

State of California
Department of Fish and Wildlife

Memorandum

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High Mountain Lakes;
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**Subject: Native amphibian restoration and monitoring in Desolation
Wilderness; Island Lake fish removal and *Rana sierrae* monitoring.**



INTRODUCTION

In early August 2017, California Department of Fish and Wildlife (CDFW) field crews began removing introduced 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. CDFW staff will continue annual monitoring of the restoration area using gill nets and electrofishing units to monitor for trout. 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 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 within 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 twenty-one 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 would be able to successfully cut back willow (*Salix* spp.) to temporarily open channels for electrofishing. As a result, CDFW, in coordination with ENF, began eradicating BK from Island Lake in 2017. Based on timelines from previous fish removal efforts in other locations, and habitat complexity at Island Lake, fish removal was expected to take several years to complete. CDFW has no current plans to remove BK from Upper or Lower Twin Lakes.

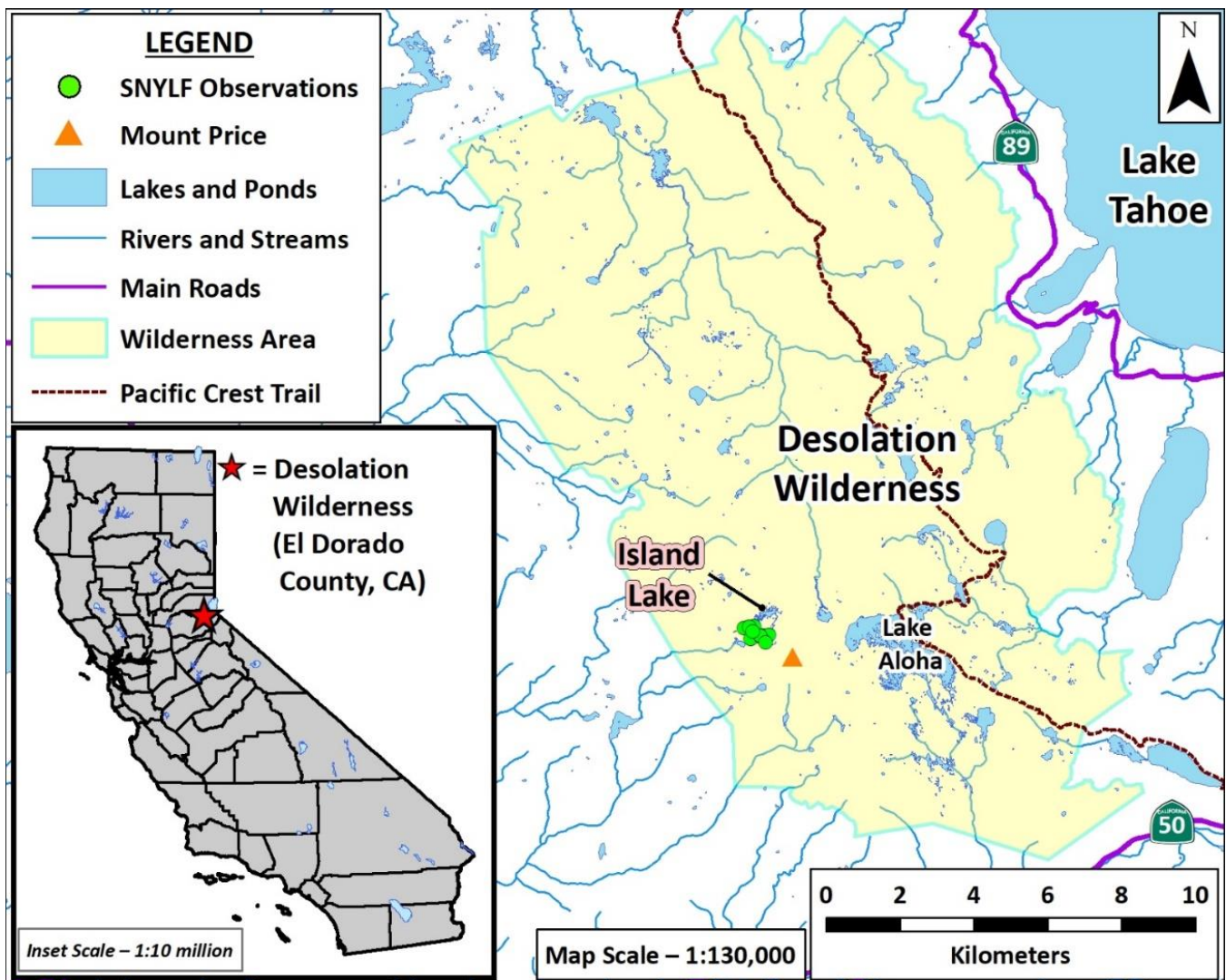


Figure 1. Desolation Wilderness, El Dorado County, CA. Green dots show Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) sites with positive detections by CDFW staff during recent visual encounter surveys (VES).



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)

