State of California

Memorandum

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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 habitat restoration efforts continued during summer 2018. Between 12 June and 16 October 2018, CDFW crews removed 643 BK from Island Lake and its tributaries. On 9 October 2018, CDFW crews set 14 gill nets to catch fish in Island Lake overwinter. CDFW plans to continue similar levels of fish removal efforts in 2019. Additionally, since 2002, CDFW has been monitoring nearby Sierra Nevada yellow-legged frog (*Rana sierrae*; SNYLF) populations. CDFW anticipates that these SNYLF populations will benefit from fish removal at Island Lake.

ENVIRONMENTAL SETTING

Island Lake is located in the Desolation Wilderness, northeast 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 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 area. 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 fish-containing 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. There are natural barriers to upstream fish movement along the stream channels draining into the pond below Island Lake. Additionally, although labor-intensive, cutting back willow to temporarily open channels for electrofishing is attainable. As a result, CDFW decided to commence eradicating BK from Island Lake and manage the site for amphibians. Based on timelines from previous fish removal efforts in other locations, and habitat complexity at Island Lake, fish removal will likely take several years to complete. CDFW has no current plans to remove BK from Upper or Lower Twin Lakes.

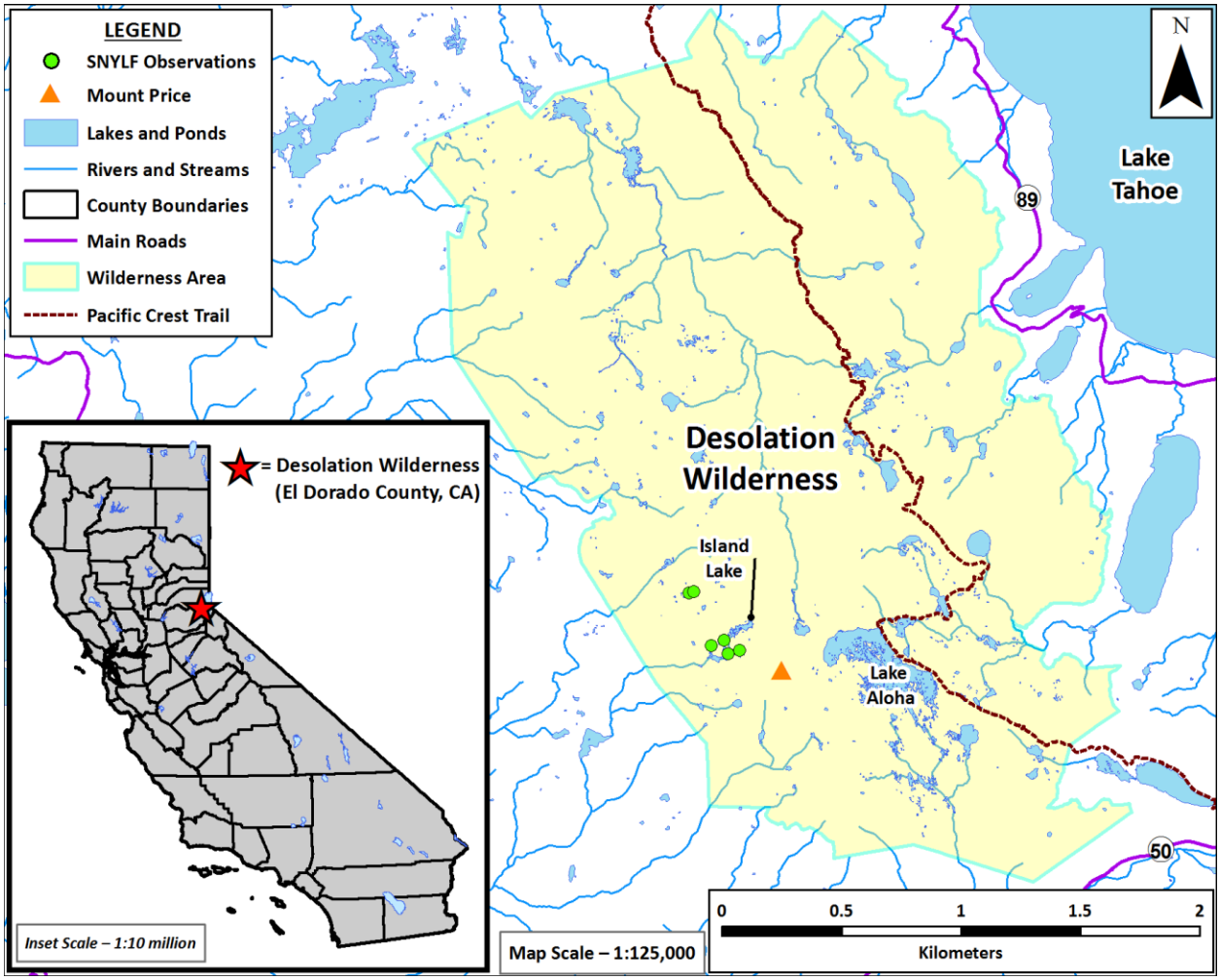


Figure 1: Desolation Wilderness, El Dorado County, CA. Green dots show *Rana sierrae* (SNYLF) sites with positive detections by CDFW staff during recent visual encounter surveys (VES).

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

Figure 3: Upper (foreground) and Lower (background) Twin Lakes (Site IDs 14197 and 14200, respectively), Desolation Wilderness, in September 2017, looking south. (CDFW)

