

State of California  
**Memorandum**

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**Subject: Native amphibian restoration and monitoring in Desolation Wilderness.**

**Clyde Lake fish removal and *Rana sierrae* monitoring.**

Fish removal activities are complete in the Clyde Lake drainage (Figure 1); California Department of Fish and Wildlife (CDFW) staff removed 96 golden trout to benefit Sierra Nevada yellow-legged frogs (*Rana sierrae*, SNYLF). Amphibian monitoring data from 2012 through 2017 suggest an increasing SNYLF population; CDFW will continue amphibian monitoring the area to document SNYLF response to fish removal.

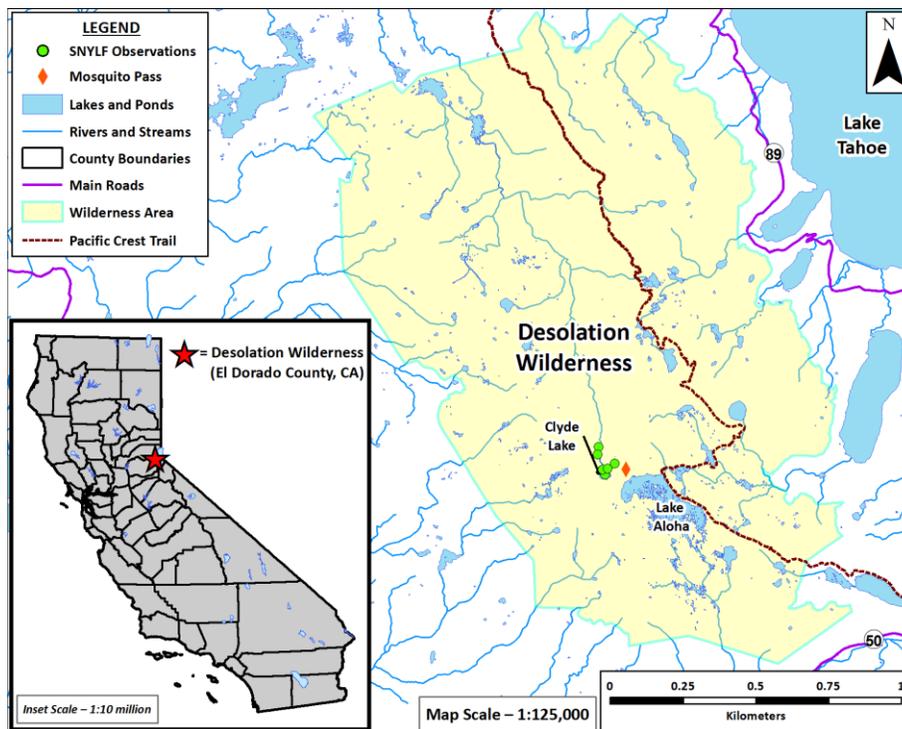


Figure 1: Desolation Wilderness, El Dorado County, CA. Green dots showing *Rana sierrae* (SNYLF) sites include positive detections by CDFW staff during recent visual encounter surveys (VES).

**ENVIRONMENTAL SETTING**

Clyde Lake is located in El Dorado County, in the Desolation Wilderness, within the Lake Schmidell Planning Watershed (PWS) at approximately 8000'. The outlet of Clyde Lake eventually becomes the Rubicon River, draining north from Desolation Wilderness to Hell Hole Reservoir, and ultimately to the Middle Fork American River. Eldorado National Forest manages this section of Desolation Wilderness and the surrounding land. Clyde Lake is accessed via the Rubicon Trail, which branches off to the west from the Pacific Crest Trail at the northern end of

Desolation Valley (Figure 1). In 2003, CDFW crews observed a small SNYLF population in the area. No fish were observed in Clyde Lake during gill net surveys in 2008 and 2010. However, golden trout (*Oncorhynchus aguabonita*) were present in the outlet stream. CDFW managers determined that eradicating the golden trout population from Clyde Lake to a barrier approximately 1.5 kilometers (km) downstream using gill nets and backpack electrofishers would be feasible, and provide additional SNYLF habitat in the Clyde Lake drainage. Once fishless, CDFW will manage Clyde Lake, the outlet stream, and associated ponds as SNYLF breeding habitat.

