State of California

Memorandum

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Cc: Region 2 Fish File

Subject: Native amphibian restoration and monitoring in Mokelumne Wilderness

Beebe Lakes: 2018 Update

On 26 September 2018, California Department of Fish and Wildlife (CDFW) staff visited the Beebe Lakes drainage (Figure 1) to add further evidence of Brook Trout (*Salvelinus fontinalis*; BK) removal in the inlet stream to Beebe Meadow. No BK were detected during three backpack electrofishing passes of the Beebe Meadow inlet stream. Those interested in learning details of the most recent CDFW visual encounter surveys (VES) and summary of Beebe Lakes drainage BK removal may consult the 2017 survey memorandum (CDFW 2018). Amphibian monitoring data from 2012 through 2017 suggest a small and persisting Sierra Nevada Yellow-legged frog (*Rana sierrae*; SNYLF) population. CDFW will continue amphibian monitoring in the area to document SNYLF response to fish removal.



Figure 1: Mokelumne Wilderness, Amador, Alpine, and Calaveras Counties, CA. Green dots showing *Rana sierrae* (SNYLF) sites include positive detections by California Department of Fish and Wildlife (CDFW) staff during recent visual encounter surveys (VES).

ENVIRONMENTAL SETTING

Beebe Lakes drainage is located in the Mokelumne Wilderness, just east of the Alpine County line. The basin is on the western slope of the Sierra Nevada, between 7,900' and 8,500'. Eldorado National Forest (ENF) manages the land and issues grazing permits in the area. The site is accessed by driving rough 4x4 roads from the Silver Lake area off Highway 88, then hiking east into the Mokelumne Wilderness, past an old trading post, and through Ladeux Meadow before reaching Beebe Lakes basin. CDFW staff conducted baseline surveys in 2001 and 2002. Staff observed BK in Beebe Lake. Staff also observed SNYLF (Figure 2) at four sites in the area. All SNYLF populations in the area are small and isolated. CDFW and ENF determined that eradicating BK from the Beebe Lakes area using gill nets and backpack electrofishers would be feasible, and provide SNYLF with more deep-water habitat. Now fishless, CDFW manages the entire Beebe Lakes drainage as SNYLF breeding habitat (CDFW 2016).

INTRODUCTION

The Aquatic Biodiversity Management Plan for the Upper Mokelumne Management Unit (CDFW 2016) identifies Beebe Lake (Site ID 14797; Figure 3), Lower Beebe Lake (Site ID 2694), Beebe Meadow (Site IDs 14791, 14795, and 14799), approximately one kilometer (km) of stream (Site 52651), three small ponds with consistent SNYLF observations (Site IDs 14774, 14802, and 14829), and several other small ponds in the basin as a Native Species Reserve (NSR; Figure 4) for SNYLF. Thus far, CDFW staff have not observed SNYLF in Beebe Lake. However, although only reaching a maximum depth of about 4 meters (m), Beebe Lake is the deepest wetted habitat in the basin. Additionally, Beebe Lake is located approximately halfway between Pond 14774 and Pond 14802 SNYLF populations. Therefore, removing BK from Beebe Lake, Beebe Meadow, and the adjoining stream has created a series of interconnected fishless aquatic habitats for SNYLF.

Beebe Lake was stocked with BK from 1930 until 2000. Gill net sampling conducted by CDFW staff in 2001 and 2010 revealed that the BK population in Beebe Lake was self-sustaining. Beginning in 2011, CDFW, with assistance from ENF personnel, began removing BK from Beebe Lake and the surrounding area to benefit SNYLF. As of 2018, after three years of monitoring without detecting BK, the basin is fishless. The most recent BK capture was in 2015. However, CDFW staff will continue to regularly survey the Beebe Lakes basin SNYLF population and monitor for presence of any latent BK.



legged frog (Rana sierrae).

Figure 2. Adult Sierra Nevada yellow- Figure 3. Beebe Lake in July 2015, looking north. (CDFW)



Figure 4: Sierra Nevada yellow-legged frog (SNYLF) detections in Beebe Lakes Native Species Reserve (NSR) by California Department of Fish and Wildlife (CDFW) field staff through summer 2017. CDFW staff have observed all SNYLF life stages in four ponds within the drainage (Site IDs 14774, 14802, 14829, and 14706). Pond 14706 is located north of the main Beebe Lakes basin and not shown on the map. CDFW has not surveyed pond 14706 since 2012 and staff have not observed SNLYF in the pond since 2010, when staff observed three egg masses. Since fish removal began, CDFW staff have observed SNYLF adults and subadults in several other parts of the basin, including Stream 52651, Pond 14785, and Pond 14799. All flowing waters in the basin drain south, through Lower Beebe Lake, east into Summit City Creek, and eventually into the North Fork Mokelumne River.

