

State of California
Department of Fish and Wildlife
Memorandum

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To: Sarah Mussulman,
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High Mountain Lakes;
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Subject: Amphibian monitoring in Tahoe National Forest, Nevada County

- ***Rana sierrae* monitoring in the Mossy Pond area**
- ***Rana sierrae* monitoring in the Rattlesnake Creek area**



ENVIRONMENTAL SETTING

The Mossy Pond area and Rattlesnake Creek are located in Tahoe National Forest, north of Highway 80 in Nevada County (**Figure 1**). The sites are accessible via United States Forest Service (USFS) dirt roads and four-wheel drive trails. The Mossy Pond complex is composed of approximately 80 lakes, ponds, and small streams set on granite benches southeast of Fordyce Reservoir (Fordyce). Many of the waterbodies in the Mossy Pond complex support small Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) populations. The Mossy Pond complex ranges in elevation from 6,400 feet (ft) (1,951 meters [m]) near Fordyce, to 8,098 ft (2,468 m) at the summit of Buzzard Roost. Various stream channels contain flowing water for brief periods each spring, but stream channels dwindle to intermittent pools during the rest of summer. United

States Geological Survey (USGS) field crews first detected SNYLF in the watershed in 1998 at Mossy Pond and Evelyn Lake; California Department of Fish and Wildlife (CDFW) began monitoring the population in 2001.

Rattlesnake Creek is located approximately 5 kilometers (km) south of the Mossy Pond complex. CDFW monitors a 2-km section of Rattlesnake Creek that flows east to west through USFS-owned land, the lower segment of a small tributary that flows from Magonigal Summit into Rattlesnake Creek, and a small pond approximately 40 m north of the creek (**Figure 1**). The Rattlesnake Creek area ranges in elevation from about 6,700 ft (2,042 m) at the lower end of the monitored segment of Rattlesnake Creek to 8,098 ft (2,468 m) at the summit of Buzzard Roost. USGS field crews first detected SNYLF in 1995 and 1996; CDFW began monitoring the population in 2009. In recent years, Tahoe National Forest (TNF) biologists have also been monitoring the SNYLF population in Rattlesnake Creek.

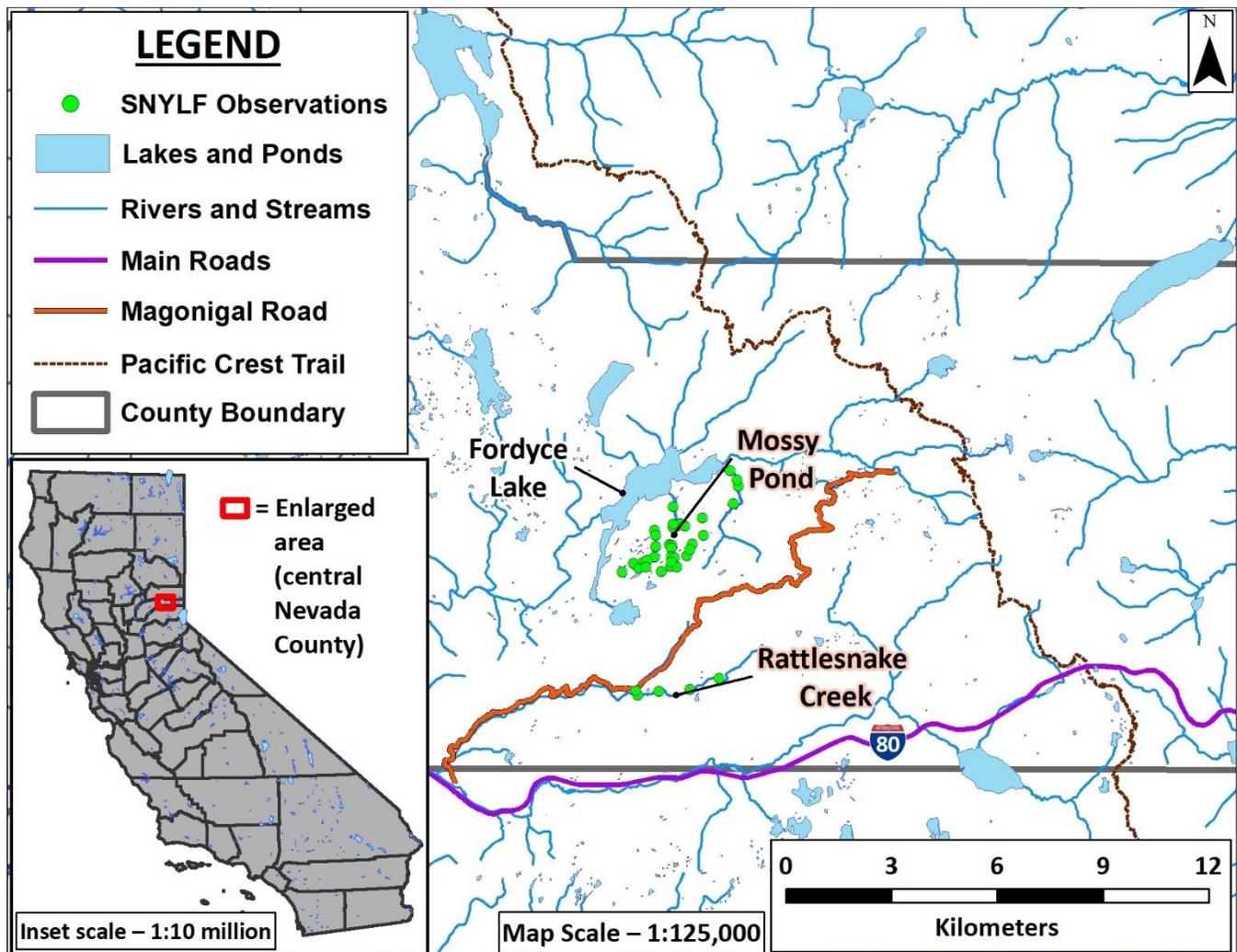


Figure 1. Mossy Pond and Rattlesnake Creek areas, Nevada County, CA. Green dots show Sierra Nevada yellow-legged Frog (*Rana sierrae*; SNYLF) detections by California Department of Fish and Wildlife (CDFW) staff during recent visual encounter surveys (VES).

