State of California
Department of Fish and Wildlife

Memorandum

Date: 10 February 2022

To: Angie Montalvo,
Senior Environmental Scientist;
Acting Sierra District Supervisor;
North Central Region Fisheries

From: Sadie DeCurtis, Scientific Aide;
Isaac Chellman, Environmental Scientist;
High Mountain Lakes;
North Central Region Fisheries

Cc: Region 2 Fish Files

Ec: CDFW Document Library

Subject: Native amphibian restoration and monitoring in Desolation Wilderness; Island Lake post-fish removal and *Rana sierrae* monitoring.

INTRODUCTION

In early August 2017, California Department of Fish and Wildlife (CDFW) field crews began removing non-native Brook Trout (*Salvelinus fontinalis*; BK) from Island Lake and connected streams using monofilament gill nets and backpack electrofishing units. Full time restoration efforts concluded in October 2020 and Island Lake now appears to be fishless. The last BK capture in Island Lake occurred in mid-summer 2019. However, in early summer 2020, CDFW staff captured three BK from the Island Lake outlet stream. Subsequent backpack electrofishing passes of the outlet stream, which occurred on multiple occasions in summer and fall 2020, resulted in no additional BK captured. On 10 October 2020, CDFW staff removed all gill nets from Island Lake. In summer 2021, CDFW staff used temporary gill net sets and electrofishing units to monitor for trout. These efforts resulted in no BK captured. CDFW plans to continue temporary gill net sets and electrofishing in a subset of stream segments on an annual basis to monitor for any trout reinvasion. Additionally, since 2002, CDFW has been monitoring Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) populations within the Island Lake basin. CDFW anticipates that these SNYLF populations will benefit from recently completed fish removal at Island Lake.

ENVIRONMENTAL SETTING

Island Lake is located in the Desolation Wilderness, El Dorado County (**Figure 1**). The lake sits within a granite basin at approximately 8,150 feet (2,484 meters) in elevation and drains southwest into Wrights Lake. Eldorado National Forest (ENF) manages the surrounding land. The site is accessed via the Twin Lakes trailhead, which is located at the northeast end of Wrights Lake.

During baseline lake surveys in 2001 and 2002, CDFW crews observed a small SNYLF population in the basin. In 2004, crews confirmed the continued presence of BK in Island Lake, Twin Lakes, and the intervening waters. The Aquatic Biodiversity Management Plan for the Desolation Wilderness Management Unit (CDFG 2012) identifies Island Lake (**Figure 2**), Twin Lakes (**Figure 3**), Boomerang Lake (**Figure 4**), and numerous small, unnamed ponds in the upper basin (**Figure 5**) as a Native Species Reserve (NSR) for SNYLF. Therefore, CDFW managers proposed eradicating the BK population in Island Lake to provide additional habitat for the small SNYLF populations in nearby ponds (CDFG 2012). However, the management plan suggested that the project might require either 1) piscicides or 2) active willow removal in tributaries of Island Lake, due to the size and complexity of lotic fish-bearing habitat.

CDFW crews conducted additional habitat assessment in 2014 and determined that physical methods would be feasible for removing BK from Island Lake and associated tributaries. Natural barriers to upstream fish movement isolate the Island Lake BK population from trout present in downstream habitat. Additionally, although labor-intensive, CDFW was able to successfully cut back willow (*Salix* spp.) to temporarily open channels for electrofishing. As a result, CDFW, in coordination with ENF, undertook eradicating BK from Island Lake between 2017 and 2020. CDFW has no current plans to remove BK from Upper or Lower Twin Lakes, which will be maintained as self-sustaining BK fisheries.

