

State of California
Department of Fish and Wildlife
Memorandum

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**Subject: Native amphibian monitoring in Amador County; Tragedy Creek
Rana sierrae monitoring**

INTRODUCTION

The Tragedy Creek area contains a small population of Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF). California Department of Fish and Wildlife (CDFW) has been monitoring the SNYLF population in Tragedy Creek since 2002. The SNYLF population is at-risk and of interest to CDFW due to the small population size, limited aquatic habitat, and presence of trout.

ENVIRONMENTAL SETTING

The section of Tragedy Creek (**Figure 1**) monitored by CDFW is located south of Highway 88 and northwest of Bear River Reservoir in Amador County (**Figure 2**). The site is located between 7,100 and 7,300 feet in elevation and drains into Bear River about two kilometers (km) above Bear River Reservoir. Tragedy Creek is a headwater tributary to the North Fork Mokelumne River. CDFW field crews have observed SNYLF along approximately 2,700 meters (m) of Tragedy Creek and within isolated ponds immediately southeast. These sites include the following Site IDs (from north to south): stream segments 50151 (**Figure 3**) and 50152 (**Figure 4**); stream pool 14740 (**Figure 5**); stream segment 52744; stream tributary 52685 (not pictured; last surveyed in 2017); stream pool 14750 (**Figure 6**); stream segment 50153 (**Figure 7**); and stream pool 14777 (**Figure 8**). Eighteen years of monitoring data suggest that the SNYLF population is either stable or in decline (see [POPULATION STATUS](#) section below for a discussion).



Figure 1. Tragedy Creek, Amador County, CA in early July 2017. This image was taken following an above average water year with large snowpack. During more typical years, Tragedy Creek is not flowing by mid-summer, and is primarily composed of intermittent pools. (CDFW)

