State of California Department of Fish and Wildlife

Memorandum

Date: 8 August 2022

- To: Leslie Alber, 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: Native amphibian monitoring in Alpine County;

• Rana sierrae monitoring in the Ebbetts Pass area



SUMMARY

The Ebbetts Pass area is located just 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, a CDFW biologist revisited the Ebbetts Pass area to conduct visual encounter surveys (VES) for SNYLF. Surveys in 2021 included all small lakes, ponds, and stream segments on Humboldt-Toiyabe National Forest (HTNF) lands that still contained surface water, with the exceptions of Lower Kinney Lake and Kinney Reservoir (**Figure 2**). During surveys, CDFW staff only observed three adult SNYLF at two separate locations (a spring-fed stream segment, Site ID 52887; and Dorothy Lake, Site ID 15042; **Figure 2**). However, in past surveys, CDFW has observed SNYLF in additional locations in the area, including Site ID 15019, Upper Kinney Lake (Site ID 15001), and Lower Kinney Lake (Site ID 14995). 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 Ebbetts Pass area, which includes Upper Kinney Lake, Lower Kinney Lake, Kinney Reservoir, and numerous small lakes and ponds along the Pacific Crest Trail (PCT) corridor, is located north of SR 4 in central Alpine County (**Figures 1 and 2**). The area discussed in this memorandum is located just outside designated wilderness, with Mokelumne Wilderness located just north of the area, and Carson-Iceberg Wilderness located just south (**Figure 1**). The Ebbetts Pass area forms the headwaters of Silver Creek, which flows into the East Carson River at Centerville Flat. Elevations in the area range from 9,695 feet (ft; 2,955 meters [m]) at the summit of Reynolds Peak to the north, 9,186 feet (ft; 2,800 m) at Ebbetts Peak to the south, and down to 8,353 ft (2,546 m) at Kinney Reservoir. Humboldt-Toiyabe National Forest, Carson Ranger District, manages this section of the Ebbetts Pass area. The area is easily accessible via SR 4 and the PCT. Additionally, several unmaintained four-wheel-drive (4x4) dirt roads connect the main lakes with SR 4, but access is limited via a locked gate 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 Ebbetts Pass area, Alpine County, CA, on 22 September 2021. Observed SNYLF life stages are denoted by letter codes in the legend: "A" = adults. All flowing waters in the area surveyed by CDFW drain into Silver Creek. Displayed five-digit numbers are Site IDs, which CDFW uses to partition waterbodies for data collection. CDFW added Site IDs 52887 and 52888 in 2021.

THREATS

Marginal Habitats

SNYLF are persisting at very low density in the Ebbetts Pass area (**Figure 2**). Known occupied habitat primarily includes small ponds and stream channels with tiny, shallow, intermittent pools. Although SNYLF have also been observed in Upper Kinney and Lower Kinney Lakes, fish are present at both sites, which limits SNYLF breeding opportunities (see below). 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

Fish are not present in many of the habitats occupied by SNYLF in the Ebbetts Pass area (e.g., Site IDs 15019, 15042, and 52887). However, CDFW stocks Rainbow Trout (*Oncorhynchus mykiss*; RT) into Kinney Reservoir (CDFW 2021a), self-sustaining Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*; LCT) are present in Lower Kinney Lake (CDFW 2018), and a sixhour, daytime gill net set in 2020 revealed that Upper Kinney Lake contains minnows, including Lahontan Redside (*Richardsonius egregius*) and Speckled Dace (*Rhinichthys osculus*) (CDFW 2020b). CDFW formerly stocked Upper Kinney Lake with LCT nearly every year from 1950 until 2000, and CDFW staff have not placed any overnight gill nets into Upper Kinney since 2001, at which time staff had captured 18 LCT among two overnight gill nets. Therefore, Upper Kinney Lake may still contain a low density trout population, although current evidence suggests that LCT may have become extirpated in the absence of stocking (CDFW 2020b).

