State of California
Department of Fish and Wildlife

Memorandum

Date: 20 February 2020

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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. These restoration efforts continued during summer 2019. Between 15 July 2019 and 4 October 2019, CDFW crews removed 14 BK from Island Lake and its tributaries. On 3 October 2019, CDFW crews set 14 gill nets in Island Lake to fish overwinter. CDFW will continue similar effort of fish removal in 2020. 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 8,100 feet 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 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 can 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 is expected to take several years to complete. CDFW has no current plans to remove BK from Upper or Lower Twin Lakes.

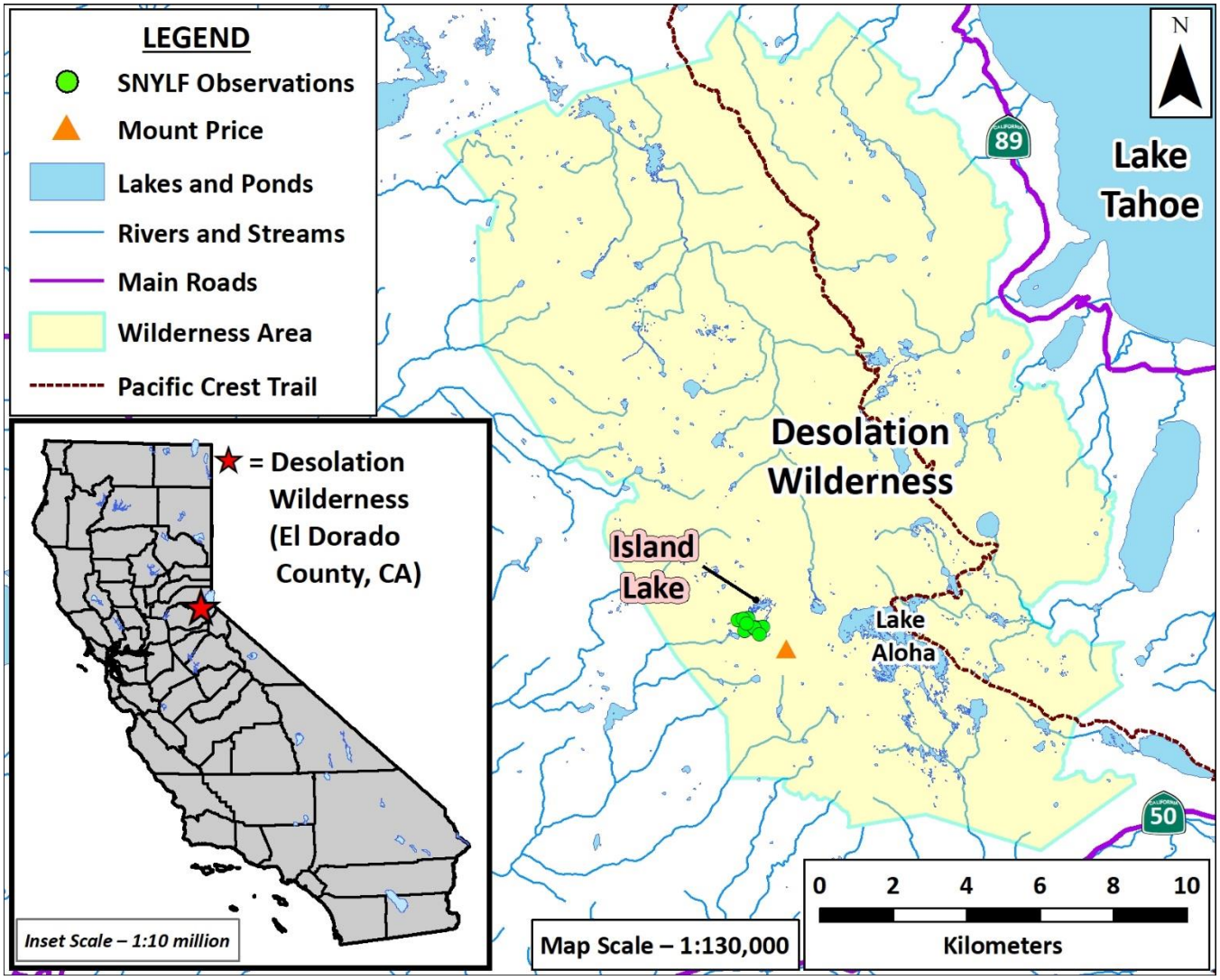


Figure 1. Desolation Wilderness, El Dorado County, CA. Green dots show *Rana sierrae* (SNYLF) sites with positive detections by CDFW staff during recent visual encounter surveys (VES).

Figure 2. Island Lake (Site ID 26594) in August 2017, looking east. (CDFW)

Figure 3. Upper (center, below talus field) and Lower (right) Twin Lakes (Site IDs 14197 and 14200, respectively), Desolation Wilderness, in July 2019, looking southeast. (CDFW)

Figure 4. Boomerang Lake (Site ID 14185), Desolation Wilderness, in July 2016, looking northeast. (CDFW)

