State of California — Department of Fish and Wildlife

Memorandum

Date: 16 September 2021

To: Sarah Mussulman,
Senior Environmental Scientist;
Sierra District Supervisor;
North Central Region Fisheries

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

Cc: Colin Purdy (Region 2 Fisheries Program Manager); Kevin Thomas (North Central Regional Manager); Rick Kuyper (USFWS Sierra-Cascades Division Chief); Laura Patterson (Statewide Amphibian and Reptile Coordinator); Region 2 Fish Files

Ec: CDFW Document Library

Subject: *Rana sierrae* tadpole rescue at Rattlesnake Creek, Nevada County

SUMMARY

Rattlesnake Creek (Rattlesnake) and the Mossy Pond area (Mossy) in Nevada County are locations at which California Department of Fish and Wildlife (CDFW) staff monitor populations of federally endangered and state threatened Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF). Biologists with Tahoe National Forest (TNF) often partner with CDFW to survey these SNYLF populations, which are of conservation importance to both agencies. In late August 2021, CDFW and TNF conducted visual encounter surveys (VES) at both populations. During surveys, TNF biologists discovered that numerous pools along Rattlesnake, many of which contained hundreds of SNYLF tadpoles, contained critically low water levels and would likely dry completely. Given the potential for significant loss of a SNYLF cohort, CDFW staff initiated communications internally and with the U.S. Fish and Wildlife Service (USFWS) to consider an emergency translocation of the stranded SNYLF tadpoles. On 2 September, partner agencies decided to move tadpoles to a large pool along Rattlesnake. However, collections soon revealed that initial visual estimates of tadpole abundance in drying pools were much lower than tadpole quantities actually present. With only a portion of the stranded tadpoles moved on 2 September ($n \approx 700$), CDFW began additional discussions with USFWS to propose moving the remaining tadpoles to Mossy, which is approximately 4 kilometers (km) north, and contains more abundant, perennial aquatic habitat. On 8 September, CDFW, USFWS, and TNF staff decided to move the remaining tadpoles to Mossy. On 9 September, CDFW and TNF staff collected and translocated 1,867 SNYLF tadpoles, rescuing a majority of tadpoles threatened with imminent desiccation.

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 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; CDFW began monitoring the population in 2001.

Rattlesnake Creek is located approximately 4 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, TNF biologists have conducted most monitoring of the SNYLF population in Rattlesnake Creek.