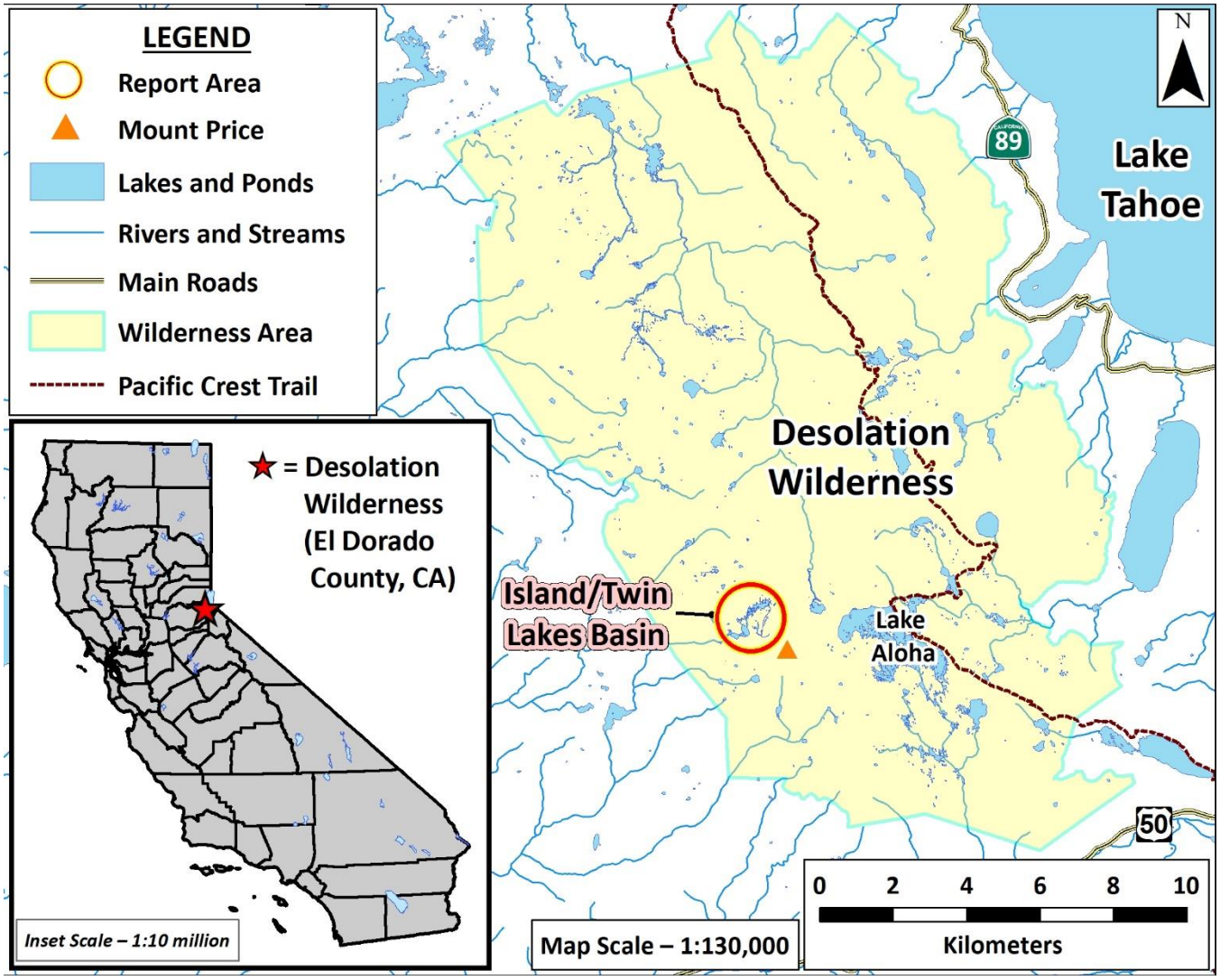


Figure 1. Desolation Wilderness, El Dorado County, CA. The area discussed in this memorandum is circled.

Figure 2. Island Lake (Site ID 26594) in June 2020, looking east. (CDFW)

Figure 3. Upper (center, below talus field) and Lower (right) Twin Lakes (Site IDs 14197 and 14200, respectively), Desolation Wilderness, in June 2020, looking southeast. (CDFW)

Figure 4. Boomerang Lake (Site ID 14185), Desolation Wilderness, in July 2020, looking northeast. (CDFW)