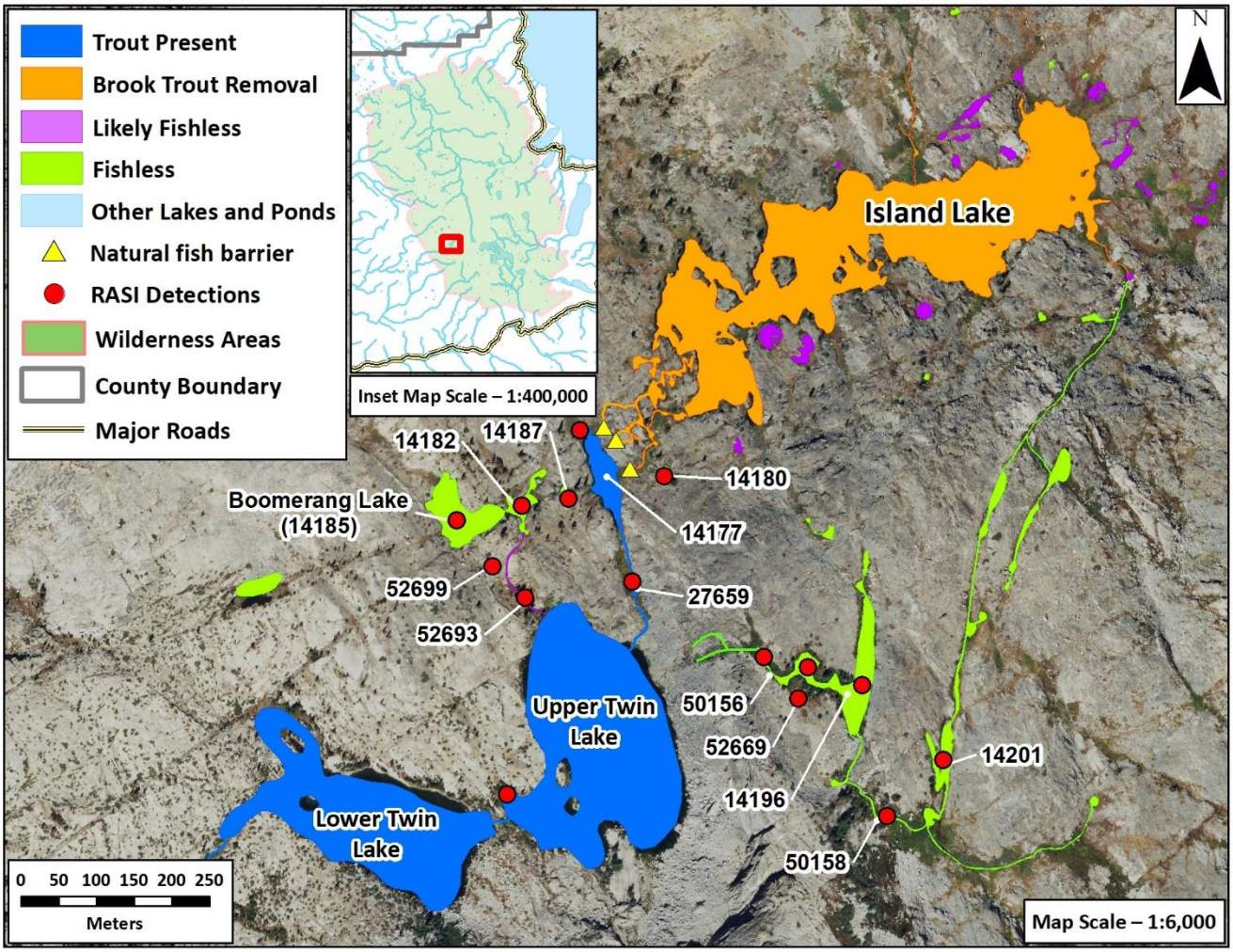


Figure 5. Brook Trout (*Salvelinus fontinalis*; BK) and Sierra Nevada yellow-legged frog (*Rana sierrae*; SNYLF) occupancy in the Island Lake area, Desolation Wilderness. CDFW crews have observed SNYLF of all life stages in a few small ponds in the basin, but not at Island Lake or the immediately adjacent ponds. 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 in 2018 and 2019; the most recent CDFW VES for each given pond. 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 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 both revealed a self-sustaining BK population. Island Lake (Site ID 26594), the outlet stream, an unnamed pond (Site ID 14177), and Twin Lakes (Site IDs 14197 and 14200) all contain persistent BK, which likely relegate 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, the waterbodies with BK likely act as a population sink for dispersing adult and subadult SNYLF. Barriers to upstream fish movement impede trout living in Twin Lakes and the unnamed downstream pond (Site ID 14177) from moving into Island Lake. In 1937, CDFW constructed a stonemasonry streamflow maintenance dam at the outlet of Island Lake (CDFG 1980). The main dam and several auxiliary dam walls form partial barriers to fish moving from the outlet stream into the lake. However, degradation of the walls during intervening years, and numerous ephemeral tributaries, allow occasional fish passage.

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 currently contain BK, SNYLF are mostly 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.

