State of California
Department of Fish and Wildlife

Memorandum

Date: 2 August 2023

To: Leslie Alber;
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Sierra District Supervisor;
North Central Region Fisheries

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

Cc: Region 2 Fish Files

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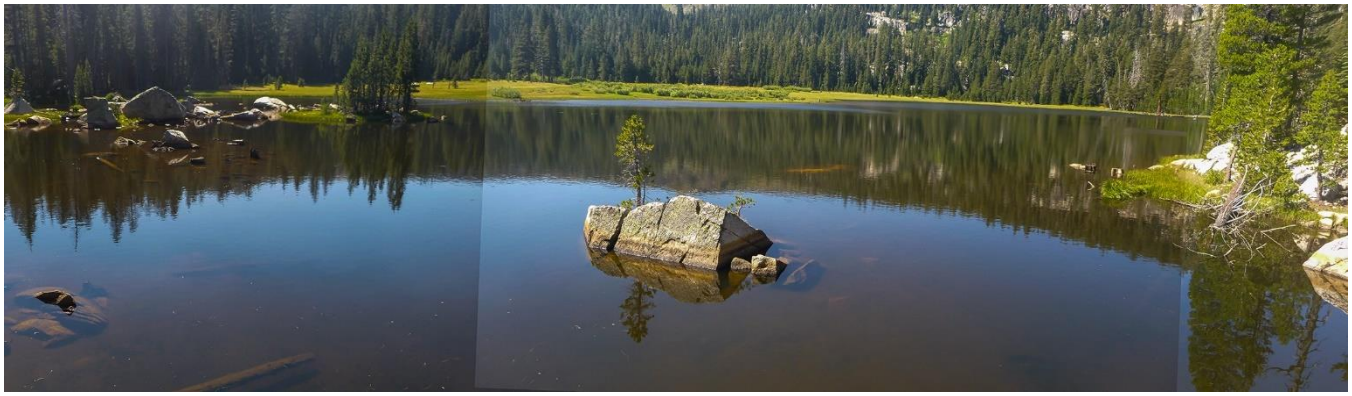
Subject: Native amphibian monitoring in Alpine County;

- ***Rana sierrae*** **surveys in the Wheeler Lake area**



SUMMARY

The Wheeler Lake area is located north of State Route (SR) 4 in Alpine County (**Figure 1**). The area contains a small population of Sierra Nevada Yellow-legged Frogs (SNYLF; *Rana sierrae*), which California Department of Fish and Wildlife (CDFW) has been monitoring occasionally since 2001. In late September 2021, CDFW staff revisited the Wheeler Lake area to conduct visual encounter surveys (VES) for SNYLF. Surveys in 2021 included Wheeler Lake, the Wheeler Lake outlet stream, and all adjacent small ponds on Stanislaus National Forest (SNF) lands (**Figure 2**). During surveys, CDFW staff only observed nine subadult SNYLF at two separate locations (Wheeler Lake, Site ID 15145; and the outlet stream, Site ID 50170; **Figure 2**). These two sites are the only locations in the Wheeler Lake area at which CDFW has observed SNYLF since 2001. VES results suggest the SNYLF population may be declining, but deriving population trends is difficult due to limited detections. The relative isolation, small population size, and potential for decline make this population of interest to CDFW.