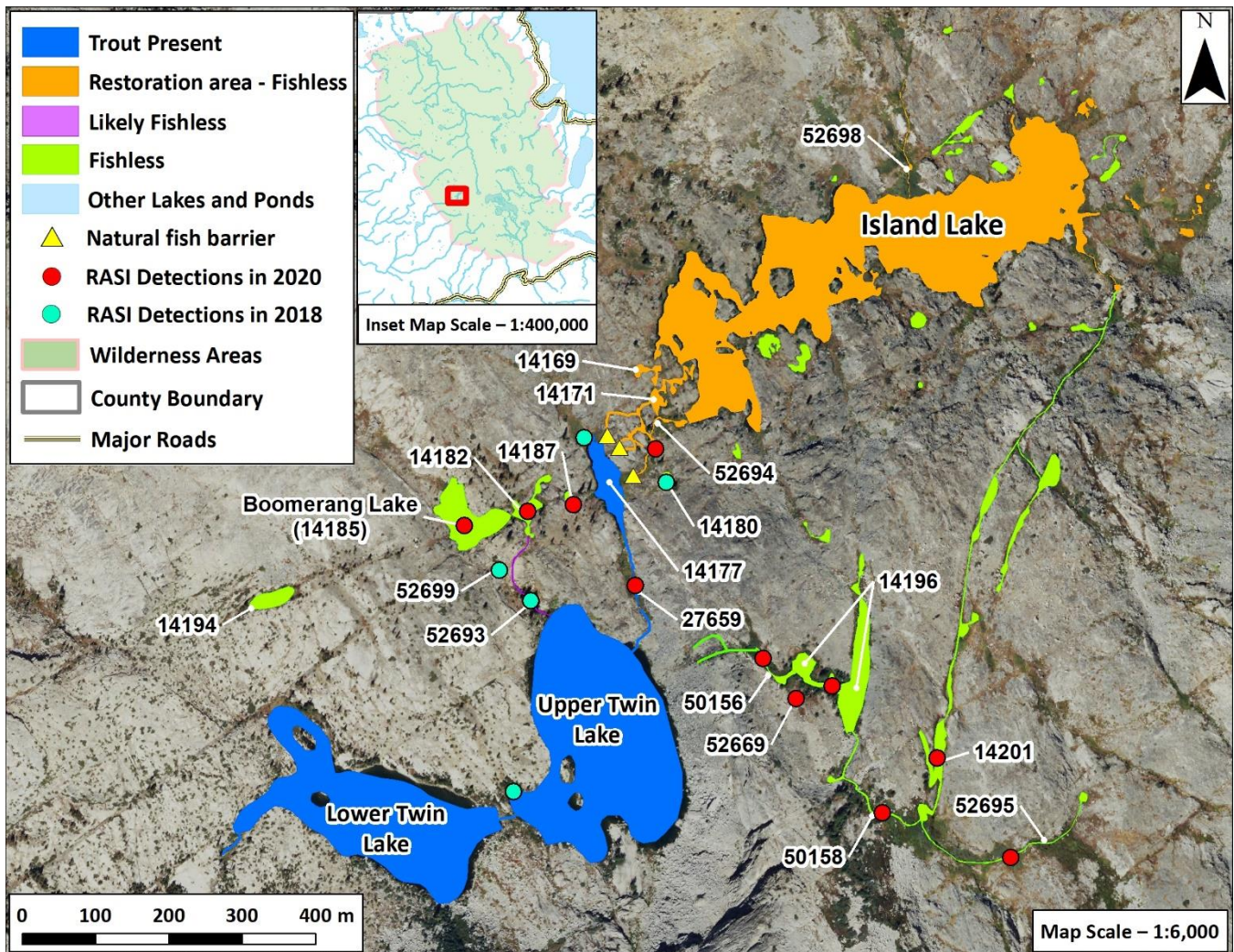


Figure 5. Brook Trout (*Salvelinus fontinalis*; BK) and Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) occupancy in the Island Lake area, Desolation Wilderness. CDFW staff have observed SNYLF of all life stages in a few small ponds in the basin. In 2020, staff observed two adult SNYLF in one of Island Lake’s outlet streams. The primary SNYLF population is located on the plateau above Upper Twin Lake (Site IDs 50156, 52669, 14196, 50158, and 14201). Lakes and ponds showing SNYLF presence are from visual encounter surveys (VES) conducted from 2018 to 2020. CDFW has occasionally observed post-metamorphic SNYLF in 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 mykiss* ssp.; GT). However, GT never became self-sustaining, and subsequent gill net surveys did not detect GT. Overnight gill net surveys in 2004 and 2008 both 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. 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 consistent 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 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.

POPULATION STATUS

Continued monitoring will be required to better assess the status and trends of the SNYLF population in the Island/Twin Lakes basin. However, visual encounter survey (VES) data between 2001 and 2020 suggest the SNYLF population has remained relatively constant for the past several years (**Figures 6 and 7**). 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).

CDFW staff observed more SNYLF of all life stages in 2020 than in any previous survey year. Staff detected 82 post-metamorphic frogs and 382 larvae (**Figures 6 and 7**). Staff conducted VES on two occasions in 2020: first in late July and again in mid-August. The reported counts of post-

metamorphic and larval SNYLF are taken from the survey in August, during which CDFW observed the highest total SNYLF counts. CDFW staff observed most SNYLF on the plateau above Upper Twin Lake (Site IDs 50156, 52669, 14196, 50158, 14201 and 52695; **Figure 5**). Additionally, CDFW staff observed at least two adult SNYLF during electrofishing efforts at Site ID 52694 (the primary outlet stream of Island Lake). Since these observations occurred on a different day, during which staff were not conducting official VES, the two adult SNYLF staff observed while electrofishing are not included in Figure 6.