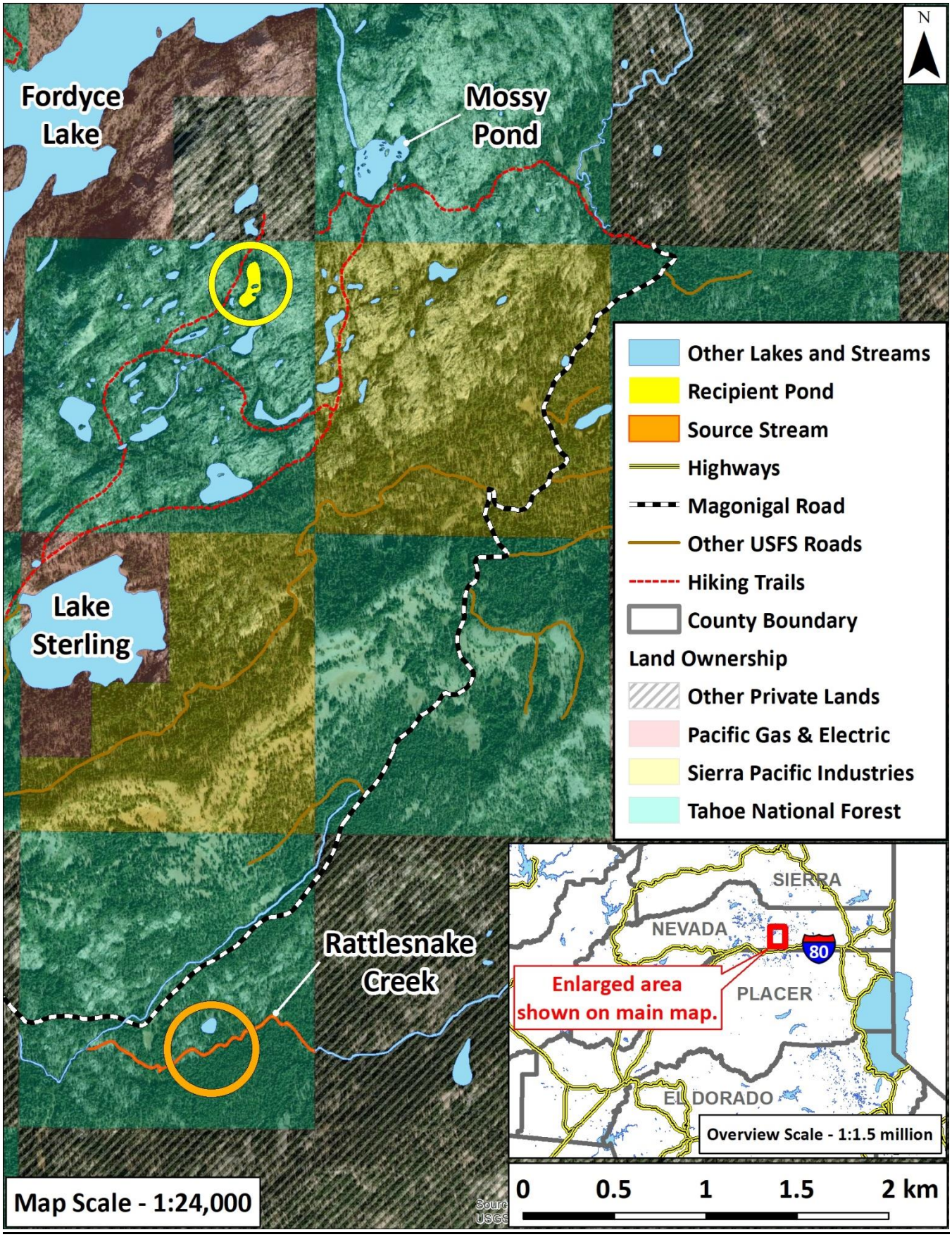

Figure 1. [See figure caption at the beginning of the next page.]

Figure 1 (continued). Rattlesnake Creek and the Mossy Pond area, Nevada County, CA. On 9 September 2021, California Department of Fish and Wildlife and Tahoe National Forest staff moved approximately 1,500 Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles from Rattlesnake Creek (area highlighted in orange) to Evelyn Lake (highlighted in yellow). Only lands owned by TNF (areas with blue-green shading) are discussed in this memorandum. The enlarged aerial map showing site details is highlighted by the red box in the inset map.

METHODS and RESULTS

A TNF biologist and field crew initially surveyed the Rattlesnake area on 30 August 2021. During the survey, staff observed numerous small, rapidly drying pools that contained SNYLF tadpoles (**Figures 2a and 2b**).

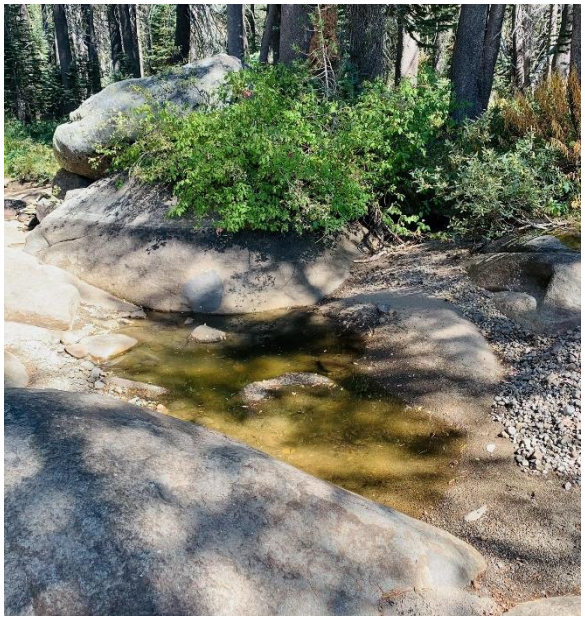

Figure 2a. One of several rapidly drying pools located on Rattlesnake Creek that contained *Rana sierrae* tadpoles on 30 August 2021. (TNF staff)

Figure 2b. Another rapidly drying pool located on Rattlesnake Creek that contained *Rana sierrae* tadpoles on 30 August 2021. (TNF staff)

On 2 September 2021, after discussions with the CDFW staff and USFWS, TNF staff received permission to move tadpoles from the drying pools to a larger, perennial pool within the same area of Rattlesnake (**Figure 3**). However, once tadpole collection began, TNF staff realized there were far more SNYLF tadpoles present than they had estimated during VES earlier in the week. Therefore, TNF staff only collected and translocated a subset of the SNYLF tadpoles present in the drying pools. In total, TNF staff collected and translocated ≈ 700 stranded SNYLF tadpoles to the perennial pool on 2 September.

