

State of California
Department of Fish and Wildlife
Memorandum

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North Central Region Fisheries

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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 dwindle to intermittent pools during the rest of summer. United States Geological Survey (USGS) field staff 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. The first official records for SNYLF in Rattlesnake Creek are from the 1960's (Brown et al. 2014). USGS field staff also detected SNYLF in 1995 and 1996, USFS staff began monitoring the area more regularly in 2003, and CDFW began collaborative monitoring with the USFS in 2009. In recent years, Tahoe National Forest (TNF) biologists have conducted most monitoring of the SNYLF population in Rattlesnake Creek.

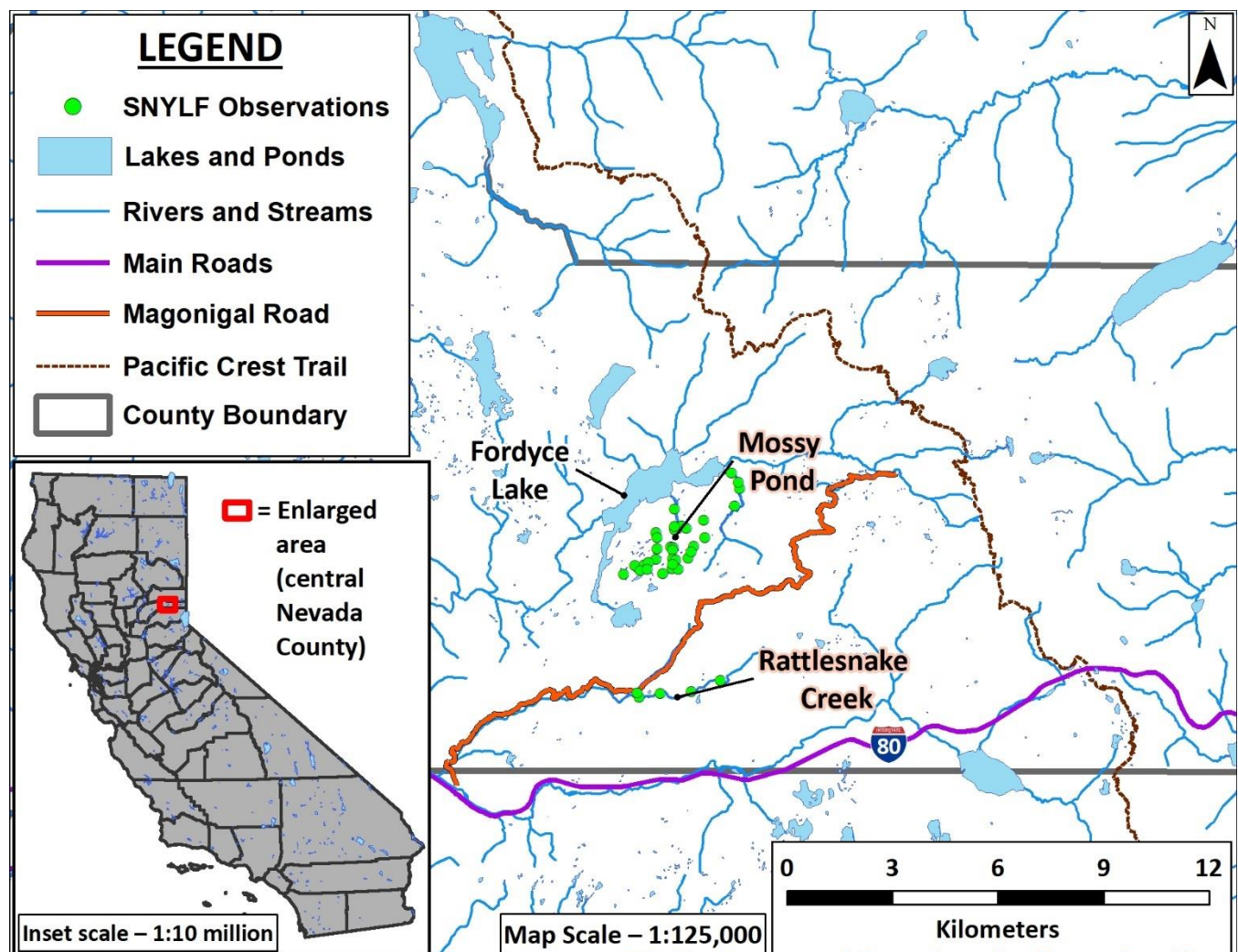


Figure 1. Mossy Pond and Rattlesnake Creek areas, Nevada County, CA. Green dots show Sierra Nevada yellow-legged Frog (*Rana sierrae*; SNYLF) detections by California Department of Fish and Wildlife (CDFW) staff during recent visual encounter surveys (VES).