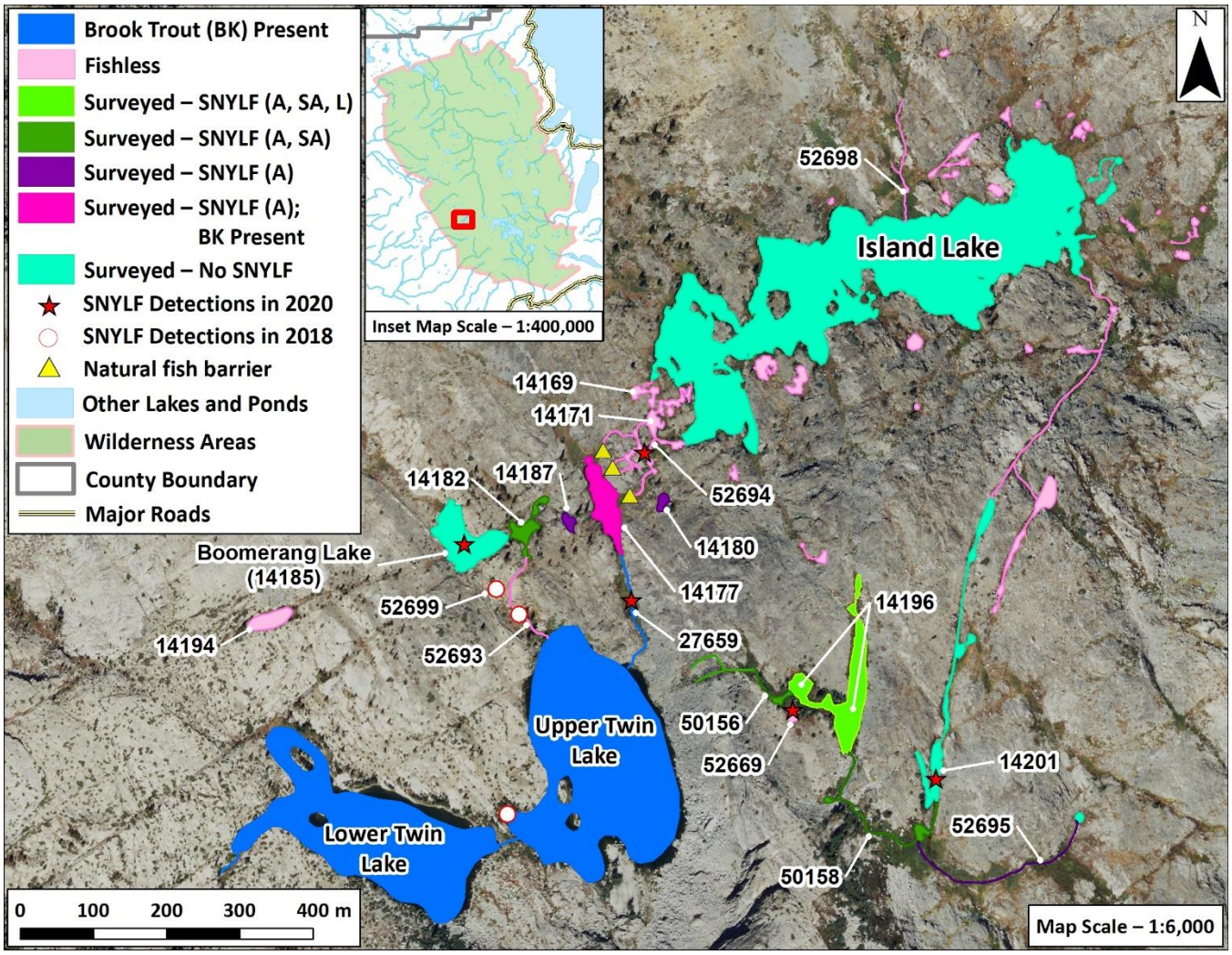


Figure 5. Brook Trout (*Salvelinus fontinalis*; BK) presence and recent Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) occupancy in Island and Twin Lakes basin, Desolation Wilderness. CDFW staff have observed SNYLF of all life stages in a few small ponds in the basin. The primary SNYLF population is located on the plateau above Upper Twin Lake (Site IDs 50156, 52669, 14196, 50158, 14201, and 52695). The SNYLF detections shown indicate the most recent year during which CDFW staff observed SNYLF occupancy at each given waterbody during visual encounter surveys (VES) in the period 2018 to 2021. Lakes with "Surveyed" descriptions in the legend are those at which CDFW conducted VES on 28–29 July 2021, whereas older detections are indicated by star icons (2020) or circle icons (2018). Surveyed sites are fishless unless otherwise noted in the legend. On 15 July 2021, CDFW staff also surveyed Island Lake and surrounding small ponds and streams, the summary results for which can be found in **Figure 6**. CDFW staff conducted very few VES in the Island Lake area during 2019, so the map only displays detections in 2018, 2020, and 2021. CDFW occasionally observes post-metamorphic SNYLF at Site IDs 14177, 27659, and along the shore of Upper Twin Lake, but crews have not observed SNYLF eggs or tadpoles in these fish-bearing habitats. Number labels shown are unique site identification codes that CDFW uses for data collection. All flowing waters drain southwest into Wrights Lake (not shown).