Figure 3. A large pool on Rattlesnake Creek, located near the small, rapidly drying pools that contained stranded Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) tadpoles during surveys on 30 August 2021. On 2 September 2021, Tahoe National Forest (TNF) staff moved ≈ 700 SNYLF tadpoles from the drying pools into this larger pool. On the day of translocations, TNF staff collected water temperatures in this large pool several times. Water temperatures remained between 9 and 10° C throughout the day, indicating that this pool may be fed by groundwater percolating through the stream substrate. (TNF staff)

After observing an unexpected abundance of stranded SNYLF tadpoles on 2 September 2021, CDFW and TNF began discussions with USFWS to potentially move the remaining stranded tadpoles to more perennial aquatic habitat in the Mossy area. The Mossy SNYLF metapopulation is only about 4 km north of Rattlesnake (**Figure 1**), and—given close proximity, seasonal aquatic connectivity, and moderate topography—SNYLF populations between the two areas may have experienced consistent gene flow in the recent past, prior to SNYLF population declines caused by introduced trout and disease (Knapp and Matthews 2000, Rachowicz et al. 2006). Additionally, the amphibian fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*) is known to be present in both the Rattlesnake and Mossy areas (CDFW, unpubl. data). Given the high likelihood of very close genetic ancestry, ubiquitous *Bd* presence on the landscape, and extant SNYLF populations in both locations, CDFW, USFWS, and TNF agreed that there would be extremely low probability of negative effects from moving SNYLF tadpoles from Rattlesnake to

Mossy. Conversely, the addition of a cohort of tadpoles from Rattlesnake to Mossy may benefit the Mossy metapopulation and provide some beneficial gene flow (Frankham et al. 2019).

On 9 September 2021, after discussions internally and with the USFWS Sacramento Office, a CDFW biologist with many years of experience working with listed California amphibians joined a TNF aquatic biologist and field crews to initiate SNYLF tadpole rescue.

Staff collected SNYLF tadpoles from seven tiny, drying pools using aquarium dip nets (**Figure 4**) and food grade, one-gallon plastic buckets (**Figure 5**) to transport tadpoles from pools into five-gallon, food grade buckets outfitted with portable aerators (**Figure 6**). Crews kept the five-gallon holding buckets out of the sun at all times to help maintain cool water temperatures and limit stress to the tadpoles during the collection phase (**Figure 7**).

Figure 4. California Department of Fish and Wildlife and Tahoe National Forest field staff using aquarium dip nets to collect Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles from a small, drying pool along Rattlesnake Creek on 9 September 2021. (CDFW)

Figure 5. Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles—collected from a small, rapidly drying pool along Rattlesnake Creek—being briefly held in a one-gallon, food grade plastic bucket before transfer to a five-gallon, food grade plastic bucket equipped with a portable aerator. (CDFW)

Figure 6. A California Department of Fish and Wildlife field staff member using an aquarium dip net to collect Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles from a small, drying pool along Rattlesnake Creek on 9 September 2021. In this instance, staff were directly placing tadpoles from the pool into a five-gallon holding bucket, which was equipped with a portable aerator. (CDFW)

Figure 7. California Department of Fish and Wildlife and Tahoe National Forest field staff using aquarium dip nets to collect Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles from a tiny, nearly dry pool along Rattlesnake Creek on 9 September 2021. Staff kept the five-gallon holding buckets in the shade at all times to keep water temperatures cool and limit stress to the tadpoles. (CDFW)

During tadpole collection on 9 September 2021, CDFW and TNF staff observed even more SNYLF tadpoles than expected following the initial tadpole collection effort on 2 September 2021 (**Figure 8**). In total, CDFW and TNF staff collected 1,867 SNYLF tadpoles from seven different drying pools on 9 September 2021 (**Figure 9**). Adding the ≈ 700 SNYLF tadpoles moved to a large pool by TNF staff on 2 September 2021, CDFW and TNF rescued approximately 2,600 SNYLF tadpoles from imminent desiccation during the rescue efforts detailed in this memorandum.