These three lakes are by far the largest waterbodies in the Ebbetts Pass area, and CDFW staff have detected post-metamorphic SNYLF at both Upper and Lower Kinney Lakes, most recently in 2012. CDFW has not observed any evidence of SNYLF breeding at either Upper or Lower Kinney Lakes, which is unsurprising, given low SNYLF densities, plus historic and current fish presence at both lakes, respectively. The remaining small lakes in the Ebbetts Pass area are found along the PCT corridor, well above Upper Kinney Lake. The only stream channels that flow from these upper ponds to Upper Kinney Lake are small, steep, and ephemeral, and appear to contain substantial barriers to any potential upstream fish movement. Therefore, the main potential threat posed by trout presence in Lower Kinney Lake (and potentially Upper Kinney Lake) is that these habitats may act as populations sinks for migrating SNYLF, which may experience direct predation (particularly among young frogs) or lack of breeding success through fish predation.

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 = 10) and 2010 (n = 8) at Site ID 15019. 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 = 12); very light (n = 4) or moderate (n = 2) *Bd* infection intensity. Therefore, although present, *Bd* levels were very low at Site ID 15019 in the period 2008–2010.

Loss of Genetic Diversity

Like many SNYLF populations in the northern Sierra Nevada, the Ebbetts Pass 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 in the North Fork Stanislaus River watershed 12 kilometers (km) to the southwest (CDFW 2021b), and in the Upper Jeff Davis Creek/Deer Creek area approximately 9 km to the northwest (CDFW 2014, 2020a). 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 Ebbetts Pass 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 <u>APPENDIX</u> for additional site photos.

During all survey years, CDFW staff have observed a large majority of SNYLF (95% of observations, when summing counts of all life stages; **Figure 3**) at one small pond (Site ID 15019; **Figures 2 and 5**) located at the northern end of a meadow complex adjacent to the PCT. Staff have observed most additional SNYLF at Lower Kinney Lake (4.5% of all observations), while the remaining sites together account for <1% of SNYLF detections (**Figure 4**). Although CDFW staff observed a single SNYLF tadpole at Upper Kinney Lake in June 2012, staff have detected all other early life stage SNYLF at Site ID 15019 (**Figures 3 and 4**).

Relative abundance of adult SNYLF detected during VES at Site ID 15019 has declined over time (Figure 3). Detections of other life stages at all sites have been more variable overall (Figures 3 and 4). However, apart from one individual at Site ID 15019 in 2012, CDFW has not detected any other subadult SNYLF in the Ebbetts Pass area since 2008 (Figures 3 and 4).



Figure 3. Number Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) of different life stages (adult, subadult, larva, or egg mass) detected during visual encounter surveys (VES) at Site ID 15019 from 2001 to 2021. Historically, California Department of Fish and Wildlife (CDFW) staff have observed most SNYLF in the Ebbetts Pass area at this location.



Figure 4. Number Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) of different life stages (adult, subadult, and larva) detected during visual encounter surveys (VES) at all other locations in the Ebbetts Pass area at which California Department of Fish and Wildlife (CDFW) staff have observed SNYLF (Site IDs 14995, 15001, 15042, and 52887) from 2001 to 2021. Of the observations shown here, most (82%) have occurred at Lower Kinney Lake (Site ID 14995). †In 2008 and 2010, CDFW did not survey Upper Kinney Lake (Site ID 15001).

*In 2021, CDFW did not survey Lower Kinney Lake. Additionally, 2021 was the first year that CDFW observed SNYLF (n = 1 adult) in Dorothy Lake (Site ID 15042). CDFW also added two new sites (Site IDs 52887 and 52888) in 2021, which are two segments of the small, spring/meadow-fed stream located just east of Site ID 15019 (see **Figure 2**).

DISCUSSION

Twenty one years of monitoring data suggest the Ebbetts Pass SNYLF population is 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 2019–2022 (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 Ebbetts Pass area, where much of the occupied aquatic habitat is small, shallow ponds and ephemeral streams (**Figure 2**). The main known SNYLF breeding pond (Site ID 15019; **Figure 5**) is currently perennial and appears to be fed by groundwater from the surrounding meadow. These current hydrologic conditions likely help mitigate the primary threat to this population during exceptionally dry water years. However, although these conditions may persist for the time being, there may be long term threats to SNYLF persistence if the water table lowers, causing these habitats to dry more frequently and over longer durations, 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 (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 Ebbetts Pass area much later in the season than past surveys (22 September, whereas CDFW conducted all previous surveys in the period 2001 to 2012 between late June and early 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, particularly at Site ID 15019. Additionally, CDFW did not survey Lower Kinney Lake in 2021, which further reduced potential for SNYLF detections.