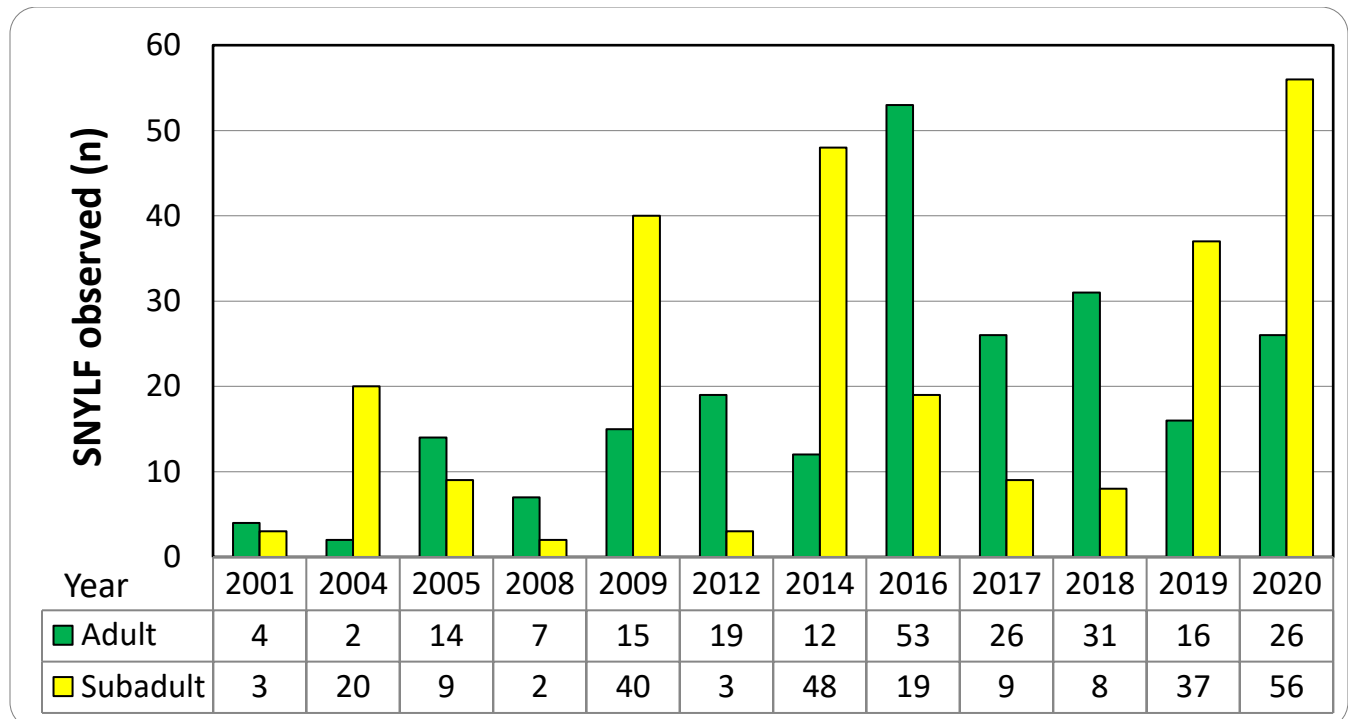


Figure 6. Number of adult (green) and subadult (yellow) Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in the Island Lake drainage. Early survey efforts were minimal and did not include the same level of effort as surveys from 2005 onward. From 2005 through 2020, each total includes VES results from Ponds 14182, 14185, 14187, 14196, 50156, 50158; and Pond 14201, except for 2017 and 2019. Totals in 2018 include two 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, and 2020. VES conducted in 2012, 2014, 2016, 2018, and 2020 included a survey of Pond 27659, which is a small stream widening pool upstream of Upper Twin Lake. VES conducted in 2020 included stream segment 52695, in which CDFW staff observed six adult SNYLF.