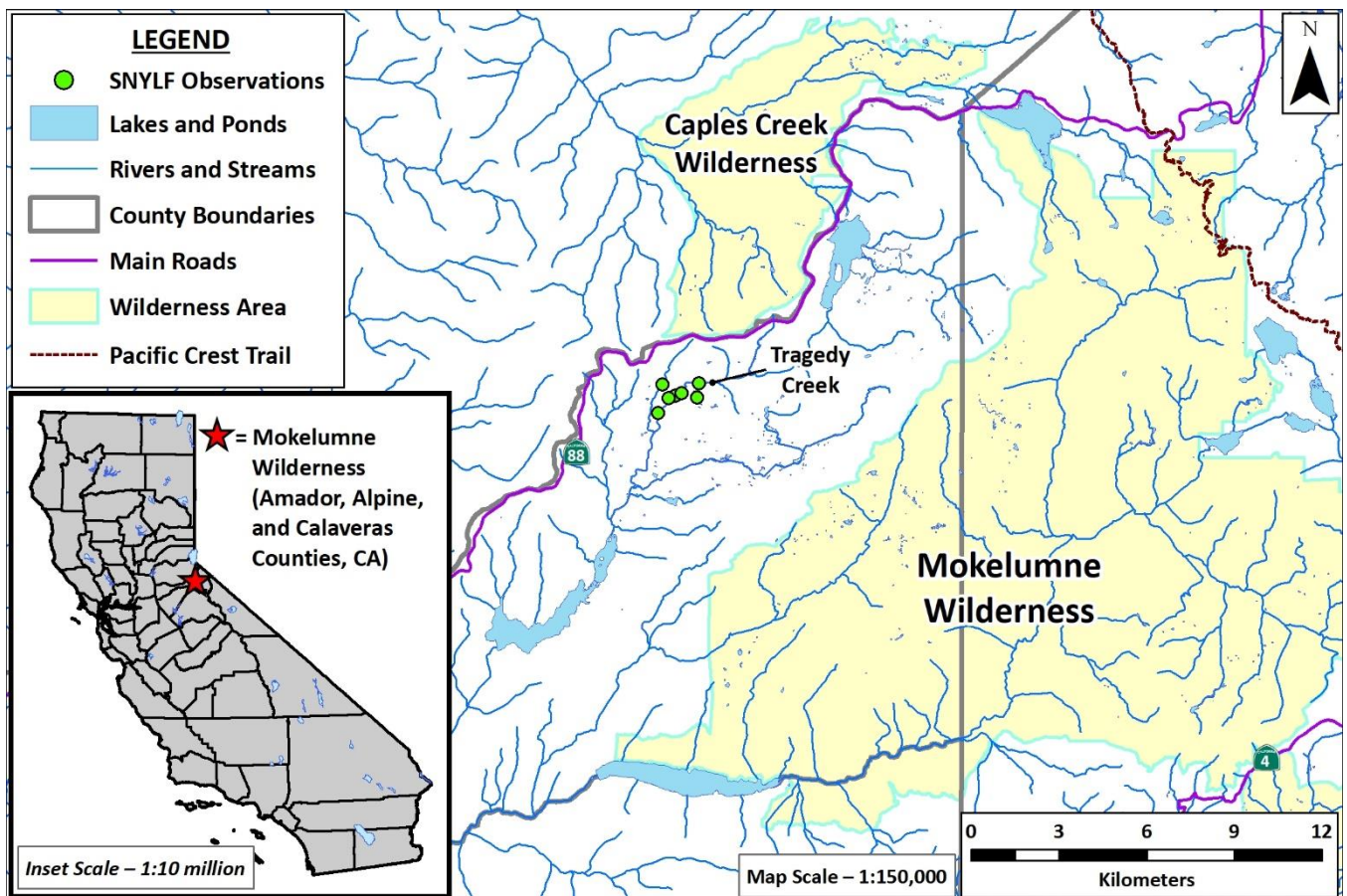


Figure 2. Map of the Upper Mokelumne area of Amador County, CA. Green dots show Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) detections by CDFW crews during recent visual encounter surveys (VES).



Figure 3. Upstream end of Site ID 50151, looking downstream, in September 2019. Flows in the stream channel were very limited. (CDFW)



Figure 4. Pooled section toward the downstream end of Site ID 50152, looking downstream, in September 2019. (CDFW)



Figure 5. Site ID 14740, looking downstream, in September 2019. The stream widening was mostly dry, with only a few pools remaining. (CDFW)



A

Figure 6. Site ID 14750 in September 2019. (CDFW)



A

Figure 7. Site ID 50153, looking downstream, in September 2019. Pooled section (foreground) and dry stream channel (background) shown. The entire reach consisted of intermittent pools separated by dry stream channel. (CDFW)



Figure 8. Downstream end of site ID 14777 in September 2019, looking upstream. (CDFW)

