaptured zoo-reared frogs, three are known to have subsequently died, and 21 have been recaptured after the passage of at least one winter. Of the 21 zoo-reared frogs known to have survived at least one winter, staff detected six in 2025 (one of which was found alive in July, but later found deceased in September). Those six zoo-reared frogs recaptured in 2025 had survived three overwinter periods.

Recapture rates have also been better than expected among wild frogs (when compared with some other areas, such as SNYLF populations in Bucks Lake Wilderness; **CDFW 2023b**). As of 2025, CDFW and PNF staff have marked and released 142 wild frogs in the Lakes Basin area. Of those 142 frogs, staff have recaptured 90 individuals at least once during follow-up surveys (staff have recaptured 63% of PIT tagged wild frogs during follow-up surveys). Of those 90 recaptured wild frogs, five are known to have subsequently died, and 67 have been recaptured after the passage of at least one winter. Of the 67 wild frogs known to have survived at least one winter, staff detected 36 in 2025.

Given the reality of imperfect detection (Schmidt 2004, Kéry et al. 2009), many frogs are not observed by field staff during any given survey. A subset of PIT-tagged frogs may not be observed for several years, and some are never seen again, despite being alive and occupying the site. However, in addition to allowing estimation of detection probabilities (Mazerolle et al. 2007), one benefit of CMR is easily allowing the determination of when an individual was last observed. Among marked wild-born SNYLF at Lakes Basin, 17 individuals went undetected for one season, only to be recaptured the following season (i.e., approximately two years passed between capture events). Two other wild frogs went three years between capture events: one of these individuals was found dead in early summer, so it is not clear if that individual survived its third winter after being PIT-tagged (i.e., the frog may have survived winter, but then died in early summer). Finally, one wild frog originally marked during the first year of CMR in 2021 was not captured again until 2025: four years between capture events.

Table 3. Summary of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) captures, early life stage collections, and captive-reared adult frog releases in the Lakes Basin area from 2021 to 2025. The numbers shown represent the number of newly marked ("NEW"), recaptured ("RECAP"), collected, and released ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which would include SNYLF individuals caught >1x in the same year).

YEAR	**NEW**	**RECAP**	**RECAP NOTES**	**EARLY LIFE STAGES COLLECTED FOR CAPTIVE REARING**	**RELEASED**	**GENERAL NOTES**
2021	64	18	All survey work in 2021 was conducted by Plumas National Forest staff. (CDFW only assisted with *R. sierrae* egg collection and transport.)	~200	0	Plumas National Forest and CDFW staff collected *R. sierrae* eggs from 10 different egg masses at Goose Lake (Site ID 12273) on 19 May 2021.
2022	36	84	49 of the recaps were zoo-reared frogs released in June. (One of these 49 zoo-reared frogs was found dead 3 days after release.)	0	164	"NEW" frog total does not include the 164 zoo-reared frogs released on 13 June 2022. However, the recapture total does include zoo-reared frogs caught during subsequent Lakes Basin site visits in 2022.
2023	10	55	20 of the recaps were zoo-reared frogs released in 2022. (Two of these 20 zoo-reared frogs were found dead.) Three of the 35 recaptured wild frogs were found dead.	0	0	
2024	14	45	Six of the recaps were zoo-reared frogs released in 2022. Two of the 39 recaptured wild frogs were found dead.	0	0	
2025	15	48	Six of the recaps were zoo-reared frogs released in 2022. (One of these six zoo-reared frogs was alive in July, but later found dead in September.)	0	0	The six zoo-reared frogs detected in 2025 were the same six zoo-reared individuals detected in 2024.

Lakes Basin Discussion

SNYLF mortalities at Goose Lake

Occasional observations of dead SNYLF adults at Goose Lake are disconcerting, but not unusual. CDFW staff have observed low numbers of SNYLF mortalities during multiple seasons in other locations (e.g., Dot Lake in Bucks Lake Wilderness; **CDFW 2023b**). The causes of death may be the result of many possible factors, including disease (Briggs et al. 2010, Smith et al. 2017), environmental conditions (Bradford 1983), attempted predation (Feldman and Wilkinson 2000), or breeding competition (i.e., drownings during amplexus caused by overzealous males; Sztatecsny et al. 2006). Mortalities in SNYLF are often attributed to *Bd*, which has been present in this location since at least 2008 (see *Disease* section above).

Plans for 2026 and beyond

Continued CMR work will improve CDFW's understanding of population demographics among the captive-reared and wild-caught SNYLF in the Lakes Basin area. This work will also provide useful information on movement, growth, and longevity of SNYLF in this important northern Sierra Nevada population. Therefore, CDFW and PNF staff plan to continue this work annually.

Additionally, CDFW may work with local zoo and university partners to develop a research project (e.g., a graduate research assistantship) on the interactions between cyprinids and SNYLF, especially early life stages, such as eggs and recently hatched larvae (see Minnows and other aquatic predators section above). The interactions of large predatory fish (e.g., trout) and SNYLF are well-studied, but there is less currently known about the interactions of smaller forage fish and Sierra Nevada amphibians, especially studies investigating potential sublethal effects on frog populations (e.g., limited breeding success, reduced size at metamorphosis, limb damage).

CDFW may also work with PNF and zoo partners to collect additional early life stage SNYLF for future captive rearing efforts in the Lakes Basin area. Success of captive rearing efforts may be determined in several ways, including staff observing, 1) released adult SNYLF persisting after overwintering, 2) additional signs of breeding (higher counts of egg masses, tadpoles, and/or recently metamorphosed frogs), and 3) evidence of new recruitment into the adult population. Augmenting these populations through captive rearing will help increase the odds of long-term SNYLF persistence in the Lakes Basin area.

Finally, if monitoring and CMR suggest a stable or increasing SNYLF population in the Lakes Basin area, CDFW will consider using this population as a source for SNYLF reintroductions (including captive rearing of early life stages, followed by release into another location; or direct translocations, if enough adult frogs are detected; Knapp et al. 2024) within SNYLF critical habitat on public lands in the northern Sierra Nevada. These conservation actions are a critical tool for assisting with species recovery, and highlighted in the Strategy (MYLF ITT 2018, pgs. 15–18).

Howard Pond

Background: VES in the Howard Pond area

Biologists from TNF have been monitoring the SNYLF population at Howard Pond (**Figures 38**) and its tributaries since 2001. Depending on the survey, TNF biologists would observe up to 15 SNYLF adults and nearly 100 larvae. Therefore, available records suggested a small, yet stable, breeding SNYLF population (TNF, *unpubl. data*). CDFW began collaborating with TNF in 2019 to more consistently monitor SNYLF in the Howard Pond area. In 2022, CDFW began CMR at the Howard Pond population. During each visit to the site, CDFW focuses survey efforts on TNF lands on the eastern side of Howard Pond, and the various ephemeral inlets and meadows off the eastern side of Howard Pond (**Figure 39**).

Figure 38. Howard Pond (Site ID 12285) in June 2024, looking northeast.

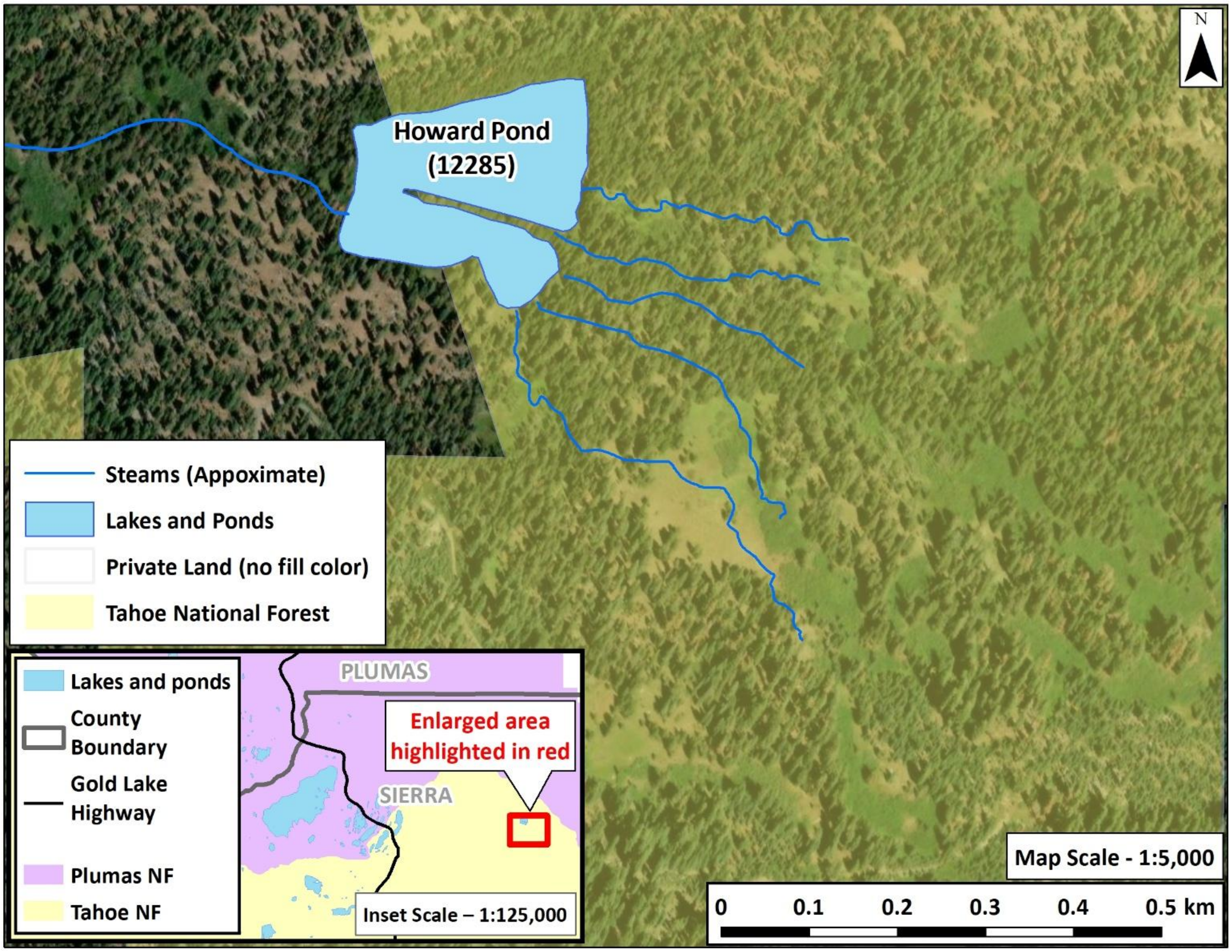


Figure 39: Howard Pond, located in Tahoe National Forests, Sierra County, CA. Focal areas for Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) capture-mark-recapture (CMR) surveys from 2022–present are public lands on the eastern side of the pond, including the ephemeral inlets and meadow areas. Howard Pond is a consistent breeding site for SNYLF. Number code shown is the CDFW Site ID.

Howard Pond Results

For additional background on SNYLF visual encounter surveys and management in the Howard Pond area, see **CDFW 2023c** and earlier survey memos found on the **CDFW Document Library**. Data summarized here include collaborative work between CDFW and TNF. PIT-tagging allows CDFW and TNF to more accurately keep track of SNYLF population demographics through time by using CMR analyses.

A summary of PIT-tagging effort by CDFW and TNF from 2022 to 2025 is below (**Table 4**). CDFW and TNF staff have captured and marked a total of 31 adult SNYLF since 2022. Thus far, staff have only recaptured one adult SNYLF (in 2024).

Table 4. Summary of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) captures in the Howard Pond area from 2022 to 2025. The numbers shown represent the number of newly marked ("NEW") and recaptured ("RECAP") ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which would include SNYLF individuals caught >1x in the same year).

YEAR	NEW	RECAP	RECAP NOTES	GENERAL NOTES
2022	14	0		One site visit by CDFW and TNF.
2023	1	0		One site visit by CDFW and TNF.
2024	5	1	Only recaptured *R. sierrae* so far during the CMR work at Howard Pond.	One site visit by CDFW and TNF.
2025	11	0		One site visit by CDFW and TNF.

Howard Pond Discussion

Thus far, CMR effort at Howard Pond has been limited. In general, CDFW staff have only been able to visit Howard Pond once per season, for a single day trip each season. This limited survey effort has led to a dearth of SNYLF recaptures. Additionally, TNF staff currently have limited resources and few current individuals who are authorized to independently PIT-tag SNYLF. Therefore, beginning in 2026, CDFW plans to invest additional survey effort into the Howard Pond SNYLF population, including attempting at least two CMR surveys per season. Goals will include locating and marking additional SNYLF adults, attempting to increase recapture rates, and better determine SNYLF habitat use in the Howard Pond area.

Jabu, Lucille, and Margery Lakes area (Desolation LTBMU), El Dorado County

Desolation LTBMU Summary

The study area consists of Jabu, Lucille, and Margery Lakes, plus several small ponds and connected (mostly ephemeral) streams, all in the southeastern corner of Desolation Wilderness, on the LTBMU (**Figure 40**). The Mountain Lakes Research Group (MLRG), based out of the Sierra Nevada Aquatic Research Laboratory (Mammoth Lakes, CA), conducted CMR surveys from 2015–2019. CDFW staff took over surveys beginning in 2020. In 2015 and 2017–2019, the MLRG included Jabu, Lucille, and Margery, plus the Tamarack Lake area (**Figure 40**). However, SNYLF do not currently appear to have established in the Tamarack Lake area, so CDFW staff have not continued CMR at that location. However, CDFW and LTBMU staff do occasionally monitor the Tamarack Lake area to attempt detecting SNYLF (**CDFW 2022b**). When compared with the MLRG's time investment during their study period, CDFW has less time available to focus on these sites, and the Tamarack Lake area is further removed from the Jabu, Lucille, and Margery Lakes area. Therefore, MLRG and CDFW determined it was more productive to forego CMR in the Tamarack Lake area, and instead focus efforts on the Jabu, Lucille, and Margery Lakes area.

Since taking over CMR in 2020, CDFW staff have normally visited the Jabu, Lucille, and Margery Lakes area once per summer (except for 2020, when staff visited the area twice, in July and September). In 2022, staff did not conduct CMR in the area.

Overall, SNYLF detections have been low, but survey effort has also been relatively low (**Table 5**). For example, in 2024, only one CDFW staff member visited the area for CMR, which also occurred later in the typical monitoring season (late spring–early fall) than usual, in early October. However, surveys in 2023 involved two CDFW staff surveying over a three-day period in late August, and surveys in 2025 involved six CDFW staff over a two-day period in mid-July. Although CMR survey effort in the Jabu, Lucille, and Margery Lakes area has been relatively low in recent years, results have demonstrated the persistence and continued recruitment of SNYLF in both the Jabu and Margery/Lucille areas.

In 2025, CDFW staff observed more SNYLF individuals in the Margery/Lucille area than seen since 2019. Staff detected 15 unique adult individuals, plus at least five subadult SNYLF. A majority of the SNYLF staff detected were in small ponds and stream channels in the area immediately surrounding Lucille and Margery Lakes. Staff also detected six unique SNYLF adults in the Jabu Lake area, plus a small number of subadult and larval SNYLF. Although the SNYLF population currently appears to remain small, the evidence of successful reproduction and population persistence is a hopeful sign that these populations may be able to persist on the landscape.

CDFW will continue closely monitoring SNYLF in the Jabu, Lucille, and Margery Lakes area, in collaboration with staff from the LTBMU, to maintain current information on population demographics, recruitment, and movement of SNYLF in the area.

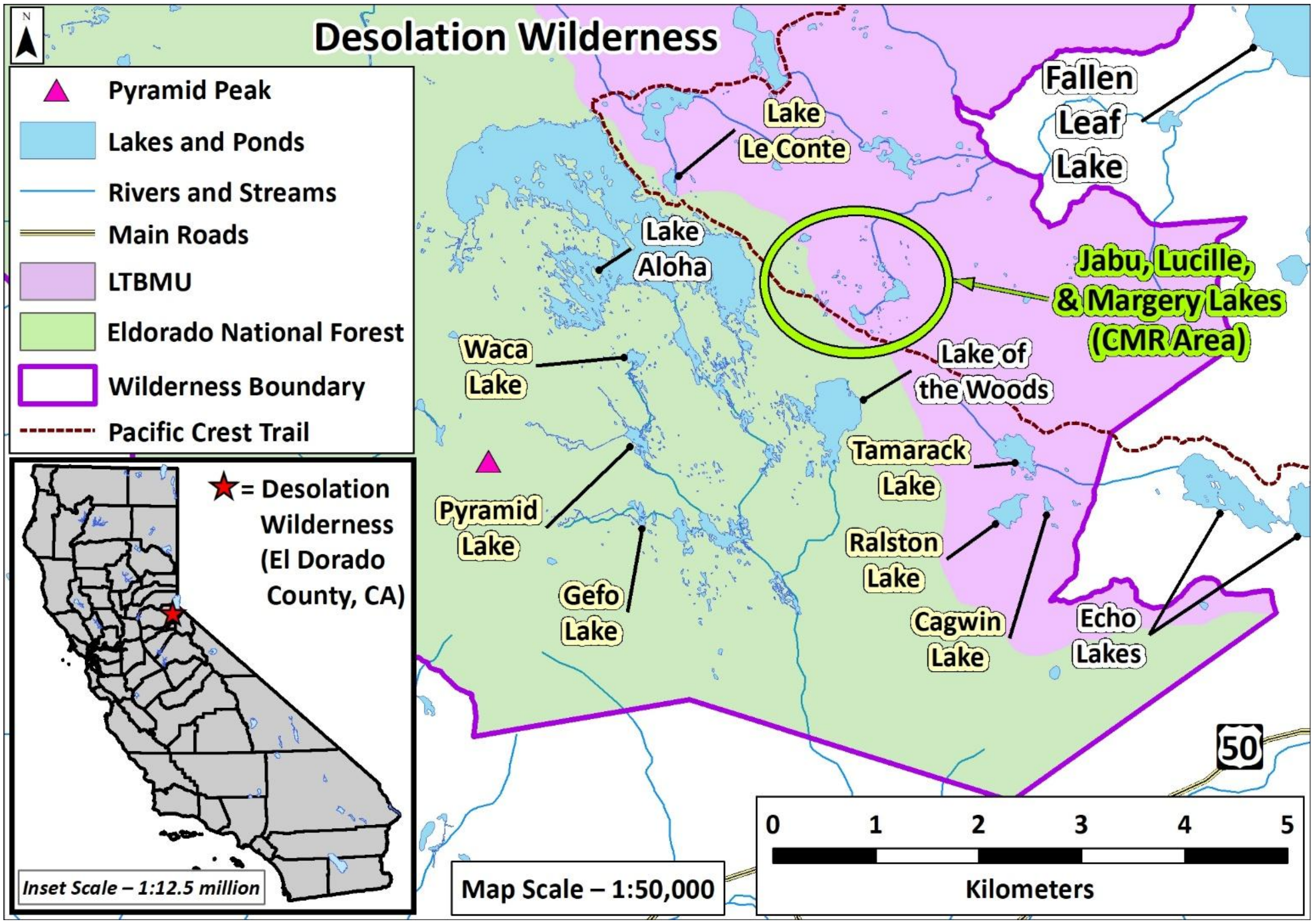


Figure 40. Location of Sierra Nevada yellow-legged Frog (*Rana sierrae*) capture-mark-recapture (CMR) surveys in Desolation Valley, El Dorado County, CA. Lakes from which Lake Tahoe Basin Management Unit, Eldorado National Forest, and CDFW staff removed fish from 2006 to 2012 include Le Conte, Waca, Pyramid, Gefo, Tamarack, Ralston, Cagwin, Jabu, Lucille, and Margery Lakes.

Background for Desolation LTBMU CMR

Periodic VES during the early 2000's revealed that very few SNYLF remained in the waterbodies on the LTBMU lands of the Desolation Valley area. Only one small pond—in the vicinity of Cagwin, Ralston, and Tamarack Lakes—contained a small breeding population of SNYLF (**Figure 41**). The ABMP for Desolation Wilderness (**CDFG 2012**) discussed that reintroductions may be needed to assist SNYLF recolonization and reduce the potential for genetic bottlenecking in this small population (CDFG 2012, pg. 48). Additionally, the ABMP identified several waterbodies on the LTBMU lands of Desolation Valley as priority fish removal sites, into which SNYLF could subsequently be translocated from extant populations on the ENF side of Desolation Valley (CDFG 2012, pg. 49). Concurrently, an interagency team, composed of CDFW, USFS, USFWS, researchers, and zoo partners, began implementing these efforts, which are also discussed in the Interagency Conservation Strategy for Mountain Yellow-legged Frogs in the Sierra Nevada (MYLF ITT 2018, pg. 35).

Figure 41. Sierra Nevada Yellow-legged Frog (*Rana sierrae*) from Desolation Valley in June 2021. (I. Chellman)

Beginning in 2008, LTBMU, with assistance from CDFW, started mechanically removing fish from Cagwin, Ralston, and Tamarack Lakes using monofilament gill nets and backpack electrofishers (USFS 2011). In 2009, LTBMU and CDFW started mechanically removing fish from Le Conte, Lucille, and Margery Lakes (USFS 2011; **Figure 40**). LTBMU completed fish removal by 2012. Non-native fish eradication allowed subsequent SNYLF reintroduction efforts to proceed.

In 2013, the MLRG began the process of collecting early life stage SNYLF from robust populations in Pyramid Valley and near the southwest corners of Lake Aloha for captive rearing at the SF Zoo. Zoo staff raised SNYLF to adulthood and MLRG subsequently released the captive-reared adult frogs into Jabu and Lucille Lakes. Additionally, in 2014, MLRG began direct translocations of adult frogs and egg masses from the same Desolation Valley source populations to Jabu and Lucille Lakes. MLRG conducted direct translocations in 2014, 2015, 2017, and 2018; and release of captive-reared frogs in 2014, 2015, 2016, and 2019. Additionally, MLRG conducted direct translocation of adult SNYLF (2017 and 2018) and release of Zoo-reared frogs (2015, 2016, and 2019) into Tamarack Lake. The most recent SNYLF to be translocated into the LTBMU were the final group of 18 captive-reared adult frogs, which CDFW staff released into Lake Lucille in June 2020. No additional SNYLF from Desolation Valley are currently held at the SF Zoo.

MLRG is the lead organization conducting capture-mark-recapture (CMR) analysis of the translocated SNYLF on LTBMU lands. To provide additional data on the fate of translocated frogs at these locations, CDFW agreed to conduct additional CMR monitoring beginning in 2020. Details from earlier CMR efforts are covered in a separate memo (**CDFW 2022b**). This memorandum provides results from additional CMR work during 2023–2025.