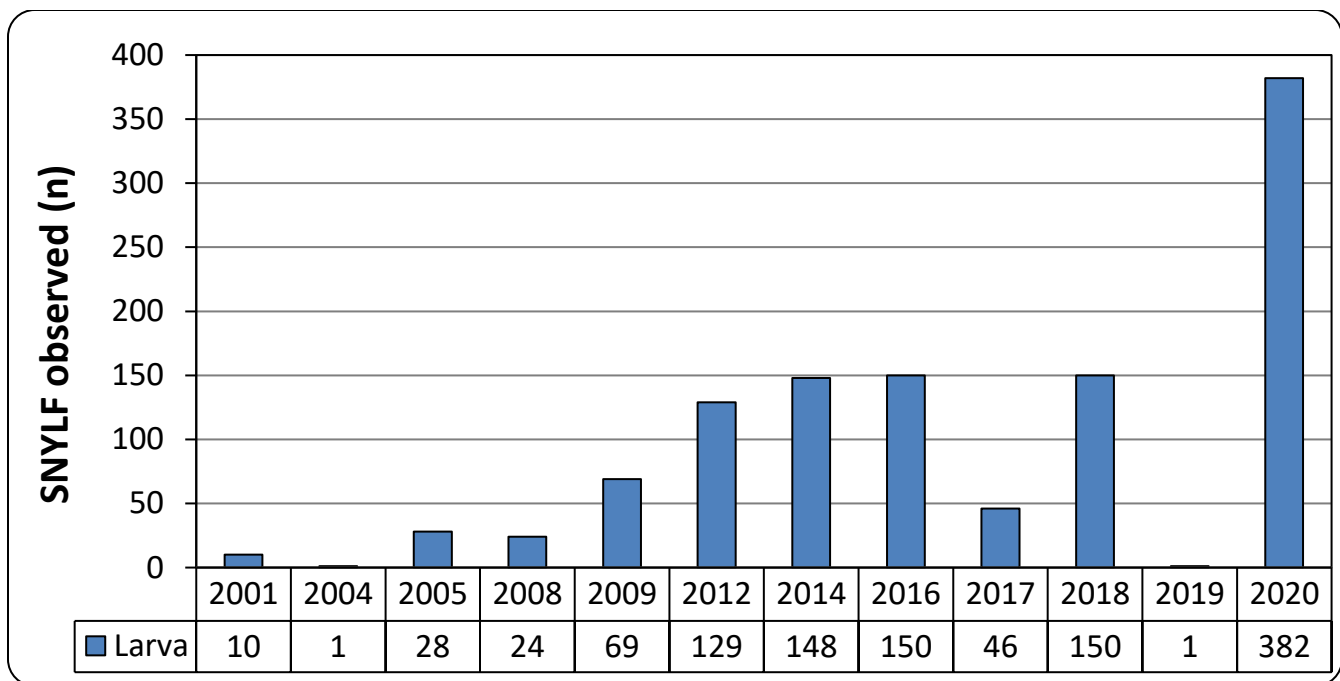


Figure 7. Number of larval Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in the Island Lake drainage. (See **Figure 6** for caveats about locations surveyed during VES.)

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 5**). Each summer, CDFW set 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 the lake over winter. In mid-October 2020, staff removed all gill nets from the drainage. Field staff used backpack electrofishers to remove BK from the Island Lake tributaries and small, adjacent ponds. Staff also used gill net fragments to remove BK from stream pools and small ponds connected to Island Lake. CDFW removed the following BK totals from Island Lake basin: 2,105 BK in 2017, 643 BK in 2018, 14 BK in 2019, and 3 BK in 2020, for a total of 2,765 BK removed.

CDFW field staff checked the 2019–2020 overwinter gill nets on 24 June 2020 and found no BK. However, staff observed three adult BK in a pooled section of the outlet stream immediately below the streamflow maintenance dam (**Figure 8**). Following this observation, field staff set a gill net fragment, and staff left the net fragment in this pool for the rest of the summer. Staff caught two BK from the net fragment on 24 June (the first day the net was set). During the same trip (24–25 June), CDFW set 25 gill nets into Island Lake. Staff checked all Island Lake gill nets on 28–29 July and found no BK. During those net checks, staff also checked the gill net fragment below the dam, which had captured one adult BK. CDFW staff checked the Island Lake nets and

stream net fragment two more times, on 17 August 2020 and 13–14 October 2020, and found no BK. Staff removed all nets from the basin following the final checks on 13–14 October 2020.

In 2020, CDFW staff conducted four separate sessions of backpack electrofishing in the inlet and outlet streams of Island Lake. During each session, CDFW staff made two or three passes of each primary stream segment (i.e., stream segments that contained most BK observed during the restoration project, including all outlet streams and inlet 52698). Additionally, on 9 September 2020, staff conducted a round of electrofishing in all of Island Lake's inlets, outlets, and immediately adjacent pools that still contained water. During these efforts, staff did not detect or capture any BK.