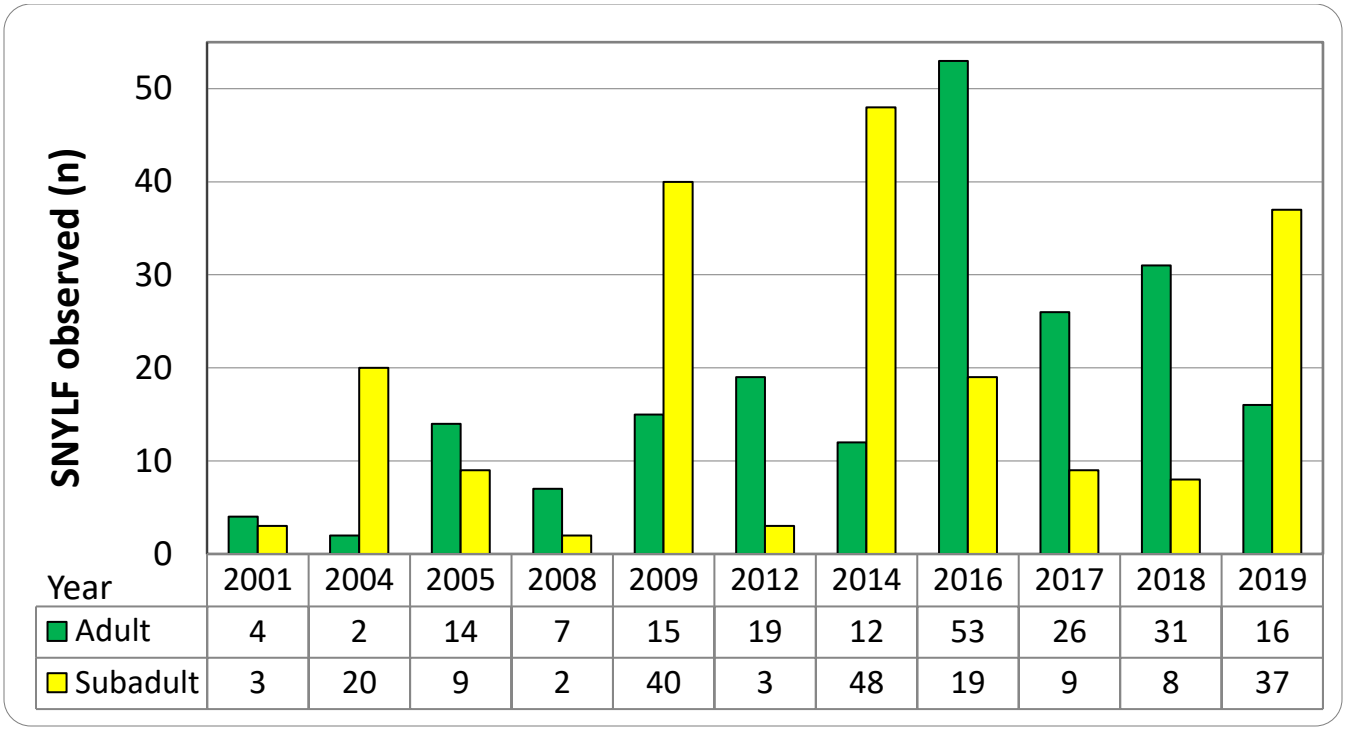
POPULATION STATUS

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 2019 suggest the SNYLF population has remained relatively consistent for the past several years (**Figures 6 and 7**). 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).

CDFW crews observed fewer larval SNYLF and a similar abundance of post-metamorphic SNYLF in 2019 when compared to VES results during the previous five years (**Figures 6 and 7**). However, in 2019, CDFW conducted most VES in Island/Twin Lakes basin during early fall, whereas CDFW initiated prior year surveys during more ideal mid-summer months (i.e., July and August). Additionally, weather conditions were not ideal during the 2019 VES of the pond in which most SNYLF tadpoles have been observed in prior years (Site ID 14196). High winds disturbed the water's surface, which made observing any tadpoles that may have been present extremely difficult.

In addition to the VES biases and survey conditions discussed above, environmental conditions during the previous winter may have played a role in the difference in observed larval SNYLF numbers. Winter 2018–2019 precipitation levels in the northern Sierra Nevada reached approximately 136% of the historical average (CDWR 2019a) and snowpack reached approximately 150% of the historical April 1st average (CDWR 2019b). These conditions resulted in snow and ice persisting in Island lake into July 2019 (**Figure 8**). Long winters and lingering winter snowpack are known to increase SNYLF mortality (Bradford 1983). Additionally, CDFW will continue monitoring the basin in the upcoming years to determine the relative abundance, general reproductive success, and demographic composition of the Island/Twin Lakes drainage SNYLF population.



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

Figure 6. Number of adult (green) and subadult (yellow) Sierra Nevada Yellow-legged Frog (*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 2019, each total VES from Ponds 14182, 14185, 14187, 14196, 50156, 50158; and Pond 14201, with the exception of 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 Pond 14194 in 2009, 2014, and 2019. VES conducted in 2012, 2014, 2016, and 2018 included a survey of Pond 27659, which is a small stream widening pool upstream of Upper Twin Lake.