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

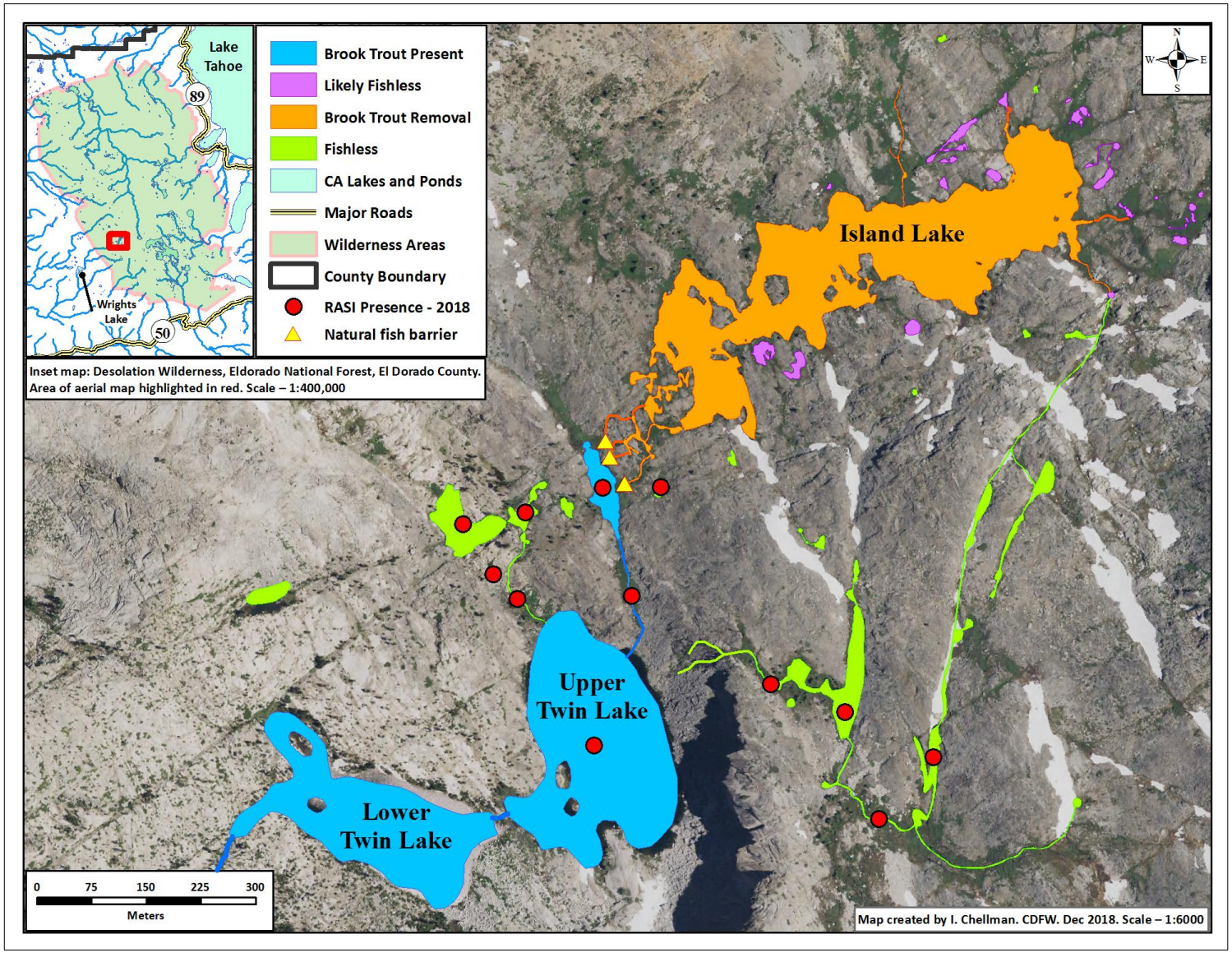


Figure 5: Brook Trout (*Salvelinus fontinalis*; BK) and Sierra Nevada yellow-legged frog (*Rana sierrae*; SNYLF) occupancy in the Island Lake area, Desolation Wilderness. CDFW crews have observed SNYLF of all life stages in a few small ponds in the basin, but not at Island Lake or the immediately adjacent ponds. The primary SNYLF population is located on the plateau above Upper Twin Lake. Lakes and ponds showing SNYLF presence are from CDFW visual encounter surveys (VES) in 2018. CDFW has occasionally observed a few post-metamorphic SNYLF in the small, fish-containing pond downstream of Island Lake (in blue) and along the shore of Upper Twin Lake, but crews have not observed SNYLF eggs or tadpoles in fish-containing habitat. 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.