Figure 5. Site ID 15019 on 22 September 2021. In past surveys (conducted periodically from 2001 to 2012), this pond and the connected meadow habitat have contained a vast majority of Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) of all life stages observed by California Department of Fish and Wildlife (CDFW) staff in the Ebbetts Pass area. In 2021, staff did not observe any SNYLF at this location. CDFW suspects that the time of year (i.e., all previous surveys occurred in mid-summer), and exceptionally dry water year may have been factors in the lack of SNYLF detections. (CDFW)

Nearly a decade passed between the surveys in late June 2012 and the most recent survey in late September 2021. This long 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 Ebbetts Pass area. Additional surveys, focused particularly on Site ID 15019 and the surrounding meadow and stream habitat (e.g., Site IDs 52887 and 52888) during July or August, will help add better evidence about the current status of the Ebbetts Pass SNYLF population.

CDFW will continue to occasionally monitor SNYLF in the Ebbetts Pass area to assess the population status over time. Long-term monitoring is needed to derive population trends and inform management plans. Given multiple potential threats to this population, including climate change/drought, fish presence, 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 HTNF with a better idea of the true SNYLF population size in the Ebbetts Pass area.

LITERATURE CITED

- Bradford, D.F. 1983. Winterkill, oxygen relations, and energy metabolism of a submerged dormant amphibian, Rana muscosa. Ecology 64:1171–1183. Available from: <u>https://www.jstor.org/stable/pdf/1937827.pdf</u>
- California Data Exchange Center (CDEC). Department of Water Resources. 2022a. California snow water content percent of April 1 average interactive plots. Accessed April 2022. Available from: <u>https://cdec.water.ca.gov/snowapp/swcchart.action</u>
- California Data Exchange Center (CDEC). Department of Water Resources. 2022b. Northern Sierra 8 station precipitation index – interactive water year plot. Accessed April 2022. Available from: <u>https://cdec.water.ca.gov/precipapp/get8SIPrecipIndex.action</u>
- California Department of Fish and Wildlife (CDFW). 2014. Aquatic Biodiversity Management Plan for the Jeff Davis Creek Management Unit. Available from: <u>http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=84128</u>
- CDFW. 2018. Lower Kinney Lake fish survey. Region 2 Survey Memo. California Department of Fish and Wildlife, Rancho Cordova, CA. Available from: <u>https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=155319</u>
- CDFW. 2020a. Jeff Davis Creek (Alpine County) *Rana sierrae* monitoring. Region 2 Survey Memo. California Department of Fish and Wildlife, Rancho Cordova, CA. Available from: <u>https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=177917</u>
- CDFW. 2020b. Upper Kinney Lake fish survey. Region 2 Survey Memo. California Department of Fish and Wildlife, Rancho Cordova, CA. Available from: <u>https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=182186</u>
- CDFW. 2021a. Kinney Reservoir, Alpine County: 2020 angler survey box analysis. Region 2 Survey Memo. California Department of Fish and Wildlife, Rancho Cordova, CA. Available from: <u>https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=195065</u>
- CDFW. 2021b. Native amphibian monitoring in Alpine County: 2020 surveys in the North Fork Stanislaus River watershed. Region 2 Survey Memo. California Department of Fish and Wildlife, Rancho Cordova, CA. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=194916
- Dettinger, M., H. Alpert, J. Battles, J. Kusel, H. Saford, D. Fougeres, C. Knight, L. Miller, and S. Sawyer. 2018. Sierra Nevada Summary Report. California's Fourth Climate Change Assessment. Publication # SUM-CCCA4-2018-004. Available from: <u>https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-004_SierraNevada_ADA.pdf</u>
- Fellers, G.M., and K.L. Freel. 1995. A standardized protocol for surveying aquatic amphibians. Technical Report NPS/WRUC/NRTR-95-01. Available from: <u>http://www.elkhornsloughctp.org/uploads/files/1172879165Fellers_Standardized_Survey_Protocol.pdf</u>