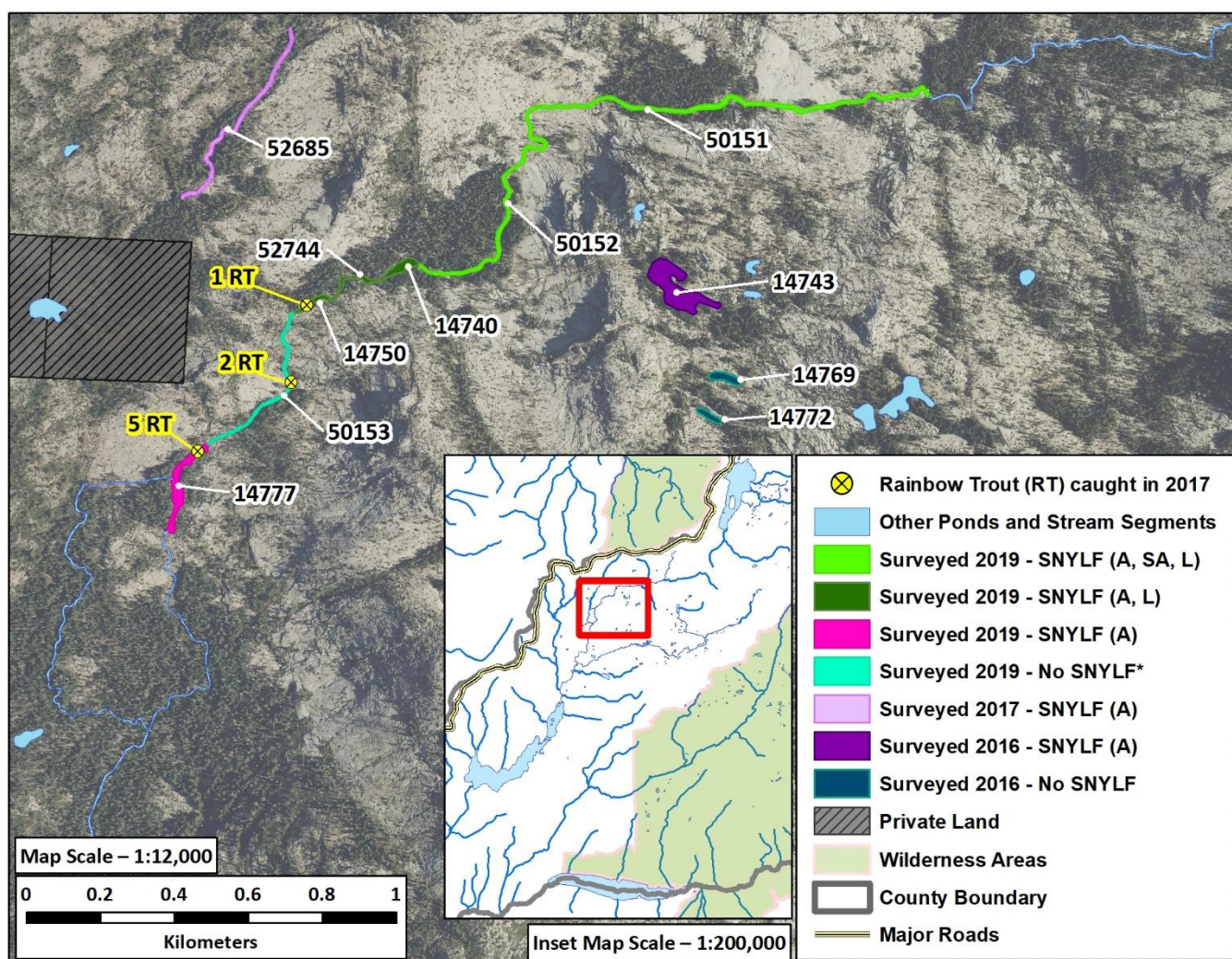


Figure 9. Trout and Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) occupancy in the Tragedy Creek area, Amador County, CA. Since the early 2000's, CDFW crews have consistently observed a small SNYLF population in this section of creek. CDFW field crews first observed trout in the lower survey reach (Site ID 50153) during visual encounter surveys (VES) in 2002. The Rainbow Trout (*Oncorhynchus mykiss*; RT) captures (yellow dots) were reported to CDFW by a recreational angler in late summer 2017. CDFW field crews did not survey all sites every year, only the most recent SNYLF observations are displayed for each site. Observed SNYLF life stages are denoted by letter codes in the legend: "A" = adults, "SA" = subadults, and "L" = larvae. All flowing waters drain southwest into Bear River, which flows through Bear River Reservoir before reaching the North Fork Mokelumne River. Displayed five-digit numbers are CDFW Site IDs.

THREATS

Marginal Habitats

SNYLF are persisting in low numbers in the surveyed reach of Tragedy Creek and the surrounding ponds (**Figure 9**). Occupied habitat includes mostly ephemeral stream channel with small, shallow, intermittent pools. Any disturbance, natural or otherwise, that results in changes to the hydrology or limnology of the habitat poses a potential extirpation risk to the population. Potential risks include severe winter conditions, extended drought, or anthropogenic habitat disturbances.

Introduced Fish

Rainbow Trout (*Oncorhynchus mykiss*; RT) are present in the lower portion of the Tragedy Creek segment that CDFW regularly monitors, including Site IDs 14777, 50153, and 14750 (**Figure 9**). The presence of RT negatively affects SNYLF breeding and recruitment in the areas where the species co-occur. Trout prey on SNYLF and are a potential source of competition for food (e.g., benthic macroinvertebrates).

CDFW field crews first observed RT at Site ID 50153 during VES in 2002, and again in 2016 and 2019. Crews have also noted RT during VES at Site ID 14777 in 2013 and 2016. In late July 2017, a recreational angler caught five RT in Site ID 14777, two RT in Site ID 50153 (**Figure 10**), and one RT in Site ID 14750 (**Figure 11**). Based on the number of observations, it appears that RT are self-sustaining in some sections of Tragedy Creek.

CDFW collected genetic tissue samples from RT captured in Tragedy Creek, downstream of Site ID 14777, in fall 2017. Analysis by the CDFW fish pathology lab revealed that the sampled trout were not triploid (i.e., sterile trout with an extra set of chromosomes), revealing that the fish did not originate from a recent CDFW hatchery source (CDFW 2015). Rather, the RT population in Tragedy Creek is a self-sustaining population introduced many years ago. CDFW does not know when, or from what source, RT were first introduced. There are no known RT-bearing waters that flow into Tragedy Creek. CDFW stocks Lower Bear River Reservoir with RT, and Upper Bear Reservoir has a self-sustaining RT population, but a large waterfall precludes upstream movement of trout from the reservoirs into the creek reaches discussed in this memorandum.