Desolation LTBMU Results:

MLRG and CDFW field staff have completed 11 years of CMR surveys in the Desolation Valley study area. Each CMR visit involved between one and six people surveying the area for two to three days during the field season (in this case, a "season" means the warmer months, during which high elevation lakes are free of ice, sites are accessible, and SNYLF are most active; ~June–September; **Table 5**). Although we provide some results from earlier survey years, most results presented below are from CDFW-led efforts between 2023 and 2025.

Table 5. Number of capture-mark-recapture (CMR) trips ("primary periods") to each waterbody among the Desolation Valley translocated Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) recipient sites, from 2015 to 2025. From 2015-2021, biologists surveyed each site on three successive days ("secondary periods"). From 2015 to 2019, the Mountain Lakes Research Group (MLRG), affiliated with University of California at Santa Barbara (UCSB), conducted CMR surveys. California Department of Fish and Wildlife (CDFW) staff took over CMR efforts in 2020. *After 2019, CDFW staff have not included the Tamarack Lake area in CMR surveys, but staff occasionally visit the site to look for SNYLF. After 2021, CDFW staff have continued occasional CMR, but not within the "Robust Design" (Kendall 2026) framework, where all waterbodies are surveyed on three successive days. Since 2022, site visits have involved surveying as many waterbodies in the Jabu, Margery, and Lucille Lakes area as time and crew availability allow, with the goal of capturing as many adult SNYLF as possible within the survey area during the allotted time.

Basin	**Jabu**		**Lucille and Margery**					**Tamarack**
Site	*52682*	*14218*	*14226*	*14235*	*14237*	*14255*	*14266*	*(5 Sites)*
2015	3	4	3	3	3	4	3	3–4 (depending on waterbody)
2016	1	1	0	0	0	1	1	0
2017	1	2	2	2	2	2	2	2
2018	2	3	2	2	1	2	2	1–3 (depending on waterbody)
2019	2	2	2	2	2	2	2	2
***2020**	2	2	2	2	2	2	2	1
***2021**	1	1	1	1	1	1	1	1
2022	0	0	0	0	0	0	0	0
2023	1	1	1	1	1	1	1	0
***2024**	1	1	1	1	1	1	1	1
2025	1	1	1	1	1	1	1	0

CDFW visited the Jabu and Lucille areas once each year from 2023 to 2025. In 2023, two CDFW staff surveyed the area over a three-day period in late August. In 2024, one CDFW staff member visited the area over a two-day period in early October. In 2025, six CDFW staff surveyed the area over a two-day period in mid-July.

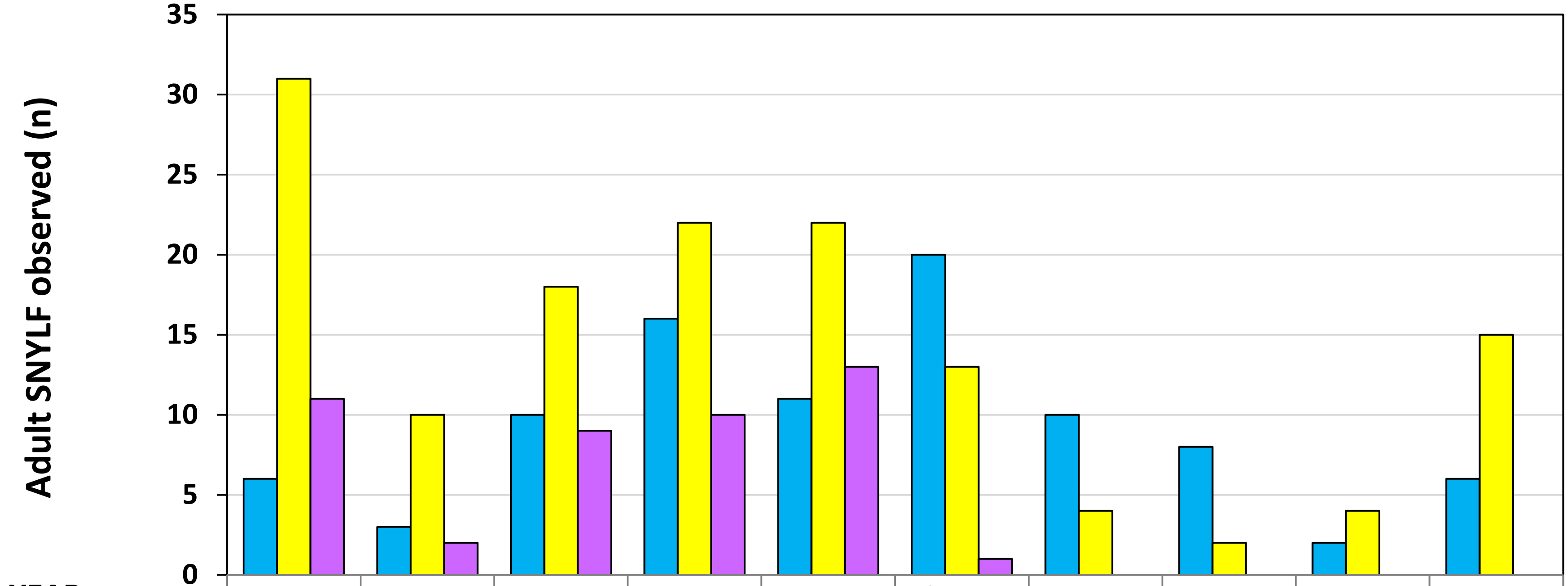
CMR techniques allowed CDFW to determine the total number of individual adult SNYLF detected by staff at each waterbody in the CMR study area each season (**Figure 42**). Although adult SNYLF detections have varied in the Jabu Lake area (including Jabu Lake and Site ID 52682; **Figure 43**), adult SNYLF numbers have generally declined since 2020. During the same time period, adult SNYLF detections had generally been declining in the Lake Lucille area. However, results from surveys in 2025 suggest a more promising SNYLF population status when compared with results from other recent years, with staff detecting more adult SNYLF in 2025 than seen since 2019 (**Figure 42**, **Table 6**). Below are the detailed breakdowns of adult SNYLF detections at each Site ID on each survey day from 2023–2025 (**Table 6**).

Staff focused survey effort on capturing any adult SNYLF observed. However, during each survey visit to the area between 2023 and 2025, CDFW staff noted observations of earlier SNYLF life stages (subadults and tadpoles). Earlier life stage observations were incidental because staff did not mark tadpoles or subadults with unique identifiers. CDFW and LTBMU staff have observed most early life stage SNYLF at Jabu Lake. However, staff have occasionally detected a small number of early SNYLF life stages in the Lake Lucille area, and detections in 2025 strongly suggest SNYLF are at least occasionally breeding at Lake Lucille, and potentially other adjacent perennial habitats.

The highest number of subadult SNYLF detected by CDFW staff during any single circumnavigation of Jabu Lake during the period included in this memo were as follows: in 2023, eight subadults; in 2024, 22 subadults; and in 2025, six subadults. These observations are lower than the number of subadults staff detected in the recent past. For example, CDFW observed 130 subadult SNYLF at Jabu Lake in early September 2020.

The highest number of larval SNYLF detected by CDFW staff during any single circumnavigation of Jabu Lake during the period included in this memo were as follows: in 2023, 10 tadpoles; in 2024, no tadpoles detected; and in 2025, 46 tadpoles. The totals were lower than observations during some surveys in the recent past. For example, CDFW detected 70 SNYLF tadpoles at Jabu Lake in July 2020.

Since beginning to survey the area in 2020, staff have only observed a small number of early life stage SNYLF in the Lake Lucille area. In 2023, staff observed one tadpole and one subadult. In 2024, staff observed 2 subadults. In 2025, staff observed at least five subadults. In the Lake Lucille area, most subadults have been observed in the inlets and outlets, which is where staff also detected most adults during surveys in 2025.



YEAR	2015	2016	2017	2018	2019	*2020	2021	2023	2024	2025
Jabu	6	3	10	16	11	20	10	8	2	6
Lucille	31	10	18	22	22	13	4	2	4	15
Tamarack	11	2	9	10	13	1				

Figure 42. Number of unique adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) individuals observed during capture-mark-recapture (CMR) surveys in each area during each year. Unique individual totals are only valid within the same year (i.e., some of the captures below include the same individuals caught on successive years). *Since 2020, CDFW has not included the Tamarack Lake area in CMR surveys. However, staff surveyed Tamarack Lake once in 2020, 2021, and 2024, using traditional visual encounter survey (VES) techniques (i.e., staff conducted a single pass of Tamarack on a single day). During VES at Tamarack in 2020, CDFW detected one adult SNYLF in the western inlet. During VES in 2021 and 2024, CDFW detected no SNYLF at Tamarack Lake.

Table 6. Number of adult Sierra Nevada Yellow-legged Frogs (SNYLF) observed on each capture-mark-recapture (CMR) survey day in the Jabu, Lucille, and Margery Lakes area in 2023, 2024, and 2025. The number shown for each site on each day is the number of individual adults observed that day. In 2025, some individuals captured on the first day (7/9) were also recaptured on the second day (7/10). Therefore, the total number of unique individuals recorded in the "2025 Total" column are occasionally lower than the combined two-day total, which would, in some cases, include duplicate records of the same individual. In the total columns, "N" = individuals newly PIT-tagged that year, and "R" = individuals that were PIT-tagged in a previous year.

	YEAR	2023			**2023 Total**		2024		**2024 Total**		2025		**2025 Total**	
Site ID	Site Name	8/29	8/30	8/31	**N**	**R**	10/2	10/3	**N**	**R**	7/9	7/10	**N**	**R**
14218	Jabu Lake	1	0	0	**1**	**0**	0	2	**1**	**1**	1	1	**0**	**1**
14226		0	0	0	**0**	**0**	0	0	**0**	**0**	0	1	**0**	**1**
14235	Lake Lucille	1	0	0	**1**	**0**	3	1	**4**	**0**	1	6	**6**	**0**
14237		0	0	0	**0**	**0**	0	0	**0**	**0**	1	1	**0**	**1**
14255	Lake Margery	0	0	1	**1**	**0**	0	0	**0**	**0**	1	1	**0**	**1**
52682		1	6	0	**3**	**4**	0	0	**0**	**0**	4	5	**2**	**3**
53392		0	0	0	**0**	**0**	0	0	**0**	**0**	2	2	**2**	**1**
53671*		0	0	0	**0**	**0**	0	0	**0**	**0**	1	1	**1**	**0**
53686*		0	0	0	**0**	**0**	0	0	**0**	**0**	0	1	**1**	**0**
53690*		0	0	0	**0**	**0**	0	0	**0**	**0**	0	1	**1**	**0**
TOTAL UNIQUE ADULTS BY DATE **and YEAR**		3	6	1	**6**	**4**	3	3	**5**	**1**	11	20	**13**	**8**

*Site ID added in 2025 (small, ephemeral ponds that were not previously mapped and, therefore, had no Site ID).

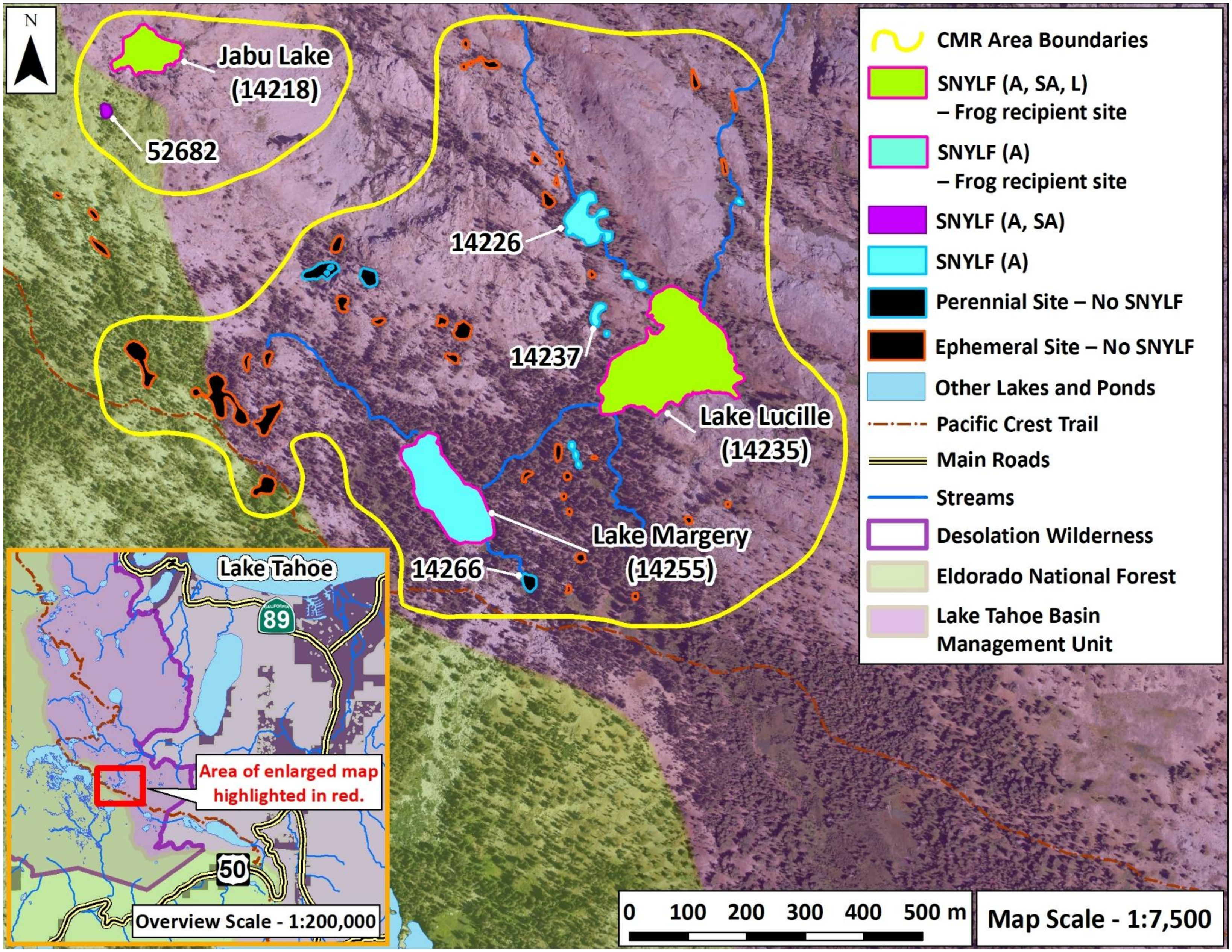


Figure 43. [See figure caption at the beginning of the next page.]

Figure 43 (continued). Spatial summary of Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) detections during capture-mark-recapture (CMR) surveys conducted by California Department of Fish and Wildlife (CDFW) staff from 2023 to 2025. Each year, CDFW visited the CMR area once, and each visit included between two and three survey days. During each day, staff surveyed the perimeter of each pond at least once, and often two or three times for waterbodies in which SNYLF are more consistently detected (e.g., Jabu, Site ID 52682, and Lucille). SNYLF letter codes in the legend, which indicate the life stages observed during CMR, are as follows: "A" = adults, "SA" = subadults, and "L" = larvae. During the three-year period, CDFW staff observed SNYLF at least once (and often repeatedly) in 10 of the waterbodies shown.

Desolation LTBMU Discussion

This section includes discussion of results and observations from CDFW surveys in 2023, 2024, and 2025.

In 2023 and 2024, adult SNYLF detections were low when compared with previous survey years. However, survey effort was also lower during these periods when compared with the past (2015–2020), during which MLRG, and later CDFW staff, visited the area more regularly.

In 2023, detections of post-metamorphic SNYLF were less than CDFW would have expected, given survey duration and time of year (late August). However, summer 2023 followed a winter with far above average snowpack (CDEC 2026a), which may have affected overwinter survival of SNYLF in some areas of the Sierra Nevada (Bradford 1983).

In October 2024, CDFW staff observed even fewer adult SNYLF in the area. However, the visit in fall 2024 involved only one staff member over a two-day period late in the season (during which SNYLF activity may have been declining with shorter days, cooler temperatures, and dry conditions in stream channels and small ponds adjacent to the main lakes), so the limited detections may have been largely due to seasonal timing and lower likelihood of detection with a single observer.

In 2025, CDFW was able to invest more staff for CMR in the Lucille, Margery, and Jabu areas, with six staff members surveying the area over a two-day period. During these surveys, staff still detected a low number of SNYLF in the Jabu area, suggesting that the population may be declining. However, low levels of reproduction are still occurring in the area, as evidenced by a small number of subadults and tadpoles detected. Survey results in the Lake Lucille area were more optimistic. Staff observed more SNYLF in the Lake Lucille area than field crews have seen since 2019.

During surveys of the Lucille Lake area in July 2025, staff detected nearly all post-metamorphic SNYLF in stream channels and small, ephemeral ponds adjacent to the main lakes. Anecdotally, CDFW staff have observed similar seasonal trends in many SNYLF populations in the northern

Sierra Nevada, where SNYLF subadults and adults seem to preferentially occupy streams and small ponds when such habitats are available, later moving to more perennial waterbodies later in the season, as stream channels and ephemeral ponds dry (I. Chellman, *pers. obs.*).

We do not know the cause(s) for the reduction in SNYLF observations in the Jabu Lake area, but there are several plausible explanations. First, *Bd* could be causing sustained levels of mortality, particularly among early life stage SNYLF (Rachowicz et al. 2006). Environmental conditions during surveys may also play a role in the more limited detections. Winds are often strong during surveys up at Jabu Lake: the lake sits in an exposed saddle, set between Desolation Valley and the Glen Alpine drainage, at about 8,500 feet in elevation. Anecdotally, this geographic placement seems to often result in breezy conditions at the lake. These weather conditions may be partly responsible for the limited tadpole detections. Windy conditions may also limit basking of post-metamorphic SNYLF in more exposed areas and prevented observers from detecting individuals seeking refuge on the lake bottom.

Emigration from the study area is another possible reason for fewer adult SNYLF observations at Jabu Lake in recent years. Based on observations during recent surveys, adult SNYLF may prefer occupying the small, shallow pond (Site ID 52682) located approximately 60 m below Jabu Lake. Some adults may choose to overwinter and breed in Jabu Lake, but then seek out other aquatic habitats during the summer. In both areas (Jabu and Lucille Lakes), post-metamorphic SNYLF may use late spring snowmelt streams and ephemeral ponds as steppingstone aquatic habitat to emigrate to other locations in Desolation Valley. Such movement is within the abilities of post-metamorphic SNYLF. For example, Lake Aloha is only about 500 m west of Jabu Lake, and SNYLF are known to travel farther distances, including several hundred meters overland during favorable conditions (e.g., during wet, early season; following rainstorms; overnight) (Pope and Matthews 2001, Fellers et al. 2007, Matthews and Preisler 2010, Brown et al. 2019, **CDFW 2020b**, Keung et al. 2021).

Another potential reason for fewer adult detections in recent years (2021 and 2023–2025; **Figure 42**, **Table 5**) is that CDFW only conducted one survey trip each season, which reduced opportunities for detecting frogs when compared with earlier years of CMR in the study area. The other CMR survey year with very few SNYLF detections was 2016, during which MLRG also visited sites during only one primary period. However, this comparison is confounded by the fact that MLRG translocated additional adult SNYLF into Jabu and Lucille Lakes following the 2016 primary period surveys (additional releases of adult SNYLF occurred in 2017–2019 at Jabu Lake, and 2017–2020 at Lake Lucille). Therefore, the limited detections in 2016 may have been largely due to fewer SNYLF being present at the sites. Despite this complication in comparing observations between years, additional surveys at other times of year may have resulted in more SNYLF individuals being detected during the period 2023–2025.

Finally, the reduction in SNYLF detections may have been in part due to mortalities through various causes, including predation, *Bd*, and overwintering conditions (e.g., a subset of frogs remaining in small ponds like Site ID 52682 may have died from overwinter oxygen depletion, since small and shallow sites can freeze to the bottom and become anoxic; Bradford 1983). CDFW did not observe evidence of any *Bd*-induced die-offs in the study area during the 2023–2025 survey period. Although *Bd*-related die-offs can occur rapidly, such catastrophic population loss is mainly known from large, Bd-naïve SNYLF populations (e.g., Vredenburg et al. 2010, Knapp et al. 2022). However, in areas where *Bd* is endemic (i.e., where the disease has been present for longer periods), losses may occur more insidiously over time (Briggs et al. 2010), and such smaller-scale losses may be additive to other sources of mortality, thus increasing the probability of long-term decline, particularly in small populations. Additionally, gartersnake (*Thamnophis* spp.) predation is common in SNYLF populations (T.C. Smith, unpubl. data). CDFW staff and researchers have directly observed gartersnakes preying on SNYLF in Desolation Wilderness, including within the CMR study area (I. Chellman, S. DeCurtis, J. Imperato, R. Knapp, and T.C. Smith; pers. obs.).

Hell Hole Meadow area (LTBMU), El Dorado County

Hell Hole Meadow area Summary

The Hell Hole Meadow area (**Figure 44**) is a site of conservation interest to CDFW and USFS because it contains one of the few known SNYLF populations present on the LTBMU (with the other being the Jabu, Lucille, and Margery Lakes area; see previous section). The Hell Hole Meadow area (**Figure 45**) contains the main meadow complex (**Figures 46 and 47**), plus numerous small ponds to the north and south (**Figures 48–52**). However, CDFW and USFS have only detected SNYLF in the main meadow and directly adjacent ponds. The area is challenging to survey, with thick emergent vegetation and dense wetland shrubs (*Alnus* sp., *Salix* sp.). Hell Hole Meadow also contains expansive shallow inundated areas, overgrown stream channels with intermittent deep pools, and even deeper pothole pools (of unknown depth), present sporadically throughout portions of the meadow and within thick vegetation around the meadow's outer perimeter (**Figure 53**).

Fish are not known to be present in the Hell Hole Meadow area. The nearest extant trout populations are downstream, in areas of Trout Creek below approximately 7,800 ft (2,377 m). Since initial detections by USFS in the late 1990's, a seemingly small SNYLF population has persisted in the Hell Hole Meadow area. Although SNYLF counts have been very low for the past 30 years, the continued persistence of the species, combined with the challenging survey conditions in the area, suggest that the population is likely larger than revealed by VES. Therefore, CDFW initiated CMR for SNYLF at Hell Hole Meadow in 2022 to gain a better understanding of the SNYLF population demographics at this site.

Since beginning CMR at Hell Hole Meadow in 2022, CDFW and LTBMU staff have only detected eight unique adult SNYLF, three of which have been recaptured one time, respectively. However, due to time constraints caused by extensive survey coverage in other areas, CDFW Region 2 staff have only been able to visit the Hell Hole Meadow area once per summer. Clearly, this level of effort is insufficient, and more effort is needed to gain a better understanding of the SNYLF population. Therefore, CDFW plans to attempt visiting the site at least twice per summer field season (more often, if scheduling allows) during at least the next two years (2026 and 2027) to attempt increasing new captures and recaptures.