INTRODUCTION

The Aquatic Biodiversity Management Plan (ABMP) for the South Yuba River Management Unit (CDFW 2014) identifies sites occupied by SNYLF as amphibian resources and prescribes regular population monitoring.

In 2012, periodic visual encounter surveys (VES) during the previous decade suggested the Mossy Pond SNYLF population could be headed toward extirpation. However, complete VES of wetted habitat during summer 2013 suggested a robust population still present in the area. After assessing all available wetted habitats in the area, CDFW concluded that previous surveys had focused on locations in the Mossy Pond area that are less often utilized by SNYLF. CDFW discovered that SNYLF in the Mossy Pond area are often found in streams and small, ephemeral ponds.

Based on this new understanding of the SNLYF population in the Mossy Pond complex, CDFW initiated a capture-mark-recapture (CMR) study in 2014. Beginning in 2015, U.S. Fish and Wildlife Service (USFWS) awarded CDFW funds for this study through the endangered species recovery grant program (Section 6 of the U.S. Endangered Species Act of 1973; Federal Grant Award #F16AP00042). The most recent funding allowed CMR field work to continue through summer 2018. A CDFW field crew, with assistance from USFS personnel from TNF, returned to the Mossy Pond complex in August 2019 to conduct VES in the Mossy Pond study area and surrounding wetlands.

CDFW has been monitoring Rattlesnake Creek (Site ID 51019) and a tributary (Site ID 51021) since 2009. Staff have consistently observed all SNYLF life stages in Rattlesnake Creek and low numbers of post-metamorphic SNYLF (adults and subadults) in Site ID 51021. Additionally, CDFW has been monitoring a small pond north of Rattlesnake Creek (Site ID 13275) since 2004. CDFW and TNF field staff visited the Rattlesnake Creek area on 26 August 2019 for one day of VES.

THREATS

Marginal Habitat

Mossy Pond has a nearly six-hectare surface area and a maximum recorded depth of 2.5 meters, though much of the pond is even shallower. Although there are multiple fishless ponds in the vicinity, CDFW has not detected evidence of SNYLF breeding at those other locations. Field crews occasionally observe SNYLF larvae and egg masses at Mossy Pond and its outlet stream, both of which are shallow. Severe winter conditions, extended drought, or anthropogenic habitat disturbances present potential extirpation risks to the population.

Disease

The Mossy Pond SNYLF population is positive for the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*). To detect *Bd*, field crews collected epithelial swabs in 2010 and 2011. Partner scientists screened the swabs for presence of *Bd* DNA using real-time quantitative polymerase chain reaction (qPCR) analysis. The swab analyses detected very light to moderate *Bd* infection intensity.

Introduced Fish

CDFW formerly stocked Mossy Pond and all named ponds in the vicinity with Brook Trout (*Salvelinus fontinalis*, BK). In 2000, in response to range-wide declines of SNYLF and a departmental reassessment of stocking practices, CDFW halted stocking at ponds in the vicinity. During surveys in 2001, CDFW field crews detected BK at five lakes in the Mossy Pond complex, including three ponds in which crews observed SNYLF. During follow-up gill net surveys in 2010, field crews did not capture any BK, which suggests that BK did not persist in the absence of stocking. Since 2010, crews have not detected any fish during visual surveys in the Mossy Pond complex.

CDFW stocked Fordyce with Rainbow Trout (*Oncorhynchus mykiss*) through 2013 and Brown Trout (*Salmo trutta*) through 1999, and recent survey data suggest trout will persist in Fordyce without additional fish plants. Crews have detected SNYLF at the downstream end of the outlet stream draining from Mossy Pond into Fordyce. Fish do not present an immediate threat to most SNYLF in the Mossy Pond complex. However, given the close proximity of trout, illegal movement of fish into currently fishless ponds that contain SNYLF presents a low probability risk. The main threat is that trout prevent SNYLF from being able to successfully breed and recruit in the largest aquatic habitat in the area; additionally, Fordyce may act as a population sink for migrating subadult SNYLF.

CAPTURE-MARK-RECAPTURE PROJECT

The field portion of the Mossy Pond CMR study ended in 2018. CDFW staff anticipate using Program MARK to analyze the data collected during the field portion of the study, applying analytical methods similar to other amphibian studies using the robust design model (e.g., Bailey et al. 2004, McCaffery and Maxell 2010, Fellers et al. 2013). For a complete description of the materials, methods, and initial results of the Mossy Pond CMR study, please consult the

memorandum "[Capture-mark-recapture at Mossy Pond, Tahoe National Forest, Nevada County – Summary of activities in 2018](#)" (CDFW 2019a).

VES IN THE MOSSY POND STUDY AREA

The Mossy Pond CMR study area consists of an approximately one square-mile section of TNF, containing Mossy Pond, its seasonally flowing outlet stream, and 12 ephemeral ponds (**Figure 2**). Prior to 2014, VES effort in the Mossy Pond area varied, both in quantity and quality. During the CMR study from 2014–2018, surveys were more consistent, during which CDFW field staff visited Mossy Pond at least three times each summer. During each trip, staff surveyed 14 sites each day for three consecutive days, for a total of nine to 12 survey days per year. Therefore, the summary of VES results for years during which CDFW was conducting the CMR study (2014–2018) include the one survey day with the highest number of SNYLF observations for that year (**Figure 3**).

With the CMR study completed, CDFW and TNF staff surveyed the Mossy Pond study area in 2019 using traditional VES methods (Heyer et al. 1994). During the 2019 VES, staff used a dip nets or their hands to capture and scan all frogs large enough to have been marked with a passive integrated transponder (PIT) tag during the CMR study. If staff detected a tag, staff recorded the PIT tag number, sex, and coordinates for the point of capture of each frog. Although VES results from inside the study area after 2018 will not be incorporated into the full CMR population analyses, subsequent data obtained from SNYLF that CDFW marked during the study period will contribute to the understanding of population dynamics in the Mossy Pond area, including SNYLF movement patterns and longevity.