Regardless of the original source, RT have persisted in this portion of Tragedy Creek, despite extreme conditions, such as the 2012–2016 drought and the heavy snowpack of 2017 and 2019. RT are likely able to persist in the few remaining perennial pools during low flow conditions. It is reasonable to assume trout will continue to persist in these reaches into the foreseeable future.

CDFW does not know if RT occur in the upper reaches of Tragedy Creek: field crews have not observed any RT upstream of Site ID 14750, and the upstream reaches (above Site ID 14740) are poorer trout habitat (**Figure 9**). RT may be present in deeper pools or shaded stream segments above Site ID 14750, but CDFW has not observed fish to date during VES. Additional survey efforts, including overnight gill net sampling and/or angling, are needed to more confidently determine the absence of RT in perennial aquatic habitats upstream of Site ID 14750.



Figure 10. A Rainbow Trout (*Oncorhynchus mykiss*; RT) hooked by an angler at Site ID 50153 in July 2017. (B. Serup)



Figure 11. Adult Rainbow Trout (*Oncorhynchus mykiss*; RT) hooked by an angler at Site ID 14750 in July 2017. (B. Serup)

Disease

Chytrid fungus (*Batrachochytrium dendrobatidis*; *Bd*) is present in all SNYLF populations in the northern Sierra Nevada that CDFW has sampled. Field crews collected fifteen epithelial swabs along the stream (Site IDs 50151, 50152, and 50153) in 2008 and 2010. 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 heavy infection intensity.

Loss of Genetic Diversity

Like many SNYLF populations in the northern Sierra Nevada, the population in Tragedy Creek is small and isolated. Most SNYLF populations in the Bear River drainage and Upper Mokelumne Management Unit (CDFW 2016) are small and isolated from one another. There is a SNYLF population located in Upper Bear River, which is the next drainage south of Tragedy Creek. However, at this time, CDFW does not yet know the size and extent of the Upper Bear River population. More extensive surveys of Upper Bear River and the surrounding aquatic habitat are planned for summer 2020.

The nearest locations with more widespread known SNYLF occupancy are Jeff Davis Creek (CDFW 2014) and Desolation Valley (CDFG 2012), both of which are in different watersheds about 25 km to the east and north, respectively. In addition to the threats presented by stochastic environmental events when a population is geographically isolated (e.g., drought, wildfire, or especially harsh winter), genetic isolation can lead to factors such as inbreeding depression, genetic drift, fixation of deleterious alleles, and loss of genetic diversity, all of which are population genetic factors exacerbated in small populations (Frankham et al. 2009).

POPULATION STATUS

During the past 18 years, CDFW field crews have observed a relatively small, but seemingly stable, SNYLF population in Tragedy Creek. Over the years, field crews have observed fairly large fluctuations in the number of various SNYLF life stages. Overall, the Tragedy Creek SNYLF population is small enough to be susceptible to extirpation through introduced trout predation, drought, and/or disease. Visual encounter surveys (VES) during the 2019 season resulted in a greater number of adult (**Figure 12**), subadult, and larval SNYLF observations than during VES in 2017 (**Figures 13 and 14**). VES during the 2017 season resulted in the lowest number of total SNYLF observations (when including all life stages) since Tragedy Creek surveys began in 2002 (**Figures 13 and 14**). Conversely, CDFW observed more larval SNYLF ($n = 1,535$) in Tragedy Creek in 2019 than during any year since surveys began in 2002 (**Figure 14**). High larval observations in 2019 contrast concerningly low observations in the previous three survey years: 2017, 2016, and 2013. CDFW staff observed fourteen, 12, and 103 larval observations in each of those three years, respectively.

Environmental conditions during winter 2016–2017 may have been a factor in the reduced SNYLF detections in summer 2017. Winter 2016–2017 was record-setting in the northern Sierra Nevada, in terms of precipitation quantity (CDWR 2017a), during which northern Sierra Nevada

snowpack levels reached about 150% of the April 1st average (CDWR 2017b). These conditions resulted in the Upper Mokelumne watershed retaining snow well into July 2017. Long winter and deep snowpack are known to increase SNYLF mortality (Bradford 1983).