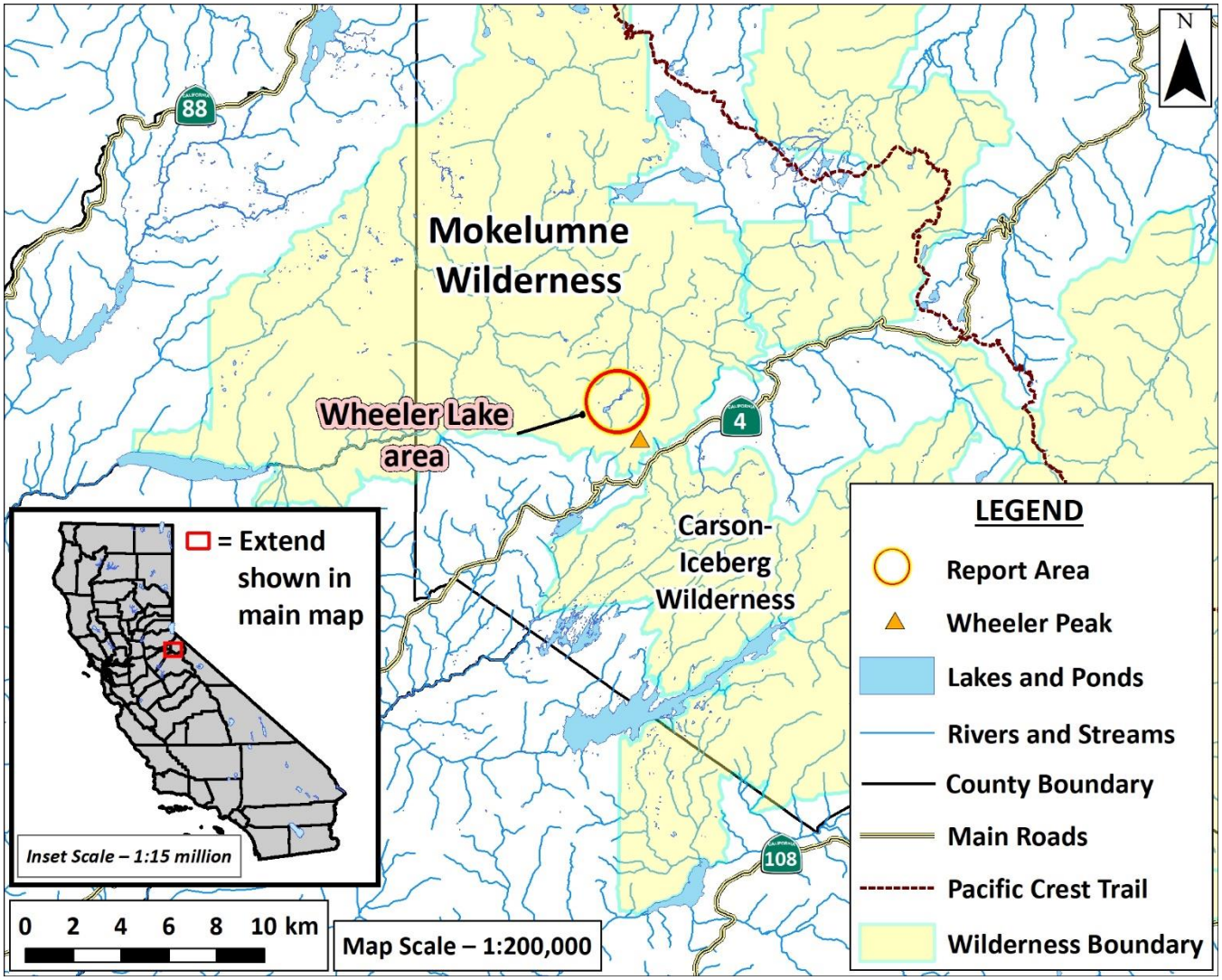


Figure 1. Southwestern Alpine County, CA, with far eastern El Dorado, Amador, and Calaveras Counties, and northern Tuolumne County, also visible on the main map. The area discussed in this memorandum is circled.

ENVIRONMENTAL SETTING

The Wheeler Lake area, which includes Wheeler Lake, the Wheeler Lake outlet stream, and numerous small ponds, is located in southwestern Alpine County, north of SR 4 and approximately 2 kilometers (km) northwest of Wheeler Peak (**Figures 1**). The entire area discussed in this memorandum is located within the Mokelumne Wilderness. The Wheeler Lake area flows into the North Fork Mokelumne River via Jackson Canyon. Elevations in the area range from 8,977 feet (ft; 2,736 meters [m]) at the summit of Wheeler Peak to the southeast, and down to approximately 7,700 ft (2,347 m) at the lower end of the surveyed area, near Site ID 15126 (**Figure 2**). Stanislaus National Forest, Calaveras Ranger District, manages the Wheeler Lake area. The area is accessible via several hiking trails that begin at SR 4.