When compared with the CMR study period, SNYLF detections in 2019 were slightly lower (**Figure 3**). However, these results do not provide evidence for a decline in the SNYLF population. The CMR study period provided several opportunities to detect SNYLF over the course of the whole summer. With at least nine surveys of the entire study area each year during the period 2014–2018, staff had a greater chance of any one survey corresponding with good survey conditions, more frogs available for detection, and/or the presence of recently metamorphosed subadults. Therefore, confounding factors that affect SNYLF detectability during VES, including weather conditions, time of year, habitat complexity, and observer bias were likely mitigated between 2014 and 2018 (Mazerolle et al. 2007).

VES are a helpful measure for obtaining a general idea of SNYLF population status, but proper interpretation of the results requires consideration of the numerous assumptions inherent with VES (Heyer et al. 1994). CMR methods provide a more accurate method for estimating population parameters, such as abundance and survivorship, by incorporating detection probability (Williams et al. 2001).

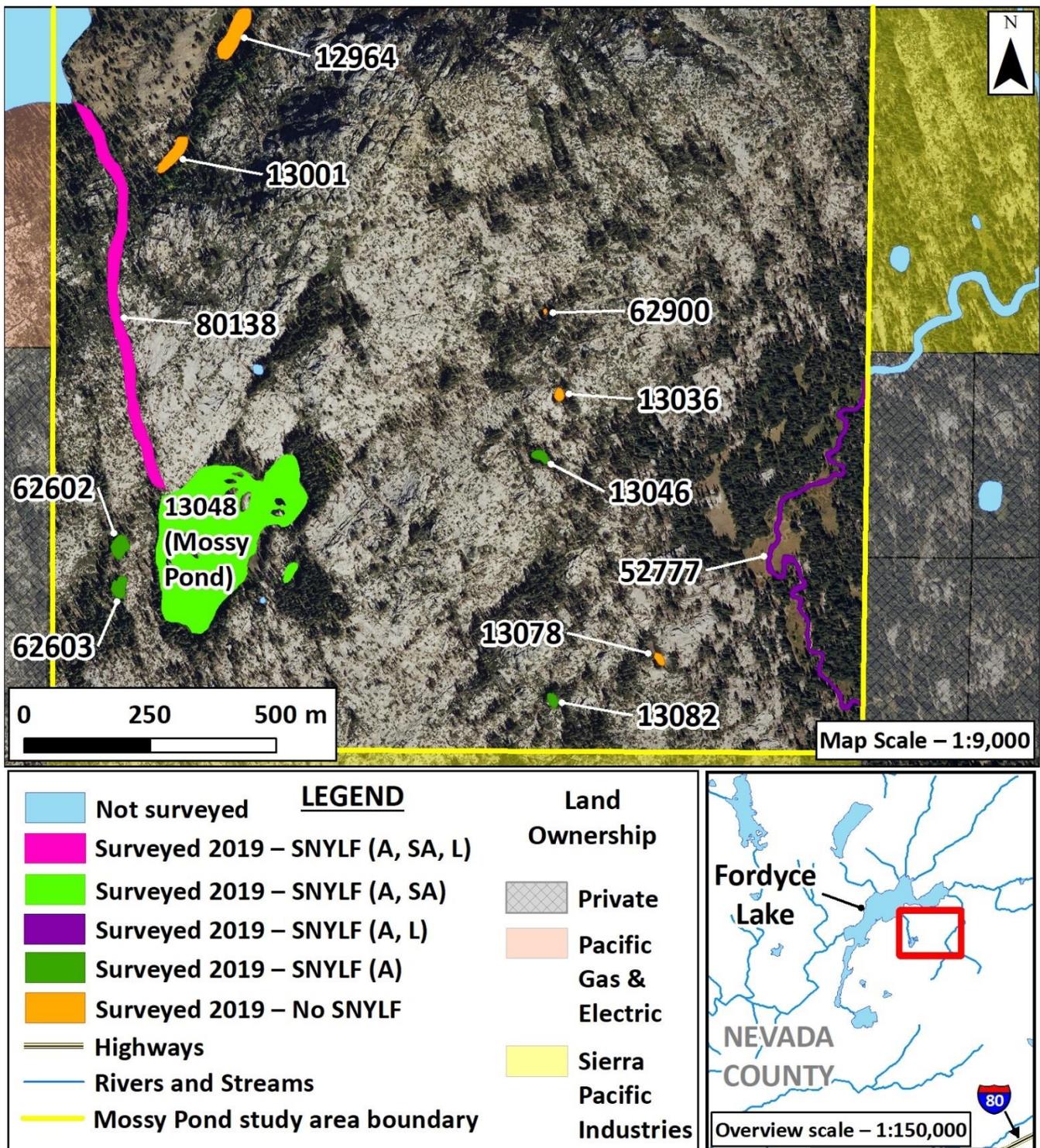


Figure 2. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations from visual encounter surveys (VES) in the Mossy Pond capture-mark-recapture (CMR) study area in summer 2019. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults, “SA” = subadults, and “L” = larvae. During the CMR study, which occurred during summers 2014–2018, CDFW staff observed SNYLF at least once (and often repeatedly) in all 14 waterbodies included in the daily surveys (some of which are not labeled in this figure). The CMR study did not include Site ID 52777, which was added in 2019.