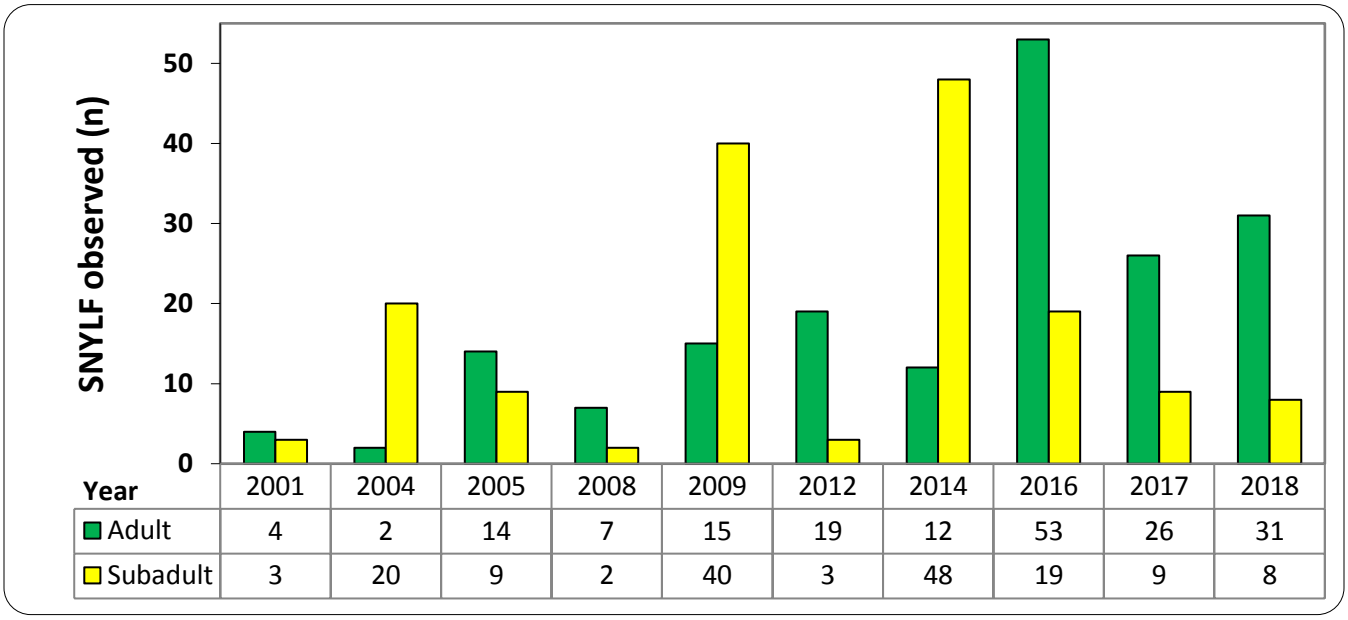
- ***Disease*** – All SNYLF populations in El Dorado County are positive for chytrid fungus (*Batrachochytrium dendrobatidis*; *Bd*). Crews collected nine epithelial swabs from SNYLF at four sites in 2008 and 2012. Partner scientists screened the swabs for presence of *Bd* DNA using real-time quantitative polymerase chain reaction (qPCR) analysis. The swab analyses detected very light to light *Bd* infection intensity.

- ***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 Brook Trout, SNYLF are mostly restricted to marginal satellite ponds, several of which often dry completely by late summer (see Appendix).