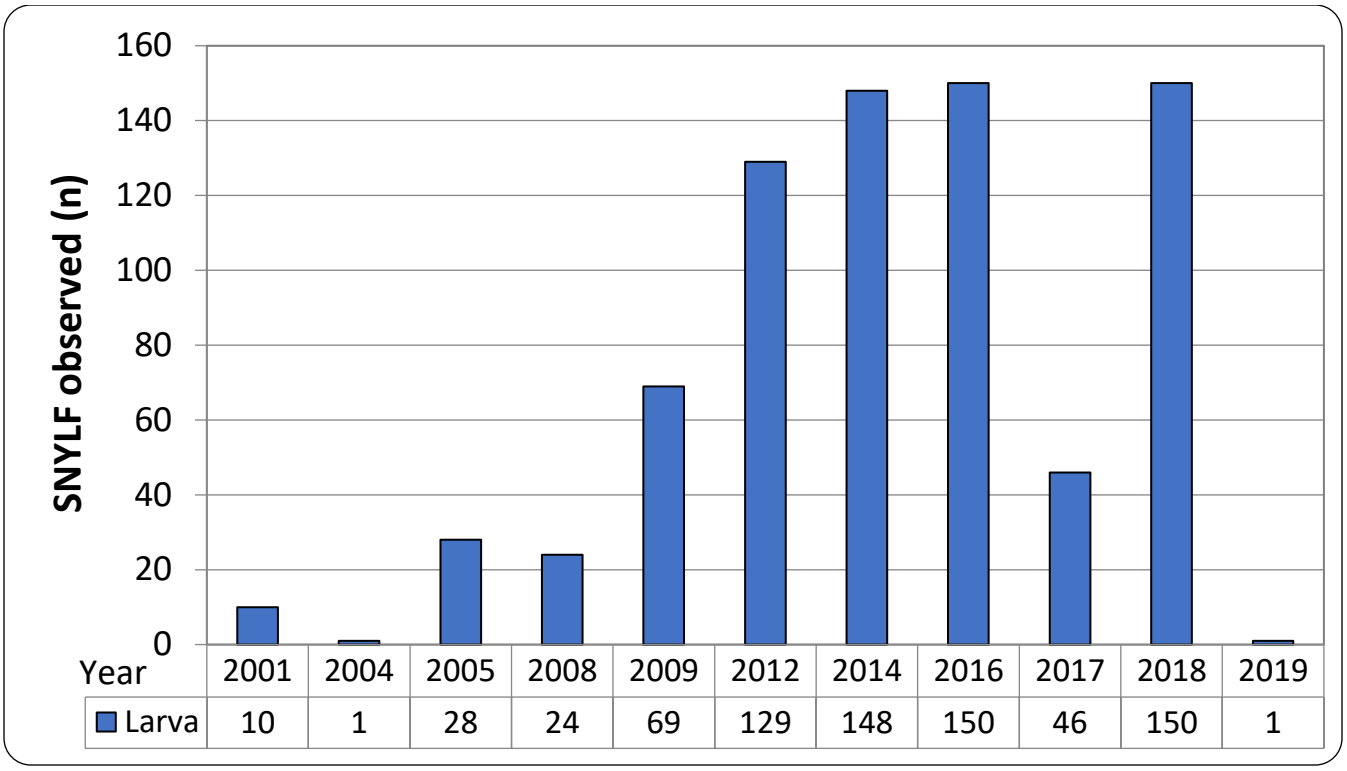


Figure 7. Number of larval Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) detected during visual encounter surveys (VES) in the Island Lake drainage. (See **Figure 6** for caveats about locations surveyed during VES.)