- Frankham, R., J.D. Ballou, and D.A. Briscoe. 2009. Introduction to Conservation Genetics. Cambridge University Press, New York, NY, USA.
- Lacan, I., K. Matthews, and K. Feldman. 2008. Interaction of an introduced predator with future effects of climate change in the recruitment dynamics of the imperiled Sierra Nevada yellow-legged frog (*Rana sierrae*). Herpetological Conservation and Biology 3:211–223. Available from: <u>http://www.herpconbio.org/Volume_3/Issue_2/Lacan_etal_2008.pdf</u>
- Mazerolle, M.J., L.L. Bailey, W.L. Kendall, J.A. Royle, S.J. Converse, and J.D. Nichols. 2007. Making great leaps forward: accounting for detectability in herpetological field studies. Journal of Herpetology 41:672–689. Available from: <u>https://www.jstor.org/stable/pdf/40060463.pdf</u>
- Rachowicz, L.J., R.A. Knapp, J.A.T. Morgan, M.J. Stice, V.T. Vredenburg, J.M. Parker, and C.J. Briggs. 2006. Emerging infectious disease as a proximate cause of amphibian mass mortality. Ecology 87:1671–1683. Available from: https://www.jstor.org/stable/pdf/20069125.pdf
- Ryan, M.E., W.J. Palen, M.J. Adams, and R.M. Rochefort. 2014. Amphibians in the climate vise: loss and restoration of resilience of montane wetland ecosystems in the western US. Frontiers in Ecology and the Environment 12:232–240. Available from: <u>https://esajournals.onlinelibrary.wiley.com/doi/epdf/10.1890/130145</u>
- Skerratt, L.F., L. Berger, R. Speare, S. Cashins, K.R. McDonald, A.D. Phillott, H.B. Hines, and N. Kenyon. 2007. Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs. EcoHealth 4:125–134. Available from: https://link.springer.com/content/pdf/10.1007/s10393-007-0093-5.pdf
- Wright, A.N., R.J. Hijmans, M.W. Schwartz, and H.B. Shaffer. 2013. California amphibian and reptile species of future concern: conservation and climate change. Final report to the California Department of Fish and Wildlife Nongame Wildlife Program. Available from: <u>https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=141383</u>

APPENDIX

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

Figure A1. View of (from left to right) Sherrold Lake (Site ID 15034), Site ID 15036 (in shade among the trees), and Kinney Reservoir (Site ID 15006). The view is looking north from Ebbetts Peak on the evening of 21 September 2021. (CDFW)

Figure A2. Site ID 15036 on the evening of 21 September 2021. Water levels in many of the small ponds in the Ebbetts Pass area were very low during surveys, and most of the smallest ponds were completely dry. (CDFW)

Figure A3. Site ID 15023 on 22 September 2021. Many small ponds were completely dry on the survey day (see main text, **Figure 2**). (CDFW)

Figure A4. Site ID 52888 on 22 September 2021. This site ID is a network of ephemeral stream channels that flows through the meadow system associated with Site ID 15019. On the survey day, this channel was almost completely dry. A few short sections toward the upstream end of the channel (southern-most end) were damp or contained brief stretches of extremely shallow surface flow, but staff did not observe any amphibians in those small areas.

Figure A5. The upstream end of Site ID 52887 on 22 September 2021. This site is connected to Site ID 52888, and primarily composed of one main stream channel, found just east of Site ID 15019. The channel flows north toward Lower Kinney Lake (Site ID 14995). The upstream end of Site ID 52887 is the start of a more deeply channelized section of stream, containing this eroded/sunken-in area in the sand. On the survey day, soon downstream of this location, surface water was flowing in the channel. Additionally, the section within 100 meters south of the Pacific Crest Trail contained intermittent pools in which California Department of Fish and Wildlife staff observed two Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) adults. (CDFW)

Figure A6. One of the small pools present along Site ID 52887 in which California Department of Fish and Wildlife (CDFW) staff observed an adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*) on 22 September 2021. (CDFW)

Figure A7. Two adult Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) briefly hand captured at Site ID 52887 by California Department of Fish and Wildlife staff on 22 September 2021. (CDFW)

Figure A8. Dorothy Lake (Site ID 15042) on 22 September 2021, looking north. (CDFW)

Figure A9. An adult Sierra Nevada Yellow-legged Frog (*Rana sierrae*) observed in Dorothy Lake on 22 September 2021. (CDFW)

Figure A10. Upper Kinney Lake (Site ID 15001) on 22 September 2021, looking north.

Figure A11. A small pool below the Upper Kinney Lake (Site ID 15001) dam on 22 September 2021. California Department of Fish and Wildlife (CDFW) staff did not observe any amphibians in this pool. Soon below this location, the outlet stream flows into dense willow, and then drops steeply as it flows toward Lower Kinney Lake (Site ID 14995). (CDFW)