CDFW suspects that the three adult BK observed and captured below the streamflow maintenance dam in early summer 2020 were likely able to persist in the main outlet stream during earlier restoration work because field staff did not previously have access to the entire stream channel (Site ID 52694). During fish removal work in 2017–2019, CDFW had trimmed back willow in several stream segments, including Site ID 52698 and the upstream end of Site ID 52694. However, field staff did not complete willow trimming in the lower section of Site ID 52694 until early summer 2020. This likely allowed a few adult BK to hold out in perennial pools that had been completely covered in willow, which had prevented access by electrofishing crews. However, CDFW completed willow trimming in the lower section of Site ID 52694 before the first round of backpack electrofishing on 30 July 2020. This work allowed field staff full access to the stream channel for all electrofishing sessions during summer and fall 2020. After completing the outlet willow cutting, CDFW staff also completed maintenance trimming in the primary inlet stream (Site ID 52698), which had previously contained the largest number of stream-based BK in the Island Lake drainage (**Figure 8**). All of these willow trimming efforts were necessary to allow the safe and effective passage of a backpack electrofishing crew.

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. CDFW plans to revisit Island Lake at least 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.

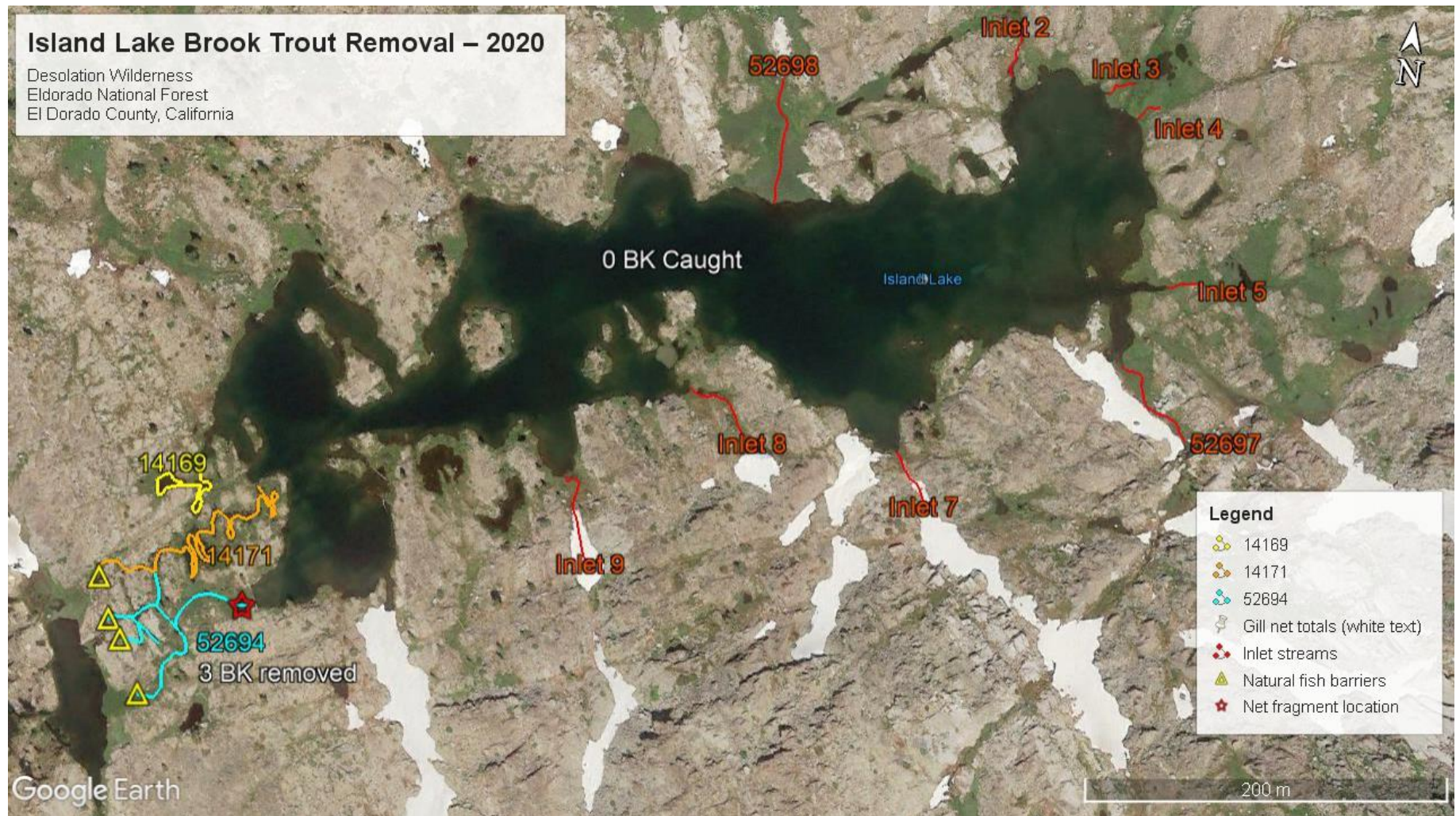