Additionally, VES results can be difficult to compare due to numerous factors, including weather conditions, time of year, and observer bias (Mazerolle et al. 2007). For example, when CDFW crews surveyed Tragedy Creek on 12 September 2019, the creek was no longer flowing in most locations and available aquatic habitat was limited to isolated pools (**Figures 4–8**). These stream conditions increase detection probability compared to higher flow years because SNYLF were concentrated into the limited available aquatic habitats. Additionally, the lack of flow allowed for greater visibility into the pools that held water. Conditions in Tragedy Creek in 2016, a survey year with a relatively high number of post-metamorphic SNYLF observations, were similar to 2019. In contrast, during 2017, field crews conducted surveys in early July, following a winter with far above average snowpack. Flows in Tragedy Creek were high and there was an abundance of aquatic habitat available, which created more difficult survey conditions, reduced visibility into the water, and provided many additional places for SNYLF to hide and remain unavailable for detection.

CDFW will continue periodic monitoring to determine the relative abundance, general reproductive success, and demographic composition of the SNYLF population in Tragedy Creek.



Figure 12. Adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) detected at Site ID 14740 during 2019 visual encounter surveys. (CDFW)

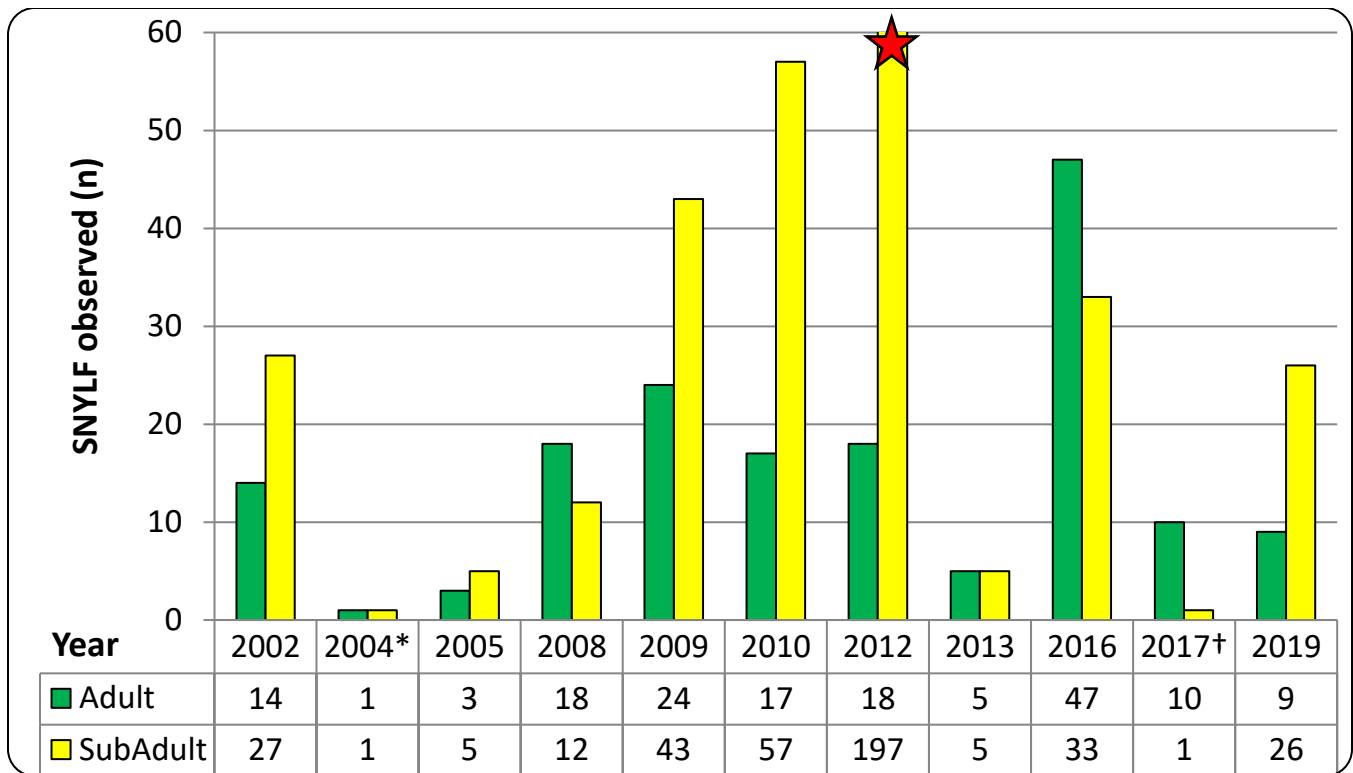


Figure 13. Number of adult and subadult Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in Tragedy Creek (Site IDs 50151, 50152, and 50153). Field crews have also detected SNYLF in pooled areas of the creek and ponds nearby (Site IDs 14740, 14743, 14750, and 14777). However, this figure includes a majority of all adult and subadult SNYLF detections from the Tragedy Creek area, and far fewer SNYLF have been observed in areas outside the main stem of Tragedy Creek. Additionally, CDFW crews have monitored the other sites less consistently. Therefore, for better comparability, this figure only presents Site IDs 50151, 50152, and 50153.