Figure 8. Island Lake on 30 June 2019. Summer 2019 followed a winter with above average snow water content and precipitation levels (CDWR 2019a, CDWR 2019b). (CDFW)

FISH REMOVAL

The fish removal areas in the Island Lake drainage include Island Lake, the fish-bearing inlet and outlet stream segments, and any immediately adjacent ponds (**Figure 5**). CDFW initiated fish removal in the Island Lake drainage in August 2017 and continued removal efforts through 2019. Each summer, CDFW has set approximately 25 gill nets, which crews repeatedly set and checked to remove BK. At the end of each summer, CDFW sets approximately 15 gill nets to remain in the lake over winter. Field crews use electrofishing to remove BK from the inlet and outlet streams of Island Lake as well as adjacent ponds. CDFW has removed the following number of BK from Island Lake basin since the fish removal project began: 2,105 BK in 2017, 643 BK in 2018, and 14 BK in 2019, for a total of 2,762 BK removed since August 2017.

CDFW field staff checked the 2018–2019 overwinter gill nets on 16 and 17 July 2019, removing seven BK. Staff set 25 summer nets on 17 July 2019 and checked the nets again on 12 and 13 August 2019, removing seven more BK, five of which were caught in a single gill net segment set in a pooled section of the outlet stream immediately below the streamflow maintenance dam, and the other two BK were caught in the main lake (**Figure 9**). CDFW staff checked the summer nets twice more, on 23 September 2019, then on 1 and 2 October 2019. During these early fall

efforts, staff did not capture any BK. On 3 October 2019, staff set 14 overwinter gill nets in Island Lake. CDFW will check these winter nets in early summer 2020.

CDFW staff conducted two rounds of backpack electrofishing in the inlet and outlet streams of Island Lake on 24 and 25 September 2019, then on 2 October 2019. During these efforts, staff did not detect or capture BK. Before backpack electrofishing in September, CDFW staff trimmed willow in the outlet stream segment to provide access to the stream channel. Before the electrofishing in October, CDFW trimmed back willow encroaching Inlet 1 (**Figure 9**). These efforts are necessary to allow the safe and effective passage of a backpack electrofishing unit and its operators in these stream segments. CDFW will conduct additional willow trimming and electrofishing during summer 2020.