## INTRODUCTION

The Aquatic Biodiversity Management Plan for the Desolation Wilderness Management Unit (ABMP; CDFW 2012) identifies Clyde Lake (Figure 1) and two nearby sites as a Native Species Reserve (NSR) for SNYLF. Additionally, the ABMP identified the outlet of Clyde Lake, which supported a small, self-sustaining golden trout population, for fish removal. The NSR consists of Clyde Lake (Site ID 14149), three unnamed outlet ponds (Site IDs 14142, 14143, and 66159), all of which support SNYLF (Figure 2), and approximately 1.5 km of stream habitat (Site IDs 50393, 52672, 51067, 66164 and 66165), in most of which SNYLF have been observed (Figure 2).

Clyde Lake was stocked with trout from 1932 until 2000. In the early days of stocking, rainbow trout (*Oncorhynchus mykiss*) were the primary species, but CDFW planted only golden trout from 1962 onward. The lake contains limited spawning habitat and golden trout eventually died off after aerial stocking of the Clyde Lake drainage ceased in 2000. In 1936, CDFW constructed a stonemasonry streamflow maintenance dam at the outlet (CDFG 1980). The dam forms an effective barrier to fish moving from the outlet stream into the lake, thereby further reducing spawning potential. Gill net surveys in 2008 and 2010 indicated that golden trout were no longer present in Clyde Lake, but the outlet stream still contained trout. As a result, CDFW decided to eradicate the remaining fish in the outlet stream down to a barrier approximately 1.5 km below Clyde Lake and manage the area for SNYLF (CDFW 2012).

Beginning in 2012, CDFW began removing golden trout from the Clyde Lake outlet stream and associated stream pools to benefit SNYLF. As of 2015, trout appear to have been completely removed; no fish were captured after 2014. However, staff continued with low levels of gill netting through 2016. Therefore, CDFW considers fish removal activities complete. The habitat now supports a small SNYLF population, which CDFW will continue to survey regularly to monitor population status and trends. CDFW staff will also occasionally monitor the site for latent non-native trout.



Figure 1: Clyde Lake (taken from the slopes west of the lake), looking east, on 8/11/2003 (CDFW).