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.

Periodic visual encounter surveys (VES) during the early 2000's suggested the Mossy Pond SNYLF population could be headed toward extirpation. However, USFS surveys of the Mossy Pond outlet stream and surrounding areas, later followed by complete VES of wetted habitat by CDFW 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 and USFS 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. Subsequently, CDFW field staff have returned to the Mossy Pond complex once per summer (August 2019 and August 2020) 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 field staff visited the Rattlesnake Creek area on 27 August 2020 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 staff 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 staff 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 staff detected BK at five lakes in the Mossy Pond complex, including three ponds in which staff observed SNYLF. During follow-up gill net surveys in 2010, field staff did not capture any BK, which suggests that BK did not persist in the absence of stocking. Since 2010, staff 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. Staff 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 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 2020 using traditional VES methods (Heyer et al. 1994). During the 2020 VES, staff used 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, they 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, adult SNYLF detections in 2020 were slightly lower, while subadult SNYLF detections were above average (**Figure 3**). Fewer adult SNYLF detections 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)

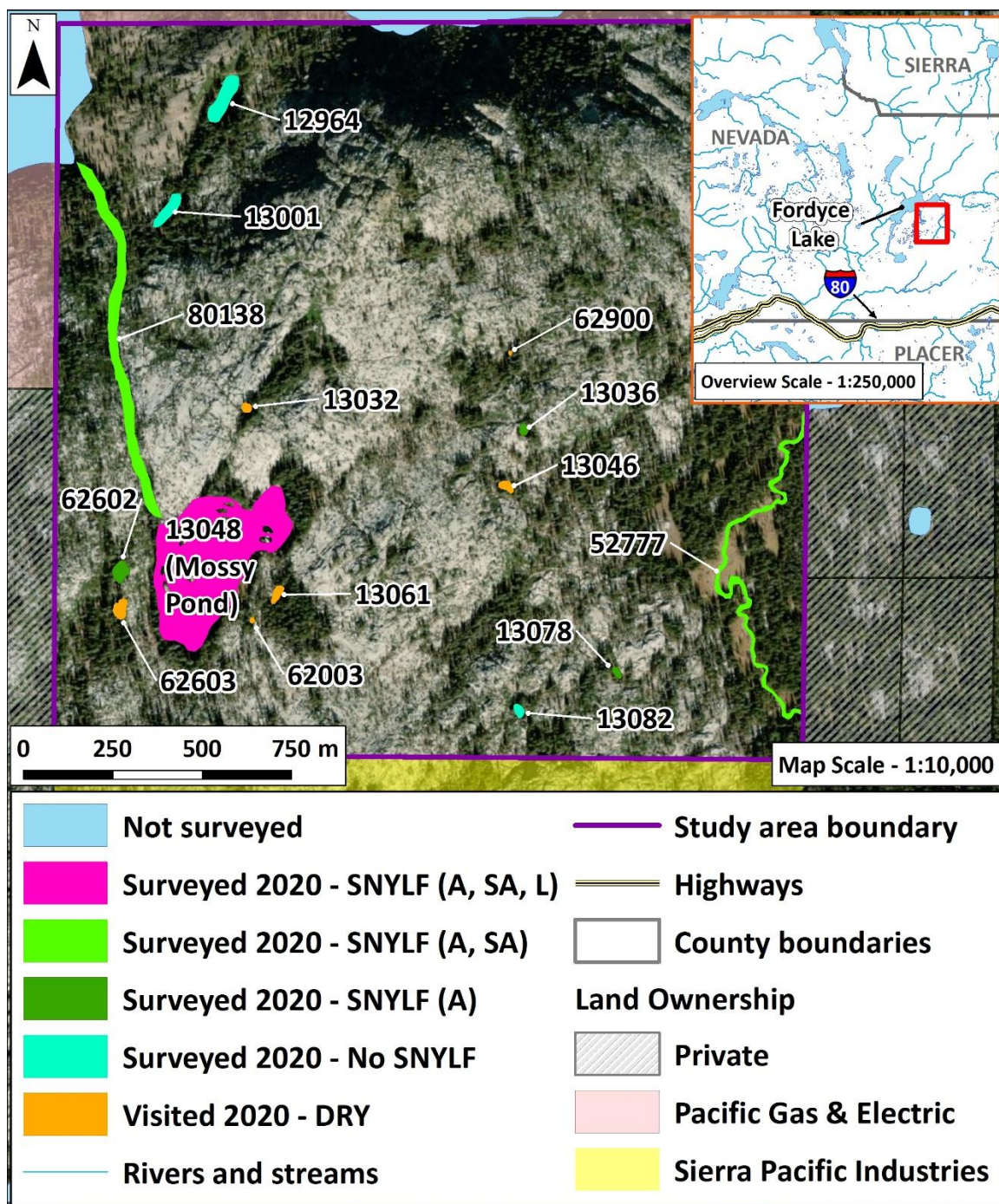


Figure 2. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations from visual encounter surveys (VES) in the Mossy Pond capture-mark-recapture (CMR) study area in summer 2020. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as 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. The CMR study did not include Site ID 52777, which was first added during VES in 2019.

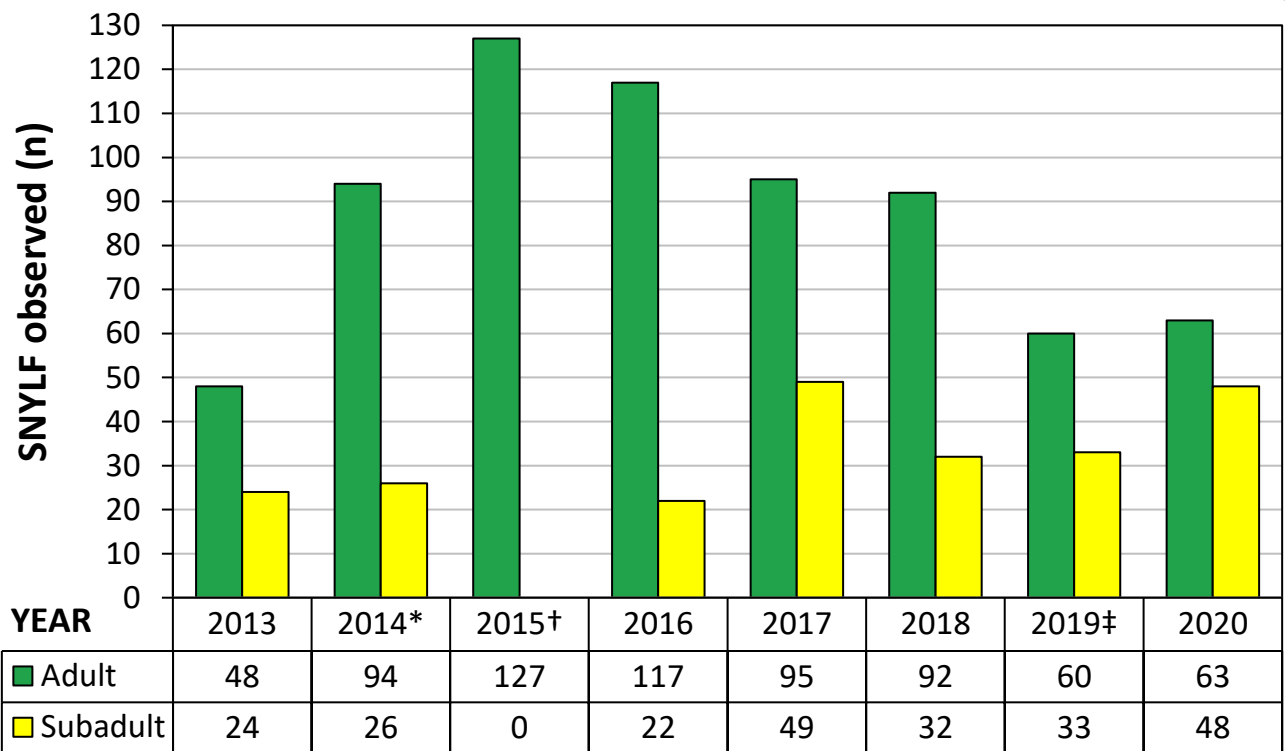


Figure 3. Count of adult and subadult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys in the Mossy Pond study area, 2013–2020. California Department of Fish and Wildlife (CDFW) began surveying some locations in the Mossy Pond area in 2001. However, earlier surveys only included a small subset of waterbodies and, therefore, counts were very low (i.e., ≤ 5 adults seen during any given survey). Therefore, the histogram only presents results beginning in 2013, which is the first year field staff surveyed the entire Mossy Pond study area. In years when staff conducted more than one survey, results shown are from the one survey day with the largest number of SNYLF detections for the year.

*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.

†Staff 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 staff 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.