THREATS

Introduced Fish

CDFW stocked Island Lake with BK from 1950 until 1965. Later, between 1970 and 1980, CDFW stocked the lake with Golden Trout (*Oncorhynchus aguabonita*; GT). However, GT never became self-sustaining, and subsequent gill net surveys did not detect GT. Overnight gill net surveys in 2004 and 2008 revealed a self-sustaining BK population. Twin Lakes (Site IDs 14197 and 14200), an unnamed pond (Site ID 14177), and connected stream habitat all contain self-sustaining BK. Prior to the commencement of fish removal, Island Lake (Site ID 26594), the outlet stream (Site IDs 14169, 14171, and 52694), and several inlets to Island Lake all contained BK (**Figure 6**). These fish relegated SNYLF to shallow habitats where drought and climate change may negatively affect long-term survival.

Brook Trout prey on SNYLF and are a potential source of competition for food (e.g., benthic macroinvertebrates). Additionally, waterbodies with BK likely act as a population sink for dispersing adult and subadult SNYLF. Although fish-containing lakes and ponds are still nearby, Island Lake now provides additional fishless habitat for SNYLF. Barriers to upstream fish movement located above Site ID 14177 (**Figure 5**) impede trout from reinvading Island Lake. However, given the proximity of self-sustaining BK to the restoration area, CDFW will maintain annual monitoring for BK in Island Lake and the connected tributaries.

Marginal Habitats

SNYLF are persisting in low numbers at several small ponds scattered around the middle of Island/Twin Lakes basin (**Figure 5**). 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. Since all large, deep water lakes in the basin contained BK until very recently, SNYLF are currently restricted to marginal satellite ponds, several of which often dry completely by late summer (see **APPENDIX**).

Disease

All SNYLF populations in El Dorado County where disease testing has been conducted are positive for chytrid fungus (*Batrachochytrium dendrobatidis*; *Bd*). Crews collected nine epithelial swabs from SNYLF at four sites in 2008 and 2012. 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 light *Bd* infection intensity.