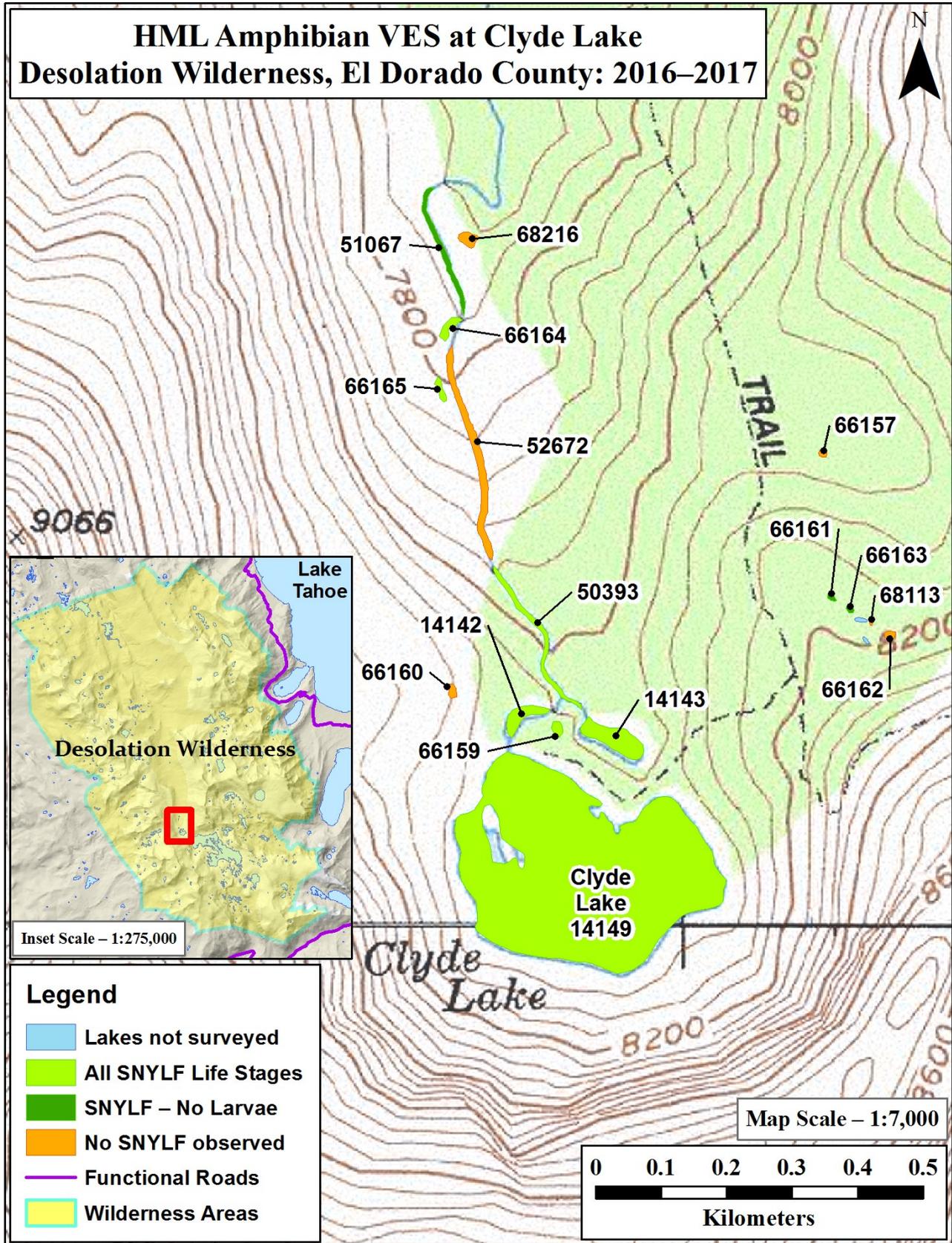


Figure 2: Locations of SNYLF and site IDs in the Clyde Lake Native Species Reserve during the 2016–2017 field seasons.

## THREATS

- **Introduced Fish** – Golden trout were present in the unnamed tributary below Clyde Lake (Site ID's 50393 and 51067), the three outlet ponds (Side ID's 14142, 14143 and 66164), and an associated off channel pond (Site ID 66165). Trout had been excluded from moving from the stream into Clyde Lake by a man made dam immediately at the lake's outlet. CDFW staff have observed SNYLF adults and subadults throughout the NSR (Figure 2), and larvae in many locations (Clyde Lake, plus site IDs 14142, 14143, 50393, 66159, 66164, 66165; Figure 2). Golden trout were formerly preying on larvae, and were a potential source of predation and competition for adult and subadult frogs. Trout are still present below the barrier that demarcates the downstream end of the NSR. Illegal movement of trout into the stream channel above the barrier, the NSR ponds, or Clyde Lake presents a potential extirpation risk for SNYLF. However, the immediate threat from trout predation has been mitigated through fish removal efforts.
- **Disease** – The Clyde Lake SNYLF population is chytrid fungus (*Batrachochytrium dendrobatidis*, *Bd*) positive. Nine epithelial swabs were collected and tested for the presence of *Bd* in 2008 and 2010; very light to moderate amounts of *Bd* DNA were detected on six swabs.
- **Marginal Habitats** – With the exception of Clyde Lake and Pond 14143, the SNYLF population is persisting in habitats with very little water. Any disturbance, natural or otherwise, that changes the hydrology or limnology of the two deep water habitats poses a potential extirpation risk to the population. Natural deterioration of the Clyde Lake dam (potentially causing changes to streamflow in shallow habitats below), severe winter conditions, extended drought, or anthropogenic habitat disturbances are some of the potential risks.

## SNYLF POPULATION STATUS

Fifteen years of monitoring data indicate the population is small, but stable, although data collected since 2012 suggest an increasing population (Figures 3 and 4). Observer bias, variation in survey conditions, and relatively low number of detections all make deriving trends difficult. Large variation in the numbers of adults observed could be due to multiple factors. For example, CDFW increased the number of areas surveyed in 2012, by including 1.5 km of stream habitat and three large pools; the habitat is complex and difficult to survey; and/or there is true variation in the population due to multiple stressors and impacts.