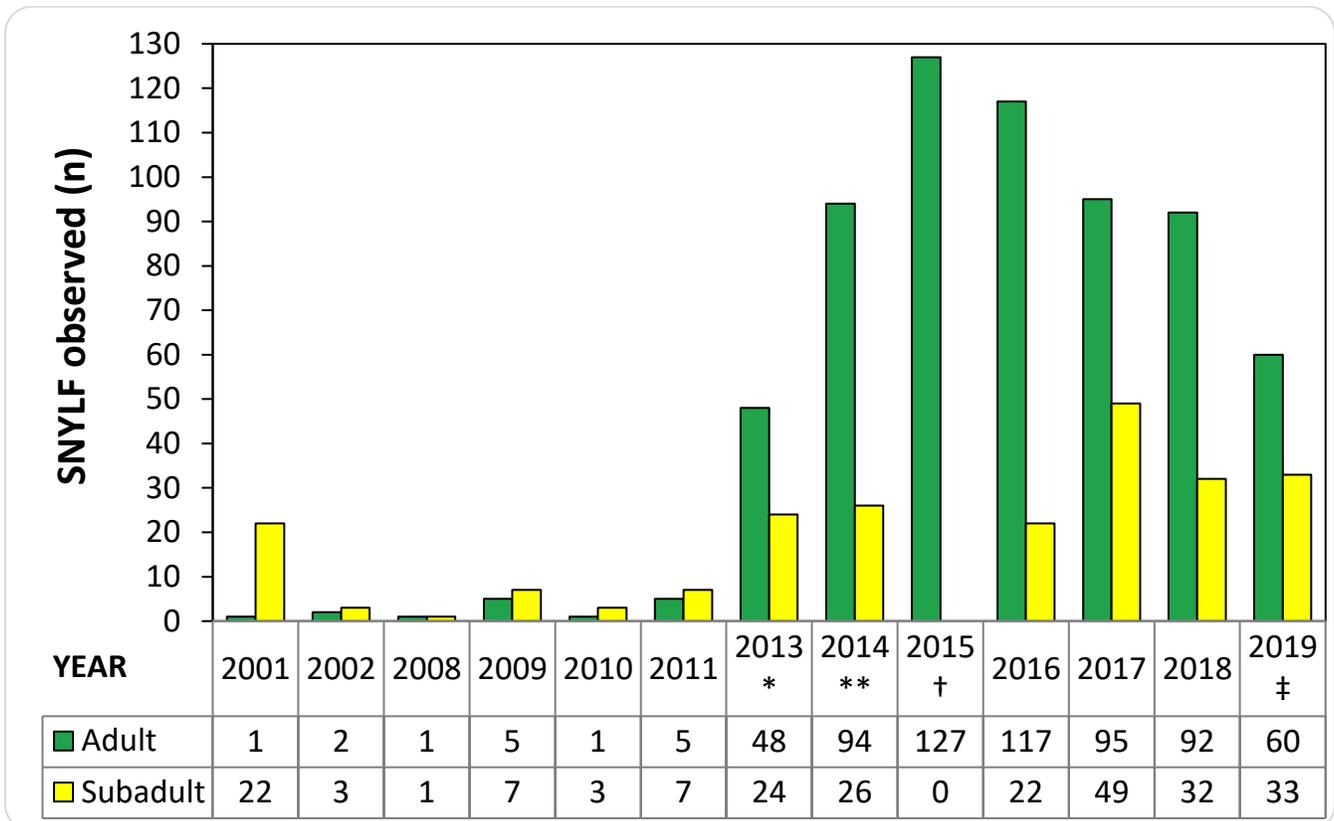


Figure 3. Counts of adult and subadult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys in the Mossy Pond study area, 2001–2019. In years when crews conducted more than one survey, results shown are from the one survey day with the largest number of SNYLF detections for the year. **Surveys before 2013 only included a subset of waterbodies.**

*From 2013 onward, California Department of Fish and Wildlife (CDFW) field crews surveyed the entire study site.

**First year of the Mossy Pond capture-mark-recapture (CMR) study. Results shown are from a visual encounter survey (VES) conducted separately from the CMR work in 2014.

†Crews did not begin documenting subadult SNYLF during CMR surveys until the final trip of the 2015 season (in September): from September 2015 onward, CDFW field crews consistently recorded subadult detections as part of the CMR survey protocol. Results shown for 2015 are from the survey day with the most detections of the summer (July 16, 2015), which is why no subadults are shown in the histogram. Results shown from 2015–2018 are from the CMR survey day with the most total SNYLF detections for that year.

‡The Mossy Pond study area was visited and surveyed only once in 2019. The field portion of the CMR study ended in 2018. Crews were no longer marking captured frogs but continued to record PIT tag numbers for recaptured frogs. Survey efforts in 2019 included a stream segment at the eastern edge of the study area that had not been included in the CMR study (Site ID 52777). CDFW staff observed two adult SNYLF at Site ID 52777 in 2019.

VES OUTSIDE THE MOSSY POND STUDY AREA

There are approximately 65 lakes, ponds, and stream segments in the Mossy Pond complex outside of the CMR study area. Between 2001 and 2019, CDFW staff have observed SNYLF of various life stages in 32 of these waterbodies. Occasional monitoring data from the past 17 years indicate a relatively large SNYLF metapopulation. However, it is difficult to draw conclusions about the population because VES results can be difficult to compare due to the factors mentioned above in the [VES IN THE MOSSY POND STUDY AREA](#) section. The level of survey effort outside the Mossy Pond CMR study area, as measured by the number of ponds surveyed, has varied during each year of VES (e.g., 43 sites were surveyed in 2013, the year with the most surveys, and six sites were surveyed in 2009, the year with the least; **Figure 5**).

In 2017 and 2019, CDFW crews captured adult SNYLF observed in the ponds closest to the study area to check for PIT tags to identify any frogs that had migrated out of the study area. During both years, CDFW staff detected one adult frog at Site ID 13094 that moved out of the Mossy Pond study area. These were two different frogs, as indicated by unique PIT tag numbers. In 2017, the captured frog was an adult female that was last captured at the northern end of Mossy Pond in September 2014. The individual CDFW staff captured in 2019 was also an adult female that was last captured in July 2015 at the very base of the Mossy Pond outlet stream (Site ID 80138), just above the southern edge of Fordyce. This frog traveled at least 1.5 km horizontal distance (and, more likely, at least 2 km along the closest path of travel via available water courses) and 200 m in vertical elevation gain along steep terrain since the last time staff observed it four years prior. During the Mossy Pond CMR study, this frog was recaptured five times between September 2014 and July 2015, each time within a 40-m radius of its original capture location at the downstream end of Site ID 80138.