‡Following completion of the CMR study in 2018, CDFW only visited the Mossy Pond study area once per year to assess the relative abundance and general status of the SNYLF population. Staff are no longer marking captured frogs, but continue to record PIT tag numbers for recaptured frogs. Survey totals from 2019 onward also included a stream segment at the eastern edge of the study area that had not been included in the CMR study (Site ID 52777).

VES OUTSIDE THE MOSSY POND STUDY AREA

There are approximately 67 lakes, ponds, and stream segments in the Mossy Pond complex outside of the CMR study area. Between 2001 and 2020, CDFW staff have observed SNYLF of various life stages in 32 of these waterbodies. Occasional monitoring data from the past 20 years indicate a relatively large SNYLF metapopulation. In 2020, CDFW and TNF staff observed fewer SNYLF outside the CMR study area than in the previous four survey years. However, the level of survey effort outside the Mossy Pond CMR study area, as measured by the number of ponds surveyed, has varied substantially during each year of VES (e.g., 55 sites were surveyed in 2013, the year with the most surveys, and only three sites were surveyed in 2015, the year with the least; **Figure 5**). In 2020, CDFW and TNF staff only surveyed nine sites outside of the CMR study area. Expectedly, the more limited VES resulted in fewer SNYLF observations. However, even when comparing VES results between years during which the same locations are surveyed, drawing conclusions about the population can be difficult because VES detections can vary widely due to the factors mentioned above in the [VES IN THE MOSSY POND STUDY AREA](#) section.

In 2017, 2019, and 2020, CDFW staff captured adult SNYLF observed in a subset of ponds close to the study area to check for PIT tags to identify any frogs that may have migrated out of the study area. During all three years, CDFW staff detected one adult SNYLF at Site ID 13094 that moved out of the Mossy Pond study area. PIT tags revealed that the frog captured in 2017 and 2020 was the same individual, and the frog captured in 2019 was a different individual. The individual captured in 2017 and 2020 was a large adult female. Before 2017, this female had most recently been captured in September 2014, along the eastern shore of Mossy Pond. 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 likely traveled at least 1.75 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 between observations in 2015 and 2019. 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.