POPULATION STATUS

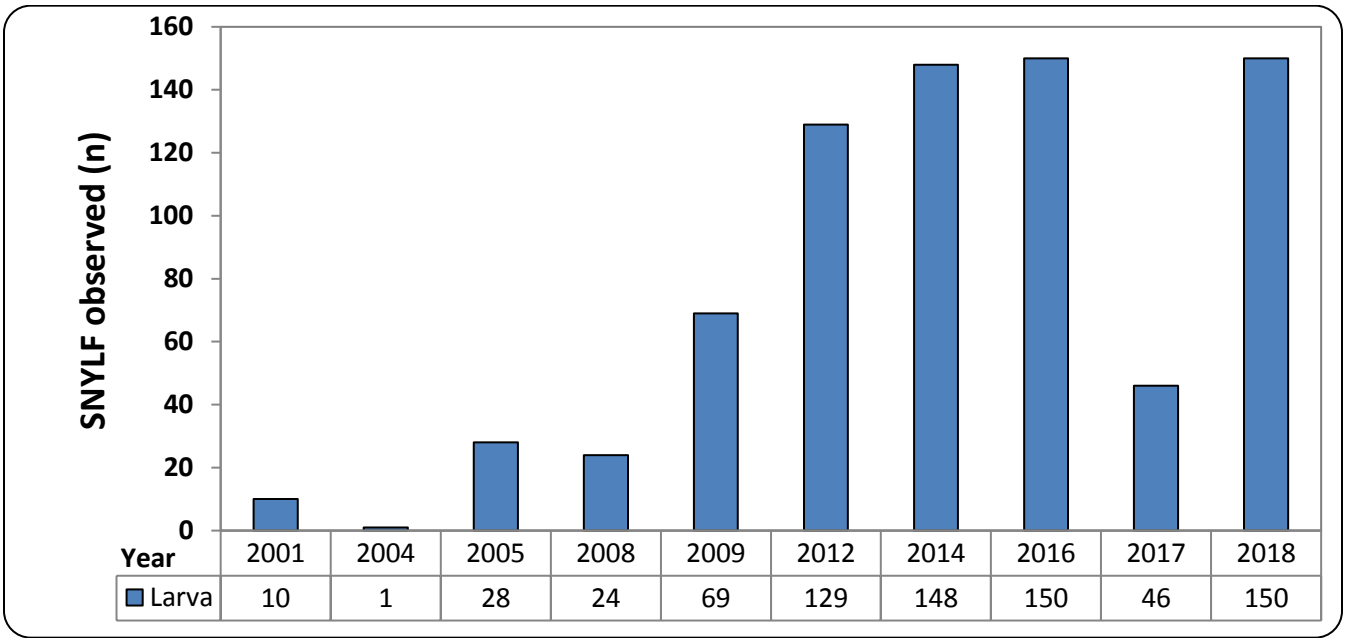
Continued monitoring will be required to better assess the status and trends of the SNYLF population in the Island/Twin Lakes basin. However, visual encounter survey (VES) data between 2001 and 2018 suggest the SNYLF population has either remained consistent or possibly increased (Figures 6 and 7). However, 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 measure for quickly and cost-effectively determining general population status of SNYLF, but proper interpretation of the results requires consideration of the assumptions inherent with VES (Heyer et al. 1994).