THREATS

- **Disease** All known SNYLF populations in the Mokelumne Wilderness are positive for chytrid fungus, *Batrachochytrium dendrobatidis (Bd)*. In 2008 and 2010, SNYLF populations in the Beebe Lakes area were genetically sampled using epithelial swabs and screened for the presence of *Bd* DNA using real-time quantitative polymerase chain reaction (qPCR) analysis. Staff collected eleven swabs from sites 14774, 14802, and 14829, and results from both years detected very light to moderate zoospore loads.
- Marginal Habitats SNYLF populations in the surrounding area are persisting at small, isolated ponds and their seasonally flowing tributaries (Figure 4). Any disturbance, natural or otherwise, that threatens overwintering habitats presents a potential extirpation risk. Potential risks include severe winter conditions, extended drought, or anthropogenic habitat disturbances.
- Introduced Fish All sites supporting SNYLF in the Beebe Lakes area are fishless. However, prior to recent fish removal activities, BK were persisting in much of the available aquatic habitat, including Beebe Lake and the nearby meadow/stream complex. The stream that connects Pond 14787 to Lower Beebe Lake flows seasonally and dries to a series of deep tannin pools by late summer. The stream and pool complexes are not ideal trout habitat, yet BK were persisting in the absence of stocking. The formerly fish-containing habitats may have been acting as population sinks for migrating SNYLF. Additionally, BK likely precluded any successful SNYLF breeding and recruitment in Beebe Lake, which supplies the only deep water habitat in the basin.
- Cattle Grazing Studies investigating direct interactions between cattle and SNYLF populations have not been conducted. However, the U.S. Forest Service (USFS) acknowledges cattle effects to aquatic resources in the Mokelumne Wilderness Management Guidelines (USFS 1995). Additionally, potential negative effects of livestock grazing on SNYLF habitat are discussed in the U.S. Fish and Wildlife Service (USFWS) final rule for listing SNYLF as a federally endangered species (USFWS 2014, pg. 24628–24630). USFWS concluded: "Current livestock grazing activities may present an ongoing, localized threat to individual populations in locations where the populations occur in stream riparian zones and in small waters within meadow systems, where active grazing co-occurs with extant frog populations." The USFWS concluded that livestock grazing that complies with USFS grazing guidelines is not expected to negatively affect most SNYLF populations (USFWS 2014).
- Loss of Genetic Diversity Like many SNYLF populations in the northern Sierra Nevada, the population in Beebe Lakes is small and isolated. Although there are small populations in relatively close proximity (e.g., Ladeux Meadow, Devils Hole Lake, Bear River, and Deadwood Canyon; CDFW 2016), the rugged landscape of the Upper Mokelumne results in the Ladeux population being the only realistic source for gene flow from a source outside Beebe Lakes. The nearest location with fairly widespread SNYLF occupancy is the Jeff Davis Creek area, which is about 14 km east of Beebe Lakes. In addition to the threats presented by stochastic environmental events (e.g., drought 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 like those in Beebe Lakes (Frankham et al. 2009).

POPULATION STATUS

Although still very small, the most recently available site-wide monitoring data (2017) demonstrate that the SNYLF population in Beebe Lakes drainage is persisting (Figure 5). The sites in which a majority of SNYLF have been observed during VES in the Beebe Lakes drainage are Pond 14774, Pond 14802, and Pool 14829 (Figure 4). During backpack electrofishing on 26 September 2018, CDFW staff observed two adult and three subadult SNYLF in the Beebe Lake meadow inlet stream (Site 52651; Figures 4 and 5). CDFW field staff did not conduct any additional VES during summer 2018. However, CDFW plans to survey the entire Beebe Lakes area for SNYLF during summer 2019.

Long term monitoring will be required to derive population trends and quantify the SNYLF population in the Beebe Lakes area. As CDFW removed BK, staff observed SNYLF occupying previously unutilized microhabitats within the NSR. CDFW staff will continue monitoring the area at least biennially. Now that fish removal is complete, CDFW manages the site for native amphibians.