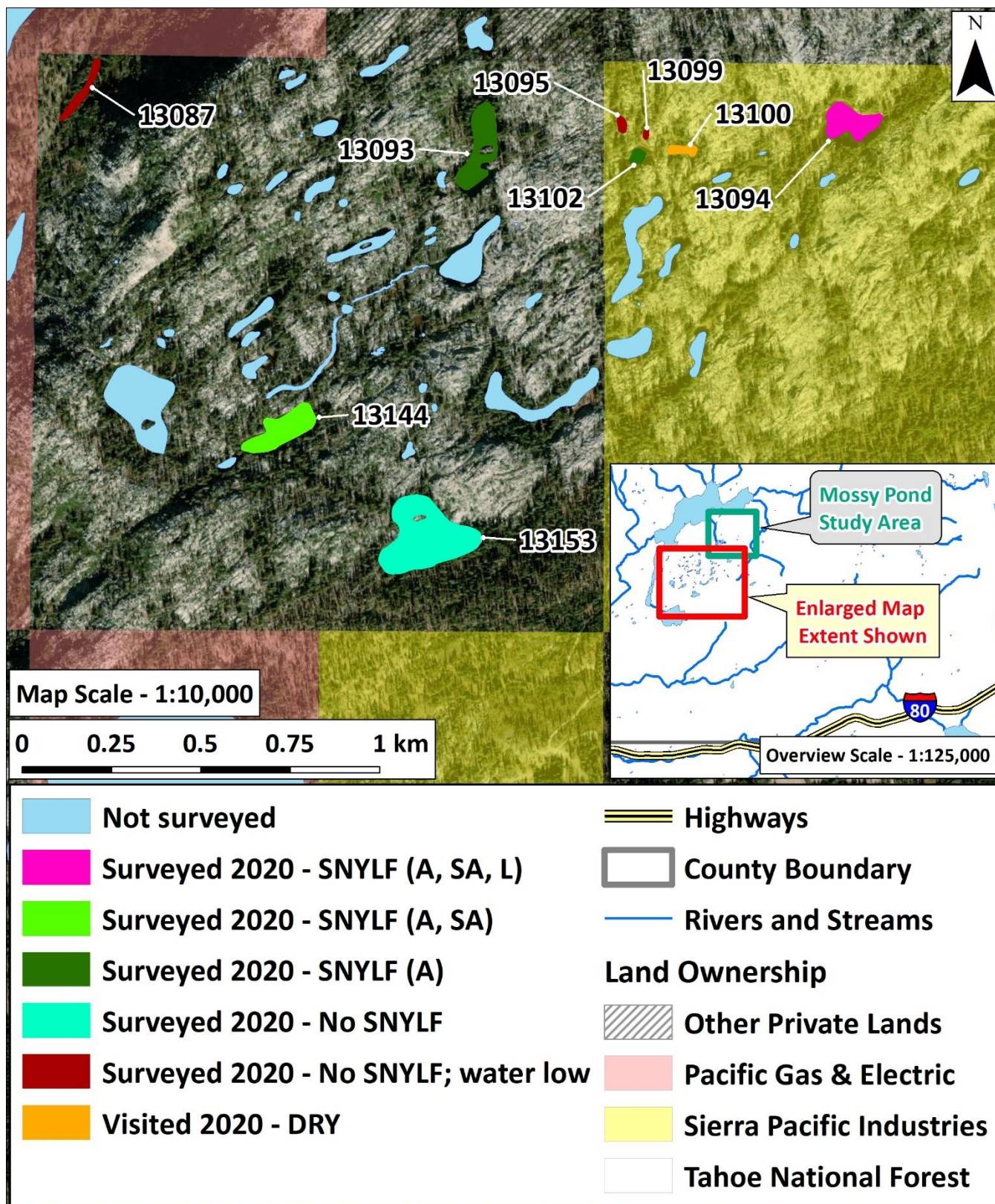


Figure 4. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations from visual encounter surveys (VES) in the Mossy Pond complex, outside of the study area, in summer 2020. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults, “SA” = subadults, and “L” = larvae.