Figure 8. Brook Trout (*Salvelinus fontinalis*; BK) capture totals in the Island Lake area during summer 2020. Brook trout numbers removed with gill nets are shown in white. No BK were detected in Island Lake or during any stream electrofishing in 2020. The only BK detected were three adults captured in a gill net fragment in the pool immediately below the streamflow maintenance dam (red star). Locations of natural barriers to upstream fish movement are shown at the yellow triangles. Since Island Lake sits in a deep granite basin, all inlets ultimately terminate at steep waterfall barriers. (Google Earth)

APPENDIX:

The aquatic habitat surrounding Island Lake is fairly complex. Numerous inlet streams are present, and many small ponds and pools are located close proximity to the lake, particularly at the east and west ends. Several of these ponds and stream segments may occasionally contain BK. However, many of these habitats dry completely late in the season. Additional aquatic habitat dries during below average water years, such as the 2012–2015 drought (Hatchett 2015). These conditions are shown below, in two recent example water years (2012 and 2017). In 2012, at the beginning of the drought, many of these smaller waterbodies dried completely by August (**Figures 9 and 11**). However, following a winter with heavy snowpack and record precipitation, nearly all ponds were full and streams were flowing in August (**Figures 10 and 12**).

These examples 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 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 deep water, 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, several of which also contain fish. This may result in SNYLF mortality through desiccation or predation by BK, especially the loss of early life stage cohorts.