Clyde Lake was fishless during CDFW gill net surveys in 2003, 2008, and 2010. Only three years prior to the sampling in 2003, CDFW planted 5,000 golden trout in Clyde Lake. The rapid loss of fish from Clyde Lake was not expected. During that same survey in 2003, CDFW crews observed 30 adult, 13 subadult (Figure 3), and 368 larval SNYLF (Figure 4) in Clyde Lake and the nearby pond 14143. Crews conducted additional surveys of Clyde Lake and the nearby pools in summer 2005, 2008, and 2010 (Figures 3 and 4). In 2012, CDFW surveyed approximately 1.5 km of Clyde Lake outlet stream for the first time, in which crews observed six SNYLF adults, 28 subadults, and four larvae.

On July 3, 2013, crews surveyed Clyde Lake, 14142, 14143, and 66159 for SNYLF (Figures 3 and 4). Crews did not survey the stream reaches in 2013. August 28–29, 2014, crews surveyed all sites in the NSR. Crews completed most surveys on the 28<sup>th</sup> during good survey conditions. However, crews surveyed Clyde Lake on the 29<sup>th</sup> during poor survey conditions, which may explain the low numbers of larvae observed (Figure 4). In July 2015, Crews observed a large SNYLF larva in site 66164; this is the first larva observed in the lower stream since 2012. On July 27-28, 2016, crews surveyed all sites in the NSR. CDFW crews recorded the largest number of individuals observed in the basin since surveys began in 2003 (Figures 3 and 4). Forty-seven of the larvae were observed in the lower stream reaches, from which crews had recently removed fish. These observations suggest that breeding in these areas may be more successful in the absence of fish. On August 30, 2017, crews surveyed Clyde Lake and pond 14142. CDFW plans to survey the entire NSR during summer 2018 to continue gathering trend data for the entire SNYLF population in the area. CDFW manages the Clyde Lake SNYLF population as an amphibian resource, and surveys the area at least biennially to monitor population status.

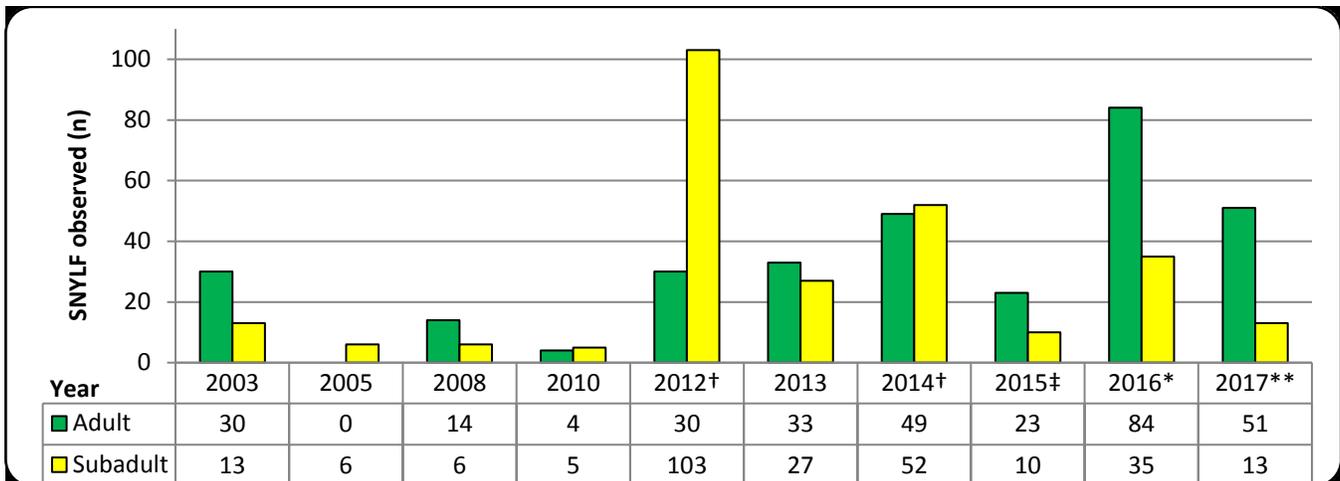


Figure 3: VES data for adult and subadult SNYLF in the Clyde Lake drainage from 2003 to 2017. CDFW surveyed Clyde Lake and pond 14143 each survey year from 2003–2010. Beginning in 2008, CDFW added pond 14142 to surveys. From 2008 onward, crews surveyed all three sites (14142, 14143, and Clyde Lake) during each VES, except for 2015 (when only the Clyde Lake outlet section was surveyed) and 2017, when 14143 was not surveyed.