Figure 8. An aggregation of Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) tadpoles located in a very small, drying pool along Rattlesnake Creek on 9 September 2021. (CDFW)

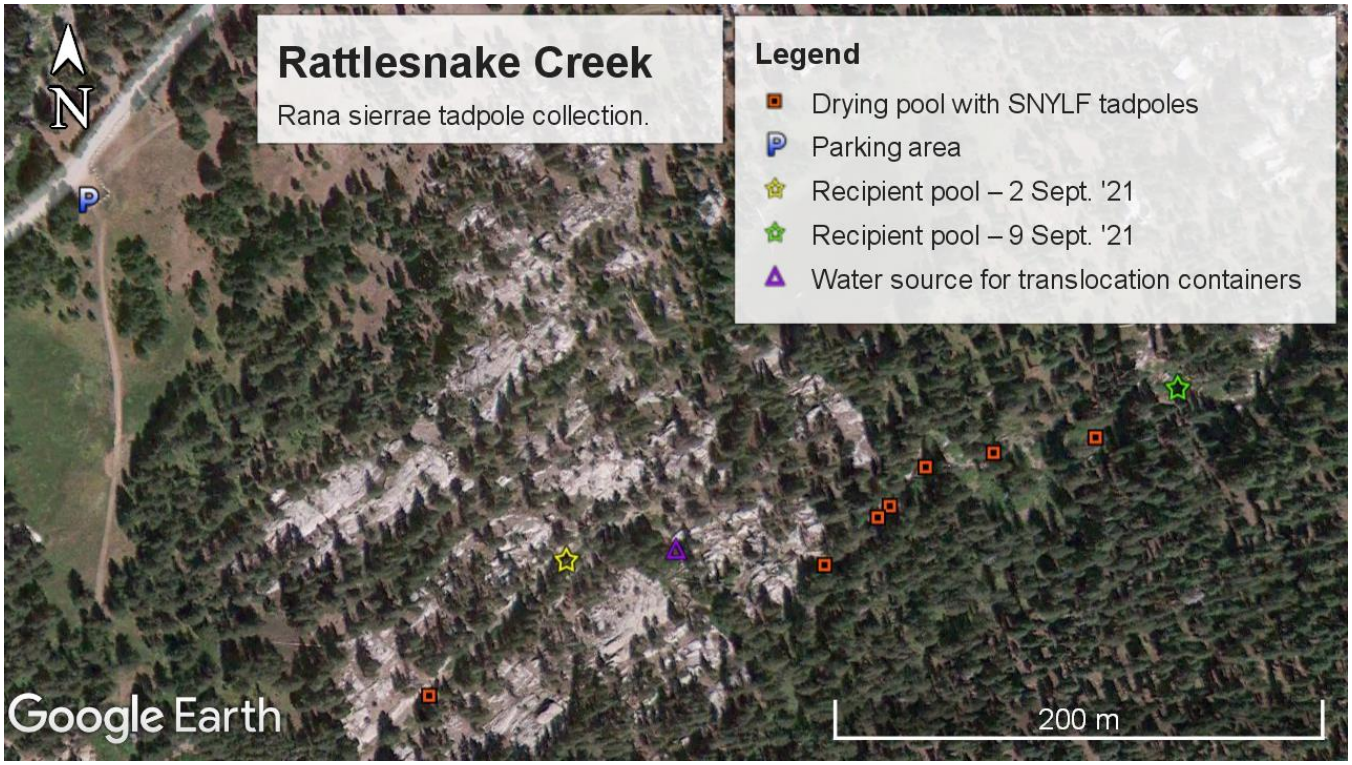

Figure 9. Aerial map of Rattlesnake Creek, showing the locations of small, drying pools in which Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles were stranded in early September 2021 (orange squares) and the location of large pools into which California Department of Fish and Wildlife and Tahoe National Forest staff moved a subset of tadpoles on 2 September (yellow star; n ≈ 700 tadpoles) and 9 September (green star; n ≈ 300 tadpoles).