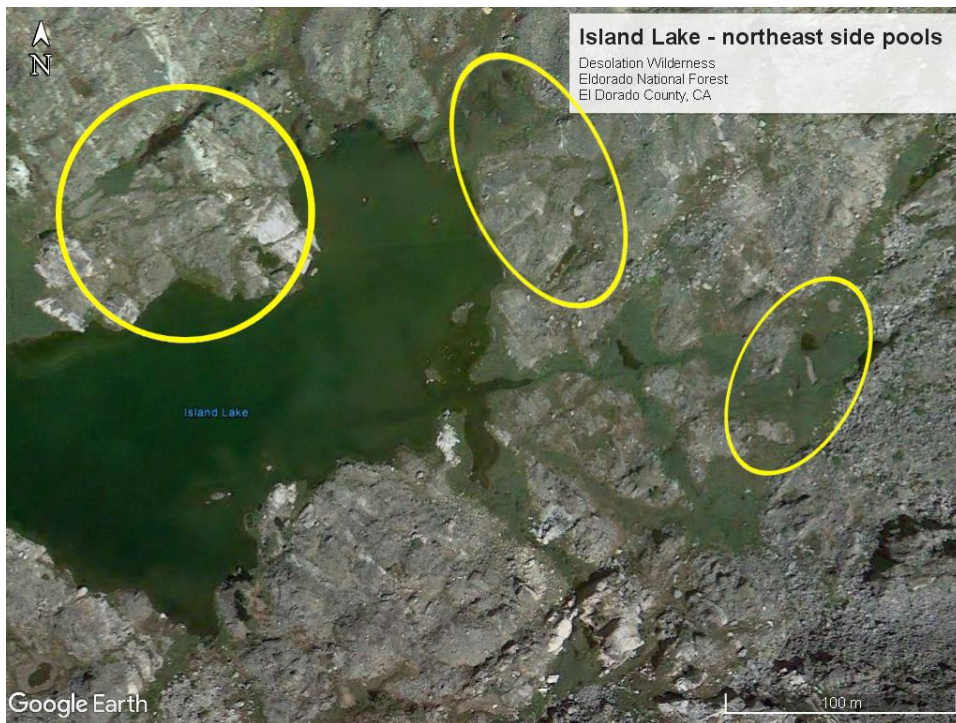


Figure 9. The eastern end of Island Lake in August 2012, at the beginning of a multi-year drought. Several areas with small, dry ponds are circled to contrast with Figure 10. (Google Earth)

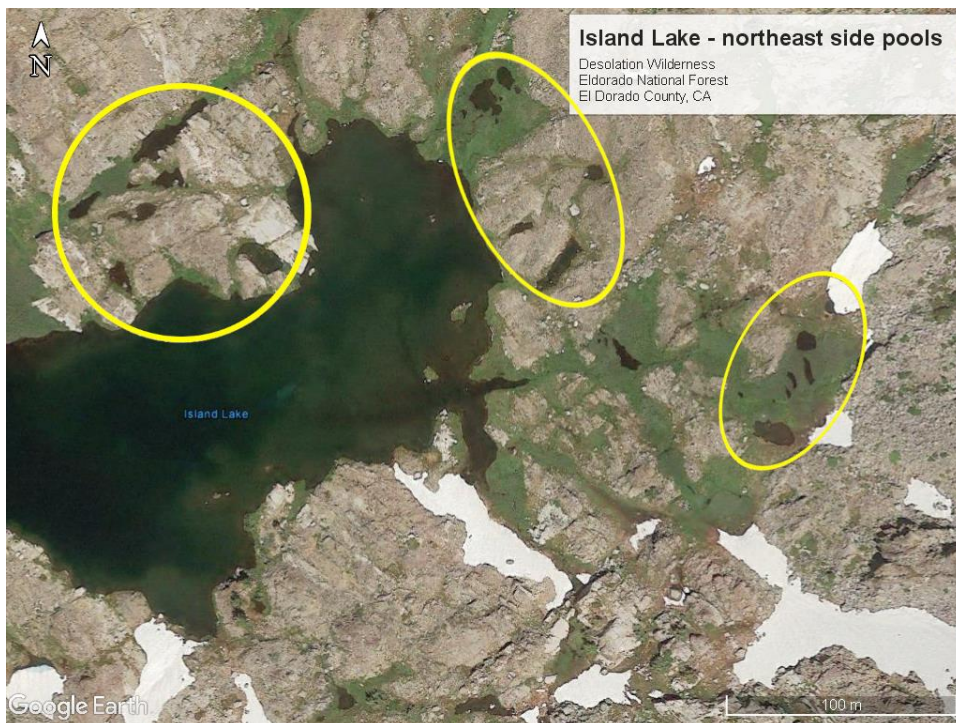


Figure 10. The eastern end of Island Lake in August 2017, after a year with above average snowpack and precipitation. Several circled areas with small ponds are wetted, in contrast to Figure 9. (Google Earth)



Figure 11. The western end of Island Lake in August 2012, at the beginning of a multi-year drought. A dense cluster of dry pools in the complex outlet channel are circled to contrast with Figure 12. (Google Earth)



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

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