Figure 5: Total number of Sierra Nevada yellow-legged frogs (SNYLF) of each life stage observed in the Beebe Lakes area between 2002 and 2018. Yearly totals primarily include observations from Ponds 14774, 14802, and 14829. The chart also includes one adult observed in stream widening Pool 14785 in 2017 and one adult observed in Pool 14799 in 2015. This chart does not include observations from Pond 14706.

*California Department of Fish and Wildlife (CDFW) staff did not survey Pond 14829 in 2002.

[†]CDFW staff began surveying stream segment 52651 in 2014. Staff have only observed post-metamorphic SNYLF in stream segment 52651 (one in 2014, one in 2015, five in 2016, one in 2017, and five in 2018).

‡In 2018, CDFW staff did not conduct visual encounter surveys (VES) for SNYLF in the Beebe Lakes basin. Staff only incidentally surveyed stream segment 52651 during three passes of backpack electrofishing on 26 September 2018.

DISCUSSION

As of fall 2015, Beebe Lakes drainage is fishless. CDFW is confident that increasing available habitat and reconnecting isolated populations will improve the likelihood that SNYLF will persist in the Beebe Lakes drainage. Although the local SNYLF population is small, surveyors have generally observed that most places continuing to hold water also contain SNYLF. Therefore, there is reason for optimism: now that BK are absent from the upper watershed, SNYLF may begin to rebound during the next several years.

Monitoring Considerations

Seventeen years of monitoring data suggest the Beebe Lakes SNYLF populations are slowly declining, although data collected since 2012 suggest a stable population. However, observer bias, variation in survey conditions, and relatively low number of detections all make deriving trends difficult. Additionally, 2015 was the first season that SNYLF did not have to share high quality stream and meadow habitat with introduced BK. Another consideration is that the recent drastic changes in winter conditions between years makes interpreting population trends even harder. 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). As of this writing, precipitation during winter 2018–2019 has been well above average (CDWR 2019). SNYLF mortality can increase during long winters with deep snow pack (Bradford 1983). Contrarily, drought conditions can dry up many areas normally occupied by SNYLF, especially in places like Beebe Lakes, where much of the available aquatic habitat is small, shallow ponds and ephemeral streams.

The habitat composition of Beebe Lakes drainage is another reason that estimating SNYLF abundance is difficult. Available habitat consists of Beebe Lake, numerous small tannin ponds (into which visibility can be highly limited), multiple springs, a long stream channel, and a large meadow complex with dozens of isolated depressions that occasionally hold water. Dense vegetation surrounds many of these aquatic areas. This habitat variety is likely beneficial for SNYLF. However, the habitat complexity and thick vegetation also reduces visibility and maneuverability for surveyors. Therefore, SNYLF detectability during VES in the Beebe Lakes drainage is likely very limited. Despite these challenges, CDFW will continue to monitor the Beebe Lake SNYLF population regularly to assess the population status over time. If feasible, CDFW may also begin marking adult SNYLF in the Beebe Lakes area with passive integrated transponder (PIT) tags. 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 occupying habitat that is challenging to survey (Mazerolle et al. 2007).

LITERATURE CITED

- Bradford, D.F. 1983. Winterkill, oxygen relations, and energy metabolism of a submerged dormant amphibian, *Rana muscosa*. Ecology 64:1171–1183.
- California Department of Fish and Wildlife (CDFW). 2016. Aquatic Biodiversity Management Plan for the Upper Mokelumne Management Unit. Available from: <u>https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=127574</u>
- CDFW. 2018. Native amphibian restoration and monitoring in Mokelumne Wilderness: Beebe Lakes fish removal and *Rana sierrae* monitoring. Available from: <u>http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=156671</u>
- California Department of Water Resources. 2019. California Data Exchange Center. Precipitation (<u>http://cdec.water.ca.gov/snow_rain.html</u>) and snowpack (<u>http://cdec.water.ca.gov/snow/current/snow/index.html</u>) data. Accessed 25 February 2019.
- Frankham, R., J.D. Ballou, and D.A. Briscoe. 2009. Introduction to Conservation Genetics. Cambridge University Press, New York, NY, USA.
- 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.
- U.S. Fish and Wildlife Service (USFWS). 2014. Endangered and threatened wildlife and plants; endangered species status for Sierra Nevada yellow-legged frog and northern distinct population segment of the mountain yellow-legged frog, and threatened species status for Yosemite toad. Federal Register 79:24256–24310.
- U.S. Forest Service (USFS). 1995. Toiyabe National Forests. Mokelumne Wilderness Management Guidelines Environmental Assessment #E095-01.