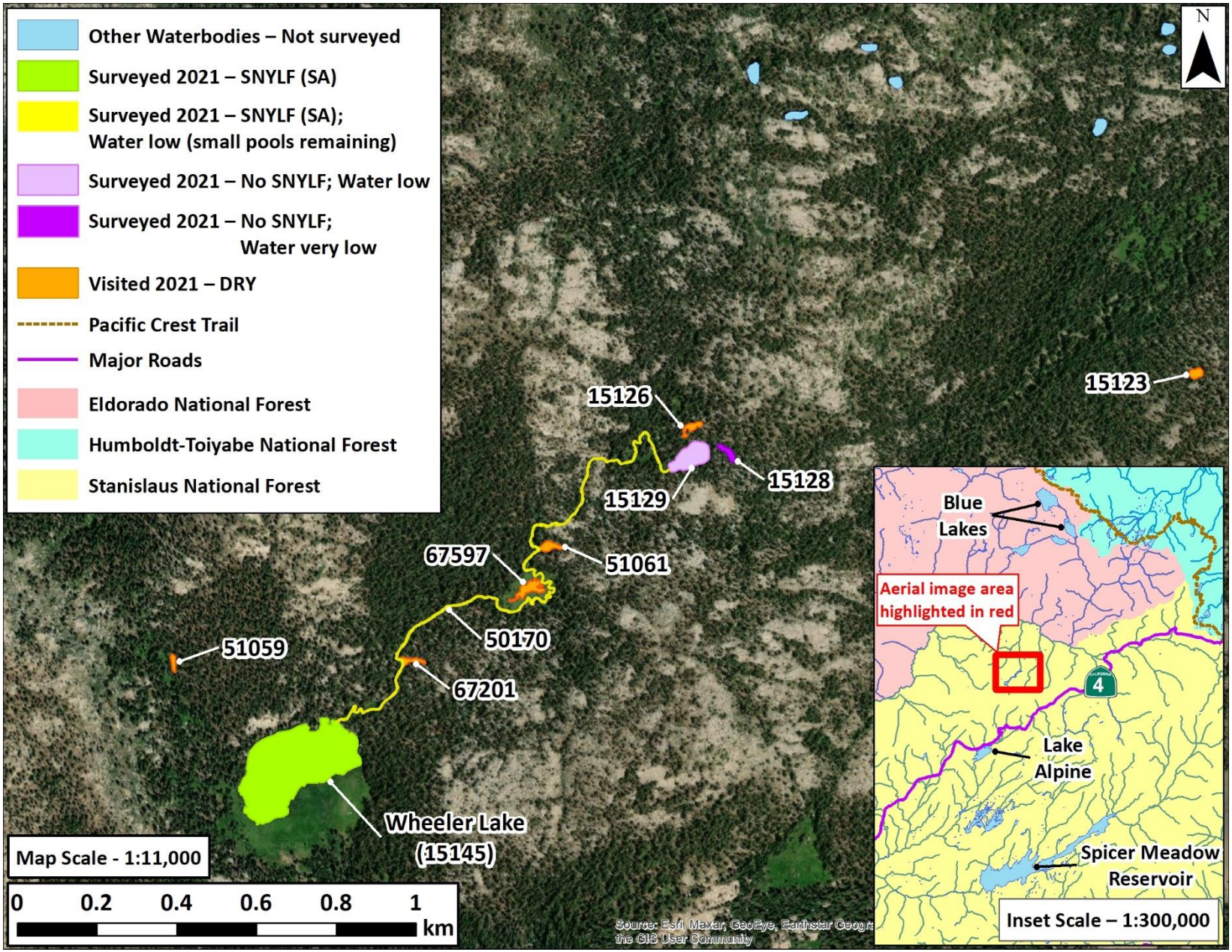


Figure 2. [See figure caption at the beginning of the next page.]

Figure 2 (continued). Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations and surface water status during visual encounter surveys (VES) in the Wheeler Lake area, Alpine County, CA, on 22 September 2021. Observed SNYLF life stages are denoted by letter codes in the legend: "SA" = subadults. All flowing waters in the area surveyed by CDFW drain north into the North Fork Mokelumne River. Displayed five-digit numbers are Site IDs, which CDFW uses to partition waterbodies for data collection.