During VES in 2018, CDFW crews continued to observe larval and post-metamorphic SNYLF at similar abundance when compared with the last five years (Figures 6 and 7). Winter 2017–2018 resulted in substantially less precipitation and lower snow pack than the previous winter, which had ended with the highest winter precipitation totals on record (CDWR 2017a and 2017b). The lower snow pack and above average winter temperatures (Swain 2018) may have been beneficial for SNYLF populations in the Sierra Nevada. Long winters with snowpack lingering well into summer (such as winter 2016–2017) can increase SNYLF mortality (Bradford 1983). Substantially less precipitation occurred in the northern Sierra Nevada during winter 2017–2018. 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
Adult	4	2	14	7	15	19	12	53	26	31
Subadult	3	20	9	2	40	3	48	19	9	8

Figure 6: Number of adult and subadult 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 2018, each total includes VES from Ponds 14182, 14185, 14187, 14196, 50156, and 50158. From 2005 onward, crews surveyed Pond 14201 during each year shown except for 2017. 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 or 2014. VES conducted in 2012, 2014, 2016, and 2018 also included a survey of Pond 27659, which is a small stream widening pool upstream of Upper Twin Lake.



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

Figure 7: Number of larval 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 2018, each total includes VES from Ponds 14182, 14185, 14187, 14196, 50156, and 50158. From 2005 onward, crews surveyed Pond 14201 during each year shown except for 2017. 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 or 2014. VES conducted in 2012, 2014, 2016, and 2018 also included a survey of Pond 27659, which is a small stream widening pool upstream of Upper Twin Lake.

Figure 8: Island Lake on 3 June 2018. Snow water content in 2018 was below the historic average, so the site was completely open and accessible by the second week of June. (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). Adjacent to Island Lake, CDFW crews are using gill nets to assess several small ponds, which may occasionally contain BK. CDFW initiated fish removal in the Island Lake drainage in August 2017. About 25 gill nets were set throughout the summer and 15 nets remained in the lake during winter 2017–2018. In June 2018, CDFW field crews returned to continue fish removal efforts.

Below average winter snowpack allowed crews to access the site by the second week of June (Figure 8). Crews removed 228 BK from 15 overwinter gill nets. In mid-June, crews re-set 27 gill nets in the lake and removed 244 BK during the following visit in mid-July. In August, crews checked the lake nets twice and conducted one round of backpack electrofishing, the efforts of which resulted in an additional 126 BK removed. Crews removed another 12 BK in September. In October, crews captured 8 BK in the main lake, and removed 25 BK during stream electrofishing and gill netting. Crews captured most stream-based BK in a single gill net set in a pooled section of the outlet stream immediately below the streamflow maintenance dam (Figure 9). Finally, crews set 14 gill nets to remain in the lake overwinter.