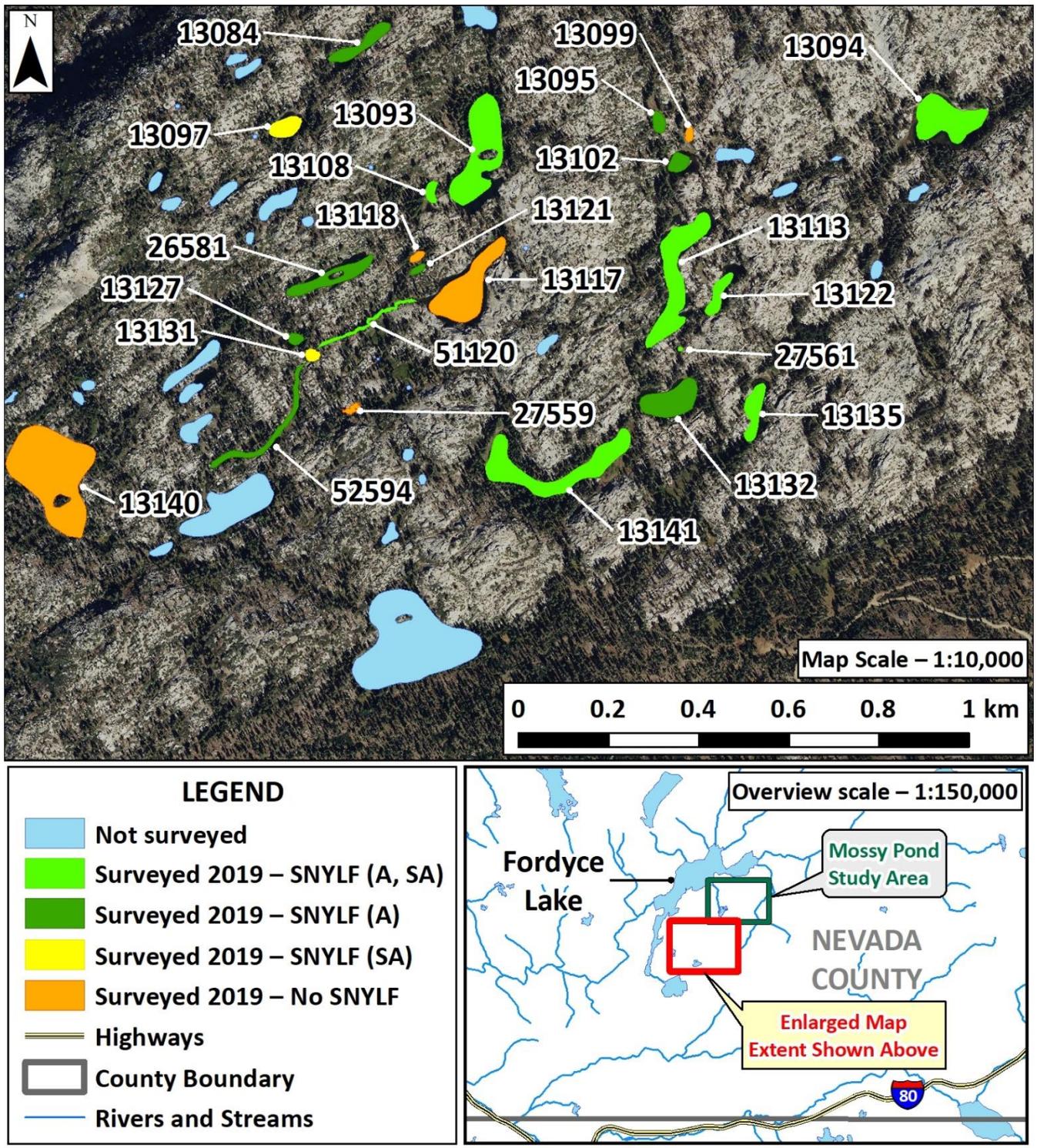


Figure 4. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations from visual encounter surveys (VES) in the Mossy Pond complex, outside of the study area, in summer 2019. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults, “SA” = subadults, and “L” = larvae.