THREATS

Marginal Habitats

SNYLF are persisting at low density in the Wheeler Lake area (**Figure 2**). Known occupied habitat only includes the main lake and outlet stream. 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 extended drought, severe winter conditions, wildfire, or anthropogenic habitat disturbances.

Introduced Fish

CDFW stocked Wheeler Lake with Brook Trout (*Salvelinus fontinalis*; BK) nearly every year from 1931 until 2000. However, VES and an overnight set of two gill nets in July 2013 indicate that Wheeler Lake has become fishless in the absence of stocking. The lake is shallow and water levels drop substantially later in the summer and fall, particularly during below average water years. The low water levels may have often caused overwinter kill of BK, and also nearly complete drying of the outlet stream, thus eliminating much of the potential BK spawning habitat. Therefore, current evidence suggests BK are no longer present in the Wheeler Lake drainage. However, before the cessation of stocking, BK likely suppressed the SNYLF population in the Wheeler Lake area for many decades.

Disease

CDFW has detected the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*), which has been implicated in amphibian declines worldwide (Rachowicz et al. 2006, Skerratt et al. 2007), in all SNYLF populations sampled in the northern Sierra Nevada. To detect *Bd*, field staff collected epithelial swabs in 2008 (n = 3) and 2010 (n = 2) at Wheeler Lake and the outlet stream. Partner scientists screened the swabs for presence of *Bd* DNA using real-time quantitative polymerase chain reaction (qPCR) analysis. Results detected either no *Bd* (n = 3) or very light (n = 2) *Bd* infection intensity. Therefore, although present, *Bd* levels were very low in the Wheeler Lake area during the period 2008–2010.

Loss of Genetic Diversity

Like many SNYLF populations in the northern Sierra Nevada, the Wheeler Lake area population is very small when compared with many historic and/or *Bd*-naïve SNYLF populations. In fact, most SNYLF populations in Alpine County are small and isolated from one another. The nearest known larger SNYLF populations are located in the North Fork Stanislaus River watershed, approximately 4 km southeast of Wheeler Lake (CDFW 2021), and the Upper Pleasant Valley

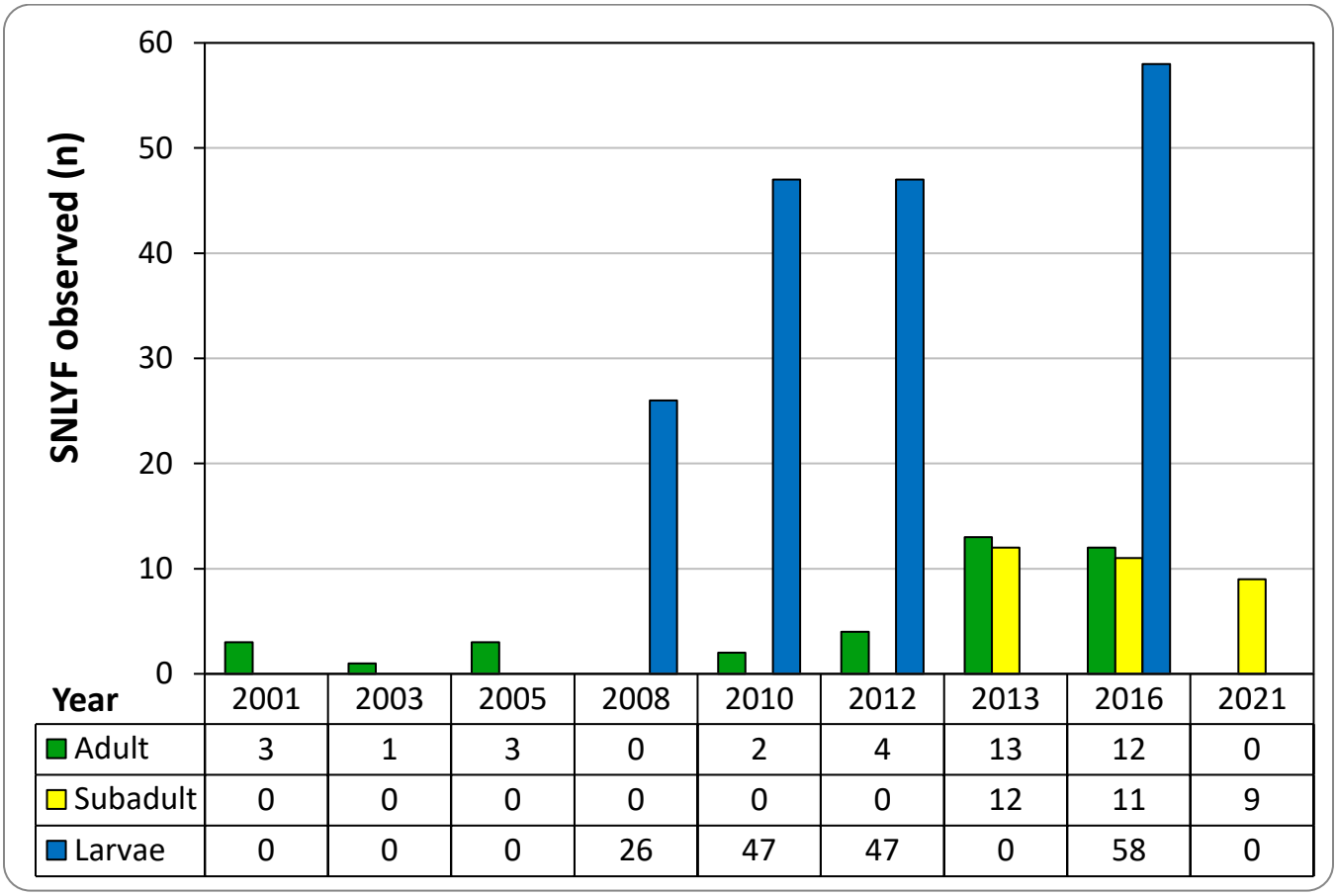
Creek/Upper Deer Creek area, approximately 12 km to the northeast (CDFW 2014, 2023). In addition to the threats presented by stochastic environmental events (e.g., drought, wildfire, or especially harsh winter) when a population is geographically isolated, genetic isolation can lead to factors such as 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).