**Symbol notations:** †2012 and 2014 surveys also include additional surveying along Clyde Lake’s outlet and associated downstream ponds (2012: 1 adult, 23 subadults, 4 larvae; 2014: 28 adults, 19 subadults). ‡2015 surveys only include a 1-km reach of Clyde Lake’s outlet and the associated ponds. \*2016 surveys included the entire Native Species Reserve, from Clyde Lake down to the barrier. \*\*2017 surveys only included Clyde Lake and pond 14142. Counts were summed across all sites and the totals are displayed.

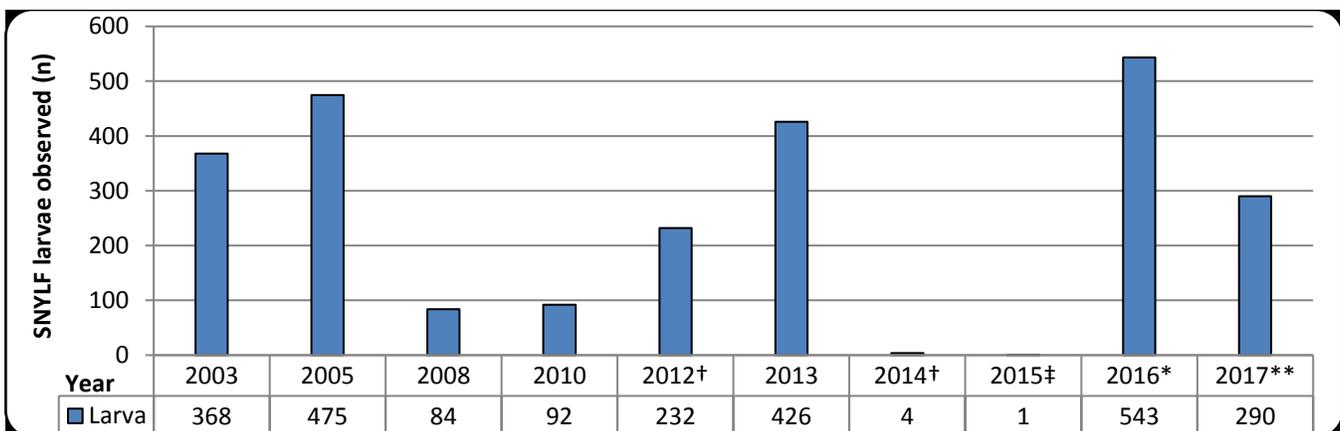


Figure 4: VES data for larval SNYLF in the Clyde Lake drainage from 2003 to 2017. CDFW surveyed Clyde Lake and pond 14143 each survey year from 2003–2010. Beginning in 2008, CDFW added pond 14142 to surveys. From 2008 onward, crews surveyed all three sites (14142, 14143, and Clyde Lake) during each VES, except for 2015 (when only the Clyde Lake outlet section was surveyed) and 2017, when 14143 was not surveyed.

**Symbol notations:** †2012 and 2014 surveys also include additional surveying along Clyde Lake’s outlet and associated downstream ponds (zero larvae were observed in the outlet in both surveys). ‡2015 surveys only include a 1-km reach of Clyde Lake’s outlet and the associated ponds (a single large larva was observed in site 66164). \*2016 surveys included the entire Native Species Reserve, from Clyde Lake down to the barrier (47 larvae were observed in the lower stream reaches and pools where fish removal was recently completed). \*\*2017 surveys only included Clyde Lake and pond 14142. Counts were summed across all sites and the totals are displayed.

## **FISH REMOVAL**

The Clyde Lake outlet (Site IDs 50393, 52672, and 51067), two connected ponds (Site IDs 66164 and 66165), and a small upstream pond (Site ID 66159) were all locations in which CDFW staff observed trout (Figure 5). Therefore, active fish removal occurred throughout the entire outlet stream area, from below the Clyde Lake dam until the bottom of stream reach 51067 (Figure 5). At the bottom of the NSR, there is a large barrier (approximately 12 meter falls), which prevents upstream fish movement (Figure 6).