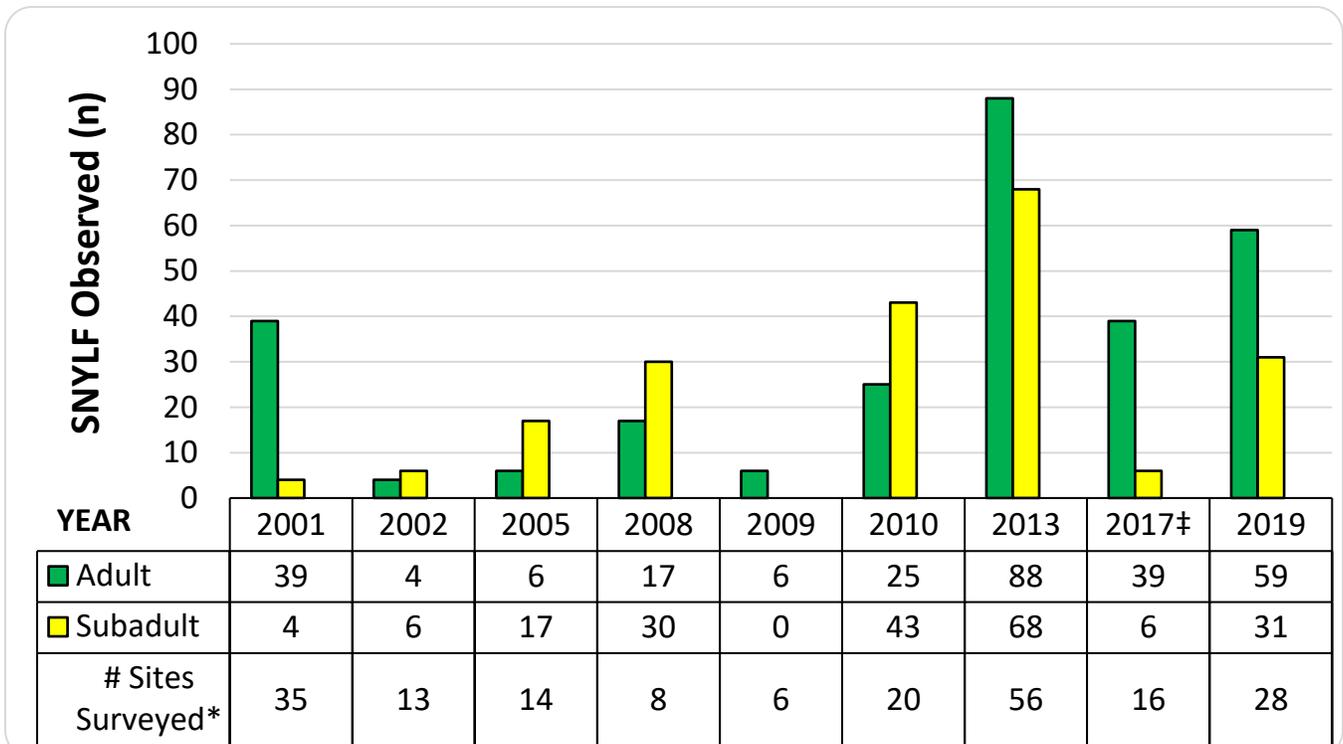


Figure 5. Counts of adult and subadult Sierra Nevada Yellow-legged Frogs (SNYLF) detected during surveys outside of the Mossy Pond capture-mark-recapture (CMR) study area from 2001–2019.

*Survey effort, as measured by the number of sites surveyed, varied greatly between survey years.

‡Surveys in 2017 were not traditional visual encounter surveys (VES). California Department of Fish and Wildlife (CDFW) staff were looking for SNYLF marked with passive integrated transponder (PIT) tags (used to provide a unique identifier for adult SNYLF captured during the Mossy Pond CMR study) that had moved outside of the CMR study area. The surveys in 2017 were confined to 16 ponds closest to the southern and eastern borders of the study area.

VES IN THE RATTLESNAKE CREEK AREA

Prior to 2019, the last time CDFW staff surveyed Rattlesnake Creek was 2016. However, TNF staff performed surveys on Rattlesnake Creek during the intervening years. On August 26, 2019, CDFW staff were joined by TNF staff to survey Rattlesnake Creek and the tributary parallel to Magonigal Road. Staff surveyed Site IDs 51019, 51021, and 13275 (**Figure 6**). Additionally, staff surveyed a segment of Rattlesnake Creek that had not been surveyed previously. This new segment (assigned Site ID 52776) is located from the confluence with Site ID 51021, downstream to the border of land owned by Sierra Pacific Industries (SPI) (**Figure 6**).

Most SNYLF that staff observed were located at Site ID 51019 (8 adults, 11 subadults, and 184 larvae; **Figures 7 and 8**). However, staff observed SNYLF in all stream segments surveyed (**Figure 6**). Additionally, staff observed an unusual number of dead herpetofauna at Site ID 13275, including 32 post-metamorphic Sierran Chorus Frogs (*Hyllola [Pseudacris] sierra*; HYSI), nine HYSI larvae, and two Southern Long-toed Salamander (*Ambystoma macrodactylum sigillatum*; AMMA) larvae. The cause of the die-off was not apparent.

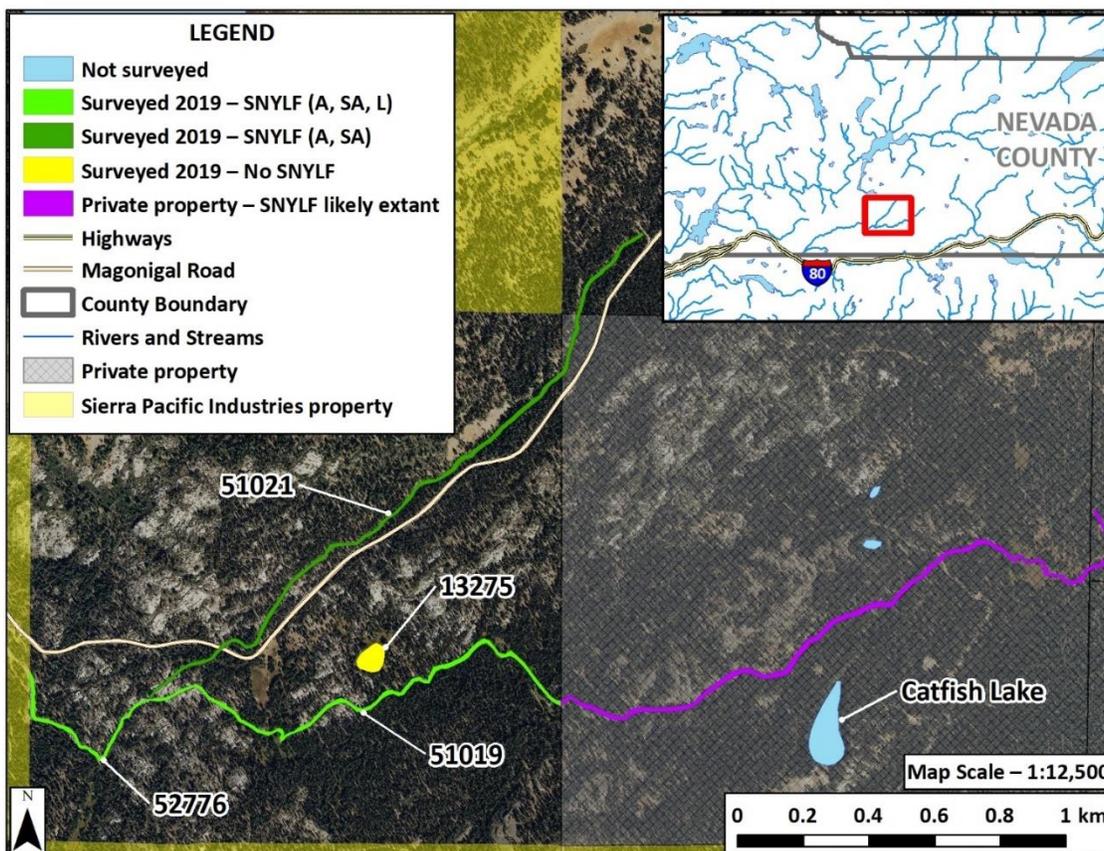


Figure 6. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations from visual encounter surveys (VES) in the Rattlesnake Creek area in summer 2019. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults, “SA” = subadults, and “L” = larvae.