Additionally, another constraint is that no current LTBMU staff are fully trained to PIT tag SNYLF. Therefore, another priority should be training and permitting at least a portion of permanent and term LTBMU staff to independently PIT tag SNYLF. There may be ideal opportunities for LTBMU staff to gain such experience at the SF Zoo, who often have focused PIT-tagging sessions with numerous threatened and endangered amphibians (primarily *R. sierrae* and *R. draytonii*). These sessions are directly supervised by highly trained staff with experience tagging thousands of frogs, and CDFW staff often participate in the tagging process at these events. Therefore, if possible, LTBMU staff should join for any available PIT-tagging sessions at the SF Zoo during spring 2026.

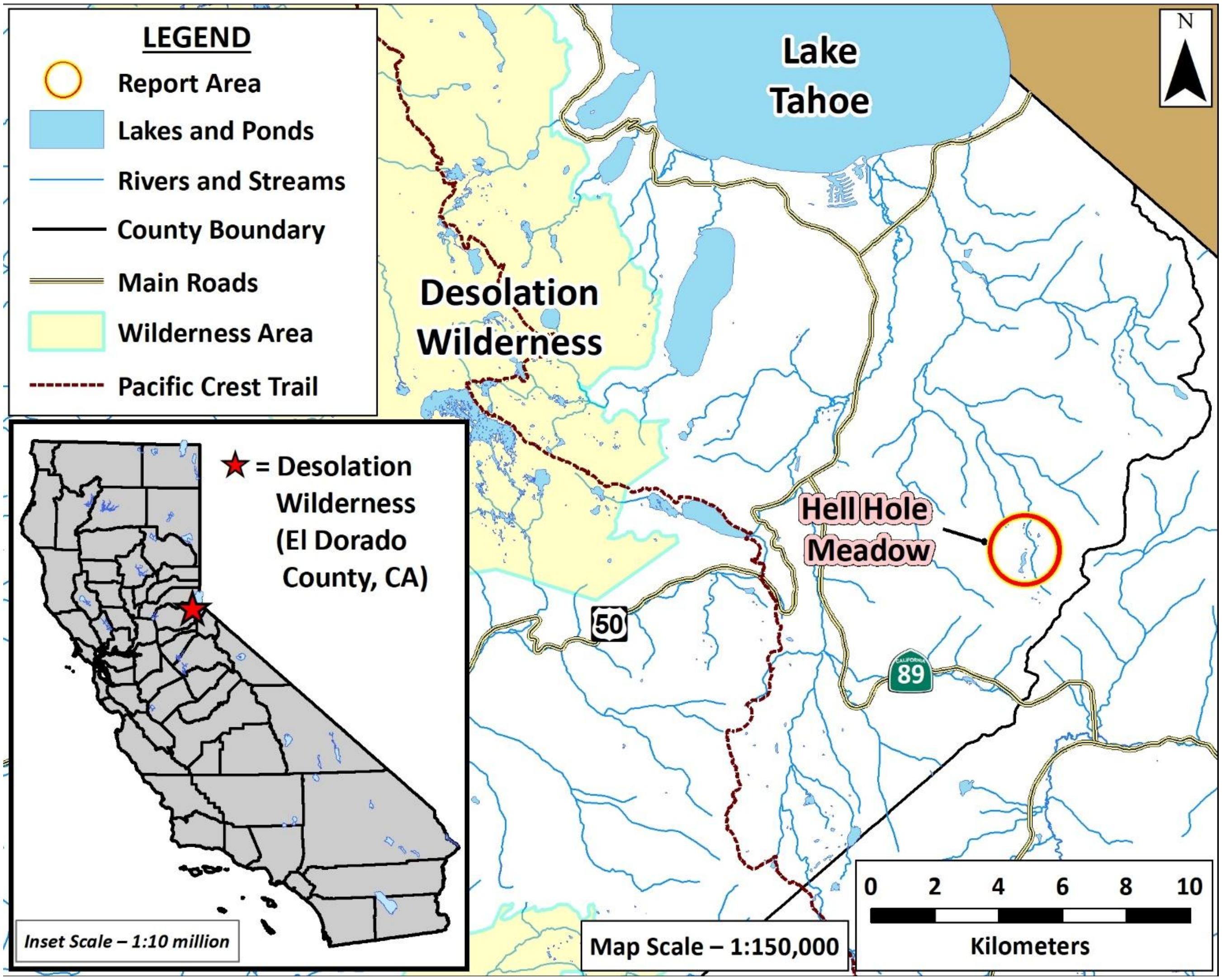


Figure 44. Eastern El Dorado County, CA. The area discussed in this section is circled.

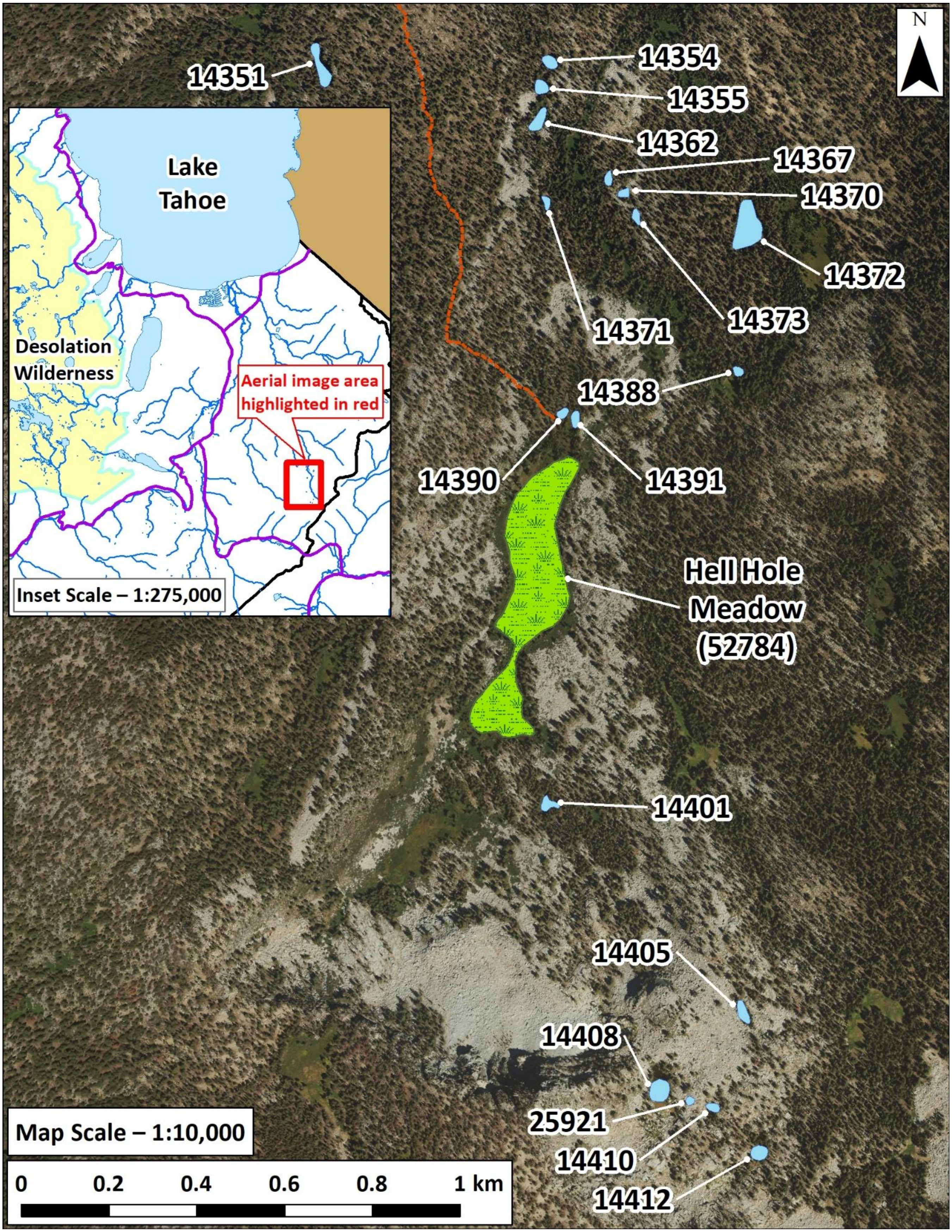


Figure 45. [See figure caption at the beginning of the next page.]

Figure 45 (continued). Hell Hole Meadow area, eastern El Dorado County, CA. California Department of Fish and Wildlife (CDFW) and Lake Tahoe Basin Management Unit staff have consistently observed Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) in the main meadow. Number labels shown are unique site identification codes that CDFW uses for data collection. The drainage flows north into Trout Creek, which flows into the south end of Lake Tahoe.

Figure 46. Hell Hole Meadow, viewed from the slope southeast of the meadow, looking northwest, in late July 2019. Lake Tahoe is visible in the background. (CDFW)

Figure 47. Ground-level view of Hell Hole Meadow in August 2023. (CDFW)

Figure 48. Site ID 14355 in mid-August 2020. (CDFW)

Figure 49. Site ID 14354 in mid-August 2020. Water levels in most small ponds surrounding the Hell Hole Meadow area that CDFW staff visited on the survey day were very low. This is one of the sites that contained Southern Long-toed Salamander larvae (*Ambystoma macrodactylum sigillatum*), which are a California Species of Special Concern. (CDFW)

Figure 50. Site ID 14362 in mid-August 2020. At the time of surveys, many of the small ponds in the area surrounding Hell Hole Meadow were completely dry, or had very recently dried. The substrate of this ephemeral pond was still muddy, but no standing water remained. (CDFW)

Figure 51. Site ID 14405 in late July 2019. (CDFW)

Figure 52. Site ID 14408 in late July 2019. (CDFW)


Figure 53. One of the numerous small, deep pothole pools present throughout Hell Hole Meadow. (CDFW)

Hell Hole Meadow area Results

Prior to the initiation of CMR, twenty-one years of VES data suggested the SNYLF population in the Hell Hole Meadow area is very small, but persisting, despite a decline in detections beginning in the early 2000's (**Figure 55**). Since more consistent amphibian monitoring began in 2002, staff have detected nearly all SNYLF in the main meadow (Site ID 52784; **Figure 45**). However, staff have also detected post-metamorphic SNYLF at Site IDs 14390 and 14391, and at Site ID 14401 (**Figure 45**). LTBMU and CDFW staff have detected all evidence of SNYLF breeding, indicated by observations of larvae and subadults, in the main meadow. Staff have not detected any SNYLF in the small clusters of ponds north (Site IDs 14354, 14355, 14362, 14367, and 14372) or south (Site IDs 14405, 14408, 14410, 14412, and 25921) of the main meadow during any survey efforts from 2002 to 2025 (**Figure 45**).

In 2019, CDFW, LTBMU, and one U.S. Fish and Wildlife Service staff joined together to survey most ponds in the Hell Hole area, including the clusters of ponds north and south of the main meadow. During these surveys, which included seven observers, staff detected the highest number of post-metamorphic SNYLF since 2003 (**Figure 55**). The large number of experienced observers and quality survey conditions during the core active season for SNYLF (surveys occurred in late July) likely explain the higher detection rates. In 2020, only two CDFW staff surveyed Hell Hole Meadow and the cluster of ponds to the north. The more limited number of surveyors needing to cover a large amount of complex habitat partially explains the lower detection rates in 2020. In 2021, LTBMU staff visited Hell Hole Meadow on two separate occasions, and additional surveyors were present. Again, increased survey effort likely helps account for the higher detections in 2021 when compared with SNYLF counts from the previous summer.

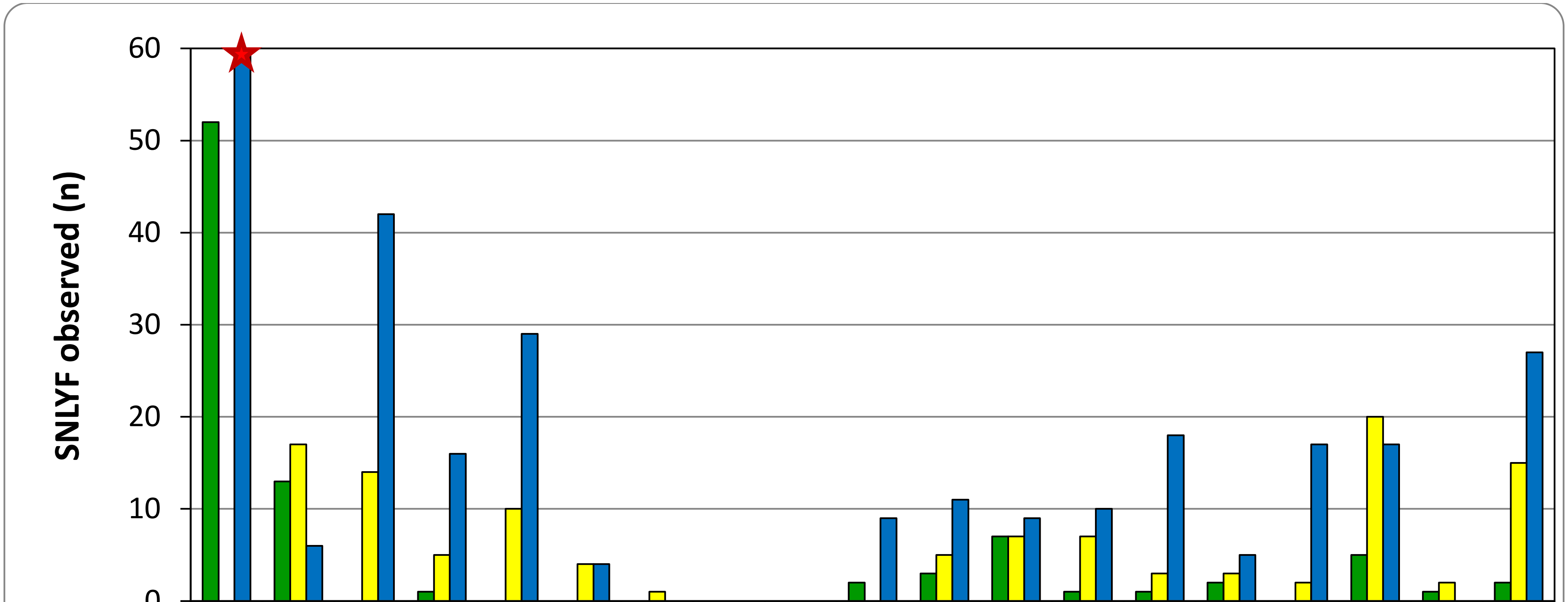
CDFW initiated CMR at Hell Hole Meadow in 2022. To increase the odds of detecting frogs, LTBMU staff have joined CDFW during most CMR trips to the Hell Hole Meadow area (**Figure 54**). During these visits, staff have surveyed the entire main meadow (Site ID 52784; **Figure 45**), plus the adjacent small ponds (Site IDs 14390, 14391, and 14401; **Figure 45**). Occasionally, staff include surveys of the more distant ponds shown in **Figure 45**; however, so far, no SNYLF have been detected at those further sites.

Since 2022, CDFW and LTBMU staff have only detected eight unique adult SNYLF in the Hell Hole Meadow area. During that time, staff have not detected more than four adult frogs during any single CMR survey of the area (**Table 7**). Staff have also observed a small number of subadult and larval SNYLF during each survey, but staff have not been keeping consistent documentation of those earlier life stages; instead, staff focus on detecting adult SNYLF.

Figure 54. LTBMU and CDFW staff at Hell Hole Meadow in August 2023.

Table 7. Summary of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) captures in the Hell Hole Meadow area from 2022 to 2025. The numbers shown represent the number of newly marked ("NEW") and recaptured ("RECAP") ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which could include SNYLF individuals caught >1x in the same year).

YEAR	NEW	RECAP	SURVEY DATE(S)	GENERAL NOTES
2022	4	0	15 August	One site visit by CDFW and LTBMU in mid-August.
2023	1	0	3 August	One site visit by CDFW and LTBMU in early August.
2024	2	1	8–9 July	One site visit by CDFW and LTBMU in early July.
2025	1	2	4–5 August	One site visit by CDFW and LTBMU in early August.



Year	2002	2003	2004	2006	2007	2008	2009	2010	2011	2012	2013 *	2014	2015	2016	2017	2018	2019	2020	2021
Adult	52	13	0	1	0	0	0	0	0	2	3	7	1	1	2	0	5	1	2
Subadult	0	17	14	5	10	4	1	0	0	0	5	7	7	3	3	2	20	2	15
Larva	211	6	42	16	29	4	0	0	0	9	11	9	10	18	5	17	17	0	27

Figure 55. Visual encounter survey (VES) data Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) in the Hell Hole Meadow area from 2002 to 2021. Data were provided to California Department of Fish and Wildlife (CDFW) by partner biologists on the Lake Tahoe Basin Management Unit (LTBMU 2021). CDFW staff joined LTBMU staff for surveys in 2019. CDFW conducted surveys independently in 2020. Survey effort, in terms of number of personnel participating in the survey and total number of ponds also surveyed in the surrounding area, varied over time. However, staff surveyed the main Hell Hole Meadow (Site ID 52784; see **Figure 45**) on each survey occasion.

*In 2013, LTBMU staff detected three SNYLF egg masses.

★ [Red star] Indicates a larval SNYLF count above the scale range of the histogram (n = 211).

Hell Hole Meadow area Discussion

The low SNYLF counts in the Hell Hole Meadow area may be due to many factors, including habitat complexity, a large survey area, observer bias, disease, and weather conditions. Additionally, the SNYLF population in the Hell Hole Meadow area may simply be quite small and tenuously persisting. As with many small SNYLF populations in the northern Sierra Nevada, limited detections make deriving trends difficult (Mazerolle et al. 2007). However, with CMR now underway, CDFW and LTBMU may be able to gain a better long-term understanding of population size, survival, growth, and movements of SNYLF in the Hell Hole Meadow area (Fellers et al. 2013).

Despite uncertainty about the true reason(s) for low SNYLF detections in the Hell Hole Meadow area, limited survey effort during the past four years (only one trip per season) likely at least partially explains low detection rates. All visits since 2022 have occurred between early July and mid-August. Although that timeframe is in the core of the typical active season for SNYLF, including additional visits to the site during different times of the active season for SNYLF may potentially increase detections (e.g., earlier in the summer, to potentially detect egg masses; or during late summer or early fall, when water levels may be lower, possibly consolidating frogs into more perennial areas). Additionally, trips involving two or three surveys days in a row may help increase detection rates. Although CDFW conducted surveys over two days in 2024 and 2025, the second survey day each season was partial, since staff needed to leave the site by early afternoon. Therefore, CDFW plans to have at least one 2–3-day survey trip during the summer months in 2026 and 2027.

Despite current uncertainty about the true SNYLF population dynamics in the Hell Hole Meadow area, continuing CMR will increase the understanding of frog demographics and movement in the area. CDFW plans to continue CMR at this site, even if future time investment needs to be minimal due to other survey and management priorities.

Middle Creek, El Dorado County

Middle Creek Summary

Middle Creek contains one of the lowest-elevation SNYLF populations in CDFW Region 2 (**Figure 56**). The population is small and isolated from other known SNYLF populations, the closest of which are in the southern Desolation Wilderness (to the northeast) and northeastern Amador County (to the southeast). The low elevation distribution, isolation, and potential for extirpation make this population of interest to CDFW. Additionally, in 2021, the **Caldor Fire** burned through Middle Creek and the surrounding area, increasing CDFW and ENF concerns about this vulnerable SNYLF population (**Figure 57**).

Fish have not been detected in the surveyed reach of Middle Creek. The nearest extant trout populations are just downstream, in the Silver Fork American River, at approximately 4,760 ft (1,451 m). There is a steep, multi-cascade barrier to upstream fish passage near the base of Middle Creek, soon above (east) of Silver Fork Road (**Figure 58**). Since initial detections by USFS and CDFW in the early 1990's, a seemingly small SNYLF population has persisted in Middle Creek. SNYLF counts have been very low for the past 30 years, but the population has continued to persist. Therefore, in 2022, CDFW initiated CMR for SNYLF in Middle Creek to gain a better understanding of the population demographics at this site.

Since beginning CMR, CDFW and ENF staff have only detected 14 unique adult SNYLF, four of which have been recaptured one to four times, respectively. Typically, CDFW and/or ENF staff have visited Middle Creek several times each season, with most surveys being concentrated in late spring/early summer and late summer. So far, CMR data strongly suggests a very small population at high risk of extirpation. Based on body size at initial capture, eight of the 14 captured adults appear to be older individuals, and all but one PIT-tagged female (five of the six total females PIT-tagged) have been >70 mm SUL upon initial capture, suggesting an overall older female demographic in this population.

Despite concerns about the decline and extirpation risk in this population, several factors confound interpretation of SNYLF capture rates. First, survey conditions can be challenging in Middle Creek. Dense vegetation is present throughout much of the survey reach, with thick annual plants (e.g., grasses, sedges, and various emergent wetland plants), umbrella plant (*Darmera peltata*), and areas of dense riparian shrubs (e.g., *Alnus* sp. and *Salix* sp.). Since the Caldor Fire burned through the area in 2021, CDFW and ENF staff have noted that annual vegetation in and around the creek channel has increased, particularly by mid-summer, further limiting visibility into the water in many locations. Additionally, consistent flows and many shaded areas limit visibility through the water column, inhibiting the ability to detect egg masses, tadpoles, and post-metamorphic frogs hiding underwater. Given these conditions, surveys early in the active season for SNYLF (i.e., spring through early summer) seem the most productive, with generally higher detection rates.

CDFW plans to attempt visiting the site at least twice per spring and summer field season (more often, if scheduling allows) during at least the next two years (2026 and 2027) to attempt increasing new SNYLF captures and recaptures in Middle Creek.