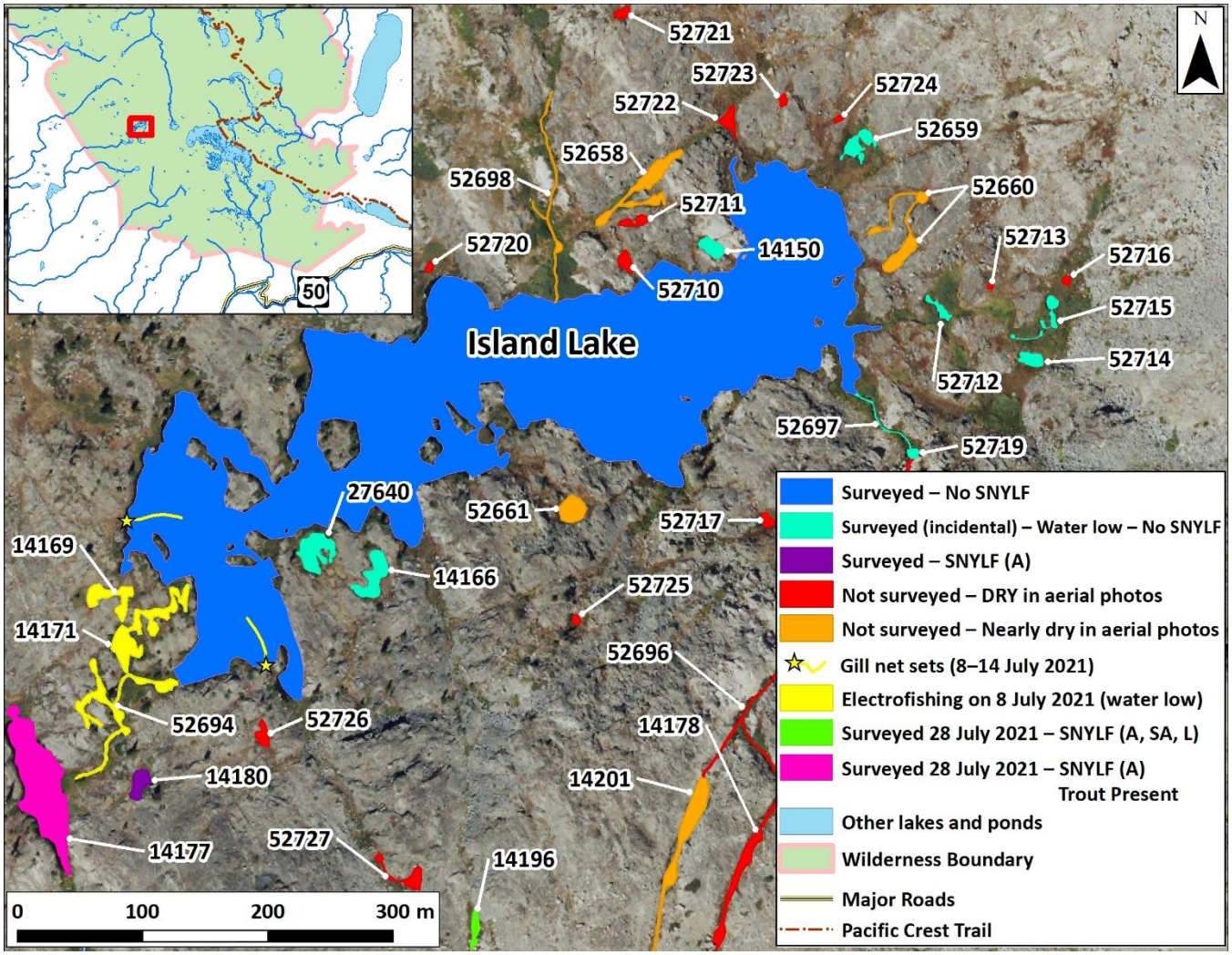


Figure 6. Visual encounter survey (VES) results and hydrologic status at Island Lake and the surrounding small ponds and stream segments on 15 July 2021. By mid-summer 2021, most small waterbodies surrounding Island Lake were either completely dry or contained very little water. During VES on 15 July 2021, staff incidentally visited several small ponds adjacent to the main lake to look for SNYLF (bright aquamarine polygons). Following surveys, staff examined high resolution aerial imagery taken in late summer 2021 to identify those non-surveyed sites that were either completely dry (red polygons) or nearly dry (orange polygons) by late August 2021. Weather conditions on 15 July 2021 were not ideal for SNYLF surveys: moderate to strong winds obscured visibility into Island Lake and may have limited basking of any SNYLF that may have been present. CDFW returned to the area in late July 2021, during which staff surveyed additional waterbodies and resurveyed Island Lake (the figure displays two waterbodies at which staff observed SNYLF in late July 2021: Site IDs 14177 and 14196). As with two weeks prior, staff did not detect SNYLF in Island Lake, but staff did observe SNYLF in other waterbodies (see Figure 5 for a visual summary of all SNYLF detections from 28–29 July 2021). This figure also shows the locations in the southwest cove where staff set two monofilament gill nets for one week to check for trout (8–14 July 2021; shown with yellow stars and lines projecting into Island Lake), plus the outlet stream and pool area at which staff conducted backpack electrofishing on 8 July 2021 (yellow polygons).