*Crews did not survey Site ID 50153 in 2004.

†Crews did not survey Site ID 50153 in 2017. Includes two adult SNYLF that field crews observed in an additional stream segment (Site ID 52685) that CDFW had not previously surveyed.

★ [red star] Indicates an outlier value beyond the range of the figure (197 subadults).

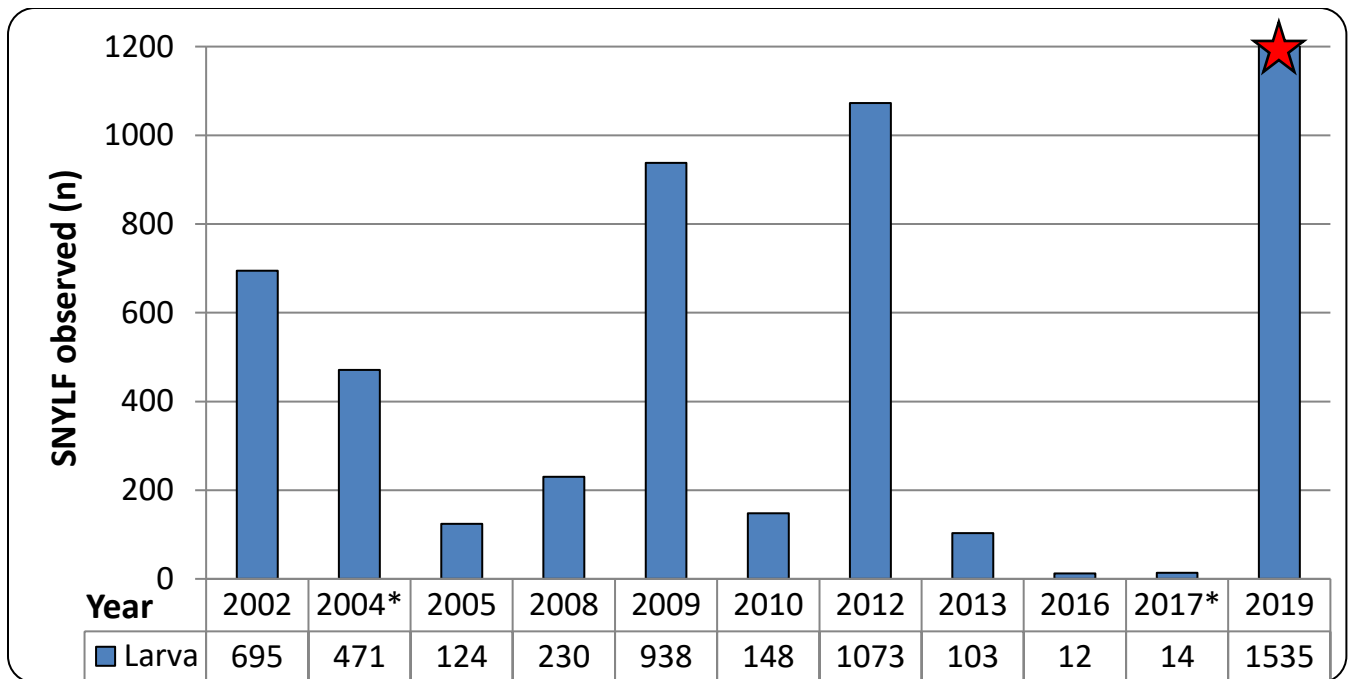


Figure 14. Number of larval Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in Tragedy Creek (Site IDs 50151, 50152, and 50153). Field crews have also detected SNYLF in pooled areas of the creek and ponds nearby (Site IDs 14740, 14743, 14750, and 14777). However, this figure includes a majority of all larval SNYLF detections from the Tragedy Creek area, and far fewer SNYLF have been observed in areas outside the main stem of Tragedy Creek. Additionally, CDFW crews have monitored the other sites less consistently. Therefore, for better comparability, this figure only presents Site IDs 50151, 50152, and 50153.

*Crews did not survey Site ID 50153 in 2004 or 2017

★ [red star] Indicates an outlier value beyond the range of the figure (1535 larvae).

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