METHODS and RESULTS

CDFW used standard VES (CDFW, unpubl. High Mountain Lakes survey protocol), modified from methods developed by Fellers and Freel (1995), to survey for aquatic species in the Wheeler Lake area. CDFW focused on surveying for amphibians, particularly SNYLF. However, CDFW staff also noted other amphibians, reptiles, and fish observed during VES. Please see the **APPENDIX** for additional site photos.

During each survey year, CDFW staff have observed all SNYLF in Wheeler Lake (Site ID 15145) and the outlet stream (Site ID 50170; **Figure 2**). Staff have observed most SNYLF larvae in the outlet stream (76% of larvae observations have occurred at Site ID 50170, when summing counts of all larvae during VES from 2001 to 2021). The percentage split for post-metamorphic SNYLF (adults and subadults) staff have observed between Wheeler Lake and the outlet stream is similar: staff have observed most post-metamorphic SNYLF in the outlet stream (78% of post-metamorphic observations, when summing counts from 2001 to 2021).

Relative abundance of post-metamorphic SNYLF detected during VES in the Wheeler Lake area has varied over time, and detections have been low enough that drawing conclusions about populations trends is difficult (**Figure 3**). See the **DISCUSSION** section for additional considerations on this topic.



Year	2001	2003	2005	2008	2010	2012	2013	2016	2021
Adult	3	1	3	0	2	4	13	12	0
Subadult	0	0	0	0	0	0	12	11	9
Larvae	0	0	0	26	47	47	0	58	0

Figure 3. Number Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) of different life stages (adult, subadult, larvae) detected during visual encounter surveys (VES) in the Wheeler Lake area from 2001 to 2021. Historically, California Department of Fish and Wildlife (CDFW) staff have observed all SNYLF in Wheeler Lake and the outlet stream.

DISCUSSION

Twenty one years of monitoring data suggest the Wheeler Lake area SNYLF population may be declining. However, low SNYLF detections make deriving trends difficult. Other important factors may be influencing changes in the number and proportion of SNYLF life stages observed between years, including weather conditions on the survey day (i.e., surveys on cooler, windier days tend to result in fewer detections than surveys on warmer, calmer days; pers. obs.) and observer bias (Mazerolle et al. 2007).