CDFW initiated fish removal efforts in October 2012. At that time, a multi-year drought (2012–2015; Swain 2015) was beginning. The initial low water year resulted in much of the outlet stream going dry by August. Due to favorable fall conditions, CDFW decided to begin fish removal, and crews removed 67 fish in October 2012. In the upstream section, staff captured two fish in pool 66159 (Figure 7). Crews also set gill nets in pool 14142 and SNYLF breeding pond 14143, in which crews caught no fish. Crews captured the other 65 fish in the lower section of stream, which consists of three large pools and a braided stream channel. A single pool incorporated into stream reach 51067 contained most fish (Figure 8). Crews removed five large fish from pool 66164, in which CDFW staff had previously observed four SNYLF larvae (Figure 9). Crews also removed a single trout from pool 66165 (Figure 10). Additionally, crews observed fry in two small pools below pool 66164. A seasonal barrier is present on the outlet of 66164 (Figure 5).

On July 3, 2013, crews checked and reset all gill nets, which captured an additional 15 fish. On August 28, 2014, crews checked and reset all gill nets in the lower stream section and captured another 14 fish. Crews captured no fish in pool 66165 and removed the net. On August 28 and 29 2014, crews set 13 overwinter nets in pool 66164 and the largest pool in stream segment 51067. On July 22, 2015, crews checked and removed the overwinter gill nets. Crews captured zero fish and visual assessment of the stream also revealed no trout observations. At this point, staff determined that CDFW had likely achieved complete trout removal in the NSR. For additional confirmation crews set four gill nets in the lower stream reach on July 28, 2016. Crews pulled the nets on October 4, 2016 and captured no fish during the two-month period of net deployment.

CDFW has determined that Clyde Lake NSR is now fishless. Crews will continue occasional monitoring in the area to assess SNYLF population status and monitor for trout. In summer 2018, crews plan to survey the entire NSR. During those monitoring efforts, crews will remain vigilant for trout, and document SNYLF during VES.

## **DISCUSSION**

Recent survey results suggest that the SNYLF population in the Clyde Lake area is doing well. The population now has additional habitat that may be capable of sustaining a more robust population into the future. Removing trout from the Clyde Lake outlet and associated ponds has removed a significant source of predation and competition on this SNYLF population. Now that fish are no longer present, SNYLF have the opportunity to capitalize on additional foraging and basking habitat, including several large pools. SNYLF may also have additional fishless breeding and overwintering habitat in the larger pools within, and adjacent to, the stream. Little is currently known about SNYLF reproductive biology and overwintering in stream habitats. However, CDFW monitors several stream-based SNYLF populations in the North Central Region, and successful reproduction is possible in some stream habitats. CDFW will continue surveying this SNYLF population regularly to monitoring population status and trends over time.