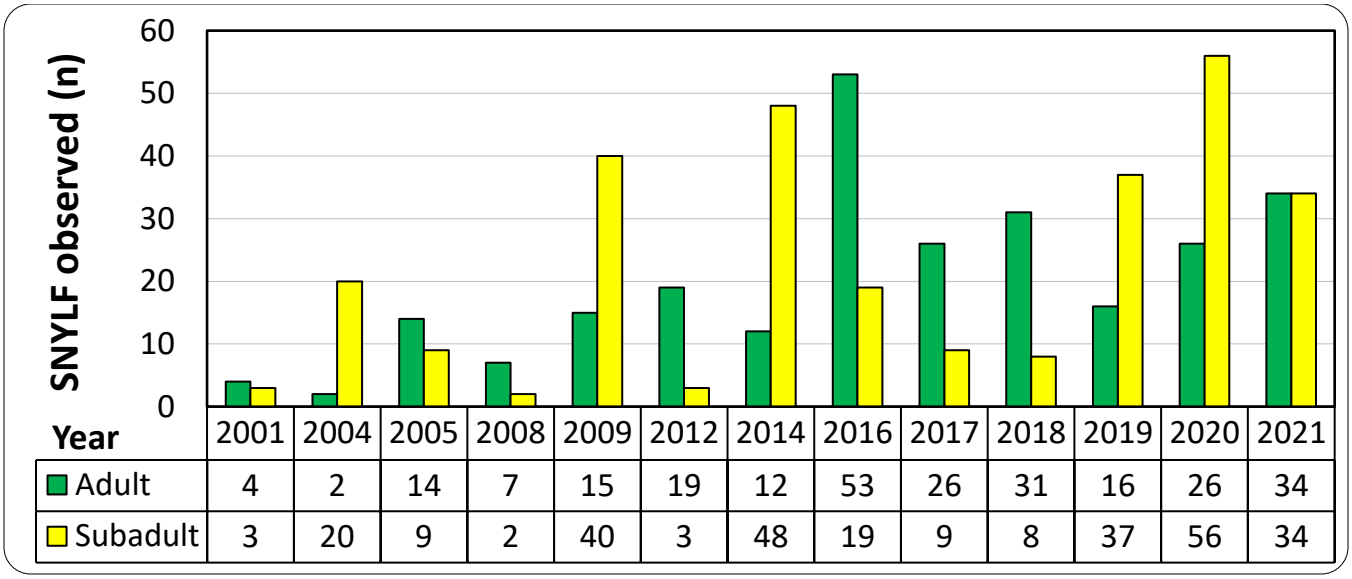
POPULATION STATUS

Continued monitoring will be required to better assess the status and trends of the SNYLF population in the Island/Twin Lakes basin. Visual encounter survey (VES) data between 2001 and 2021 suggest the SNYLF population has remained relatively constant for the past several years (**Figures 7 and 8**). However, VES results can be difficult to compare due to numerous factors, including variability in survey effort, weather conditions during the survey, time of year, and observer bias (Mazerolle et al. 2007). VES is a useful, inexpensive measure for quickly determining general population status of SNYLF, but proper interpretation of the results requires consideration of the assumptions inherent with VES (Heyer et al. 1994).

Staff conducted VES on two occasions in 2021: on 15 July 2021 and 28-29 July 2021. CDFW staff observed more adult SNYLF than in the previous four years (**Figure 7**). Additionally, staff detected more SNYLF larvae in 2021 (n = 1106) than during any previous survey year. (**Figure 8**).

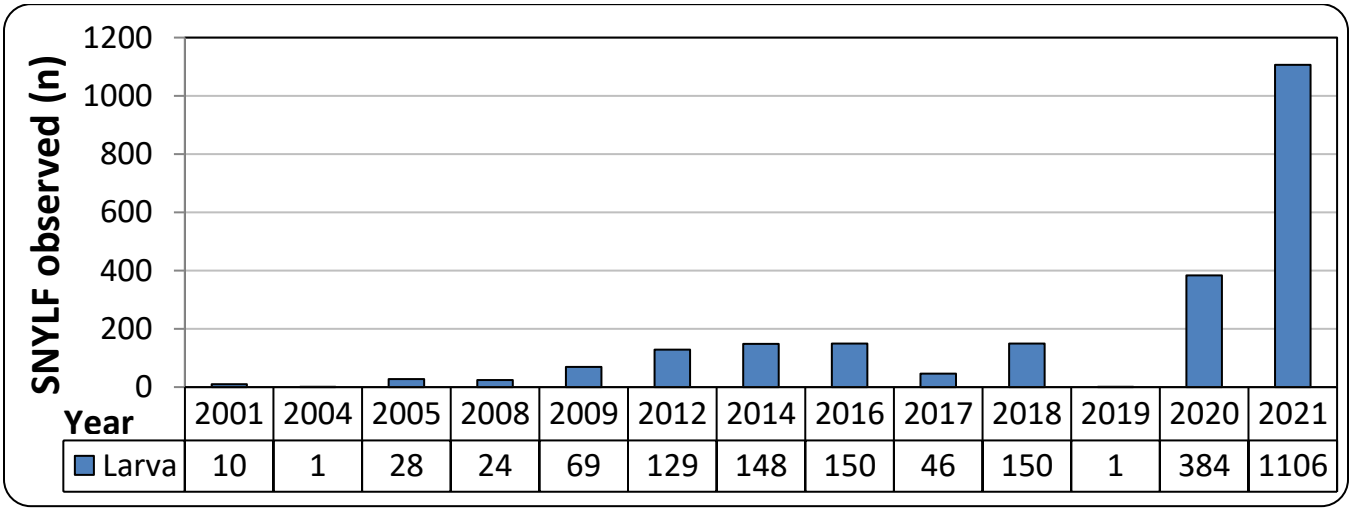
On 15 July 2021, CDFW staff only officially surveyed two sites (Site ID 14180 and Island Lake; **Figure 6**). During the survey around Island Lake, staff incidentally surveyed (i.e., quickly spot-checked for SNYLF) most small ponds and streams that still contained water and were located adjacent to the main lake (**Figure 6**). During these survey efforts, staff observed one large adult female SNYLF in Site ID 14180, but detected no other frogs. Conditions for that day were poor for VES, with moderate steady winds and strong gusts.