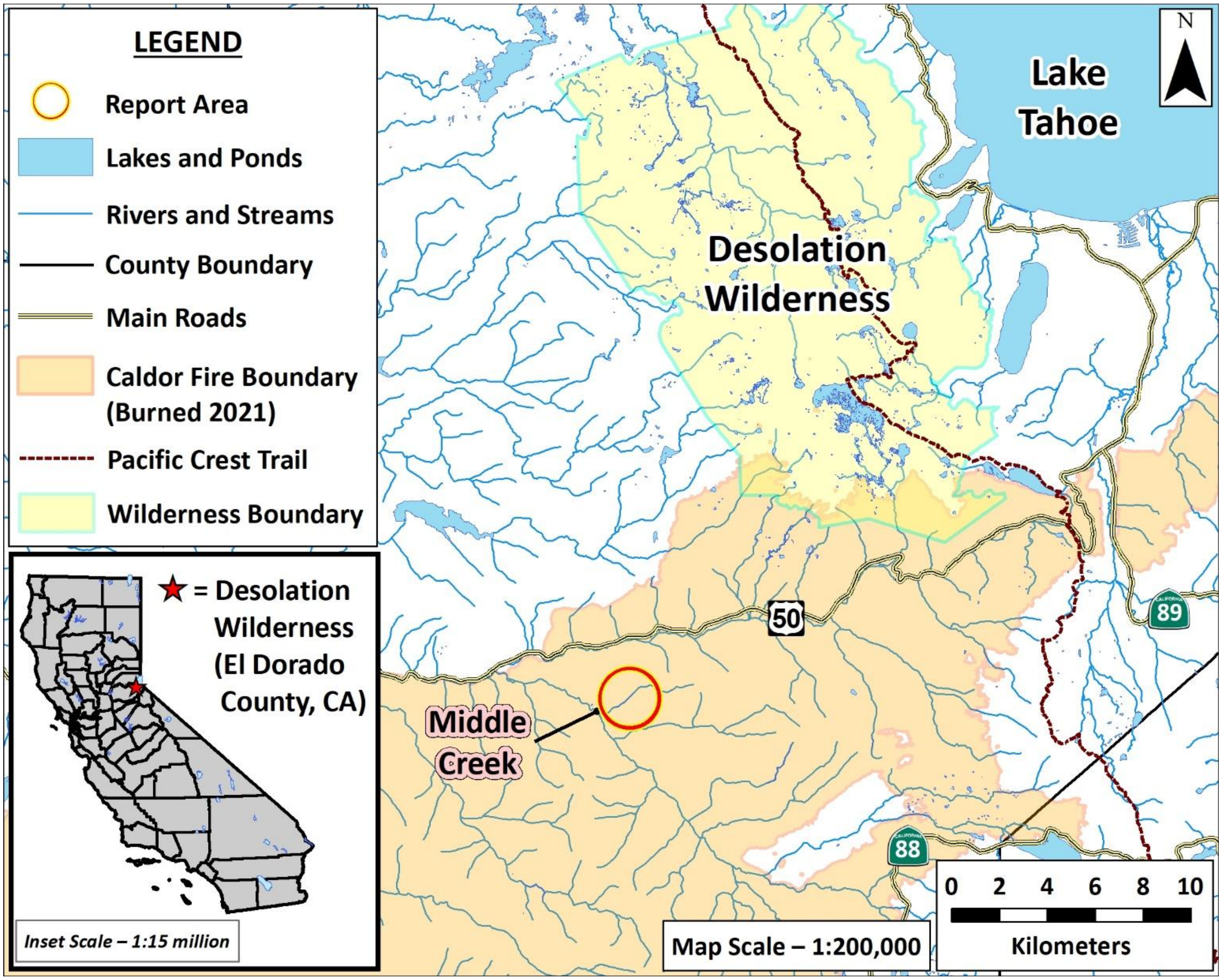


Figure 56. Eastern El Dorado County, CA. This map shows the Desolation Wilderness boundary and perimeter of the Caldor Fire, which burned through the area in late summer and early fall 2021. The area discussed in this section is circled

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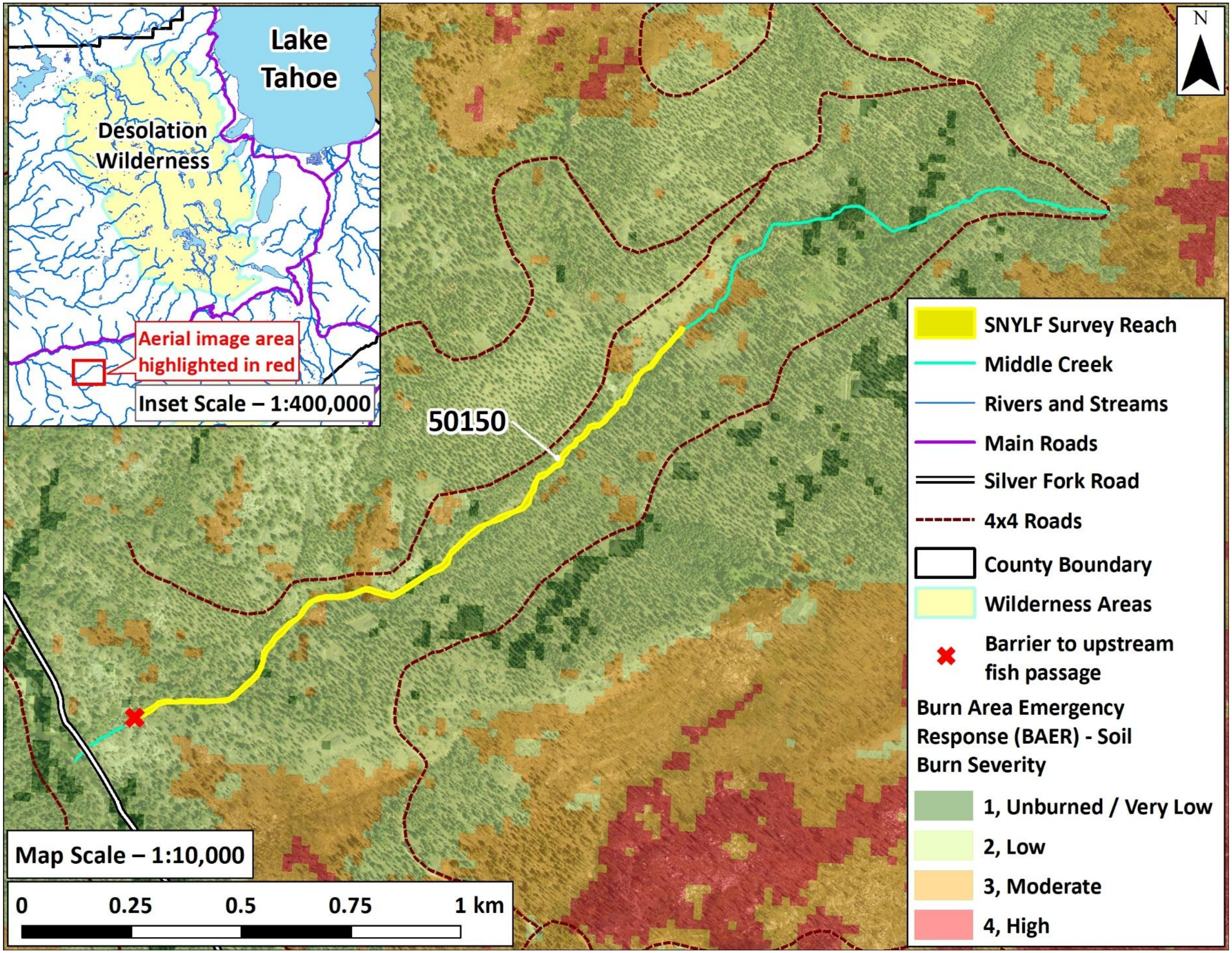


Figure 57. [See figure caption at the beginning of the next page.]

Figure 57 (continued). The monitored section of Middle Creek (Site ID 50150; shown in bright yellow), CA. California Department of Fish and Wildlife (CDFW) staff have observed Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) in this section of creek during periodic surveys from 2002 through 2021. CDFW and Eldorado National Forest staff began SNYLF capture-mark-recapture at Middle Creek in 2022. This map displays the Burned Area Emergency Response (BAER) soil burn severity assessment from the U.S. Forest Service. The number label shown is the unique site identification code that CDFW uses for data collection. Middle Creek is a headwater tributary to Silver Fork American River, which flows into the South Fork American River downstream of Kyburz.

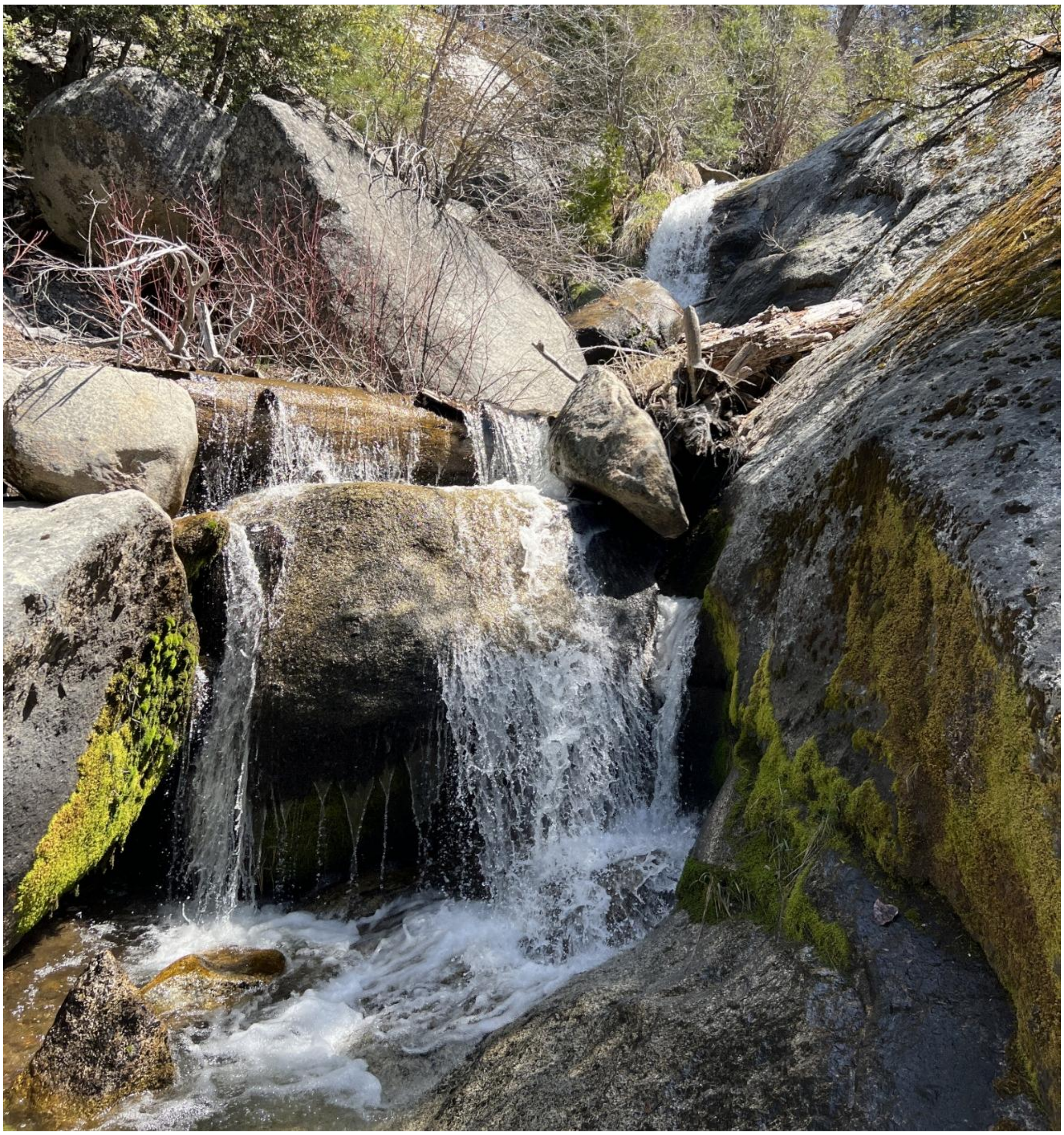
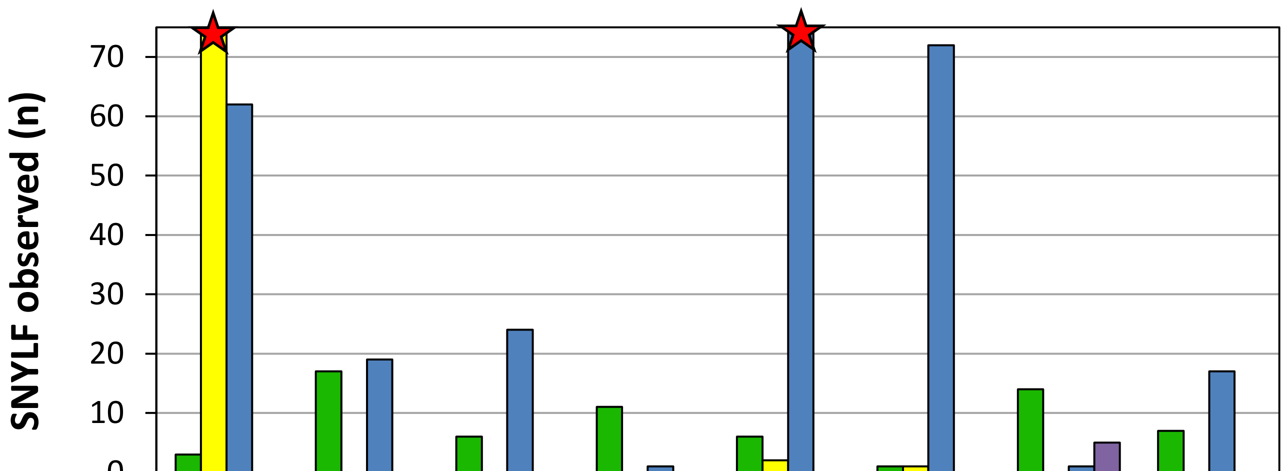


Figure 58. View looking upstream within the barrier to upstream fish passage along the lower section of Middle Creek, approximately 100 meters upstream of Silver Fork Road.

Middle Creek Results
Twenty-four years of monitoring data demonstrate that the Middle Creek SNYLF population is persisting, albeit at a small population size (**Figure 59, Table 8**).

Typically, CDFW and/or ENF staff have visited Middle Creek several times each season, with most surveys being concentrated in late spring/early summer and late summer. Since beginning CMR, CDFW and ENF staff have only detected 14 unique adult SNYLF, four of which have been recaptured one to four times, respectively.

Current CMR data strongly suggest a very small population at high risk of extirpation. Based on body size at initial capture, eight of the 14 captured adults appear to be older individuals, and all but one PIT-tagged female (five of the six total females PIT-tagged) have been >70 mm SUL upon initial capture, suggesting an overall older female demographic in this population (**Figure 60**).



Year	2002	2005	2008	2009	2010	2012	2017	2020
Adult	3	17	6	11	6	1	14	7
Subadult	161	0	0	0	2	1	0	0
Larva	62	19	24	1	114	72	1	17
Egg Mass	0	0	0	0	0	0	5	0

Figure 59. Results from Sierra Nevada Yellow-legged Frog (*Rana sierrae*) visual encounter surveys (VES) in Middle Creek from 2002 to 2020. Red stars indicate values above the scale displayed on the y-axis.

Table 8. Summary of adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) captures in Middle Creek from 2022 to 2025. The numbers shown represent the number of newly marked ("NEW") and recaptured ("RECAP") ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which could include SNYLF individuals caught >1x in the same year).

YEAR	NEW	RECAP	SURVEY DATE(S)				GENERAL NOTES
2022	5	0	9 August		16 Sept		
2023	5	2	15 June	21 June	30 June	17 Aug	15 June visit by USFS only.
2024	1	5	22 May		10 June		22 May visit by USFS only.
2025	3	2	24 Apr	30 June	7 Aug	6 Oct	

Figure 60. A large, older adult female Sierra Nevada Yellow-legged Frog (*Rana sierrae*) basking on a rock in Middle Creek in late June 2025. (CDFW)

Middle Creek Discussion

Few adult frog detections during VES and CMR, population isolation, and impacts from environmental events—such as wildfire (e.g., the Caldor Fire in 2021) and drought (e.g., the periods 2012–2015, and 2020–2022; CDEC 2026b)—all present imminent concerns for the continued persistence of this population. These potential perils place the Middle Creek SNYLF population at much higher risk of extirpation from stochastic events than larger SNYLF populations with greater connectivity to other extant populations.

Despite concerns about the decline and extirpation risk in this population, several factors confound interpretation of SNYLF capture rates. First, survey conditions are often challenging in Middle Creek. Dense vegetation is present throughout much of the survey reach, with thick annual plants (e.g., grasses, sedges, and various emergent wetland plants; **Figure 61**), umbrella plant (*Darmera peltata*; **Figure 62**), and areas of dense riparian shrubs (e.g., *Alnus* sp. and *Salix* sp.; **Figure 63**).

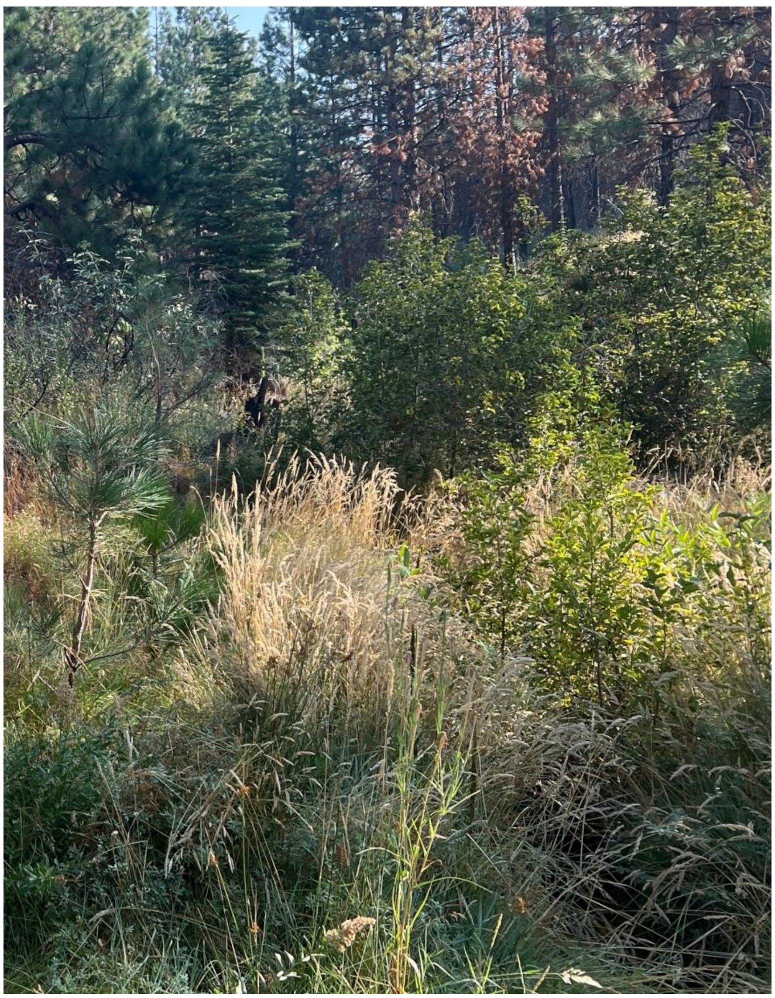


Figure 61. Thick annual vegetation and wetland shrubs surrounding the main channel of Middle Creek in September 2022.

Figure 62. A U.S. Forest Service Aquatic Biologist (center-left, just right of the small cedar tree) surveying the lower survey section of Middle Creek in August 2022. The broad-leafed vegetation dominating the foreground is *Darmera peltata*, commonly known as umbrella plant.

Figure 63. Two California Department of Fish and Wildlife staff members surveying Middle Creek in August 2023.

Since the Caldor Fire burned through the area in 2021, CDFW and ENF staff have noted that annual vegetation in and around the creek channel has increased, particularly by mid-summer, further limiting visibility into the water in many locations. Additionally, consistent flows and many shaded areas limit visibility through the water column, inhibiting the ability to detect egg masses, tadpoles, and post-metamorphic frogs hiding underwater. Given these conditions, surveys early in the active season for SNYLF (i.e., spring through early summer) seem the most productive, with generally higher detection rates.

Although the Middle Creek SNYLF population is persisting, the wildfire and risks from drought periods have increased CDFW and ENF concerns about the long-term viability of this small population. Wildfires are a natural part of the western forest ecology, but the size and severity of fires has increased in recent years, particularly in the face of rising temperatures, and frequency and severity of droughts (Goss et al. 2020, Swain et al. 2020, Shi et al. 2021). Many SNYLF individuals appear to be capable of enduring direct effects from wildfires by seeking refuge underwater, under banks, or in other locations sheltered directly from fire, as evidenced by observations of post-metamorphic SNYLF individuals in aquatic stream systems within recently burned areas. Recent examples of these observations (circa 2021) include Middle Creek (J. Mabe, ENF, *pers. comm.*) and Bean Creek (Plumas County; C. Dillingham, Plumas National Forest, *pers. comm.*), the latter of which was within a high burn severity area of the Dixie Fire. However, the post-fire effects to habitat, in particular sediment pulses potentially altering or eliminating pools used for breeding, are cause for concern. These potential impacts to breeding habitat may be transient; however, the loss of only one or two years of breeding opportunities could pose a threat to the long-term persistence of small SNYLF populations, particularly when combined with other persistent threats.

Another potential concern for the Middle Creek SNYLF population is that crews detected few larval SNYLF in recent survey years (since 2017). There are many possible explanations for the low larval detections, including: 1) limited reproductive success during dry years in 2012–2015, 2018, and 2020–2022 (at several points during those years, very little aquatic habitat may have remained in Middle Creek by late summer and fall), 2) low visibility from relatively high stream flows (winter-spring 2016–2017, 2018–2019, and 2022–2023 were above average precipitation periods; CDEC 2026b), larvae possibly being swept downstream during high spring flows, and 4) observer bias.

CDFW will continue to monitor this population regularly, particularly given the concerns surrounding post-fire effects to SNYLF breeding habitat. For at least the next two seasons (2026 and 2027), CDFW plans to attempt visiting Middle Creek at least twice per spring and summer field season (more often, if scheduling allows) to attempt increasing new SNYLF captures and recaptures in Middle Creek. Thereafter, CDFW plans to visit Middle Creek at least once annually for CMR, even if separate funding is not secured for hiring field crews to help conduct the work.

Dufrene Pond area, Amador County

<u>*Dufrene Pond area Summary*</u>

The Dufrene Pond area (**Figure 64**) is a site of conservation interest to CDFW and ENF because it contains a small and isolated SNYLF population. The Dufrene Pond area (**Figure 65**) contains two small, manmade ponds (**Figures 66 and 67**), plus a stream segment (**Figures 68 and 69**) and the upper section of Little Bear River (**Figure 70**). CDFW and ENF have detected SNYLF throughout the area shown in **Figure 65**, but a majority of SNYLF detections have occurred at Dufrene Pond (Site ID 27501; **Figures 65 and 66**) and within the first several hundred meters of the Dufrene Pond outlet stream (Site ID 53614; **Figure 65**). Dufrene Pond is also a consistent SNYLF breeding site.

Fish are not known to be present in the Dufrene Pond area. The nearest extant trout populations are in the lower section of Little Bear River, below a small barrier to upstream fish passage (**Figure 65**). CDFW regularly stocks Lower Bear River Reservoir with Rainbow Trout and Brown Trout. Since initial detections by USFS in the early 1990’s, a seemingly small SNYLF population has persisted in the Dufrene Pond area. Although SNYLF counts have been low for the past 30 years, the continued persistence of the species suggests that the population is larger than revealed by VES. Therefore, CDFW initiated CMR for SNYLF in the Dufrene Pond area in 2023 to gain a better understanding of the SNYLF population demographics at this site.