Given the large number of stranded tadpoles collected, and limited space available among translocation containers, CDFW staff made the decision to release ≈ 300 of the SNYLF tadpoles collected on 9 September 2021 into a large, perennial pool located approximately 100 m upstream of the nearest drying pool from which staff had collected tadpoles (**Figure 10**). This recipient pool is located at the base of a small stretch of Rattlesnake Creek that appears to hold water year round and contains a small amount of flowing water, even during late summer in dry years, such as 2020 and 2021. Most of this flowing reach is relatively steep gradient with bedrock and large boulder substrate, in which CDFW and TNF staff have not previously observed SNYLF tadpoles. However, the large pool at the base of this flowing segment is flat, with fine gravel, cobble, and organic substrate. On 9 September 2021, this pool also contained a low density cohort of SNYLF tadpoles. Therefore, the habitat appeared highly suitable for SNYLF, and large enough in size to accommodate an additional 300 SNYLF tadpoles.

Figure 10. A large, perennial pool on Rattlesnake Creek, which is located at the base of a section of the creek that appears to flow year round. On 9 September 2021, California Department of Fish and Wildlife and Tahoe National Forest staff moved approximately 300 Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles—collected from a small, drying pool 100 m downstream—into this location. (CDFW)

After releasing the subset of collected tadpoles into the upstream pool (**Figure 10**; and also shown by the green star in **Figure 9**), CDFW and TNF proceeded to transport the remaining ≈ 1,500 SNYLF tadpoles to Evelyn Lake, in the Mossy area (**Figure 1**).

To transport the remaining tadpoles to Mossy, CDFW and TNF staff carried tadpoles—inside of two aerated five-gallon buckets and a six-gallon plastic container—to vehicles located at a small parking area along Magonigal Rd. (USFS Road 85; **Figures 1 and 9**). Once at the vehicles, staff used aquarium dip nets to gently transfer a subset of tadpoles into 10 separate one-gallon, food grade plastic buckets filled with water collected from Rattlesnake Creek (**Figure 9**, purple triangle icon). Staff placed no more than 75 tadpoles into each one-gallon container. Staff allotted the remaining ≈ 750 tadpoles evenly into two separate five-gallon, food grade containers filled with water from Rattlesnake Creek and outfitted with portable aerators. This arrangement resulted in fairly equal tadpole densities per given unit of water (i.e., approximately 75 tadpoles per gallon of water).

For transport to the Mossy trailhead, staff placed all one-gallon plastic containers into an extra-large cooler and insulated the containers with one-gallon bags of water ice and pieces of polyethylene foam pads (**Figure 11**). Staff held the five-gallon buckets inside air-conditioned vehicle cabs so staff could secure the buckets and keep water cool during transport. Once at the Mossy trailhead, staff packed the one-gallon containers into backpacks, using gallon bags of water ice as insulation to keep containers cool. Staff transported the five-gallon, aerated buckets using an external frame backpack. Staff placed the buckets on the base of an L-shaped frame, wrapped the bucket with a polyethylene foam pad, and placed one-gallon bags of water ice on either side of the bucket, between the pad and bucket. Staff then secured the insulated bucket wrap using 175-lb. test zip ties (**Figure 12**). The zip ties kept the bucket securely on the frame, while also holding the insulation and bagged ice in place during transport. All transport containers had secured lids (snap-on for the one-gallon and threaded screw-on for the five-gallon) to prevent excessive water spillage or loss of tadpoles.

Figure 11. One-gallon, food-grade plastic buckets with snap-on lids, each of which contained stream water and up to 75 Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles. Containers were held inside a large cooler with bagged water ice and foam insulation during vehicle transport to the recipient site trailhead near Mossy Pond, Nevada Country, CA. (TNF staff)

Figure 12. Five-gallon Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpole transport bucket with screw-on lid, outfitted with a portable aeration supply, secured with extra-large zip ties to an external frame backpack and insulated with polyethylene foam pads. Staff placed two gallon-sized bags of water ice between the bucket and foam pad to keep the bucket cool during transport. After this photograph was taken, another ring of zip ties was placed around the bucket and through the frame to keep the load secure. (TNF staff)

After securely packing all tadpole transport containers, staff walked the tadpoles (**Figure 13**) approximately 2 km to Evelyn Lake (**Figure 14**), which is a small, perennial pond located on TNF land southwest of Mossy Pond (**Figure 1**). Staff moved containers to the water's edge, then slowly and gently poured the contents of the containers into Evelyn Lake (**Figure 15**). Staff released all ≈ 1,500 tadpoles into shallow water at the southwest side of the lake, close to a small, ephemeral pond that connects to Evelyn Lake in spring and early summer. **Figures 16 – 18** show additional photos of the release site and process.