In early summer 2019, field crews will check the overwinter gill nets. After cleaning and repairing the nets, crews will place the full suite (approximately 25) of summer nets into Island Lake to capture BK throughout the summer. CDFW field crews will visit the Island Lake area regularly (likely every two weeks) during weekdays to check gill nets, remove fish from streams with a backpack electrofishing unit, and conduct VES for native amphibians. Efforts in 2019 will likely concentrate on the BK remaining in inlet and outlet stream segments.

During summer 2018, field crews again used brush loppers to cut back willow growing in several stream channels. Most brush trimming efforts in fall 2018 occurred in the outlet stream segment below the Island Lake streamflow maintenance dam. These efforts are necessary to allow using backpack electrofishing units to remove BK from several stream channels. Additional willow trimming and electrofishing will continue in summer 2019.

CDFW field crews removed 643 BK from Island Lake basin in 2018. In total, CDFW crews have removed 2,748 BK from Island Lake basin since the project began in August 2017.

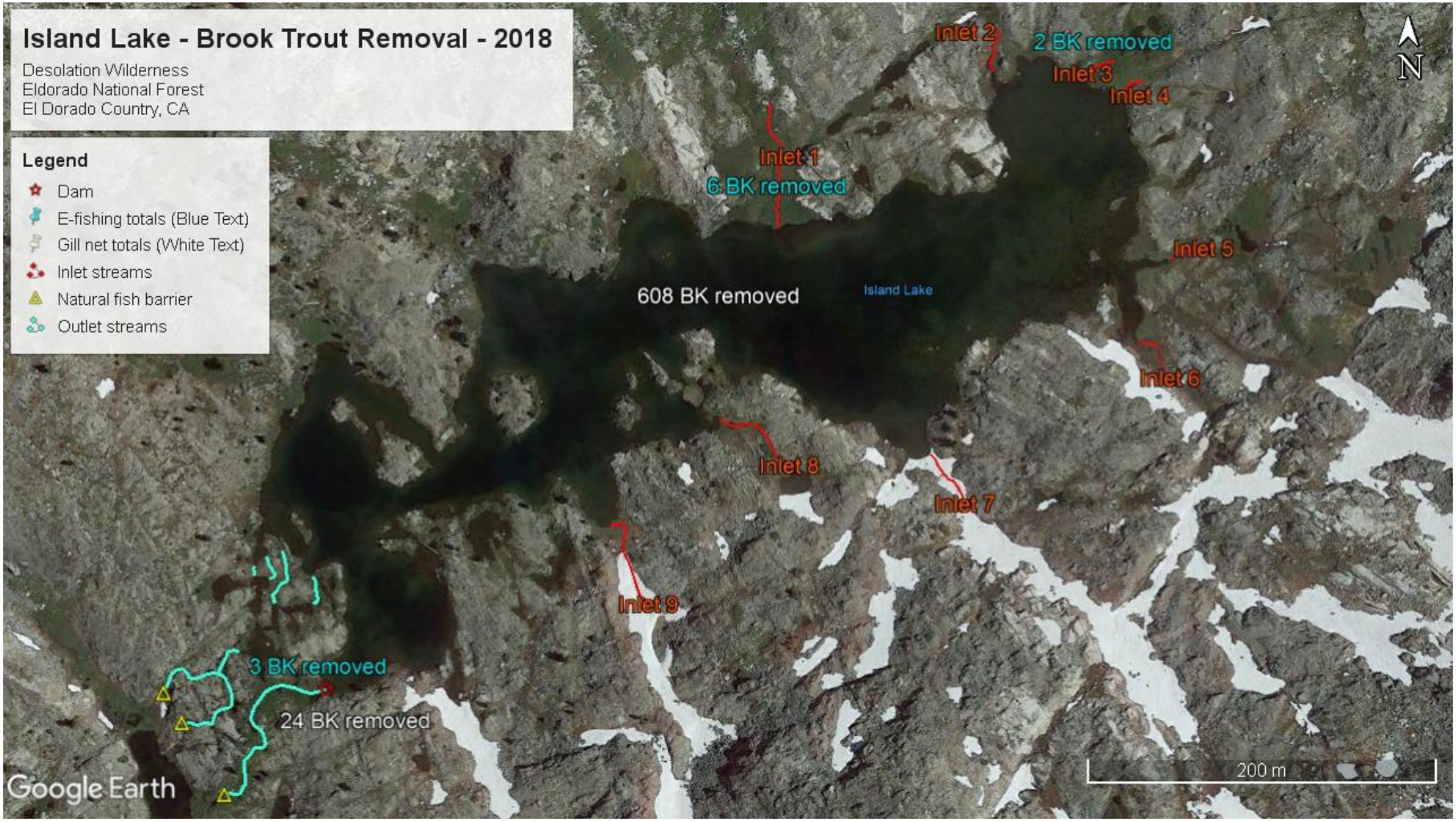


Figure 9: Brook Trout (*Salvelinus fontinalis*; BK) capture totals in the Island Lake area during summer 2018. Brook trout numbers removed with gill nets are shown in white, while individual stream segment BK removal via electrofishing are shown in blue. Locations of natural barriers to upstream fish 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 located in 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. Fish removal efforts will continue each year until eradication is completed. Much of the fish removal will occur as the result of physical removal with gill nets and backpack electrofishing units, but other areas will naturally go dry during the course of the project. Second, these unstable conditions emphasize the importance of providing additional deep water, perennial, fishless aquatic habitat for SNYLF. Many of the ponds, to which SNYLF have been restricted by BK, dry up and likely become completely unsuitable for frog occupancy. Therefore, SNYLF need to seek out other locations that retain water, several of which also contain fish. This may result in SNYLF mortality (especially the loss of early life stage cohorts) through desiccation or predation by BK.