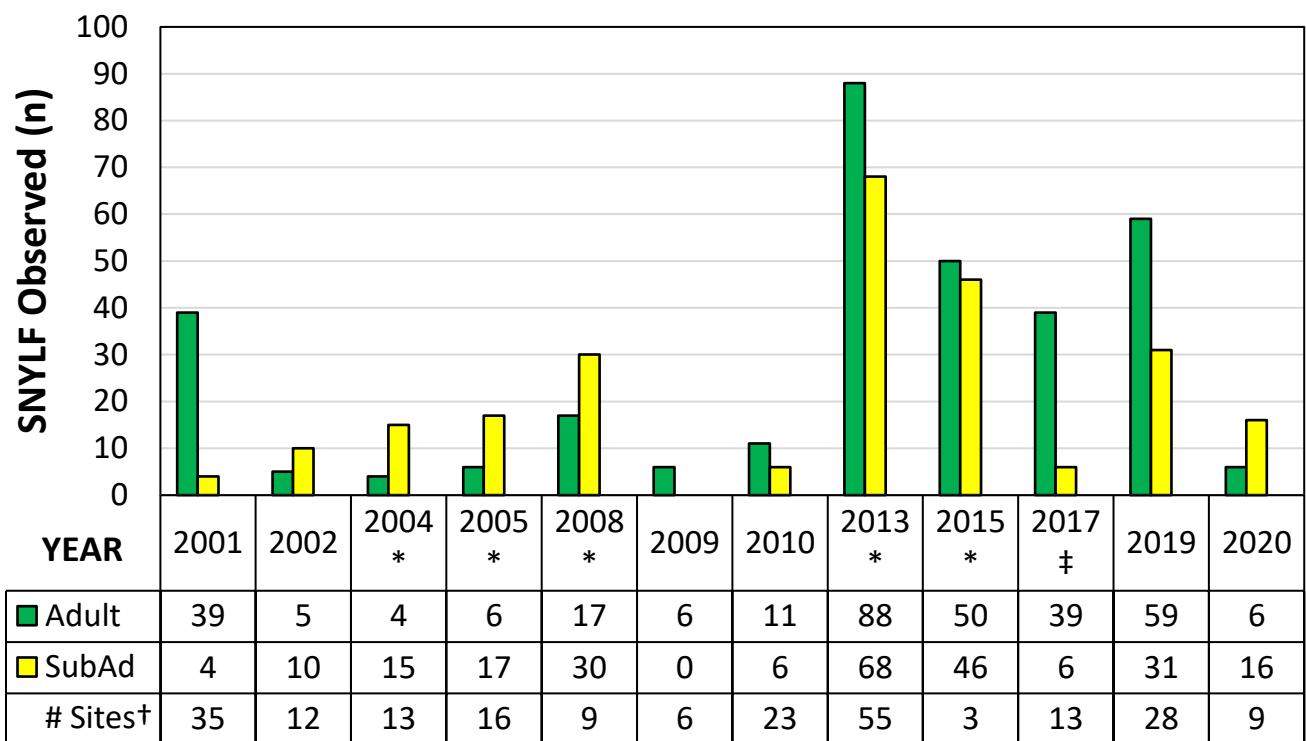


Figure 5. Counts of adult and subadult Sierra Nevada Yellow-legged Frogs (SNYLF) detected during surveys outside of the Mossy Pond capture-mark-recapture (CMR) study area from 2001–2020. These results are derived from a collection of 67 labeled (i.e., locations that have associated Site IDs) lakes, ponds, and streams outside of the Mossy Pond study area that California Department of Fish and Wildlife (CDFW) staff have surveyed at least once (and often several times) during the past 20 years.

†The last row of the data table displays the number of sites (out of the 67 total identified waterbodies) surveyed each year. Survey effort, as measured by the number of sites surveyed, varies substantially between survey years.

*During these years, one location—Site ID 50133 (a stream segment east of the study area)—accounted for a majority of SNYLF observations.

‡Surveys in 2017 were not traditional visual encounter surveys (VES). 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 ponds closest to the southern and eastern borders of the study area.

VES IN THE RATTLESNAKE CREEK AREA

CDFW staff surveyed Rattlesnake Creek on 27 August 2020. Staff surveyed Site IDs 51019 and 52776 (**Figure 6**). Site ID 52776 was first surveyed and assigned an ID number in 2019. This new segment is located from the confluence with Site ID 51021, downstream to the border of land owned by Sierra Pacific Industries (SPI) (**Figure 6**). Staff did not survey Site IDs 13275 and 51021 in 2020 (**Figure 6**).

In 2020, most SNYLF observed by staff were located at Site ID 51019 (6 adults, 21 subadults, and 614 larvae; **Figures 7 and 8**). However, staff also observed SNYLF at Site ID 52776 (**Figure 6**). In 2020, staff observed more SNYLF larvae in Rattlesnake Creek than in any previous year.