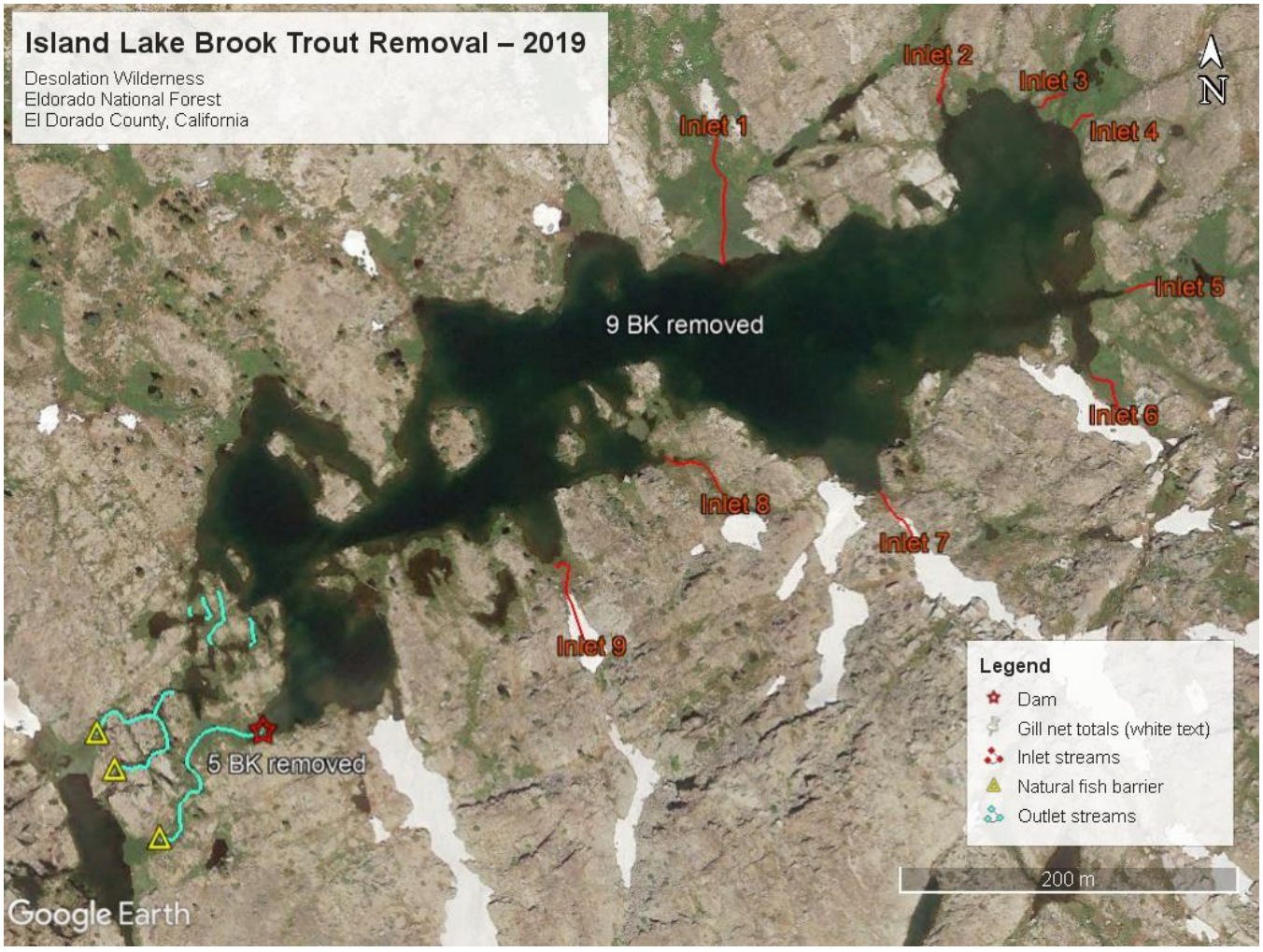


Figure 9. Brook Trout (*Salvelinus fontinalis*; BK) capture totals in the Island Lake area during summer 2019. Brook trout numbers removed with gill nets are shown in white. No BK were detected during inlet stream electrofishing in 2019. Locations of natural barriers to upstream fish movement from below the basin are shown at the yellow triangles. Location of the CDFW streamflow maintenance dam is shown at the red star. 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 in 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 10 and 12**). However, following a winter with heavy snowpack and record precipitation, nearly all ponds were full and streams were flowing in August (**Figures 11 and 13**).

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 will occur 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.