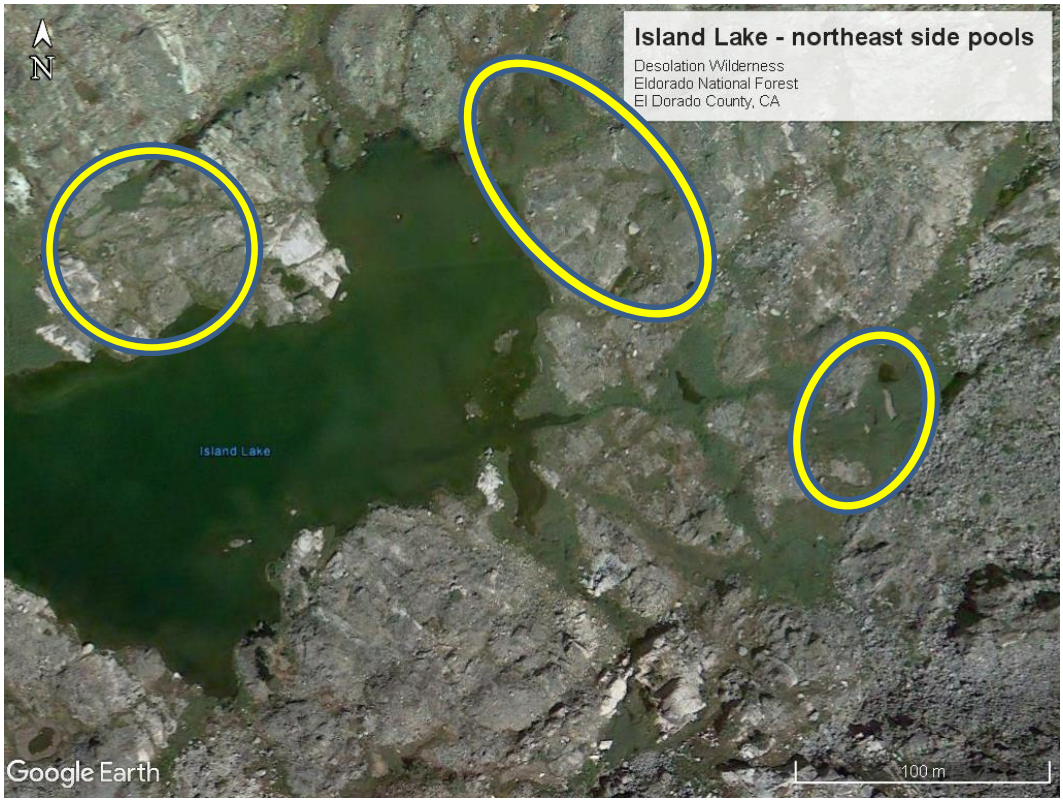


Figure 10: The eastern end of Island Lake in August 2012, at the beginning of a multi-year drought. Several areas with small ponds are circled to compare with Figure 11. (Google Earth)

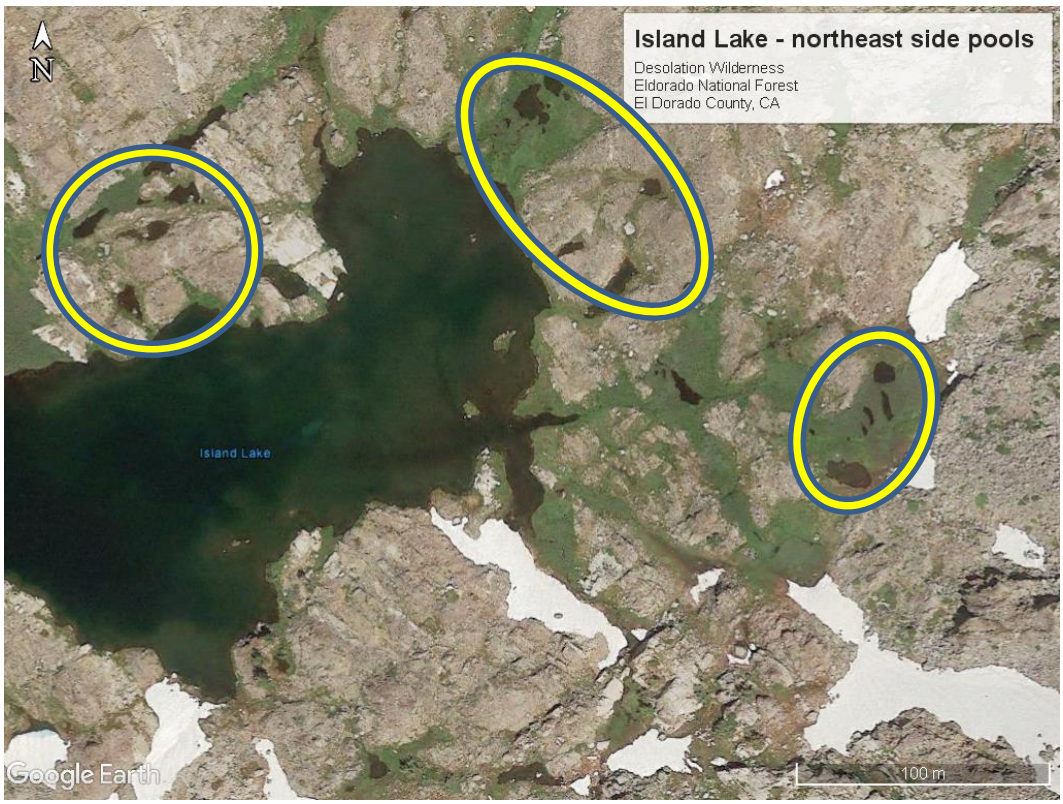


Figure 11: The eastern end of Island Lake in August 2017, after a year with far above average snowpack and record-breaking precipitation. Several areas with small ponds are circled to compare with Figure 10. (Google Earth)

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

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