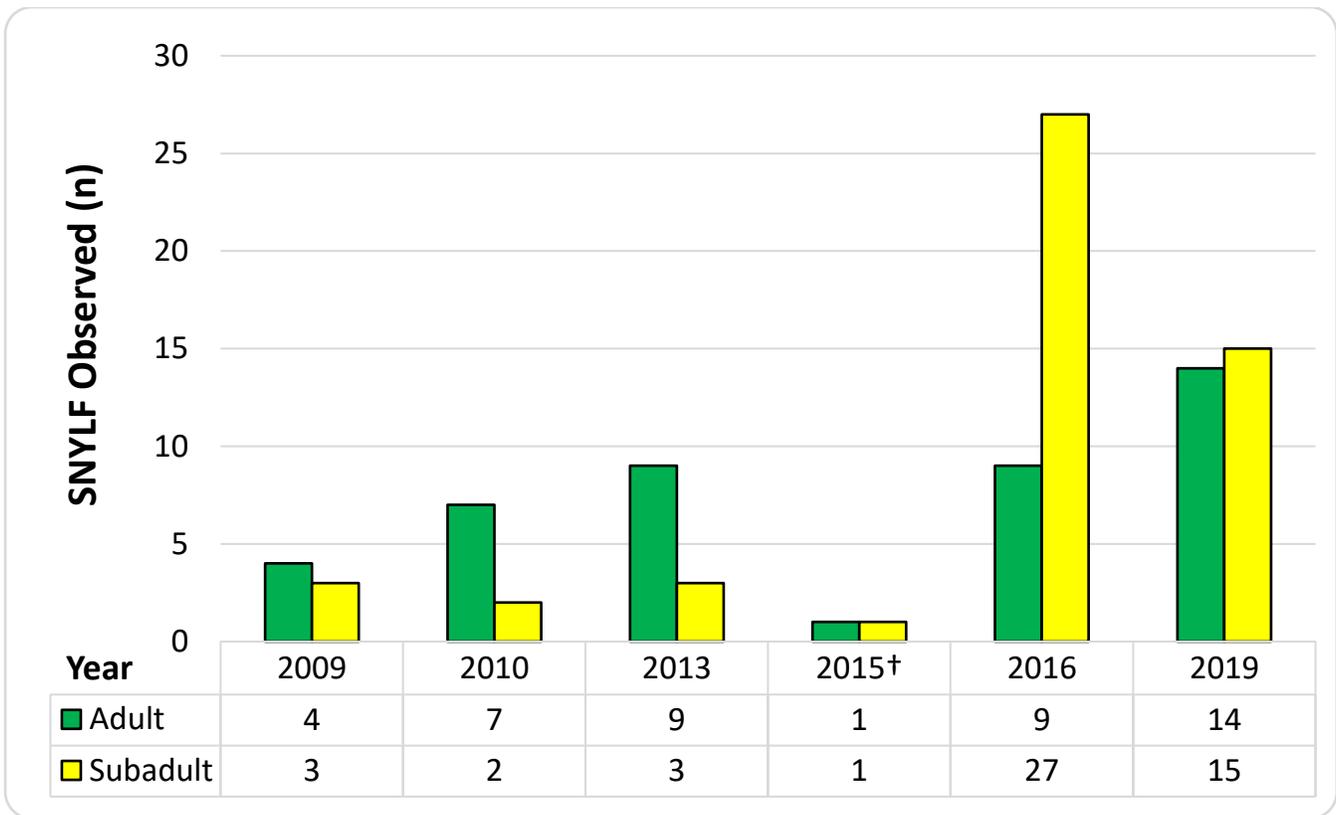


Figure 7. Counts of adult and subadult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys in the Rattlesnake Creek area from 2009–2019. Histogram only includes observations from Sites IDs 51019 and 51021. CDFW staff have not observed any SNYLF at Site ID 13275 since 2004, during which CDFW staff observed eight adults, 200 recently metamorphosed frogs, 220 larvae, and four egg masses.

†In 2015, surveys occurred in mid-September, and weather conditions were poor, including overcast with occasional hail. Additionally, 2015 was an exceptionally dry year, following the lowest snowpack since weather records began (CDWR 2020). Therefore, apart from occasional pools, little water remaining in Rattlesnake Creek. These conditions likely explain the very low post-metamorphic SNYLF detections in 2015.