Since beginning CMR in the Dufrene Pond area in 2023, CDFW and ENF staff have only detected 12 unique adult SNYLF, 10 of which have been recaptured at least once. These results currently indicate that the SNYLF population in the Dufrene Pond area is very small and at risk of extirpation. However, staff have also detected up to 32 small SNYLF egg masses in Dufrene Pond (ENF staff observed 20 egg masses in 2022, and CDFW staff observed 32 egg masses in late spring 2024 and 22 egg masses in late spring 2025), suggesting a larger population than staff have detected during CMR.

CDFW and ENF staff have typically visited Dufrene Pond between three and four times each late spring–fall season. For the past several years, CDFW and ENF staff have tried to make it to Dufrene Pond as snow is melting to locate and monitor SNYLF egg masses. SNYLF have often selected a location where eggs quickly become stranded as snowmelt runoff drops (**Figure 71**), which has resulted in CDFW and ENF coordinating with USFWS to relocate egg masses a short distance into deeper water where the eggs will be less likely to desiccate. CDFW plans to continue visiting the Dufrene Pond area during the breeding period to monitor egg masses, and at least twice per summer field season (more often, if scheduling allows) during at least the next two years (2026 and 2027) to attempt increasing adult SNYLF captures and recaptures.

Finally, one additional unique challenge with SNYLF management at Dufrene Pond is the illegal introduction of goldfish (*Carassius auratus*). On at least two separate occasions in recent years (2022 and 2025), someone has planted several goldfish into Dufrene Pond (**Figure 72**). The reasons for the illegal introduction are unclear, but CDFW and ENF suspects the intent is mosquito abatement. On both occasions, CDFW and ENF staff have subsequently netted goldfish out of Dufrene Pond. As an attempt at both education and deterrent, in early October 2025, CDFW placed several laminated signs, directing the public to not plant fish into Dufrene Pond, on the cattle exclusion fence surrounding the pond (**Figure 73**). CDFW plans to maintain these signs and continue removing any fish that may be subsequently detected in Dufrene Pond.

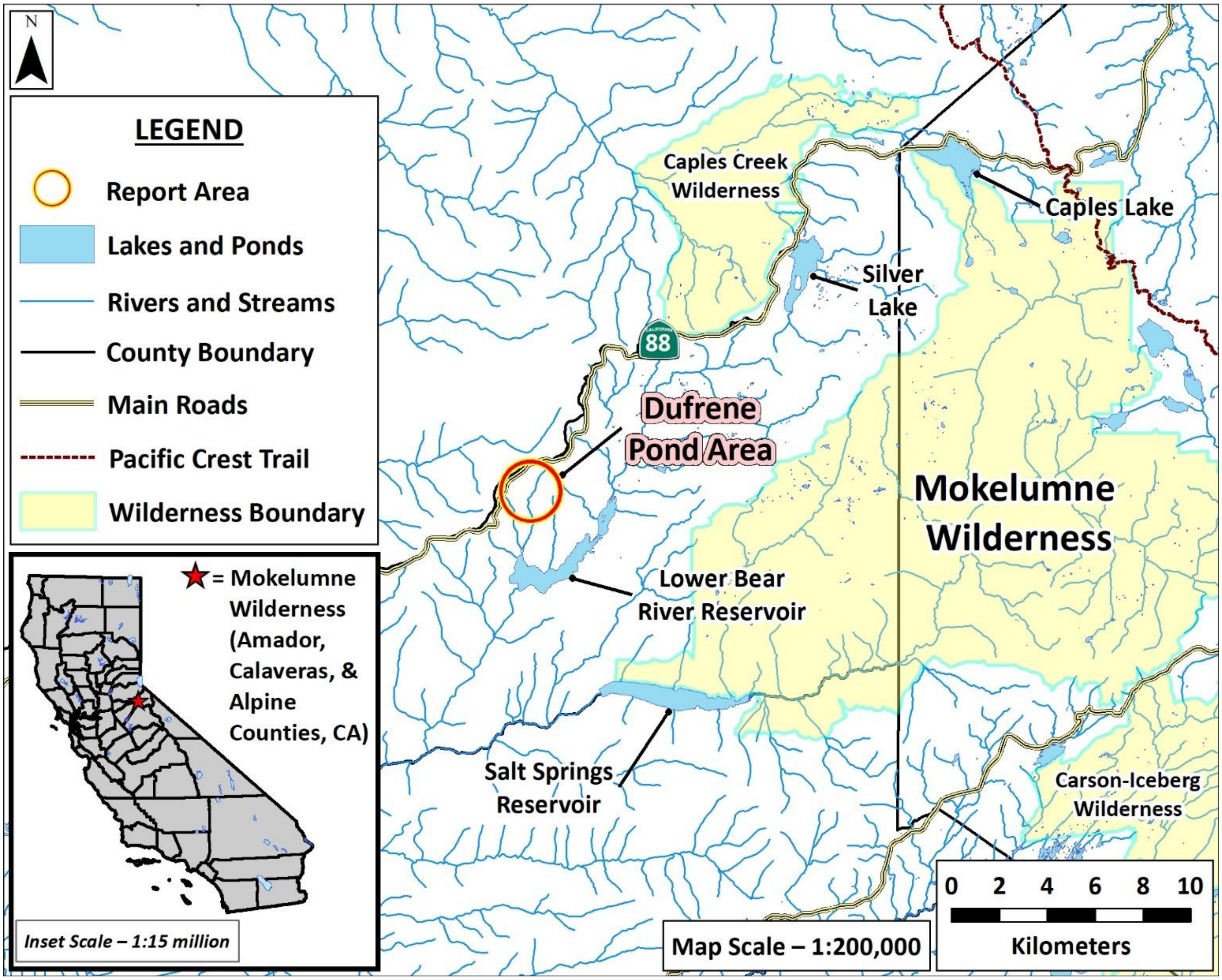


Figure 64. Eastern El Dorado County, CA. This map shows the Desolation Wilderness boundary and perimeter of the Caldor Fire, which burned through the area in late summer and early fall 2021. The area discussed in this section is circled.

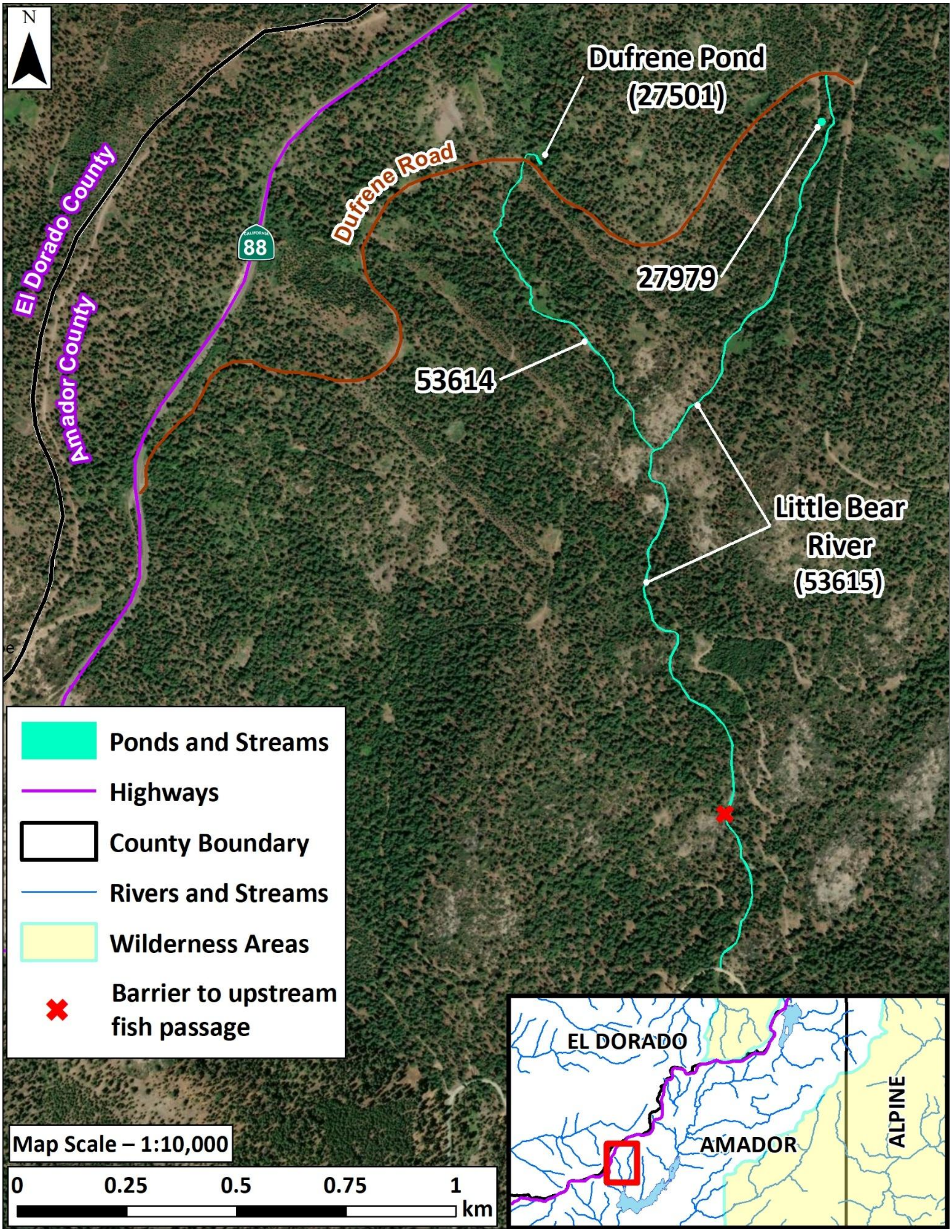


Figure 65. [See figure caption at the beginning of the next page.]

Figure 65 (continued). The Dufrene Pond area, Amador County, CA. California Department of Fish and Wildlife (CDFW) staff have observed Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) during periodic surveys of Dufrene Pond (Site ID 27501) between 2003 and 2022. CDFW and Eldorado National Forest staff began SNYLF capture-mark-recapture in this area in 2023. Number labels shown are unique site identification codes that CDFW uses for data collection. Middle Creek is a headwater tributary to Silver Fork American River, which flows into the South Fork American River downstream of Kyburz.

Figure 66. Dufrene Pond (Site ID 27501) on 13 June 2025. This is a manmade pond

Figure 67. A tiny manmade drafting pond between an old U.S. Forest Service road and Little Bear River (Site ID 27979) on 13 June 2025.

Figure 68. Stream segment 53614 (the Dufrene Pond outlet) on 23 May 2024.

Figure 69. Lower section of stream segment 53614 (the Dufrene Pond outlet), looking downstream, on 31 July 2023. (CDFW)

Figure 70. A section of Lower Bear River (Site ID 53615), just upstream of the confluence with Site ID 53614 (the Dufrene Pond outlet stream), on 20 June 2024. (CDFW)

Figure 71. Sierra Nevada Yellow-legged Frog (*Rana sierrae*) egg masses attached to the underside of a log at Dufrene Pond that are beginning to become stranded above water. (CDFW)

Figure 72. A goldfish, soon after removal from Dufrene Pond, which had been illegally released into the pond in early summer 2025. (CDFW)

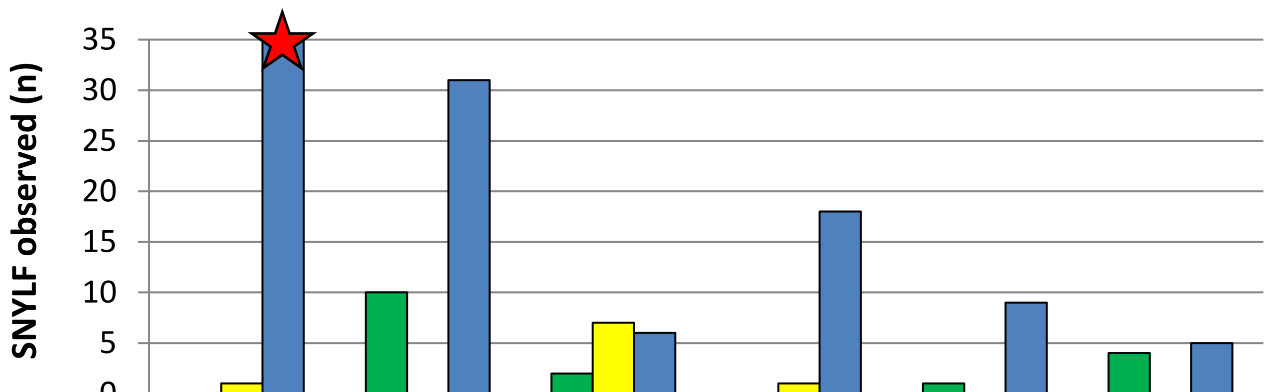
Figure 73. One of several laminated signs along the cattle exclusion fence surrounding Dufrene Pond. CDFW staff placed these signs in fall 2025. (CDFW)

Dufrene Pond area Results

Twenty-two years of monitoring data demonstrate that the Dufrene Pond area SNYLF population is persisting, albeit at a small population size (**Figure 74, Table 9**).

Typically, CDFW and/or ENF staff have visited the Dufrene Pond area several times each season, with most surveys being concentrated in late spring/early summer and late summer/early fall. Since beginning CMR, CDFW and ENF staff have only detected 12 unique adult SNYLF, 10 of which have been recaptured one to five times, respectively. Most recaptured individuals have only been recaptured once (n = 6), but some have been recaptured several times, including three individuals have been recaptured ≥ three times.

Current CMR data suggests a small population at risk of extirpation, but egg mass counts indicate a larger population than revealed through CMR alone. Based on body size at initial capture, most of the 12 captured adults are fully mature individuals, with five of the six PIT-tagged females having been >70 mm SUL upon initial capture, suggesting an overall older female demographic in this population.



Year	2003	2005	2008	2010	2012	2016
Adult	0	10	2	0	1	4
Subadult	1	0	7	1	0	0
Larva	101	31	6	18	9	5

Figure 74. Results from Sierra Nevada Yellow-legged Frog (*Rana sierrae*) visual encounter surveys (VES) in the Dufrene Pond area from 2003 to 2016. The red star indicates a value above the scale displayed on the y-axis.

Table 9. Summary of adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) captures in the Dufrene Pond area from 2023 to 2025. The numbers shown represent the number of newly marked ("NEW") and recaptured ("RECAP") ***individuals*** each year (i.e., for recaps, the numbers shown are **not *capture events***, which could include SNYLF individuals caught >1x in the same year).

YEAR	NEW	RECAP	SURVEY DATE(S)				GENERAL NOTES
2023	8	4	26 July	31 July	19 Oct		26 June and 19 Oct visits by USFS only.
2024	3	5	23 May	20 June	29 Aug	11 Oct	
2025	1	7	7 May	13 June	25 June	6 Oct	

Dufrene Pond area Discussion

One of the primary concerns about the Dufrene Pond area SNYLF population is limited aquatic habitat and long-term cumulative effects of recurring drought (King et al. 2024). Fishless habitat in the Dufrene Pond area is limited to two small ponds and about 2.5 km of small stream channels. Although Little Bear River is perennial, and Dufrene Pond is fed by several small springs, water levels in the stream channels often become very low in late summer and fall, especially during low water years, and large portions of the Dufrene Pond outlet become dry later in the summer. Dufrene Pond is a manmade pond that is slowly filling with fine silt from the surrounding meadow, and the much smaller manmade pond west of Little Bear River (Site ID 27979; **Figures 65 and 67**) is ephemeral.

Similarly to the Middle Creek SNYLF population discussed above, these habitat limitations likely play a role in the seemingly small SNYLF population size in the Dufrene Pond area, which puts this SNYLF population at greater risk of inbreeding depression or extirpation from environmental events like drought or wildfire (Gutierrez et al. 2021). Looking more broadly to the surrounding area, larger and more widespread SNYLF populations are still present, such as in the Tragedy Creek and Upper Bear River areas (**CDFW 2020a**, **2021**). The Dufrene Pond area SNYLF populations were formerly more connected to these other nearby SNYLF populations. However, the creation of Bear River Reservoir and long-term fish stocking have disconnected the Dufrene Pond area SNYLF population from larger and more perennial habitats to the south and west.

Another potential concern for the Dufrene Pond area SNYLF population is that the only known (and seemingly preferred) reproduction site for SNYLF is located at the mouth of a tiny inlet to Dufrene Pond. There are several old logs located across this part of the inlet, and SNYLF frequently use these logs as attachment points for egg masses during the breeding season, which coincides with periods of higher snowmelt runoff into Dufrene Pond. However, water levels in this tiny inlet stream quickly drop as snow recedes, often resulting in multiple egg masses attached to the underside of these logs becoming exposed to air and rapidly leading to desiccation (**Figure 71**).

Given these conditions, CDFW and ENF staff have consulted with USFWS and CDFW Wildlife Branch to move egg masses imminently threatened with stranding into adjacent habitat in Dufrene Pond, often within the same channel (just below the area with the logs) or at the pond margin. However, this task is complicated by the fact that Dufrene Pond contains very deep (up to about 4 feet deep in the middle of the pond), fine sediment, which has been slowly building in the pond for many years. This fine sediment can easily suffocate or completely bury egg masses, which is likely one of the reasons the SNYLF have selected the inlet for breeding, since the water is clear and cold, albeit very shallow.

In response to these unfavorable and habitat-limited conditions for egg masses, CDFW staff placed a small tree into the western side of Dufrene Pond in May 2025 to provide another option for egg mass attachment, given the previous lack of other options in the pond (**Figure 75**). Staff placed the tree so that branches are facing the deeper (northwest-facing) side of Dufrene Pond, and as the tree settles and dies in place, the branches will sit beneath the water surface, but some branches will remain above the silt layer (**Figure 76**). When staff last visited the site in March 2026, the tree had further settled following winter snowpack, and additional branches were sitting beneath the water surface (**Figure 77**).

Figure 75. A small conifer placed into Dufrene Pond by CDFW staff on 6 May 2025. Staff placed the small tree to provide a temporary alternative location for Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) to attach egg masses.

CDFW and ENF staff may remove sections of the logs, which SNYLF have been using as egg mass attachment points, currently spanning the Dufrene Pond inlet. This potential removal of log segments would occur outside of the breeding season. However, CDFW, ENF, and USFWS still need to finalize plans on potential alternative egg attachment options in the inlet. The goal will be preventing future egg mass stranding, while also avoiding the destruction of habitat on which SNYLF may rely for breeding. Additionally, staff are considering minor inlet channel alterations to provide deeper water (e.g., removing sediment buildup using hand tools), while also avoiding an influx of sediment from Dufrene Pond.

CDFW plans to collaborate with ENF staff on a general management plan for the Dufrene Pond area. This plan may include moving the cattle fence surrounding the pond back 8–10 feet to reduce encroachment by cattle (which will often come right up to the edge of Dufrene Pond), partial sediment removal from the main pond to increase open water habitat and allow for better egg mass deposition sites, and modifying the inlet to reduce further risk of SNYLF egg mass stranding.

Additionally, CDFW, along with any available assistance from ENF, will continue to monitor this population regularly, particularly given the concerns surrounding SNYLF breeding habitat and long-term drought risk. For at least the next two seasons (2026 and 2027), CDFW plans to attempt visiting the Dufrene Pond area at least twice per spring and summer field season (more often, if scheduling allows) to attempt increasing new SNYLF captures and recaptures. Thereafter, CDFW plans to visit the Dufrene Pond area at least once annually for CMR, even if separate funding is not secured for hiring field crews to help conduct the work.

Figure 76. A small conifer placed into Dufrene Pond by CDFW staff on 18 March 2026. Staff placed the small tree to provide a temporary alternative location for Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) to attach egg masses.

Figure 77. Up close view of a small conifer placed in Dufrene Pond on 18 March 2026. Staff placed the small tree in Mary 2025 to provide a temporary alternative location for Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) to attach egg masses.

Finally, one additional challenge with SNYLF management at Dufrene Pond is illegal introduction of goldfish. On at least two separate occasions in recent years (2022 and 2025), someone has planted several goldfish into Dufrene Pond (**Figure 72**). The reasons for the illegal introduction are unclear, but CDFW and ENF suspect the intent is mosquito abatement. Goldfish present a threat to SNYLF in the form of direct predation on, or damage to, young tadpoles, and spreading unknown aquatic pathogens. On each occasion, two or three goldfish have been detected, and on both occasions, CDFW and ENF staff have subsequently netted the goldfish out of Dufrene Pond. As an attempt at both education and deterrent, in early October 2025, CDFW placed several laminated signs—directing the public to not plant fish into Dufrene Pond—on the cattle exclusion fence surrounding the pond (**Figure 73**). CDFW plans to maintain these signs and continue removing any fish that may be subsequently detected in Dufrene Pond. As of May 2026, these signs are still present on the barbed wire fence that surrounds the pond.

Beebe Lake area, Alpine County

Beebe Lake area Summary

The Beebe Lake area drainage (**Figure 78**) is an area from which CDFW and ENF staff had worked to remove introduced Brook Trout (BK) to restore habitat for SNYLF. Those interested in learning more about initial fish removal in the Beebe Lake area may consult the 2017 Beebe Lake area survey memo (**CDFW 2018**). Around 2019, BK were illegally planted back into Beebe Lake and CDFW re-initiated fish removal in 2020. Since the second fish removal effort, no subsequent BK have been detected in the area since summer 2021. Those interested in details about the second fish removal effort may consult the Beebe Lake area memo update from 2023 (**CDFW 2023d**).

The Aquatic Biodiversity Management Plan for the Upper Mokelumne Management Unit (**CDFW 2016**) identifies Beebe Lake (Site ID 14797), Lower Beebe Lake (Site ID 2694; which is filling in with sediment and is no longer a lake, but rather an occasionally flooded meadow with stream channels), Beebe Meadow (Site IDs 14791, 14795, and 14799), approximately 1.5 kilometers (km) of stream (Site IDs 52651, 52707, and 52783), three small ponds with consistent SNYLF observations (Site IDs 14774, 14802, and 14829), and several other small ponds in the basin as a NSR (**Figure 79**) for SNYLF. Thus far, CDFW staff have not observed SNYLF in Beebe Lake, which is the deepest wetted habitat in the basin, with a maximum depth of about four meters. However, long term presence of BK and subsequent illegal fish planting have delayed the long-term goal of SNYLF regaining use of Beebe Lake.

Amphibian monitoring data from 2012 through 2025 suggest a small SNYLF population that appears to be stable. Population trends can be difficult to determine in small SNYLF populations. However, to help better determine SNYLF population status in the Beebe Lake area, CDFW staff began CMR monitoring of SNYLF in the Beebe Lake area in summer 2022.