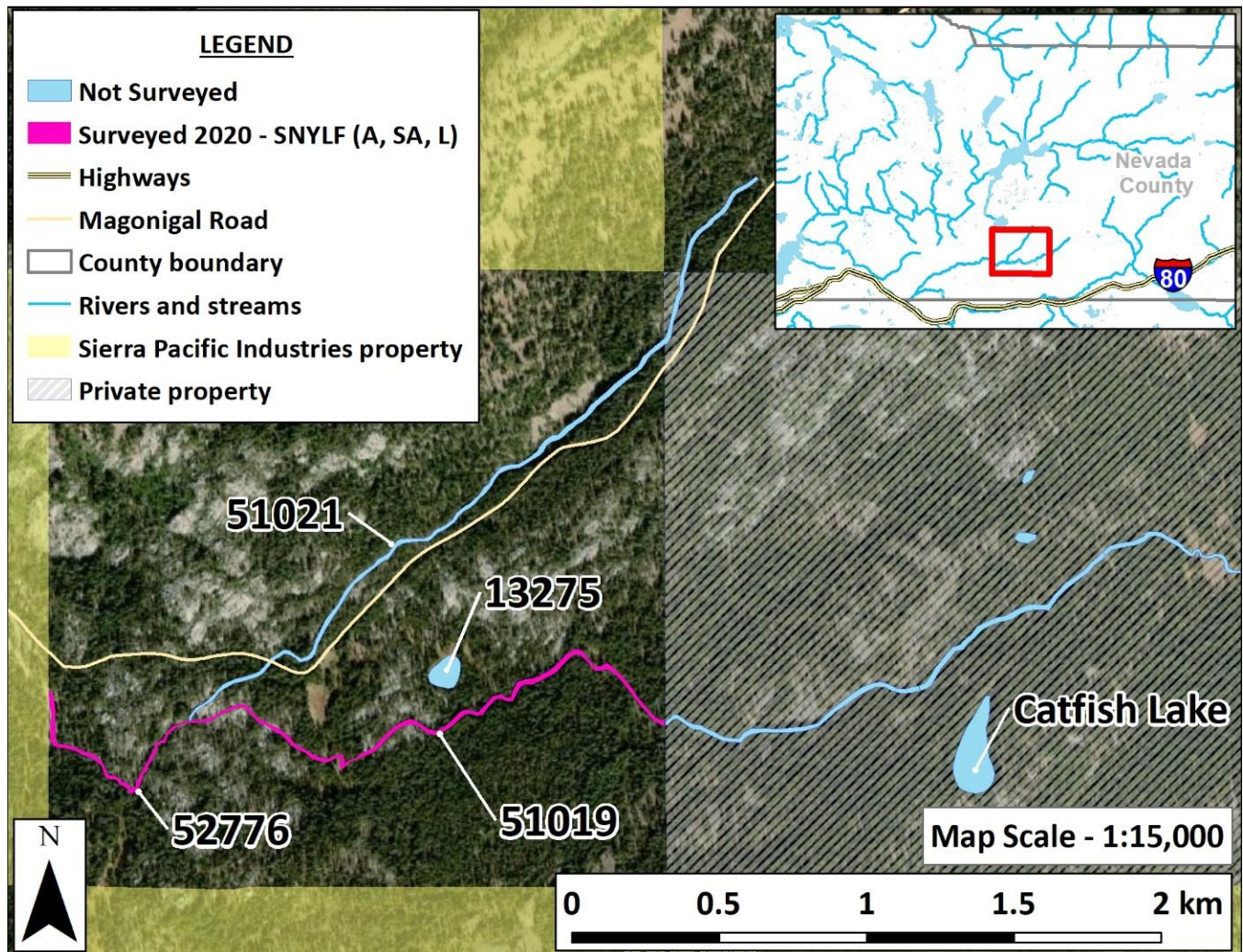


Figure 6. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations from visual encounter surveys (VES) in the Rattlesnake Creek area in summer 2020. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults, “SA” = subadults, and “L” = larvae.

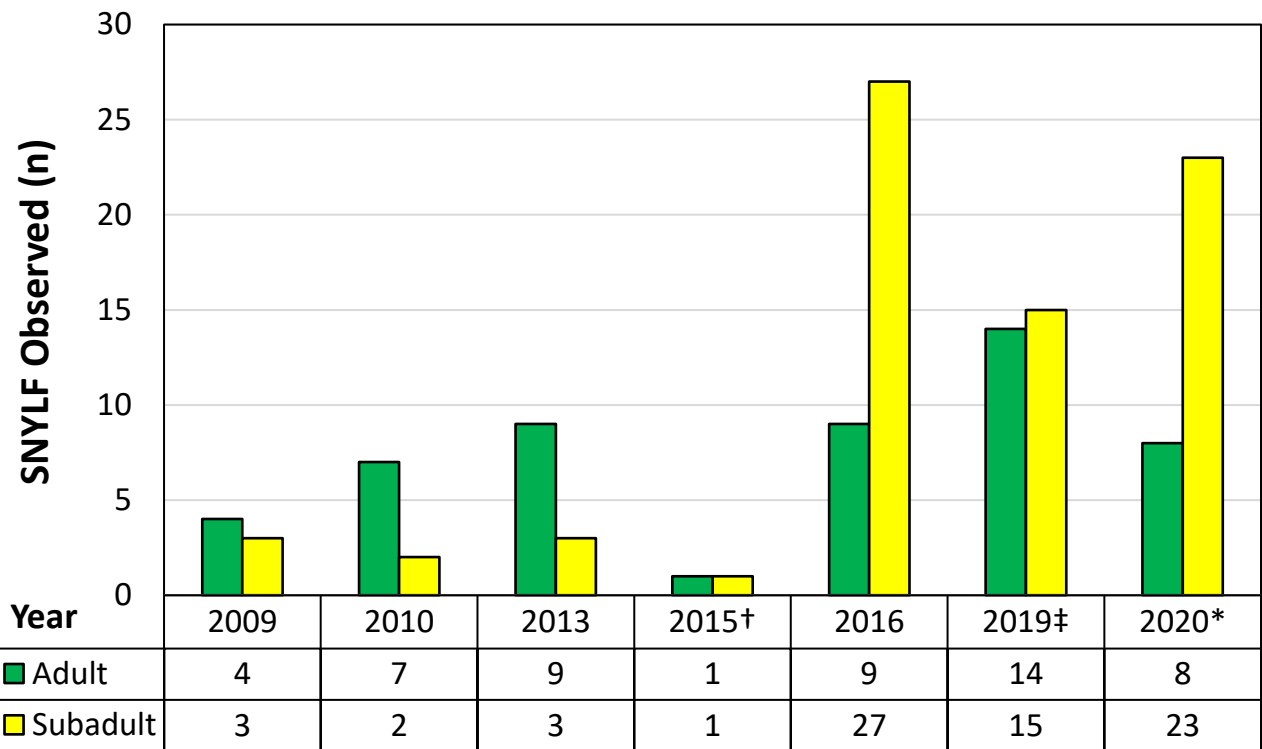


Figure 7. Counts of adult and subadult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys in the Rattlesnake Creek area from 2009–2020. The histogram includes observations from Sites IDs 51019, 51021, and 52776. CDFW staff have not observed any SNYLF at Site ID 13275 since 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.