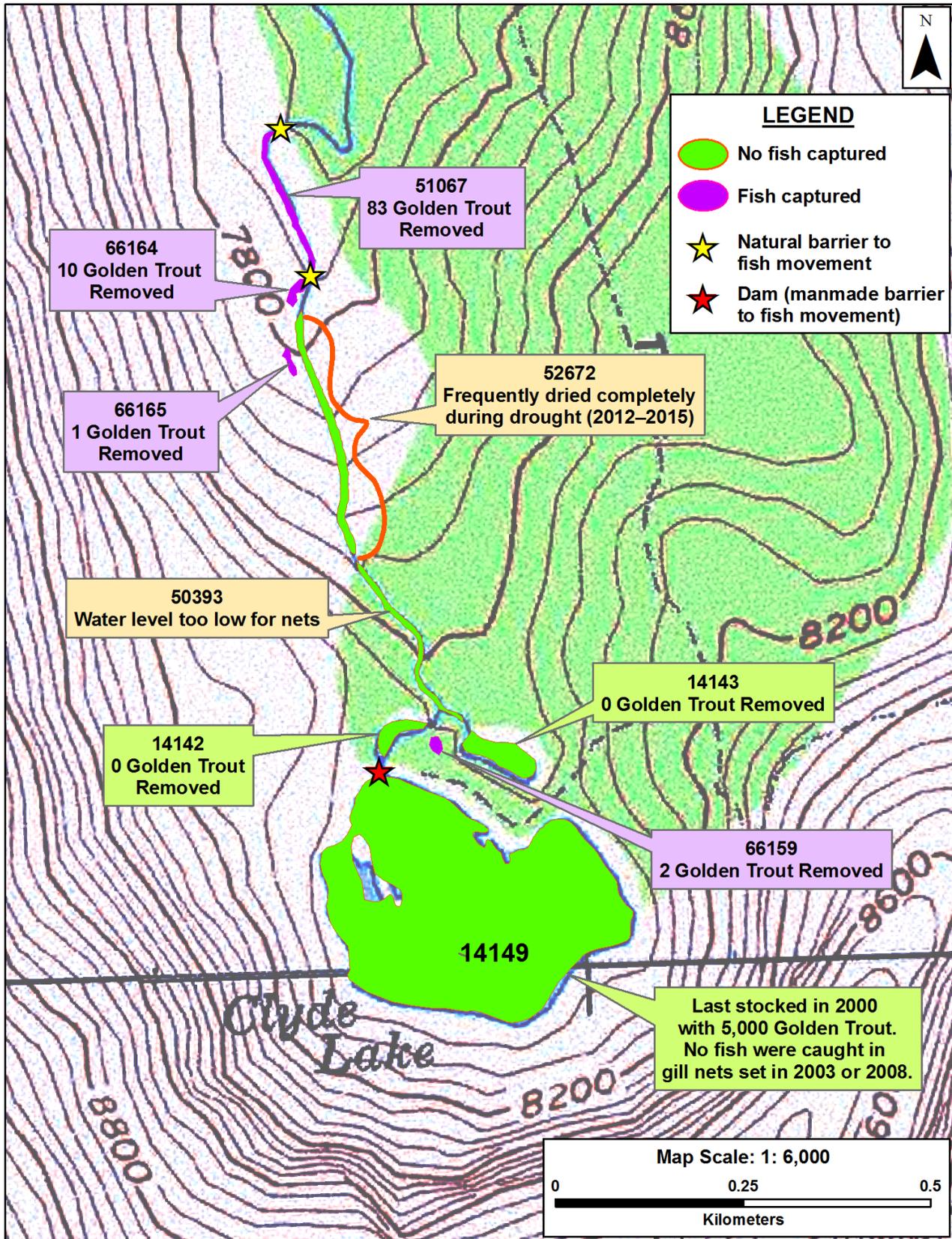


Figure 5: Locations with and without fish captures during Clyde Lake drainage fish removal. Labels show lake site IDs and the number of fish captured at that site between 2012 and 2014. No fish were captured during fish removal efforts in 2015 and 2016. Locations of natural barriers to upstream fish movement are shown at the yellow stars. Location of the manmade dam, which acted as a barrier to fish attempting to move into Clyde Lake, is shown at the red star.



Figure 6: Barrier at the bottom of stream reach 51067. The barrier is a 12-m cascade with three large steps, each of which is approximately 3 m high. (CDFW)



Figure 7: Pool 66159, as viewed from the east. Two golden trout were removed in October 2012. Six adult, one subadult, and 25 SNYLF larvae were seen in this pond on 7/27/2016. (CDFW)



Figure 8: Largest pool in the lower stream section 51067, looking north. 83 golden trout were captured in this stream segment from 2012–2014, and fry were seen in the shallow southern section in 2012. No trout were observed or captured in 2015 and 2016. 18 adult and two subadult SNYLF were seen in this stream reach on 7/27/2016. (CDFW).



Figure 9: Pool 66164, looking north. Five golden trout were removed in October 2012, two golden trout were removed in 2013, and three golden trout were removed in 2014. No golden trout were captured here in 2015 or 2016. One adult and four large SNYLF larvae were seen in this pond on 7/27/2016. (CDFW)



Figure 10: Pool 66165, as viewed from the south. One golden trout was removed from this pool in October 2012. No golden trout were captured here during subsequent gill-netting efforts in 2013 and 2014. One SNYLF larvae was seen in this pool on 7/27/2016. (CDFW)

#### **LITERATURE CITED**

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