Therefore, the 2021 SNYLF data presented in this memorandum primarily include counts of post-metamorphic and larval SNYLF from the 28–29 July survey, during which CDFW surveyed most of the primary habitat currently occupied by SNYLF. During this survey period, staff observed most SNYLF on the plateau above Upper Twin Lake (Site IDs 50156, 14196, 50158, and 52695; **Figure 5**) Additionally, all larvae detected by staff were located at a single site (Site ID 14196).



Year	2001	2004	2005	2008	2009	2012	2014	2016	2017	2018	2019	2020	2021
Adult	4	2	14	7	15	19	12	53	26	31	16	26	34
Subadult	3	20	9	2	40	3	48	19	9	8	37	56	34

Figure 7. Number of adult (green) and subadult (yellow) Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in the Island Lake drainage. Early survey efforts were minimal and did not include the same level of effort as surveys from 2005 onward. From 2005 through 2021, each total includes VES results from Ponds 14182, 14185, 14187, 14196, 50156, 50158; and Pond 14201, except for 2017 and 2019. Totals in 2018 and 2021 include adult SNYLF caught in Pond 14180. CDFW crews did not survey Upper Twin Lake (Site ID 14197) and Site ID 14194 in 2009, 2014, 2019, 2020, and 2021. VES conducted in 2012, 2014, 2016, 2018, 2020, and 2021 included a survey of Pond 27659, which is a small stream widening pool upstream of Upper Twin Lake. VES conducted in 2020 and 2021 included stream segment 52695.



Year	2001	2004	2005	2008	2009	2012	2014	2016	2017	2018	2019	2020	2021
Larva	10	1	28	24	69	129	148	150	46	150	1	384	1106

Figure 8. Number of larval Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in the Island Lake drainage. (See **Figure 7** for details about locations surveyed during VES.)

FISH REMOVAL

CDFW initiated fish removal in the Island Lake drainage in August 2017 and continued removal work through October 2020. During those efforts, CDFW staff removed BK from Island Lake, the fish-bearing inlet and outlet stream segments, and any immediately adjacent ponds (**Figure 6**). Each summer, CDFW set into Island Lake approximately 25 gill nets, which field staff repeatedly set and checked to remove BK. At the end of summers 2017–2019, CDFW set approximately 15 gill nets to remain in Island Lake over winter. In mid-October 2020, staff removed all gill nets from the drainage. Additional details about fish removal background can be found in the **CDFW Memorandum for Island Lake fish removal and *Rana sierrae* monitoring through 2020** (CDFW 2021).

Although the primary restoration activity is now complete in the Island Lake drainage, CDFW staff will continue annual monitoring of the lake and main tributaries using overnight gill net sets and backpack electrofishing. Diligent monitoring for any BK reinvasion is especially important, given the proximity of self-sustaining BK in Site ID 14177 and Twin Lakes (**Figure 5**) and complexity of the habitat surrounding Island Lake (**Figure 6**). As conditions allow, CDFW plans to revisit Island Lake up to twice per field season, likely in early summer (to monitor stream segments soon after high flows following snowmelt) and early fall, when water levels are lower and electrofishing efforts tend to be more efficient.

As part of these continued monitoring efforts, CDFW visited Island Lake on 8 July 2021 to temporarily set two gill nets in the southwest cove (**Figure 6**). Staff removed the nets one week later, on 14 July 2021. The gill net set resulted in zero fish captures. Additionally, on 8 July 2021, CDFW staff conducted one session of backpack electrofishing in the outlet stream, including any remaining stream pools (Site IDs 52694, 14171, 14169; **Figure 6**). During this session, CDFW staff made one pass through each primary stream segment. Staff detected no BK during this session. Staff did not conduct any additional electrofishing in summer and fall 2021 because the Caldor Fire prevented site access from mid-August through the onset of winter conditions. CDFW anticipates returning to Island Lake for monitoring in 2022, when site conditions allow, and access is available via Wrights Lake Road.