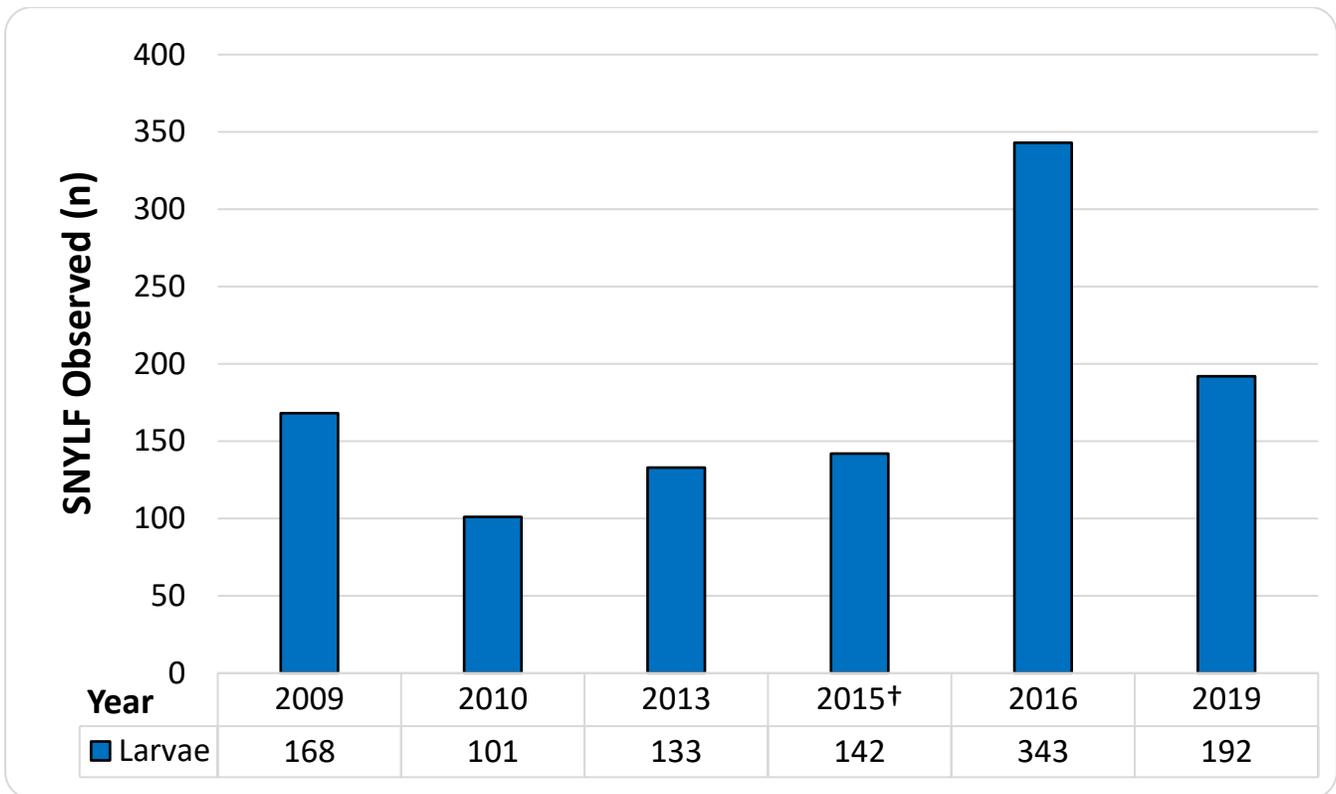


Figure 8. Counts of larval Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys in the Rattlesnake Creek area from 2009–2019. Histogram only includes observations from Sites IDs 51019 and 51021. CDFW staff have not observed any SNYLF at Site ID 13275 since 2004, during which CDFW staff observed eight adults, 200 recently metamorphosed frogs, 220 larvae, and four egg masses.

†In 2015, surveys occurred in mid-September, and weather conditions were poor, including overcast with occasional hail. Additionally, 2015 was an exceptionally dry year, following the lowest snowpack since weather records began (CDWR 2020). Therefore, apart from occasional pools, little water remaining in Rattlesnake Creek. Although little water was available compared with other years, the low water likely concentrated SNYLF larvae into small pools with undisturbed surfaces, in which CDFW staff could easily observe larvae. These conditions may partially explain why larval SNYLF detections in 2015 were more comparable with other survey years, whereas post-metamorphic SNYLF detections were substantially lower.

DISCUSSION

Once population analysis using CMR methods is completed, CDFW will have more detailed knowledge of the SNYLF population structure at Mossy Pond. These results, in concert with subsequent annual VES, will allow CDFW to estimate how many post-metamorphic SNYLF may be removed from the population annually for future translocation efforts to supplement or reestablish SNYLF populations in Nevada County, per the recommendations of the Mountain Yellow-legged Frog Interagency Technical Team (MYLF ITT) (2018). In summer 2020, CDFW plans to begin one such project in Five Lakes Basin.

Five Lakes Basin is located approximately 8 km west of Mossy Pond, directly north of the Black Buttes. In 2013, the MYLF ITT discussed using the Mossy Pond SNYLF population as a source for translocations to the Five Lakes Basin area. The following year, the project was formally proposed in the ABMP for the South Yuba River Management Unit, which highlighted Five Lakes Basin as a priority area for non-native fish removal to help reestablish a SNYLF population on the TNF (CDFW 2014). Subsequently, the MYLF ITT finalized the “Interagency Conservation Strategy for Mountain Yellow-legged Frogs in the Sierra Nevada” (Strategy; MYLF ITT 2018), which lists non-native fish removal and translocations in Five Lakes Basin as part of the species conservation action plan (MYLF ITT 2018; Attachment 1, pg. 30; Attachment 2, pg. 4).

In 2018, CDFW staff completed a site assessment of Five Lakes Basin and anticipated that non-native fish removal would be feasible to complete, given relatively low fish densities, simple habitat structure, small waterbody sizes, and tributaries that normally dry completely by mid-summer (CDFW 2019b). Those interested in seeing complete details of the Five Lake Basin assessment and VES may consult the memorandum “[Native aquatic resource assessment in the Black Buttes area \(Grouse Ridge Non-motorized Area, Tahoe National Forest, Nevada County\)](#)” (CDFW 2019b). Current VES data suggest that very few, if any, SNYLF remain in the greater Five Lakes area. For example, CDFW staff observed a single adult in the lower section of Five Lakes Basin in 2018 (CDFW 2019b). This was the first SNYLF observation in the Five Lakes area by CDFW staff in a decade. Given that the Five Lakes Basin SNYLF population is effectively extirpated, reestablishing a SNYLF population will require translocations from the greater Mossy Pond area.

In December 2019, U.S. Fish and Wildlife Service (USFWS) awarded CDFW funds for the project through the endangered species recovery grant program (Section 6 of the U.S. Endangered Species Act of 1973; Federal Grant Award #F19AP00750). This project will first involve using mechanical methods (gill nets and backpack electrofishing units) to remove non-native trout from Five Lakes Basin. CDFW anticipates that the fish removal portion of the project will take approximately two to three years, after which CDFW staff will hike SNYLF into Five Lakes Basin, using well established protocols (MYLF ITT 2018, Attachment 3).

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