Since beginning CMR in the Beebe Lake area, CDFW staff have detected 30 unique adult SNYLF, five of which have been recaptured one time each. Since 2022, CDFW staff have visited the Beebe Lake area for CMR surveys only once per year. However, due to limited staffing, CDFW did not visit the site for CMR in 2024. The relatively limited CMR effort so far, combined with relatively low recapture rates, indicate that the SNYLF population in the Beebe Lake area is larger than revealed through past VES surveys. However, additional survey effort will be necessary to better determine population demographics of the Beebe Lake area SNYLF population. These data will help inform SNYLF recovery in the Beebe Lake area. This information is especially important given past illegal activities in area, which have disrupted SNYLF restoration.

CDFW, in collaboration with ENF, will continue consistent SNYLF monitoring in the Beebe Lake area. In 2026 and 2027, CDFW staff plan to visit Beebe Lake area twice per season, if time and staffing availability allow. Additionally, CDFW staff will continue occasional gillnetting to detect any further illegal fish reintroductions that may be attempted in the basin.

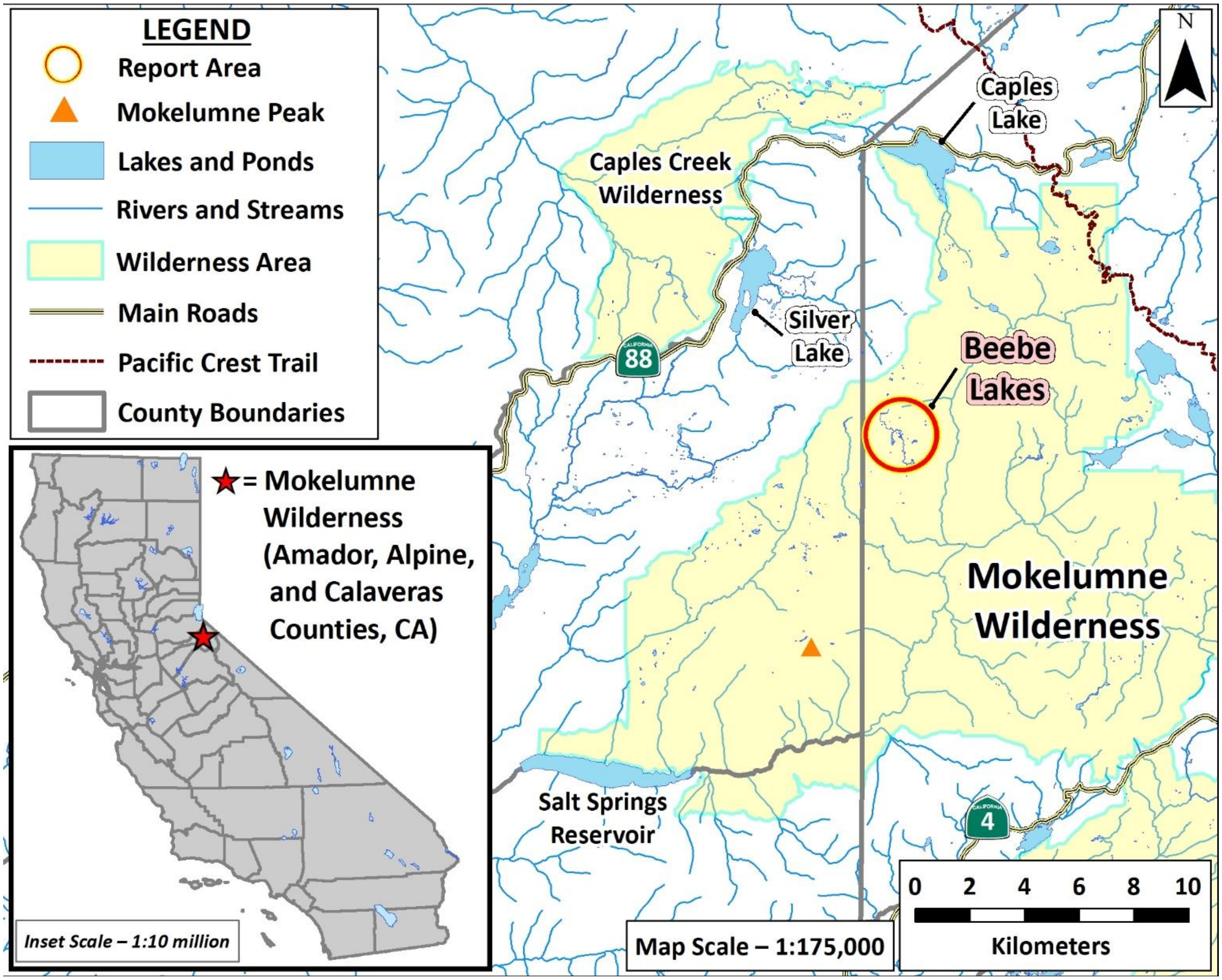


Figure 78. Mokelumne Wilderness, Amador, Alpine, and Calaveras Counties, CA. The area discussed in this section is circled.

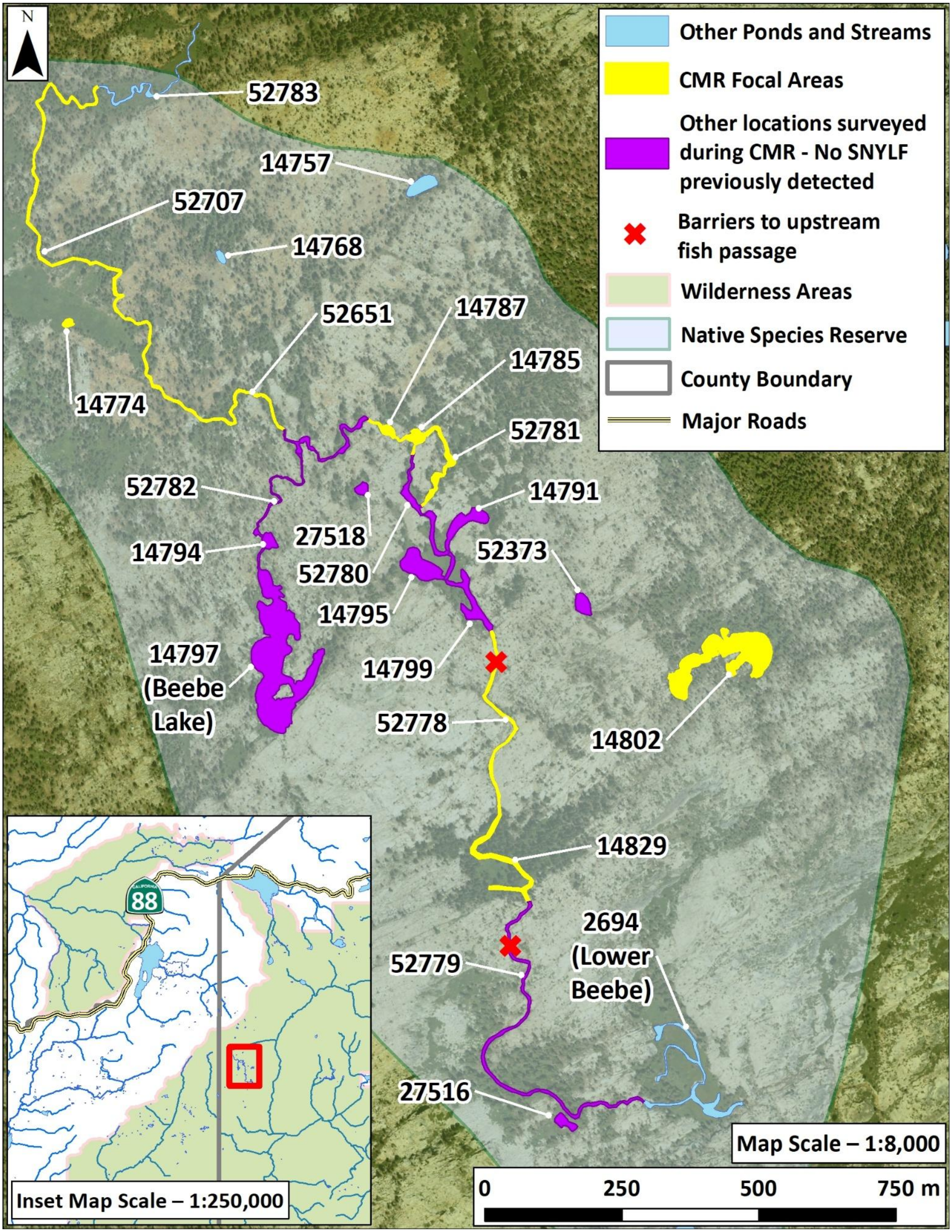


Figure 79. [See figure caption at the beginning of the next page.]

Figure 79 (continued). Focal areas for Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) capture-mark-recapture (CMR) surveys in the Beebe Lake area from 2022–present are displayed in yellow. California Department of Fish and Wildlife (CDFW) staff occasionally monitor all other ponds and meadows shown on this map, but the areas in yellow receive most survey attention. Numbers are CDFW Site IDs. SNYLF are known to breed at Site IDs 14774, 14802, and 14829. Non-native Brook Trout (BK) were formerly present in Beebe Lake (Site ID 14797) and the meadow, streams, and small ponds to the northeast (Site IDs 14785, 14787, 14791, 14795, 14799, 52651, 52780, and 52781). CDFW (and, previously, ENF staff) removed BK from the Beebe Lake area from 2011–2017; and then again from 2020-2025, following illegal BK planting. CDFW staff will continue occasional gill net monitoring at this site to detect any further illegal trout planting. All flowing waters in the basin drain south, then east into Summit City Creek, and eventually into the North Fork Mokelumne River.

Beebe Lake area Results

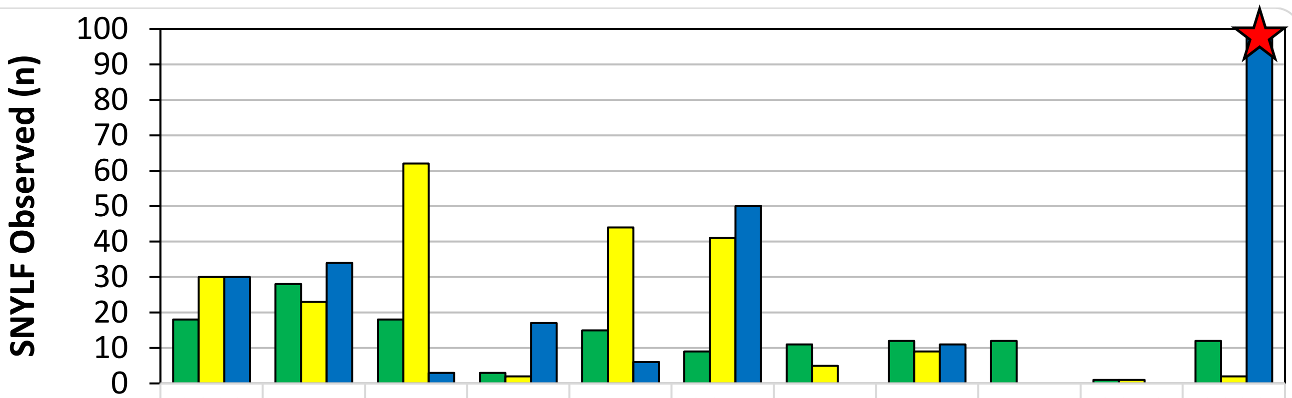
Prior to the initiation of CMR, nineteen years of VES data suggested the SNYLF population in the Beebe Lake area is small, but relatively stable, following a decline in detections beginning in the early 2000's (**Figure 80**). Since consistent amphibian monitoring began in 2002, staff have detected a majority of SNYLF at Site IDs 14774, 14802, and 14829 (**Figure 79**). During backpack electrofishing in late September 2018, CDFW staff several post-metamorphic SNYLF in the Beebe Lake meadow inlet stream (Site ID 52651; **Figure 79**). CDFW returned to Beebe Lake in late September 2019, during which staff detected very few SNYLF. However, CDFW conducted the surveys late in the summer and conditions were atypically cold during VES. In late June 2020, CDFW field staff returned to VES the Beebe Lake area, during which conditions were more ideal than during the site visit in late summer 2019. In 2020, staff surveyed 16 Site IDs in the NSR, during which staff observed 12 adults, two subadults, and 132 tadpoles. Staff detected nearly all larvae in the perennial meadow pool (Site ID 14774; **Figure 81**). This is the highest larval SNYLF count observed so far by CDFW in the Beebe Lake area. In 2021, staff focused on non-native fish removal, but site access was also limited for much of the summer due to the **Caldor Fire**, so CDFW did not conduct SNYLF surveys in the Beebe Lake area.

In late August 2022, one staff member conducted CMR at eight Site IDs in the NSR (**Figure 79**). Additionally, staff performed more rapid, incidental surveys in Beebe Meadow and dry (or mostly dry) stream segments. In total, staff observed 14 SNYLF adults, 10 of which staff captured and marked with PIT tags. Staff also observed eight SNYLF subadults and 75 larvae. The number of post-metamorphic SNYLF that staff observed in 2022 is very similar to counts during the past decade, although subadult SNYLF counts have occasionally been notably higher (e.g., 2008, 2012, and 2014; **Figure 80**). However, the high subadult counts in some years is likely an artifact of survey timing, since observed subadults are often frogs that metamorphosed later in the summer and early fall.

In 2023, CDFW staff did not conduct CMR for SNYLF in the Beebe Lake area.

In 2024, two CDFW staff visited the Beebe Lake area for CMR surveys in mid-July. Staff surveyed 12 Site IDs (14739, 14774, 14785, 14787, 14802, 14829, 52651, 52707, 52778, 52779, 52781, and 52783; **Figure 79**) and detected SNYLF at seven of those locations. In total, staff observed 23 adults and six subadults. Staff captured 14 of the 23 adults observed: 13 SNYLF were newly PIT-tagged and one was a recaptured individual originally marked in 2022.

In 2025, two staff visited the Beebe Lake area in mid-August for CMR surveys. Staff surveyed six Site IDs (14774, 14802, 14829, 52651, 52778, and 52781). Staff also conducted more cursory surveys at other nearby sites, including 14785 and 14787. In total, staff detected 12 adult, eight subadult (one of which was found dead), and about 40 larval SNYLF. Of the 12 adults, staff captured 11, four of which were recaptured frogs and seven of which staff newly PIT-tagged. Full CMR results are shown in **Table 10**.



Year	2002 *	2005	2008	2010	2012	2014 †	2015	2016	2017	2019 §	2020 ^
Adult	18	28	18	3	15	9	11	12	12	1	12
Subadult	30	23	62	2	44	41	5	9	0	1	2
Larvae	30	34	3	17	6	50	0	11	0	0	132

Figure 80. Results from Sierra Nevada Yellow-legged Frog (*Rana sierrae*) visual encounter surveys (VES) in the Beebe Lake area from 2002 to 2020. Yearly totals primarily include observations from Site IDs 14774, 14802, and 14829. The chart also includes occasional SNYLF adult individuals seen Site IDs 14785, 14787, 14799, and 52707.

*CDFW did not survey Site ID 14829 in 2002.

†CDFW began surveying Site ID 52651 in 2014. Until 2020, staff had only observed post-metamorphic SNYLF in Site ID 52651 (one in 2014, one in 2015, five in 2016, one in 2017, and five in 2018). However, CDFW observed one subadult and one tadpole in late June 2020.

§CDFW staff began surveying Site ID 52707 in 2019.

^In 2020, CDFW staff surveyed farther up the Beebe Meadow inlet stream (Site ID 52707) than during previous surveys. Staff also surveyed the entire stream reach between Lower Beebe and Beebe Meadow (Site IDs 52779, 14829, and 52778).

[Red star] Indicates a larval SNYLF count above the scale range of the histogram (n = 132).

Table 10. Number of adult Sierra Nevada Yellow-legged Frogs (SNYLF) captured during each capture-mark-recapture (CMR) survey day in the Beebe Lake area in 2022, 2024, and 2025. The number shown for each site on each day is the number of individual adults observed that day. In the total columns, "N" = individuals newly PIT-tagged that year, and "R" = individuals that were PIT-tagged in a previous year. "N/A" means "Not Applicable" (no SNYLF were PIT-tagged in the Beebe Lake area prior to 30 August 2022).

YEAR	2022	**2022 Total**		2024			**2024 Total**		2025			**2025 Total**	
Site ID	8/30	**N**	**R**	7/17	7/18	7/19	**N**	**R**	8/18	8/19	8/20	**N**	**R**
14774	0	**0**	**N/A**	1	0	0	**1**	**0**	0	0	0	**0**	**0**
14802	4	**4**	**N/A**	0	3	0	**2**	**1**	0	1	0	**1**	**0**
14829	6	**6**	**N/A**	0	4	0	**4**	**0**	8	0	0	**4**	**4**
52651	0	**0**	**N/A**	0	0	3	**3**	**0**	0	0	2	**2**	**0**
52779	0	**0**	**N/A**	0	3	0	**3**	**0**	0	0	0	**0**	**0**
TOTAL UNIQUE ADULTS BY DATE **and YEAR**	10	**10**	**N/A**	1	10	3	**13**	**1**	8	1	2	**7**	**4**

Figure 81. Site ID 14774 in June 2021, looking northeast. This spring-fed meadow pool is one of the few locations in Beebe Lake area where CDFW staff have occasionally observed Sierra Nevada Yellow-legged Frog (*Rana sierrae*) breeding, including egg masses and tadpoles. (Compare with **Figure 5,** in the Cattle Grazing section, which shows this same pond viewed from the other side in late summer 2022, following more intense cattle use during a dry water year.) (CDFW)

Beebe Lake area Discussion

Twenty-three years of monitoring data suggest the Beebe Lake area SNYLF population has remained relatively stable (albeit at a small population size; **Figure 80, Table 10**). However, observer bias, variation in survey conditions, and relatively low number of detections all make deriving trends difficult. Additionally, SNYLF have been forced to contend with introduced predators (BK) for many decades. Although BK were absent from the NSR by 2017, observations in 2020 prove that there was only a brief window—of at most three years—during which SNYLF were not functionally overlapping with BK in at least some locations in the Beebe Lake area. As of summer 2021, BK appear to once again be extirpated from Beebe Lake and Beebe Meadow. However, brazen sabotage of fish removal efforts in 2014 and 2021 (**Figure 82**), mean that CDFW will need to remain vigilant in this drainage to prevent additional BK infiltration and allow SNYLF the opportunity to regain a foothold in their native habitat.

Another confounding factor in interpreting long term SNYLF population trends is recent drastic changes in water years. For example, since 2012, winter precipitation (in the form of snow water content) in the northern Sierra Nevada has repeatedly swung between far below average (2012–2015, 2018, 2020–2022, 2025) and far above average (2017, 2019, and 2023), with very little in between (2016, 2024) (CDEC 2026b). SNYLF mortality can increase during long winters with deep snowpack (Bradford 1983). Contrarily, drought conditions can dry up many areas normally occupied by SNYLF, especially in places like the Beebe Lake NSR, where much of the available, long-term fishless aquatic habitat is small, shallow ponds and ephemeral streams. A mitigating factor to exceptionally dry water years is that sections of the meadow west of Site ID 52707 appear to be perennial, and this spring-fed water source prevents the largest pool in the meadow (Site ID 14774; **Figures 79 and 81**) and the Beebe Meadow inlet stream from drying entirely during poor water years. Clearly, this water source provides a refuge for SNYLF, in part indicated by the consistent reproduction observed in Site ID 14774 (although see the Cattle Grazing section above, and caption for **Figure 5**).

The habitat composition of Beebe Lake drainage can increase the challenge of capturing SNYLF for CMR. Available habitat consists of Beebe Lake, numerous small ponds darkly stained with tannins, multiple springs, a long stream channel with deep (and stained) pools, and a large meadow complex with dozens of isolated depressions that occasionally hold water. Dense vegetation surrounds many of these aquatic areas. This habitat variety is likely beneficial for SNYLF. However, the habitat complexity and thick vegetation also reduces visibility and maneuverability for surveyors. Therefore, SNYLF detectability in the Beebe Lake drainage is can be limited.

Despite these challenges, CDFW will continue to monitor the Beebe Lake SNYLF population regularly to assess the population status over time. Long-term CMR will be required to derive population trends and quantify the SNYLF population in the Beebe Lake area, particularly following the reemergence of BK in the NSR. In 2026 and 2027, CDFW hopes to visit the Beebe

Lake area twice per season for CMR. Over time, PIT-tagging SNYLF in this manner will allow more accurate estimation of population size, especially for a relatively small population occupying habitat that is challenging to survey (Mazerolle et al. 2007). Additionally, CDFW will set monitoring gill nets to check for illegally planted BK.

Figure 82. Gill net sabotage at Beebe Lake in September 2014. People somehow strung up gill nets high into the canopy of a dead snag adjacent to Beebe Lake. These same individuals, or perhaps someone else, stole 11 of 13 gill nets set at Beebe Lake and the nearby meadow ponds in early summer 2021, following the re-initiation of gillnetting after Brook Trout were illegally reintroduced into Beebe Lake around 2019. (CDFW)

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ATTACHMENT 1. CDFW High Mountain Lakes (HML) Project 2024 Field Protocols and Data Recording Instructions

California Department of Fish and Wildlife, North Central Region, Sierra Fisheries

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2024 Goals: This survey is designed to estimate current amphibian and nonnative sportfish occupancy patterns, relative abundances, and long-term distributions and population trends of these species across the northern Sierra Nevada. This information will be used to identify climate-resilient habitats and the recovery of sensitive aquatic amphibians while informing current and future management of widespread nonnative sportfish populations.

Survey123 Data Capture Procedures

Survey Header (Site Details) Methods

Site Details is the initial site header form and precedes other elements of the survey, including the three survey Subforms: **Visual Encounter Survey** (VES), **Mark-Recapture**, and **Fish Survey**. Site details must be filled out thoroughly for each site, even if it's dry. All survey forms need to be reviewed for accuracy after the survey to ensure all the relevant fields are filled in and the data are accurate. Most visual encounter and fish survey sites were surveyed around 20+ years ago, and many others have been resurveyed at least once in subsequent years. These surveys replicate and add to the previous efforts across hundreds of survey locations so that long-term comparisons can be made across the landscape. Many habitat attributes collected during the original survey ~20 years ago will not need to be repeated if the site hydrology is stable and the site has changed little between survey visits.

County: Select the county name from the drop down menu. Counties included are HML regions of the northern Sierra Nevada. Use "Other" if survey is outside of the counties listed.

CA Lake ID: The unique numeric Site ID (integer value) found on the high mountain lakes GIS layer (e.g., 26594). Once the **County** is selected, only **Site ID**'s in that county are displayed. Use "Other" for surveys of sites that are either (a) not in the **CA Lake ID** lookup list, (b) located outside of study area (not in a mapped basin), or (c) for incidental observations of animals that are not in sites (e.g., Northern Rubber Boa on road, Sierra Nevada Yellow-legged Frog at road crossing, etc.). Enter "99999" for a site that does not have an ID.

Site Name: (Text) Name of site on topographic map or high mountain lakes layer. If unnamed, enter "NA".