‡From 2019 onward, the histogram includes SNYLF observations from Site ID 52776. Site ID 52776 was first surveyed and assigned a Site ID number in 2019.

*CDFW field staff did not survey Site ID 50121 in 2020.

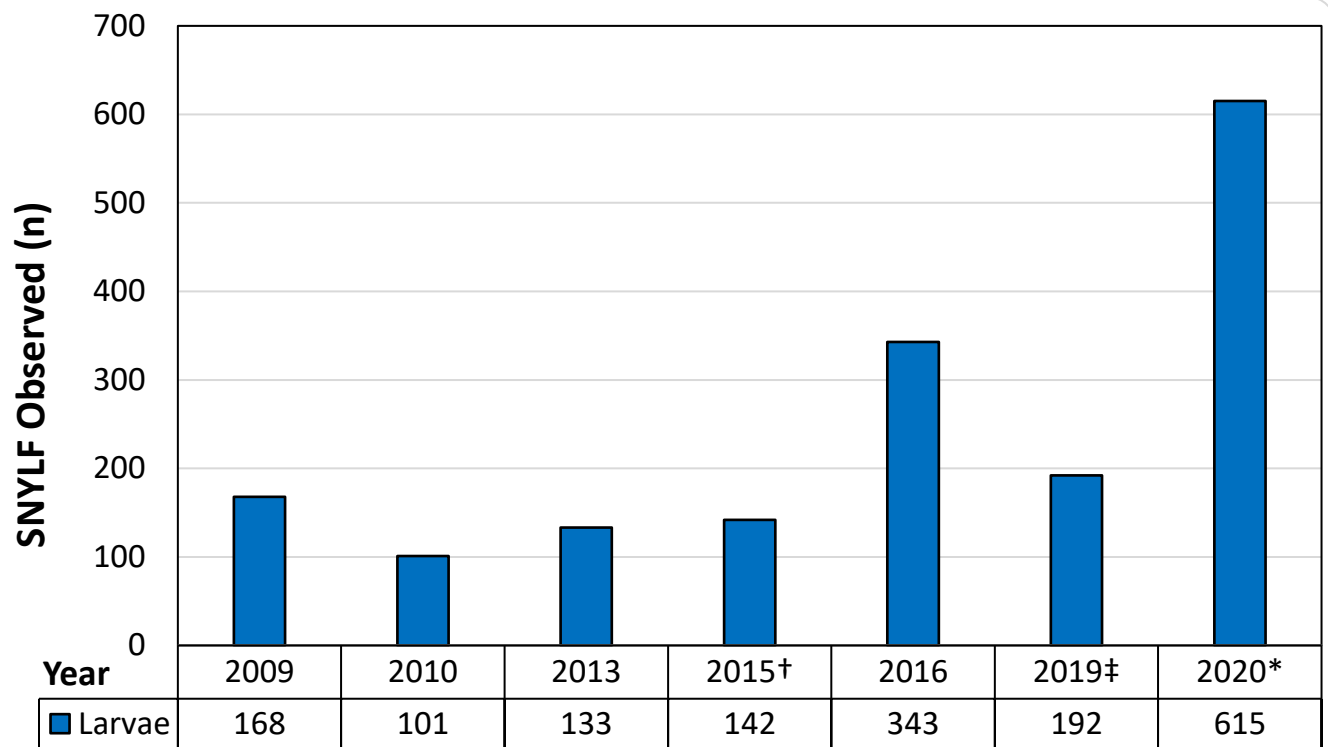


Figure 8. Counts of larval Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys in the Rattlesnake Creek area from 2009–2020. The histogram includes observations from Sites IDs 51019, 51021, and 52776. CDFW staff have not observed any SNYLF at Site ID 13275 since 2004, during 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.

‡From 2019 onward, the histogram includes SNYLF observations from Site ID 52776. Site ID 52776 was first surveyed and assigned a Site ID number in 2019.

*CDFW field staff did not survey Site ID 50121 in 2020.

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 began removing non-native trout from Five Lakes Basin, which is a location into which CDFW plans to reestablish SNYLF translocated from the greater Mossy Pond area. 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 management in the Black Buttes area](#)” (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 first involves using mechanical methods (gill nets and backpack electrofishing units) to remove non-native trout from Five Lakes Basin, which CDFW staff began in 2020. 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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