Another notable confounding factor is drastic shifts in precipitation and snowpack in the Sierra Nevada during the past decade. These dramatic inter-annual fluctuations increase the difficulty of interpreting population trends. For example, since 2012, winter precipitation in the northern Sierra Nevada has alternated from far below average during an extended drought (2012–early 2016), to record-setting (2016–2017), to well below average (2017–2018), to well above average (2018–2019), and back to far below average during late 2019–early 2022 (CDEC 2022a, b). The winter prior to the surveys discussed in this memorandum was one of the driest on record (CDEC 2022b).

Overwinter SNYLF mortality can increase during long winters with deep snowpack (Bradford 1983). Contrarily, drought conditions can dry up areas normally occupied by SNYLF, especially in places like the Wheeler Lake area, where much of the occupied aquatic habitat is small, shallow ponds and ephemeral streams (**Figure 2**). Although Wheeler Lake is currently perennial, the outlet stream and all surrounding ponds are threatened with complete drying, particularly during dry years. Currently, California is experiencing another multi-year period of below-average precipitation and snowpack (CDEC 2022a, b), following a similarly long drought period within the past decade (2012–early 2016). If the water table lowers, particularly with continued trends of warmer annual temperatures, later onset of winter precipitation, earlier onset of spring snowmelt, and precipitation falling more often as rain than snow, these habitats may dry more frequently and over longer durations, leading to increased potential of this small SNYLF population being extirpated (Lacan et al. 2008, Wright et al. 2013, Ryan et al. 2014, Dettinger et al. 2018).

Finally, an important environmental consideration related to SNYLF detections is the calendar date during which staff conduct surveys (i.e., depending on weather conditions, shoulder season surveys of high elevation amphibian habitat—in May into early June, and late September into early October—may lead to poorer detectability when compared with surveys during the core summer period of late June through early September; pers. obs.). Survey timing is likely a significant factor in the low number of detections in 2021. CDFW surveyed the Wheeler Lake area much later in the season than past surveys (22 September, whereas CDFW conducted most previous surveys in the period 2001 to 2016 between mid-June and August; the surveys with highest SNYLF detections of which all occurred in mid-summer). CDFW suspects that the late season surveys and exceptionally dry water year likely played a large role in the limited SNYLF detections in 2021.

Figure 4. Wheeler Lake (Site ID 15145) on 22 September 2021. In past surveys (conducted periodically from 2001 to 2016), this lake and the seasonally connected outlet stream have contained Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) of all life stages. (CDFW)

Five years had passed between the surveys in late August 2016 and the most recent survey in late September 2021. This gap in surveys, combined with the 2021 surveys occurring late in the typical SNYLF monitoring season during an exceptionally dry water year (CDEC 2022a, b) are reasons that CDFW is cautious about drawing any conclusions about SNYLF decline in the Wheeler Lake area. Additional surveys during July or August, will help add better evidence about the current status of the Wheeler Lake area SNYLF population.

CDFW will continue to occasionally monitor SNYLF in the Wheeler Lake area to assess the population status over time. Long-term monitoring is needed to derive population trends and inform management plans. Given potential threats to this population, in particular climate change/drought and disease, CDFW may consider future efforts to mark adult SNYLF with passive integrated transponder (PIT) tags. Over time, marking adult SNYLF in this manner would allow capture-mark-recapture analysis, which can provide a more accurate estimation of population size, especially for a relatively small population (Mazerolle et al. 2007). Over time, these marking efforts may provide CDFW and SNF with a better idea of the true SNYLF population size in the Wheeler Lake area.

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APPENDIX

Additional survey photographs from the Wheeler Lake area, taken by CDFW staff in late September 2021.

Figure A1. View of the Wheeler Lake outlet stream (Site ID 50170) on 22 September 2021. Only very small, intermittent pools remained during the survey. (CDFW)

Figure A2. Site ID 15129 on 22 September 2021. Water levels in many of the small ponds in the Wheeler Lake area were very low during surveys, and most of the smallest ponds were completely dry. (CDFW)

Figure A3. Site ID 15128 on 22 September 2021. (CDFW)