Survey Date: The date of the survey visit. (This should default to the current date when you begin entering the survey record.)

Site Location: An expandable map used to pinpoint and adjust the surveys XY location. It's extremely important to get accurate site coordinates for every survey location (site) whenever a header is filled out. For meadows, get a location in the center of the site; for lakes/ ponds, get either the center, if dry, or the outlet location of larger ponds and lakes, since those spots tend to be furthest from the cirque headwall and often have better satellite coverage. When you start a new header, the app automatically generates coordinates. Unless you are standing directly where you want to record coordinates, please adjust by updating the location. (This goes for all coordinate captures in Survey123.) For example, in the VES subform, when you generate a new species observation record, it produces coordinates where the record was first created. If data are being entered in locations other than the observation (e.g., back at camp), then they either need to be deleted (small sites do not need specific coordinates, except when early life stages of listed herps are observed) or adjusted based on the field map.

Collecting Coordinates: It's extremely important to collect coordinates for the site location. In addition, we want to collect coordinates for novel sightings, such as features or areas with Sierra Nevada Yellow-legged Frog (RASI) egg masses or larvae. Given their rarity, we want coordinates for all PIT-tagged RASI individuals. All spatial projections for all devices will be set to UTM-NAD83.

Site Type: (Lookup List) Enter the appropriate category that best defines the wetland type. On a 7.5' map, a lake with a surface area of 0.5 hectares is approximately 3 mm x 3 mm viewed at 100%. (0.5 hectares= 50 x 100 meters). If the site is a waterbody >0.5 hectares (ha) and >2 m deep, select: **Lake**. If the site is a shallow waterbody <2 meters deep and <0.5 ha, select **Pond**. For meadows and large meadow ponds, see table below and select the most appropriate meadow type. If the site is along a stream lacking meadow habitats, then select **Stream**; if the site is a constructed water drafting location next to a road, select **Drafting Pond**; if the site is an artificial reservoir of any size, select **Reservoir**; for other site types, select **Other**, and add description to the **Site Visit Notes**.

Meadow Type	Description

Basin Peatland	Meadow occurs along edge of lake and includes floating vegetation mats on top of water.
Depressional Seasonal	A gentle sloping meadow or meadow pond often surrounded by peaty soils that occurs in a topographic depression and surface water dries up most years.
Depressional Perennial	A gentle sloping meadow or meadow pond with peaty soils. Occurs in a topographic depression and retains some water all year.
Discharge Slope	Dominant source of water is from ground water that emerges at or near the meadow surface in the form of springs or seepage areas.
Lacustrine Fringe	Sloping meadow occurs along edge of lake, but not floating/ entering the water. Meadow has discrete isolated lentic habitats that could be used for amphibian breeding.
Riparian High Gradient	Prominent Stream flows through meadow. Slope >4%
Riparian Middle Gradient	Prominent Stream flows through meadow. Stream Slope ≥2 – ≤4%
Riparian Low Gradient	Prominent Stream flows through meadow. Stream Slope <2%

Start and End Coordinates for Stream Surveys (**Start UTM E**, **Start UTM N**; **End UTM E**, **End UTM N**): Use these fields to record the start and end UTM coordinates for stream surveys, specifically. (For lakes, ponds, meadows, etc., use the **Site Location** feature discussed above.)

Surveyors: (Lookup List) Select all surveyors that helped collect any data at the site (i.e., VES, CMR, Fish, Habitat).

Wind: (Lookup List) Enter the appropriate category to represent current wind conditions at the site. If there is no breeze present, select **Calm**. If there is an intermittent or steady light breeze present (<5 mph), select **Light**. If there is an intermittent or steady moderate wind present (5–20 mph), select **Moderate**. If there is an intermittent or steady heavy wind present (>20 mph), as evidenced by white-capped waves on the surface of a waterbody, select **Strong**. Have this category best reflect what the overall wind conditions were during the survey.

Weather: (Lookup List) Select the appropriate category to represent the weather condition during your VES. If the sky has less than 5% cloud cover, select **Clear**. If the sky has 5–50% cloud cover, select **Partly Cloudy**. If the sky has 51–95% cloud cover, select **Mostly Cloudy**. If the sky has 100% cloud cover, select **Overcast**. If it is raining, select **Rain**. If it is snowing, select **Snow**. If wildfire smoke is substantial, widespread, with poor distant visibility, select **Smoke**. Have this category best reflect what the overall wind conditions were during the survey.

Air Temp (°C): Measure air temperature at the start of your VES survey from the shore, in the shade (use your body's shadow to shade the thermometer if necessary) at 1 m above the water surface.

Water Temp (°C): Measure the water temperature at the start of your VES survey approximately 0.5 m out from shore and 10 cm under the water surface. For meadows, record the water temperature in a location that best characterizes the meadow temperature (pond or stream).

Survey Type: (Lookup List) What type of survey was conducted during the site visit? Select **Full Survey** when both a formal VES and fish survey (i.e., gill net, hook-and-line, or electrofishing were used to sample fish; <u>if you only conducted visual surveys for fish, this category does not apply</u>); select **VES Only** when a VES was completed (including visual observations for fish); select **Incidental** when a partial VES or incidental observation was recorded at a site or at a random location, such as a trail or road, etc; select **CMR Only** for capture-mark-recapture surveys; select **Fish Only** when a site was only surveyed for fish.

Hydrology: (Lookup List) What is the hydroperiod of the site? Determine the best category that describes the sites persistence.

Hydrology	Persistence	Attributes
Short	<1 year	Temporary or no inlets/outlets. Shallow, often <1 meter deep. No aquatic vegetation. Fairy shrimp, but few other invertebrates. Not spring-fed. Submerged cracked mud bottom indicating annual drying. Usually dries within weeks to mid-summer, after snowmelt disappears.
Intermediate	1 to 5 years	Temporary or no inlets/outlets. Shallow, often <1.5 meters. Little/no aquatic vegetation. Rarely spring-fed. Drawdown/bathtub ring evidence prominent. Dries often in drought years.
Perennial	Decades	Often has perennial inlets/outlets. Often >1 meter deep. Aquatic vegetation/lilies. Robust invert diversity. Fish present. Often spring-fed. Could dry in exceptional multi-year droughts.
Permanent	Centuries	Often has perennial inlets/outlets. Deep, often greater than 5 meters. Aquatic vegetation/lilies. Robust invert diversity. Fish present. Large watershed area. Never dries.
Artificial	Unknown	Man-made reservoir or highly modified/dammed natural site used for water storage.
Unknown	NA	When you rarely cannot make the call.

Turbidity: (Lookup List) What is the turbidity of the site? If the water is clear, select **Clear**; if the water is transparent, but tea-colored with tannins, select **Stained**; if the water is not transparent and turbid, select **Cloudy**.

Max Depth (m): Decimal (00.00) What is the maximum depth of the site <u>during your visit</u>? We'll usually only be directly measuring this value when setting a gill net from a float tube in lakes and large ponds. To do this, we use either an electronic depth gauge or a rope with graduations attached to a rock bag. For small ponds and meadows, find the deepest feature in the wetland complex—lotic or lentic, and either measure with tape or using graduations on a dip net. If you do not actually measure this value, leave it blank, and skip to **Depth Category**.

Depth Category: (Lookup List) Select the appropriate depth category from the entire site (for sites where maximum depth is actually measured, ALSO fill out this field). Select **Dry** if the site is dry during the survey visit. If you are not able to obtain a maximum depth for a waterbody or meadow-complex, then use your best visual judgement for depth category to characterize the site.

Inlets: (Integer) How many significant flowing inlets enter the site during your survey?

Outlets: (Integer) How many significant flowing outlets exit the site during your survey?

Drainage: (Lookup List) What is the drainage class for the site? If the site has at least one inlet and one outlet with flowing surface water that you estimate will flow all summer long, select **Perennial**; if the site only has dry inlet and outlet channels, or the inlets and outlets have low surface water flow that you estimate will go completely subsurface before the end of the summer, select **Occasional**; if the site has no evidence of inlet or outlet channels, select **None**.

Disturbance (Lookup List): Select all disturbance categories observed at the site during your visit. Disturbance can be natural or artificial. Pay special attention to site outlets to see if they have small rock dams currently influencing hydrology (**Dam on Natural Site)**. Record head cutting in meadows caused by livestock or OHV tracks. Although VES surveys should be avoided during high recreational activity, record **Other** and add a comment in the **Site Visit Notes**. Add emphasis for any significant site disturbance in the **Site Visit Notes.**

Dam Evidence (Lookup List): Is the site currently being dammed by an artificial structure (e.g., earthen, stonemasonry, or concrete) or is there evidence of a former artificial dam at the site outlet? If current, select **Currently Dammed**, if former dam evidence is present select **Yes**.

Barriers Present? (Yes/No): For stream surveys, note whether you observed any barriers to upstream fish passage. In general, any vertical drop ≥ 2 m, especially without a plunge pool beneath, may be a barrier to upstream movement of high elevation, stream form trout species. Since we are not conducting a detailed assessment of definitive fish barriers via this documentation method, use your best judgment about whether fish could surmount the obstacle in question under various flow conditions. Large vertical waterfalls, or long, stretches of sheet flow running over steep bedrock are the type of definitive fish barriers we are especially interested in noting using these fields.

 # Barriers Seen: (Integer) How many significant barriers to upstream fish passage did you see during your survey? Note: we'll only document coordinates and notes for up to two fish barriers. When surveying inlets or outlets of a main lake, document the first two barriers within proximity of the lake. You do not need to collect coordinates or notes for any additional barriers, but note the total number here.

Barrier 1 Details (**Barrier 1_UTM E**, **Barrier 1_UTM N**, and **Barrier 1 Description**): Enter coordinates (from a GPS app or your inReach) and a brief description (e.g., "3 meter waterfall") for the first barrier.

Barrier 1 Photo(s): Take at least one photo of the barrier, making sure to place an object of known size vertically in the image (e.g., we usually use our VES dip net, standing vertically at the base of the barrier with the pole extended).

Barrier 2 Details (**Barrier 2_UTM E**, **Barrier 2_UTM N**, and **Barrier 2 Description**): Enter coordinates (from a GPS app or your inReach) and a brief description (e.g., "3 meter waterfall") for the second barrier.

Barrier 2 Photo(s): Take at least one photo of the barrier, making sure to place an object of known size vertically in the image (e.g., we usually use our VES dip net, standing vertically at the base of the barrier with the pole extended).

Site Length (m): Estimate or pace the maximum length of the site to 0.1 meters. Not required if the length is listed in the FieldMaps site attribute table AND if water levels are stable. If the site is drying, record current site length.

Site Width (m): Estimate or pace the average width of the site to 0.1 meters. Not required if the width is listed in the FieldMaps site attribute table AND if water levels are stable. If the site is drying, record current average site width.

Lotic (m^2): Decimal (00.0) Reserved for Meadows. Estimate the total lotic (flowing) habitat in meters squared present during the survey visit. Does not include inlets above meadow and outlets below meadow.

Lentic (m^2): Decimal (0.00) Reserved for Meadows and Ponds or Lakes that are experiencing drawdown (drying) during the survey visit. Estimate the total lentic (standing) habitat in meters squared available during the survey visit.

Drawdown (m): Decimal (00.00) Record the vertical distance (height) from the water surface at the time of your visit up to the bank-full line or bathtub ring where the site is expected to be completely full in the spring.

% Silt Transects: (Integer) (lentic waters only) What is the littoral zone silt substrate composition? Not required if Littoral Zone substrate is listed in the FieldMaps site attribute table. If the site is small or has lots of amphibians, estimate silt after the VES is complete.

Sites <100-meter wetted perimeter: estimate % of the total littoral zone that is made up of silt.

Sites with >100-meter wetted perimeter: conduct littoral transect surveys and convert to a percentage silt.

Meadow sites: estimate the % silt of all wetland features combined as we do not conduct transects in meadows.

Transect method: While walking around the lake/pond perimeter during the VES, stop after a set number of paces and categorize the substrate at the lake edge in your field notebook using the dot method (pace count is related to obtaining 50 evenly distributed transects at a site depending on its estimated perimeter [e.g., the pace count for a site perimeter of 200 m is 4 m]). Determine if silt is the dominant substrate along a 1 m wide imaginary transect line starting at the lake edge, extending perpendicular from shore 3 m out along the lake/pond bottom. Silt particles are classified as being <0.06mm. When at a transect where there is less than 3 m of water from the shore to the center of the lake, categorize the transect using whatever length is present from shore to the center of the lake. Tally silt when it's the greatest proportion over all other types (i.e., pebble, gravel, cobble, boulder, bedrock). Tally "other" when silt is not the dominant substrate. After the survey, calculate the % silt out of the total transects and record answer in field forms.

Herps Present? (Yes/No): Once the survey is completed, use this field to note whether you observed any herps.

Fish Present? (Yes/No): Once the survey is completed, use this field to note whether you observed or captured any fish.

Site Visit Notes (Text): Any important notes related to the site and your survey visit.

Site Drawing: (Freehand) Draw the site perimeter. Add prominent inlets, outlets, and streams. For meadows, add ponds that are of interest; also add ponds and edge meadows of interest that were surveyed along with a main large pond or lake. Indicate deep spot for ponds and lakes. Label with the CA Lake ID, if known.

Site Photo(s): Take photos that best capture the site's overall habitat and setting. This is usually achieved from a vantage point above the site. Make sure the lens of your phone or tablet is clean. Panoramas often work great, but try to limit image file size. Also photograph any observed damage, such as OHV impacts or grazing.

Visual Encounter Survey Methods

We will be conducting amphibian and reptile (herp) surveys at pre-determined locations (i.e., we will provide a map that shows the locations to survey; or, when using Field Maps, we will provide a list of CA Lake IDs to survey). If you find any unmapped ponds while visiting a designated area: survey the location, and on the **Site Details** form, select "Other" under "CA Lake ID" and record that this is a new/unmapped pond in the "Site Visit Notes." You will need a notebook, datasheet, and smartphone or iPad (with our Survey 123 forms pre-installed), pencils, thermometer, dip net, and timepiece for determining total survey duration. Time of day, temperature, and weather are important factors affecting the quality of any VES survey. Time your surveys to occur during the warm portions of the day (roughly 9am – 5pm), however, the time window can vary depending upon time of year and local favorable weather conditions. If the weather is too cold or stormy, VES surveys can be very inaccurate, so you should not conduct surveys during inclement weather.

To conduct a herp survey at lakes and ponds, start your timer and walk **slowly** around the perimeter of the site, visually scouting for herps near the shoreline while counting the number of adults, subadults, metamorphs, neonates (newborn snakes), larvae, and egg masses you find of each species. (For snakes, only neonates, subadult, and adult applies.) Pause often to look ahead for basking animals. Use your net to sweep habitat and banks to spook hidden animals. If its windy enough to obscure the water column with surface ripples, wait for water surface to clear between gusts. If humans are recreating along the shore or in the water, then request if they could pause until you move through. Depending on the number of campers at the site, choose a time in advance when the site is likely to be less busy (mid-morning). For meadows, do a timed herp survey focusing on shorelines and aquatic and wadable habitats. Do not completely ignore the rest of the meadow (e.g., zig-zag through moist areas that are near open water features).

Run your stopwatch throughout the survey to determine survey duration. Pause your stopwatch whenever you stop actively surveying (e.g., when you need to move around large obstacles, take a snack/lunch break, etc.).

For prominent inlet and outlet streams at lakes and meadows, survey channels for amphibians, reptiles, and fishes from where they meet the feature for up to 200 meters. Some streams may be intermittent. Inspect residual pools in drying channels. If the stream connects to another survey site in under 100 meters, survey half the distance to the other site so the inlet/outlet survey can be done at each site.

If necessary, use a dip net to catch herps for identification and record in field notebook, iPad, or data sheet. All data needs to be entered into Survey123 during the same day of the survey, regardless of how it was recorded. Each species/life stage/survey method combination detected should be recorded in separate rows (e.g., chorus frog adults detected **Visually** during the timed survey in one row, and adults detected **Aurally** during the timed survey in another row). In addition, each species/life stage/survey method combination detected incidentally (e.g., detected before or after the timed survey) also should be recorded in a separate row under **Incidental**. For large lakes/ponds and meadows, record UTMs for all spatially separate habitat features having reproductive stages (Egg, Larvae, Metamorph).

For any double-observer surveys, we follow the methods of Fellers et al. (2015; "Wetland Occupancy of Pond-Breeding Amphibians in Yosemite National Park, USA"). Each person surveys a given location independently (one person surveys the site, then the other person surveys the site soon afterward), waiting 15 minutes to an hour between the first and second survey (to allow time for herps to recover from disturbance caused by the initial pass). Do not wait more than an hour to begin the second survey, since conditions need to be as similar as possible during both surveys. **Importantly:** during the first survey, the second observer must not watch the survey, and observers may not discuss what they observed until both surveys are completed. For areas with close clusters of wetland features, the most efficient method is often for each person to survey a different, nearby location in the survey area, and then switch waterbodies (i.e., each person surveys the spot the other person just surveyed). Additionally, both surveyors should conduct their surveys in the same direction, and start from the same original starting point, so each observer experiences the best approximation of identical survey conditions (e.g., at lentic sites, both observers should conduct their surveys clockwise or counterclockwise; for lotic sites, both surveyors should conduct their surveys in an upstream direction). Finally, alternate who conducts the first survey at each waterbody, so that the same person is not always conducting the first or second survey, respectively.

Visual Encounter Survey Subform

If the site is being surveyed with two passes for determining species detection rates (double-observer surveys), then each surveyor fills out their own **Visual Encounter Survey** subform under the same **Site Details** header. Additionally, if the site is large and is being surveyed by multiple observers during each pass, then each surveyor fills out their own **Visual Encounter Survey** subform under the same **Site Details** header form.

VES Surveyor: (Lookup List) indicate the surveyor doing the VES pass.

VES Observer: (Lookup List) Choose **Single** for a site that is only surveyed with one pass. For resurvey sites used to calculate species detection rates, choose **Primary** (first observer), or **Secondary** second observer, depending on which VES is being done (first or second). If the site is large, requires only a single pass, but is split between two or more surveyors, each surveyor fills out their own **Visual Encounter Survey** subform under the same Header and selects **Single**.

Start Time: (AM/PM) The time when the VES is initiated.

End Time: (AM/PM) The time when the VES is completed.

VES Duration: (Minutes) Record the total time spent searching by using a stopwatch while searching for herps. Do not include time spent surmounting lake-side obstacles (e.g., cliffs), breaks, identifying specimens in hand, or recording extensive notes. The duration is used to calculate observations based on active observation effort. If two people survey the same site by walking in opposite directions around the lake perimeter, each person enters their own survey duration in their own **Visual Encounter Survey** subform.

VES Details subform (nested under Visual Encounter Survey subform)

Observation Location: [An expandable map used to pinpoint and adjust the survey's XY location (see details about collection coordinates under "**Site Location**" and the **Collecting Coordinates** box under **Survey Header** methods at the beginning of this protocol).] You do not need to note the location for most observations during a normal VES (as opposed to CMR, where we document the location of all PIT-tagged frogs). Once the VES subform is open, the Observation Location map should autofill. Therefore, for other observations where the location isn't needed, click the "⊗" at the upper right side of the map (to the right to the displayed UTM coordinates) to remove the location. Use this waypoint feature specifically for documenting the location of notable or rare observations, such as *Rana sierrae* egg masses. If you record a waypoint with this feature, explain why in the **Observation Notes.**

Species: (Lookup List) Select the species you have detected. If you cannot determine species, identify to the lowest level (e.g. Anura sp.).

Life Stage: (Lookup List) Select the life stage you have detected for a given species: **Egg, Larvae, Metamorph** (tail nub still present), **Subadult, Adult, Neonate** (snakes), and **Fry, Parr,** or **Adult** for fishes.

Detection Type: (Lookup List) Select the method used to detect a given species.

Waterbody Type: (Lookup List) Mandatory collection for reproductive stages. Select the type of waterbody where age 0 stages of amphibians are present indicating breeding. Stages include eggs, larvae (1 and 2 year for salamanders), and metamorphs. For species observations in inlets or outlets (outside of the main pond, lake, meadow) always indicate **Inlet** or **Outlet**.

Total Detected: (Integer) Record the total number of detections for a specific data entry group.

Total Swabbed: (Integer) Record the total number of animals swabbed for *Bd* (amphibians) or *OO* (snakes) from a specific data entry group. (see *Bd* and *OO* sampling Appendices)

Time To Detection (TTD)**:** (Integer) ***For threatened and endangered, species of special concern, or gartersnake species only***. For CDFW Region 2 HML surveys, we will primarily collect TTD data on Sierra Nevada Yellow-legged

Frogs (*Rana sierrae*), Southern Long-toad Salamanders (*Ambystoma macrodactylum sigillatum*), and gartersnakes (*Thamnophis* spp.). However, we would also record TTD for Foothill Yellow-legged Frogs (*Rana boylii*), Cascades Frogs (*R. cascadae*), California Red-legged Frogs (*R. draytonii*), and Northwestern Pond Turtles (*A. marmorata*), depending on the survey location.

TTD is the time in minutes elapsed from the survey start until detecting a given herp species and age class. This field is largely reserved for recording the time to first detection for a given herp species at each site relative to the total survey duration. Round up to the nearest minute on your stopwatch at time to first detection for each species and age group. These data can be used to determine detection probabilities for species/age groups. For each species noted above, *except for gartersnakes*, record the first observation of an early life stage (egg, larvae, or metamorph) and the first observation of any post-metamorphic stage (subadult, adult). For gartersnakes, record TTD for the first snake of any species or lifestage. Typically, we only observe Valley Gartersnakes (*T. sirtalis*), Mountain Gartersnakes (*T. elegans*), and Sierra Gartersnakes (*T. couchii*) during HML surveys in CDFW Region 2.

Species Photo(s): Take photos of any noteworthy observations for that particular species and lifestage. For example, clusters of egg masses, malformations/injuries, unusual colors or patterns, etc.

Observation Notes: (Text) Notes related to the specific species/age class data entry group.

Capture-Mark-Recapture Methods

Current *Rana sierrae* capture-mark-recapture (CMR) locations in CDFW Region 2 (circa summer 2024).