APPENDIX:

This section highlights differences in ephemeral aquatic habitat in the Island Lake area during wet and dry water years. The examples provided below are relevant for two primary reasons. First, from the standpoint of BK removal, many of these small and/or ephemeral waterbodies will not support self-sustaining BK. Much of the fish removal from 2017 to 2020 occurred as the result of physical removal with gill nets and backpack electrofishing units, but other areas are ephemeral, and periodically dry under normal variation in yearly precipitation. Second, these unstable conditions emphasize the importance of providing additional perennial, fishless aquatic habitat for SNYLF. Many of the fishless ponds dry up and likely become unsuitable for frog occupancy. When these peripheral ponds dry, SNYLF need to seek out other locations that retain water, some of which also contain fish (e.g., Twin Lakes and Site ID 14177; **Figure 5**). This may result in SNYLF mortality through desiccation or predation by BK, especially the loss of early life stage cohorts. However, fish removal at Island Lake has provided a predator-free oasis of perennial aquatic habitat into which SNYLF will hopefully move naturally over time.

The aquatic habitat surrounding Island Lake is fairly complex. Numerous inlet streams are present, and many small ponds and pools are located close to the lake, particularly at the east and west ends. Prior to fish removal work, several of these adjacent ponds and stream segments may have occasionally contained BK. However, many of these peripheral habitats dry completely late in the season, and additional locations (which may hold water year-round during more 20th-century-average water years) go completely dry during below average water years, such as 2012–2015, 2018, and 2020–2021.

The diametrically opposing conditions of ephemeral habitats near Island Lake are shown below, in two recent example water years (2017 and 2020). In 2017, after a winter with well above average snowfall and record-breaking precipitation for the northern Sierra Nevada (CDEC 2021), all adjacent ponds, streams, and stream pools were full in late summer (**Figures 9 and 11**). However, in 2020, following a winter with well below average snowpack and precipitation (CDEC 2021), many of these smaller waterbodies dried completely by early fall (**Figures 10 and 12**).

Winter 2020–2021 resulted in even less precipitation and lower snowpack than the year before, so aquatic habitats surrounding Island Lake looked very similar in late summer 2021 to those conditions present during fall 2020 shown in **Figures 10 and 12**. However, available aerial imagery was poorer in 2021, due to smoke from the Caldor Fire.

Figure 9. The eastern end of Island Lake in August 2017, after a year with above average snowpack and record-breaking precipitation. Circled areas with small ponds are wetted, in contrast to Figure 10. (Google Earth)

Figure 10. The eastern end of Island Lake in October 2020, after a year with far below average snowpack and precipitation. Circled areas with small ponds are completely dry, in contrast to Figure 9. (Google Earth)

Figure 11. The western end of Island Lake in August 2017, after a year with above average snowpack and record-breaking precipitation. A dense cluster of wetted pools in the complex outlet channel and a group of small ponds are both circled to contrast with Figure 12. (Google Earth)

Figure 12. The western end of Island Lake in October 2020, after a year with far below average snowpack and precipitation. Both circled areas, which contain wetted habitat in Figure 11, are almost entirely dry in this Figure. (Google Earth)

LITERATURE CITED

California Data Exchange Center (CDEC). Department of Water Resources. 2021. Northern Sierra 8 station precipitation index water year plot. Accessed 14 Dec 2021. Available from: https://cdec.water.ca.gov/reportapp/javareports?name=PLOT_ESI.pdf (Interactive precipitation plots also available here: https://cdec.water.ca.gov/precipapp/get8SIPrecipIndex.action)

California Department of Fish and Game (CDFG). 2012. Aquatic Biodiversity Management Plan for the Desolation Wilderness Management Unit. California Department of Fish and Wildlife, Rancho Cordova, CA. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=59961

California Department of Fish and Wildlife (CDFW). 2021. Native amphibian restoration and monitoring in Desolation Wilderness; Island Lake fish removal and *Rana sierrae* monitoring. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=190618

Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.-A.C. Hayek, and M.S. Foster (eds.). 1994. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D.C.

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.