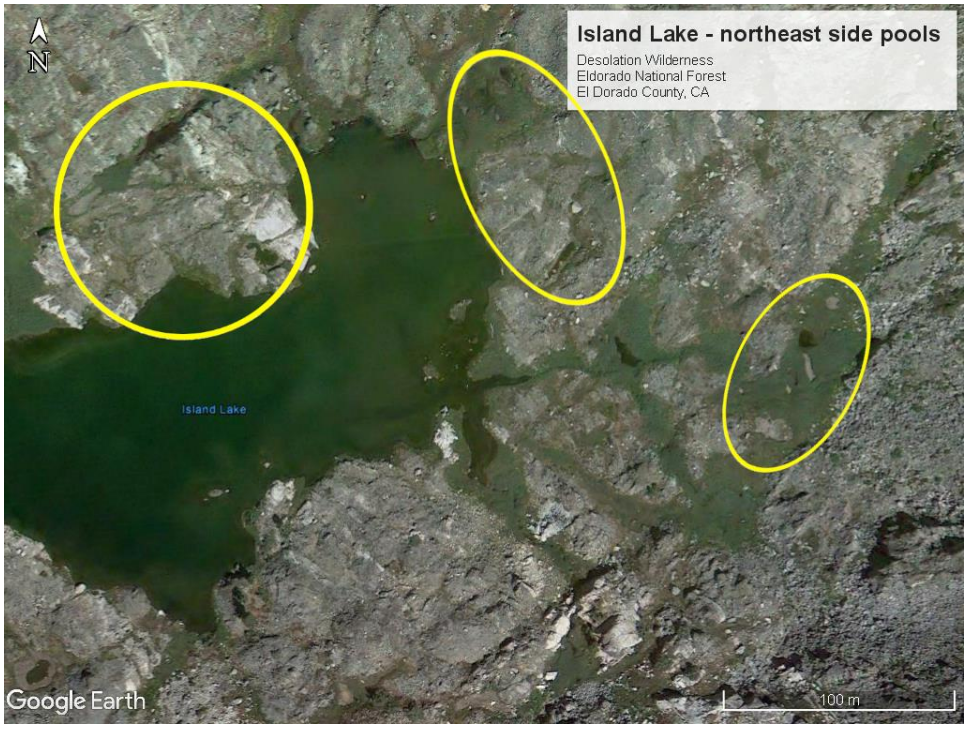


Figure 10. The eastern end of Island Lake in August 2012, at the beginning of a multi-year drought. Several areas with small, dry ponds are circled to contrast with Figure 11. (Google Earth)

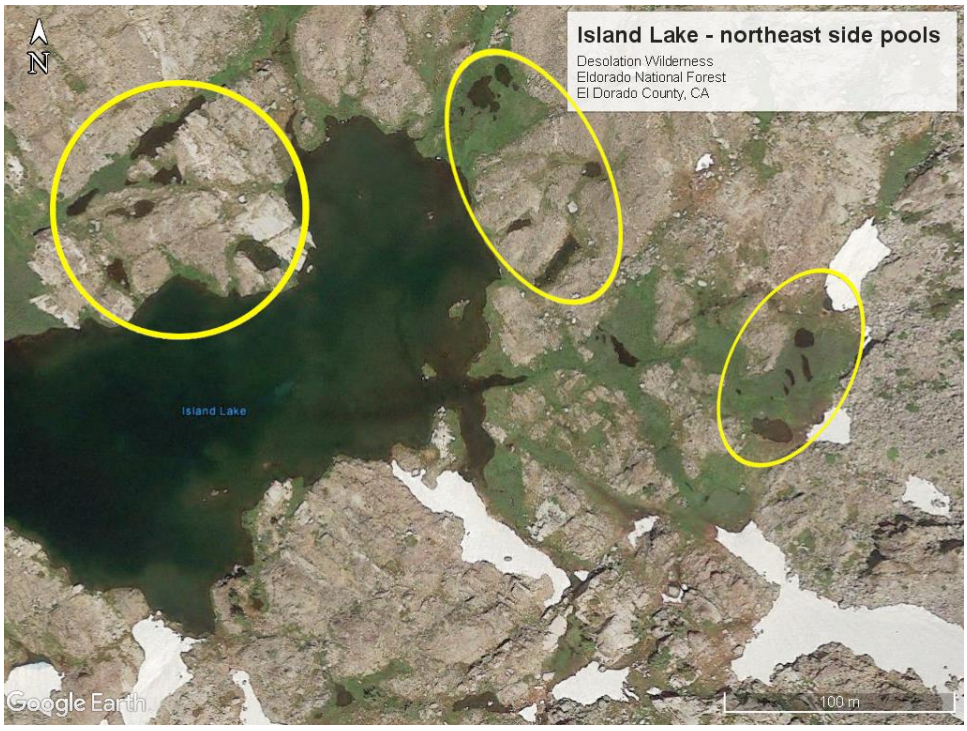


Figure 11. The eastern end of Island Lake in August 2017, after a year with above average snowpack and precipitation. Several circled areas with small ponds are wetted, in contrast to Figure 10. (Google Earth)

Figure 12. 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 13. (Google Earth)

Figure 13. 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 12. (Google Earth)

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