Figure 13. California Department of Fish and Wildlife and Tahoe National Forest staff members hiking containers of Sierra Nevada Yellow-legged Frog tadpoles to Evelyn Lake, Tahoe National Forest, Nevada County, CA. (TNF staff)

Figure 14. Evelyn Lake, Tahoe National Forest, Nevada County, CA. On 9 September 2021, California Department of Fish and Wildlife and Tahoe National Forest staff released ≈ 1,500 Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles at this location. Tadpole containers are visible in the shade at the far left side of the photograph. (CDFW)

Figure 15. A Tahoe National Forest biologist releasing Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles at Evelyn Lake, Tahoe National Forest, Nevada County, CA on 9 September 2021. (CDFW)

Figure 16. All containers used to transport Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles from drying pools on Rattlesnake Creek to Evelyn Lake, Tahoe National Forest, Nevada County, CA on 9 September 2021. (CDFW)

Figure 17. A Tahoe National Forest staff member releasing Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles into Evelyn Lake, Tahoe National Forest, Nevada County, CA on 9 September 2021. (CDFW)

Figure 18. Two California Department of Fish and Wildlife staff members releasing Sierra Nevada Yellow-legged Frog (*Rana sierrae*) tadpoles into Evelyn Lake, Tahoe National Forest, Nevada County, CA on 9 September 2021. (CDFW)

DISCUSSION

CDFW acknowledges that the SNYLF tadpole rescue efforts described in this memorandum are an unsustainable solution for long-term mitigation of impacts from drought and climate change on SNYLF populations present in small ponds and intermittent lotic habitats, many of which are highly susceptible to drying (Brown et al. 2019, Wilkins et al. 2019). However, this effort demonstrates a fast, efficient, and cost-effective solution to rescue a large number of stranded tadpoles that would have otherwise died from desiccation and predation. CDFW and TNF were able to undertake the entire effort during only two day trips into the field, mainly with the assistance of seasonal field staff. This rescue operation, and similar efforts by other biologists working with endangered amphibians in the northern Sierra Nevada (e.g., C. Dillingham, Mt. Hough Ranger District, Plumas National Forest, pers. comm.), demonstrate that similar methods can be used in the future to successfully increase the chances that a subset of an endangered amphibian cohort can survive and recruit into the adult population.

CDFW and TNF biologists plan to continue monitoring the SNYLF populations in the Rattlesnake and Mossy areas during suitable weather conditions during late summer and fall 2021, with specific focus on the areas into which tadpoles were moved at both locations. The two agencies also plan to continue surveying these sites annually as part of normal monitoring efforts. In 2022, CDFW staff hope to potentially encounter metamorphosing SNYLF, or a higher number of subadults than have previously been observed in Evelyn Lake (in which CDFW and TNF staff have typically only observed a few adult and subadult SNYLF during any single VES), which will provide anecdotal evidence of some success from the effort.

LITERATURE CITED

Brown, C., M.P. Hayes, G.A. Green, and D.C. Macfarlane. 2014. Mountain yellow-legged frog conservation assessment for the Sierra Nevada mountains of California, USA. USDA Forest Service. Interagency technical report R5-TP-038. Available from: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3811864.pdf

Brown, C., L. Wilkinson, K.K. Wilkinson, T. Tunstall, R. Foote, B.D. Todd, and V. Vredenburg. 2019. Demography, habitat, and movements of the Sierra Nevada Yellow-legged Frog (*Rana sierrae*) in steams. Copeia 107:661–675.

Frankham, R., J.D. Ballou, K. Ralls, M.D.B. Eldridge, M.R. Dudash, C.B. Fenster, R.C. Lacy, and P. Sunnucks. 2019. A practical guide for genetic management of fragmented animal and plant populations. Oxford University Press, New York, NY, USA.

Knapp, R.A., and K.R. Matthews. 2000. Nonnative fish introductions and the decline of the mountain yellow-legged frog from within protected areas. Conservation Biology 14:428–438.

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.

Wilkins, L.G.E., K.R. Matthews, Z.L. Steel, S.C. Nusslé, and S.M. Carlson. 2019. Population dynamics of *Rana sierrae* at Dusy Basin: influence of non-native predators, drought, and restoration potential. Ecosphere 10:e02951.