Site	Area	Forest	County	Notes
4-Q Lakes	Desolation Wilderness	Eldorado	El Dorado	Population established by translocation.
Beebe Lakes	Mokelumne Wilderness	Eldorado	Alpine	Former fish removal site.
Dufrene Pond	Lower Bear River Reservoir	Eldorado	Amador	Old cattle pond and adjacent streams.
Gold/Rock Lakes	Bucks Lake Wilderness	Plumas	Plumas	BK removed from Gold. Captive-reared frog recipient site.
Goose/Haven Lakes	Lakes Basin	Plumas	Sierra	Captive-reared frog recipient site.
Hellhole Meadow	Tahoe Basin	LTBMU	El Dorado	One of only a few sites in the Tahoe Basin with extant RASI.
Howard Pond	Lakes Basin	Tahoe	Sierra	Partly on Tahoe NF land, partly on private land.
Jabu/Lucille/Margery	Desolation Wilderness	LTBMU	El Dorado	Population reestablished via translocation.
Middle Creek	Silver Fork American	Eldorado	El Dorado	One of the lowest elevation RASI populations. Isolated.
Mt. Pleasant Ponds	Bucks Lake Wilderness	Plumas	Plumas	Captive-reared frog recipient site.
Tamarack/Ralston/Cagwin	Desolation Wilderness	Eldorado	El Dorado	Population reestablished via translocation. Few frogs remain.
Bean and Spanish Creeks	Greater Quincy	Plumas	Plumas	For reference: USFS CMR Area.
South Fork Rock Creek	Greater Quincy	Plumas	Plumas	For reference: USFS CMR Area.
S. Fork, E. Branch Rock Creek	Greater Quincy	Plumas	Plumas	For reference: USFS CMR Area.
Lone Rock Creek	Diamond Mountains	Plumas	Plumas	For reference: USFS CMR Area.

CMR sites are surveyed using VES techniques, but only post-metamorphic life stage Sierra Nevada Yellow-legged Frogs (*Rana sierrae*, RASI) are captured. At a CMR site, we mark any RASI >40 mm snout-to-urostyle length (SUL) with passive integrated transponder (PIT) tags, which are an inert, glass-encapsulated transponder. The PIT tags are tiny: about 8 mm long and 1.4 mm wide. PIT tags are not internally powered, but they provide a unique identification code when read by a compatible tag reader (our current readers are Biomark HPR Lite models).

*When visiting a site for CMR, specifically, you do not need to collect all the data in the **Site Details** main header form (Page 1 of the Survey123 forms). Collect only the following data on form Page 1:

County, **CA Lake ID**, **Site Nam**e (if applicable), **Survey Date**, **Site Location**, **Site Type**, **Surveyors**, **Wind**, **Weather**, **Air Temp (°C)**, **Water Temp (°C)**, **Survey Type**, **Hydrology**, **Turbidity**, **Drainage**, **Disturbance**, **Dam Evidence**, **Herps Present?**, **Fish Present?**, **Site Visit Notes**, and **Site Photos**. Also, if you are surveying a stream section, in particular if the stream reach doesn't have an established CA Lake ID with known start and end points, document your start and end UTMs in the **UTM E @ Start**, **UTM N @ Start**, **UTM E @ End**, and **UTM N @ End** fields.

*Scan gartersnakes in populations where we have tagged frogs.

Upon capturing a frog ≥40 mm SUL at a CMR site, use the PIT tag reader to check if the frog already has a PIT tag. Hold down the "READ" button and scan within an inch or two of both the dorsal and ventral surfaces of the frog. If the frog already has a PIT tag, select "Recapture" in the **Pit Tag Status** field. Record the tag # in the **Pit Tag Number** field. If the frog is not a recapture, select "New" in the **Pit Tag Status** field. Weigh the frog in a small, plastic sandwich bag, being sure to deduct the weight of the bag (tare) before recording the measurement: the small sandwich bags we use weigh one gram when clean and dry. Measure SUL of the frog from a seated position, by holding the frog in your left hand and resting the frog on your thigh, while gently stretching out the frog's back (so its torso is straight). Then, hold the calipers in your right hand, carefully placing the tip (far end) of the calipers on the tip of the urostyle (which is noticeably firm to the touch) and then elongating the calipers until they just barely touch the tip of the frog's snout. To reduce the spread of disease, thoroughly rinse your net and hands between captures, use separate plastic bags for weighing each individual, and clean all measuring implements (scissors and calipers) with alcohol between marking frogs.

PIT tag insertion:

1. At the beginning of the day, place a small quantity of ethanol into the PIT tag container to initially sterilize the tags. Gently shake the container to ensure the tags get evenly coated in alcohol, then leave the lid off and let the bottle sit in the sun until the tags air dry.
2. Pull a tag from the container and set within easy reach on a clean surface, such as the lid of the PIT tag container.
3. Hold the frog in one hand with its back exposed, and use your thumb and forefinger to gently constrict the skin on both sides of the upper back. The goal is to raise up a small skin fold on which you can more easily gain a purchase with surgical scissors to make a tiny incision (ideally, just wide enough to pass the width of the PIT tag).
4. Use your cleaned (dipped in alcohol and dried) surgical scissors to make a small (~3 mm) incision in the pinched skin. Ideally, hold the scissors perpendicular to the frog's back (tip facing straight down), which will make a straight-lined incision. If you hold the scissors at a shallower angle, make sure the tip of your scissors point toward the head of the frog, which will make a small V-shaped incision, with the tip of the "V" pointed towards the ventral end of the frog.
5. Insert the tag through the incision and use your finger to gently slide the tag down the frog's body (the tags moving quite easily beneath the skin), over the sacral hump, and down onto the base of the dorsal end of the torso. We want the tag to sit right above the vent (i.e., at the bottom of the frog's back, close to the cloaca).
6. Scan the tag and record the new number in the **Pit Tag Number** field.
7. Make sure location, weight, length, sex, and PIT tag number have all been recorded without error.
8. Release the frog where you caught it.
9. Clean your surgical scissors between each use by rinsing in ethanol.

Capture-Mark-Recapture (subform)

Species: (Lookup List) In 2024, this will primarily be Sierra Nevada Yellow-legged Frogs, but we may occasionally PIT tag other listed ranids in our region.

Frog Location: An expandable map used to pinpoint and adjust the frog's XY location. See the Site Location and Collecting Coordinates box at the beginning of this protocol for notes about this feature. Make sure the coordinates recorded are for the actual location where you detected the frog.

Waterbody Type: (Lookup List) If animals were seen in an associated water body such as in a **Meadow** or small **Pool** near the lake/ pond being surveyed or in the **Inlet** or **Outlet** stream, then indicate which type.

Pit Tag Status: (Lookup List) Was the Pit Tag from a previous survey or was it newly applied? Choose the appropriate category that best describes the PIT Tag status.

Pit Tag Number: (Text) Record the completed Pit Tag number (e.g. 982000407491384). Note, our Biomark HPR Lite PIT tag readers also store PIT tag numbers, including the date and time the PIT tag was scanned. Therefore, we have a backup of the PIT tag numbers and scan dates/times, but these Survey 123 forms are the primary repository for these data.

Life Stage: (Lookup List) What is the life stage of the individual frog? (**Subadult** or **Adult**)

Sex: (Lookup List) The sex of an individual frog; **Male**, **Female**, or **Unknown** (animals ~<40 mm in length normally do not show sexual characteristics)

SUL (mm): Decimal (00.0) The snout-to-urostyle length of an individual frog in mm.

Weight (g): Decimal (00.0) The weight of an individual frog in grams.

Swab Collected?: (Lookup List) Record whether an skin or buccal swab was collected for genetic analysis and/or Bd (*Batrachochytrium dendrobatidis*) monitoring. Options include "Skin" (epithelial), "Buccal", and "No Swab".

Swab ID: Record the unique ID of the epithelial or buccal swab collected. In most cases, this will be an 8-digit code, beginning with either "MISC" or "DESO", followed by four numbers.

Chin Pattern Photo: As a backup to PIT-tagging, we'll also take a photo of each PIT-tagged frog's chin pattern. The chin patterns of our native ranid frogs are unique (although the color, contrast, and visibility of the pattern can change over time), sort of like a fingerprint.

Notes: (Text) Any notes of interest associated with the individual frog record. For example, if the frog has any injuries or malformations, if the frog appears gravid, or atypically skinny, etc.

Fish Survey Methods

In some locations, we will be setting gill nets to determine whether fish are present. In other locations, we know (or assume) fish are present, and we specifically target the site to determine the general status of the fishery (i.e., Are fish still present? What is the current species composition? Are we seeing various size classes, or only older adults?). In other cases, we are visiting the areas specifically to conduct herp-focused surveys and we don't have the need to set any gill nets.

For locations where we have removed non-native fish for a restoration project, or we have otherwise assumed that fish are absent (e.g., areas with known *Rana sierrae* populations): if you see fish, you should set a gill net (if you have one available). If you don't have a net, record details about the observation in your survey notes (e.g., your best guess about species, an estimate of the number seen, approximate sizes observed, and any photos you can obtain). In general, if we are visiting any locations where there is *any question about whether fish are present* in a lake and we specifically *don't* want fish to be there (e.g., former non-native fish removal sites), set a net.

If you surveyed for fish visually, provide a brief justification regarding why you chose that method in the **Reason no gill net set** dropdown field (e.g., too many obstructions, such as vegetation or logs; the site is shallow with entire bottom visible; etc). A visual fish survey is justified for small/shallow sites (e.g., because the lake is < 2m deep, you can see the entire bottom, and there are positively no fish), or in locations where we are specifically there for herp VES or CMR only. However, fill out the Fish Survey subform form for every VES.

Gill Net Survey Methods

Objectives: Our fish survey methods are designed to provide an accurate representation of fish species composition and size structure in lakes and ponds, as well as provide an estimate of catch per unit effort (CPUE) at each location. To quantify the size structure of each fish species present at a particular location, we need a sample of at least 20 fish, and preferably not more than 50. In lakes that have a very small fish population, capturing even 10 fish may not be possible. Where we're sampling fish, we will set one net for a minimum of 4 hours and maximum of 12 hours. Nets can be set at any time of day, but are often set just before dark and pulled first thing in the morning. To minimize logistical problems and safety hazards, however, do not pull nets in the dark. Time your net sets appropriately. For example, don't set a net at 6 PM, since this would mean either pulling the net at 10 PM or waiting until morning and exceeding the 12-hour maximum set duration. If the lake has a dense trout population, you may want to paddle the float tube out to count fish in the net after 4 hours. If you have 40 or more fish after 4 hours, pull the net to avoid capturing an inordinate number of specimens. Use this 4-hour minimum net set duration only when absolutely necessary.

Setting Nets: Before getting into your float tube, you'll want to make sure you have a complete net setup, including your gill net with a sufficient length of p-cord shore anchor line attached to a loop at the end of the small mesh/near shore side of the net's top side, and a float line (bundle of thin, strong nylon twine with a PVC "donut"-style float attached). Also, make sure you have a rock anchor in the pocket of your float tube: the rock anchor is a short length of p-cord with a sliding knot that secures a small rock at one end (to help the net sink to the lake bottom and stay in place while set) and a small carabiner secured to the other end, to clip onto the bottom loop at the far/deep water end of the net's sinking line. It's also handy to have some extra nylon twine (if you need to lengthen the float line while setting the net), pocket knife (tethered to the float tube, lest your knife be lost to the depths), and lighter so you can prevent fraying on cut ends of nylon twine.

If an outlet is present, gill nets should be set there, if conditions allow. If there is no outlet, or it's not feasible to place a gill net there (water <2 m deep, log jams, etc.), set the net at the inlet. If an inlet is not present or is not suitable, set the net in any suitable location along the lake shore. If possible, choose an area that's 3–8 m deep. (Net dimensions are 36 meters long by 1.8 meters tall.) Before setting a gill net, submerge the entire net while it's still bundled on the net hook; dry nets that have been used previously are much more susceptible to tangling/sticking together. To set the net, tie the p-cord to a tree, shrub, or large anchor rock. Allow enough p-cord slack so the near-shore side of the net is far enough off shore to be fully submerged in the water (and preferably so the top of the shore-side of the net is at least 0.5–1 m below the surface).

Get in your float tube, lay the net across the float tube (with the net bundle in your left hand and the net handle in your right hand, or vice versa), and paddle backwards slowly while feeding out the net. It can help to hold the net up so it's not touching the float tube while setting, since the monofilament mesh can get snagged on parts of the float tube. In general, the net should be set perpendicular to the shore. If you can see the bottom while setting the net (wearing your polarized sunglasses can help), keep an eye out for submerged logs (especially ones with branches still present) or large rocks: if possible, you want to avoid setting a gill net over those features, since the net can easily become snagged on submerged objects. If you encounter a tangle while feeding out the net, shake the net. Do not just pull on the net to remove a snag, since that can tighten the tangle. Shaking will nearly always rid the net of the tangle.

When you get to the end of the net, paddle backwards until the net is taut. Keep ahold of the handle and free the float line so it can be smoothly fed into the water while setting the net. Then, clip the carabiner of your rock anchor to the loop at the bottom of the net. Drop the anchor rock first, then the hook (while keeping ahold of the float line); that way, the net will be oriented correctly with the sinking side down and float side upright in the water column. Slowly release the floatline while paddling backwards to keep the net taut. Record the time when you finish setting the net. Make sure the entire net is below the water surface along the shore to minimize tangling non-target species, such as birds, mammals, and herps.

Pulling Nets: Make sure you have an empty stuff sack with you during the net retrieval process. In some cases, when few fish are caught, you can just remove fish as you're bringing in the net, placing them into the stuff sack as you go. However, in most cases, you'll want to bring in the entire net with all the fish still in the monofilament, then remove and process the fish on shore.

After 4–12 hours, retrieve the net by floating out to the far end and pulling the net up by the float. Wrap up the float twine and place the twine/float bundle into your coat pocket or life vest (or detach the float and line, and place that in your float tube pocket). Also, unclip the rock anchor and stick that into the float tube pocket. Pull the net toward you, and begin placing the net back onto the hook by sticking the hook through every third loop directly beneath the little floats along the top line of the net (the floats are small, elongated football-shaped objects placed at regular intervals along the top line). Slowly paddle in while hooking the net; you can simultaneously pull yourself along the net while moving towards shore taking in the net. Continue pulling in the net until you reach the shore.

Detach and bundle up the anchor line. Carry the net to an area for fish removal, making sure that net doesn't touch the ground; also keep an eye out for any fish that may fall out of the net while you're moving to an appropriate area for processing. Lay the net down in a meadow or on a sandy flat: meadow or open bedrock areas are preferable, but nearly any place will work; however, stay away from areas with lots of woody vegetation, pine needles, pinecones, and sharp rocks: pinecones, needles, and sticks easily get caught in gill nets (and they're a pain to remove), and the nets can get snagged and damage on woody shrubs and sharp rocks.

If a relatively small number of fish were caught (e.g., ≤20), you may be able to lay out the entire net. However, if open space is limited or the net captured many fish, you'll want to lay out the net in smaller sections. In that case, spread out the first 10 feet of net and remove the fish. After removing all fish from the first 10 feet of net, spread the next 10 feet of net and fold up the first 10 feet. Continue until you have removed all fish from the net. The net management process once fish removal is complete: restring onto the handle, rinse in the lake, air dry in the shade, twist and tie in a knot to prevent tangling, and stuff into a sack where the net is always stored between uses. If the net gets torn, then repair it by stitching holes shut with fishing line before using the net again.

Measurements: If no fish were captured in the gill net, select **None** in the **Fish Species Present** field. If fish were captured, record the species, total length, and weight of all fish. Measure fish using vinyl sewing tape laid out on the ground. Measure fish total lengths to the nearest mm. Weigh fish using Pesola spring scales. Use the 100 g scale for all fish <100 g, and the 1 kg scale for larger fish. (We sometimes also use 300 g scales for mid-sized fish.)

Disposal: Be careful about disposing fish carcasses because we do not want the carcasses attracting the attention of backpackers or bears. The best disposal method is to pop the fish's swim bladders by cutting open their body cavities, put the fish in a stuff sack, paddle out into the lake until you reach a deep area, and dump them. Burial of fish on land should be avoided, as animals can smell the fish and will dig them up. Returning the dead fish to the waterbody keeps the biomass/nutrients that the fish acquired in the waterbody.

Fish Survey Subform

Fish Detection Methods: (Lookup List) What methods were used to detect fish? Select all that applied to the visit, regardless of whether fish were seen or not.

Fish Species Present: (Lookup List) What species of fish were observed at the site? Select all species observed across all survey methods. If there are no fish present at the site, enter **None**.

Fry Seen: (Lookup List) Were fry (very small, juvenile fish) seen at the site? (As immature salmonids become larger and develop a series of bars/elongated ovals on their sides, which called parr marks, the fish are then known as "parr.")

Redds Seen: (Lookup List) Were redds (fish nests; depressions dug into the gravel that are usually clear of algae) seen at the site? If you think you may have seen redds, but you're not sure, select **Unknown** and provide an explanation in the **Fish Survey Notes**. If you think the potential redd may be visible via photo, you can also take a picture using the **Fish Captures Photo** field at the bottom of the Fish Survey subform.

Fish Locations: (Lookup List) If fish were detected at the site, select all habitat types where fish were observed, based on combined methods (e.g., gill net, VES, redds, etc.).

Net Set Location: (Lookup List) was the net set near an **Inlet**, **Outlet**, or **Neither**?

Net Set Date/Time: (24-hour) The date and time the gill net was set. Time is recorded once the entire net has been deployed and lowered into position.

Net Pull Date/Time: (24-hour) The date and time the gill net was retrieved. Recorded when you begin pulling the net.

E-Fish Lentic Effort: (Integer) Time spent electrofishing in lentic water bodies (stillwater; lakes and ponds) recorded in seconds. Record at the completion of electrofishing.

E-Fish Lotic Effort: (Integer) Time spent electrofishing in lotic water bodies (flowing water; rivers and streams) recorded in seconds. Record at the completion of electrofishing.

Gill Net Location: (geopoint) An expandable map used to pinpoint and adjust XY location of the net. See the Site Location and Collecting Coordinates box at the beginning of this protocol for notes about this feature. Make sure the coordinates recorded are for the actual location where you set the net.

Fish Survey Notes: (Text) Specific notes related to the fish survey, fish observations, and sign.

Fish Capture Metrics Subform (nested under fish survey subform)

Fish Species: (Lookup List) The species of fish captured via gill net, hook and line, or electrofishing.

Other Species: (Lookup List) The species of animal other than fish captured by the gill net.

Count: (Integer) The count bin for individual or groups of fish or non-fish gill net captures. When fish are measured individually, this field will always equal a count of 1.

Length Range (mm): (Lookup List) Lengths binned into various size groups for individual or groups of fish. Only use this field if you have captured >50 fish, and/or if you do not have the time to process the catch. Do not collect weight if you are using length range.

Total Length (mm): (Integer) The total length of an individual fish capture (from tip to snout to the top of the caudal fin, while compressing the caudal fin from top to bottom), in millimeters. Measure lengths using tapes.

Weight (g): Decimal (00.0) The weight of an individual fish in grams. If the fish weight exceeds the scale capacity, cut the fish into parts *after* taking the length measurement AND after taking the photo(s) of the fish. Add up the individual weights. Cut fish in a plastic bag so you can also retain and weigh the internal organs and fluids.

Fish Captures Photo: Take at least one photo showing all fish captured from the gill net. After removing all fish from the net, lay the fish neatly (side-by-side) in rows on the ground and place the measuring tape next to one end of the row(s). Preferably, arrange fish by species and size (i.e., all brook trout together, from largest to smallest; etc.). The only exception to this requirement is when you have a large quantity of minnows (e.g., speckled dace, Lahontan redside, or golden shiner). If you do not have a measuring tape for some reason, place an object of known size next to the fish, such as a pencil, Sharpie, or Pesola scale.

Capture Notes: (Text) Notes related to a specific gill net capture or capture group.

Post-survey Data Methods

The easiest and most efficient method is to collect data directly into the Survey123 app on your phone. However, to preserve the phone's battery—in particular, if you are running low on battery power and either 1) don't have your battery bank close by, or 2) your battery bank is losing power—and/or to avoid unintentionally dunking the phone in a lake, you may decide to collect data in a Rite-in-the-Rain notebook during the survey, and then enter the data once the survey is finished. **If you choose to initially gather data in a notebook, ensure that you have this protocol available to remind yourself of all the data that needs to be collected.**

During surveys, you can either keep the phone in your day pack or back at camp. However, the former is preferred (i.e., carrying the phone with you and entering the data into Survey123 after each survey is completed). That way, you avoid building up an entire day's worth of surveys and needing to enter the data all at once at the end of the day. One of the main things to remember when entering data into Survey123 after-the-fact is that coordinate locations will NOT be correct in the automated geopoint maps in the survey forms: you will need to specifically move the coordinates to the correct locations, so it's vital that you write down the correct coordinates for various waypoints (rare/unique frog observations, gill net set locations, PIT-tagged frogs, etc.) in your notebook. Keeping track of photos can also become problematic, so make sure to write down the correct photo IDs for all survey photos you collect during the survey. You can go back and select photos to upload into the survey forms (using the folder icon that's to the right of the camera icon), but make sure you're selecting the correct photos. That may be easier said than done if you have numerous surveys to enter and a lot of photos built up. **So, whenever possible, please enter the data for each site immediately after you have completed the survey, before moving to the next location.**

For CMR surveys, in particular, it's very important to have your notebook data well-organized. Given the importance of the CMR data (including the effort involved in obtaining these data), and fact that we may not have signal to upload the Survey123 data until after the trip, I am requesting that you collect all the core CMR in a notebook as a backup, in case of phone failure or damage before the data can be uploaded. In addition to the basic header information (refer to the list of **Site Details** information needed for CMR in the "Capture-Mark-Recapture Methods" section above), below is an example (using fake data) of how to set up your notebook for CMR:

New/ Recap	**PIT Tag #**	**Sex**	**SUL (mm)**	**Weight (g)**	**CA Lake ID**	**Coordinates**		**Photo #'s**	**Swab?**	**Swab ID**	**Notes**
N	982000407491999	F	67	32	13932	703195	4394266	IMG_8122	Y	MISC1342	Healthy. Gravid?
R	982000407491364	M	58	29	13922	703286	4394278	IMG_8123	N	N/A	Missing right thumb.

In many areas that we survey, there won't be any wireless signal available to export surveys to the cloud. Therefore, please save the surveys in your Survey123 Outbox for upload once you have signal available. Many areas we visit have limited areas with mobile signal available, although it can be spotty. Isaac can give you information on where you can get a signal at some of the field sites we visit with some regularity. If you're using a personal phone and your wireless data is limited, we can specifically wait to upload the data until you have access to a wifi signal to avoid using cellular data from your plan. Isaac also has a CDFW-issued phone that you're welcome to use for inputting data into Survey123, to avoid using your own phone and data, if that's your preference. **In sum: we went to get these data "Sent" (uploaded to the cloud/ArcGIS Online) as soon as possible.**

Since 2024 is the first year we're using Survey123, there will inevitably be some problems to work through. We'll have a data QA/QC process once the core field season is over, to ensure the data are clean. Ultimately, I am planning to come up with a workflow to append the data we collect in Survey123 to the HML Access Database, which has been the repository for HML data for over 20 years.

Let Isaac know if you have any questions about this protocol. Also, especially since this is our first season using this new protocol, also let Isaac know if you notice any errors, omissions, or things that aren't clear. Thank you!