

State of California
Department of Fish and Wildlife
Memorandum

Date: 6 June 2023

To: Leslie Alber, Senior Environmental Scientist;
Sierra District Supervisor;
North Central Region Fisheries

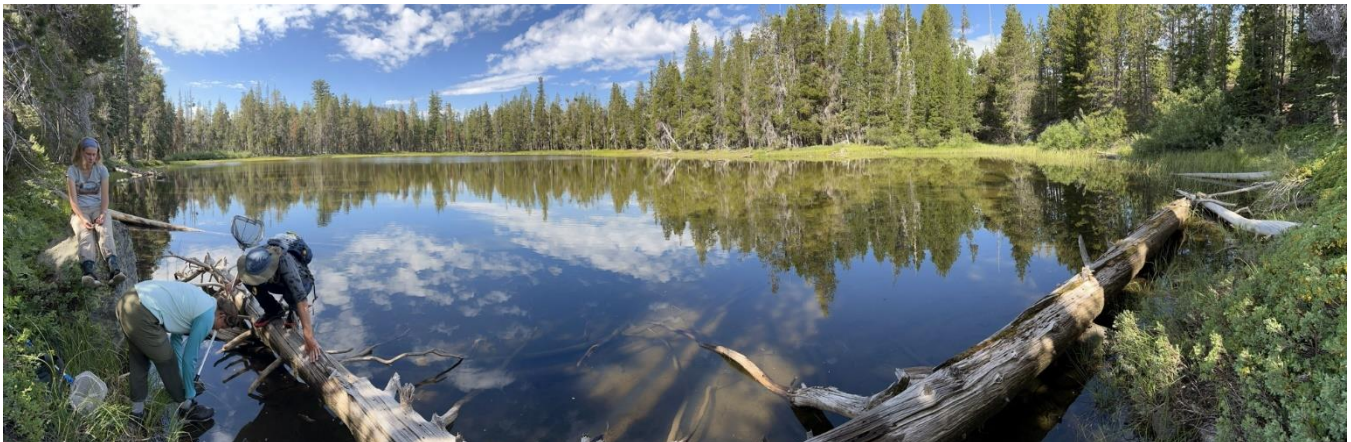
From: Isaac Chellman, Environmental Scientist;
High Mountain Lakes;
North Central Region Fisheries

Cc: Region 2 Fish Files

Ec: CDFW Document Library

Subject: Native amphibian monitoring in Sierra County

- ***Rana sierrae* surveys along the Gold Lake Highway corridor**



ENVIRONMENTAL SETTING

The Goose Lake area is located in northern Sierra County, adjacent to the Gold Lake Highway and east of the Pacific Crest Trail (**Figure 1**). Elevations in the area range from 6,400 feet (ft) (1,951 meters [m]) in elevation at Gold Lake reservoir, to 7,500 ft (2,286 m) at an unnamed summit two kilometers (km) west of the reservoir. Most land in the Goose Lake area is managed by Plumas National Forest (PNF), but the southeast section of the lake basin (including Snag Lake and several unnamed ponds) is managed by Tahoe National Forest (TNF; **Figure 2**). During visual encounter surveys (VES) in 2001, California Department of Fish and Wildlife (CDFW) crews observed Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) at four ponds in the area. Monitoring surveys conducted in the intervening years have suggested a small, but persisting, SNYLF population.

Howard Pond is also located in northern Sierra County, approximately 6 km east of Gold Lake reservoir and 3.5 km east of the Gold Lake Highway (**Figure 1**). Local elevations range from 7,004 ft (2,197 m) at nearby Howard Creek Meadow, to 8,107 ft (2,471 m) at the summit of Haskell Peak, 2.5 km to the southeast. Most land around Howard Pond is managed by the TNF. However, a portion of the surrounding land, including the western edge of Howard Pond, is owned by Graeagle Land and Water Company (**Figure 3**).

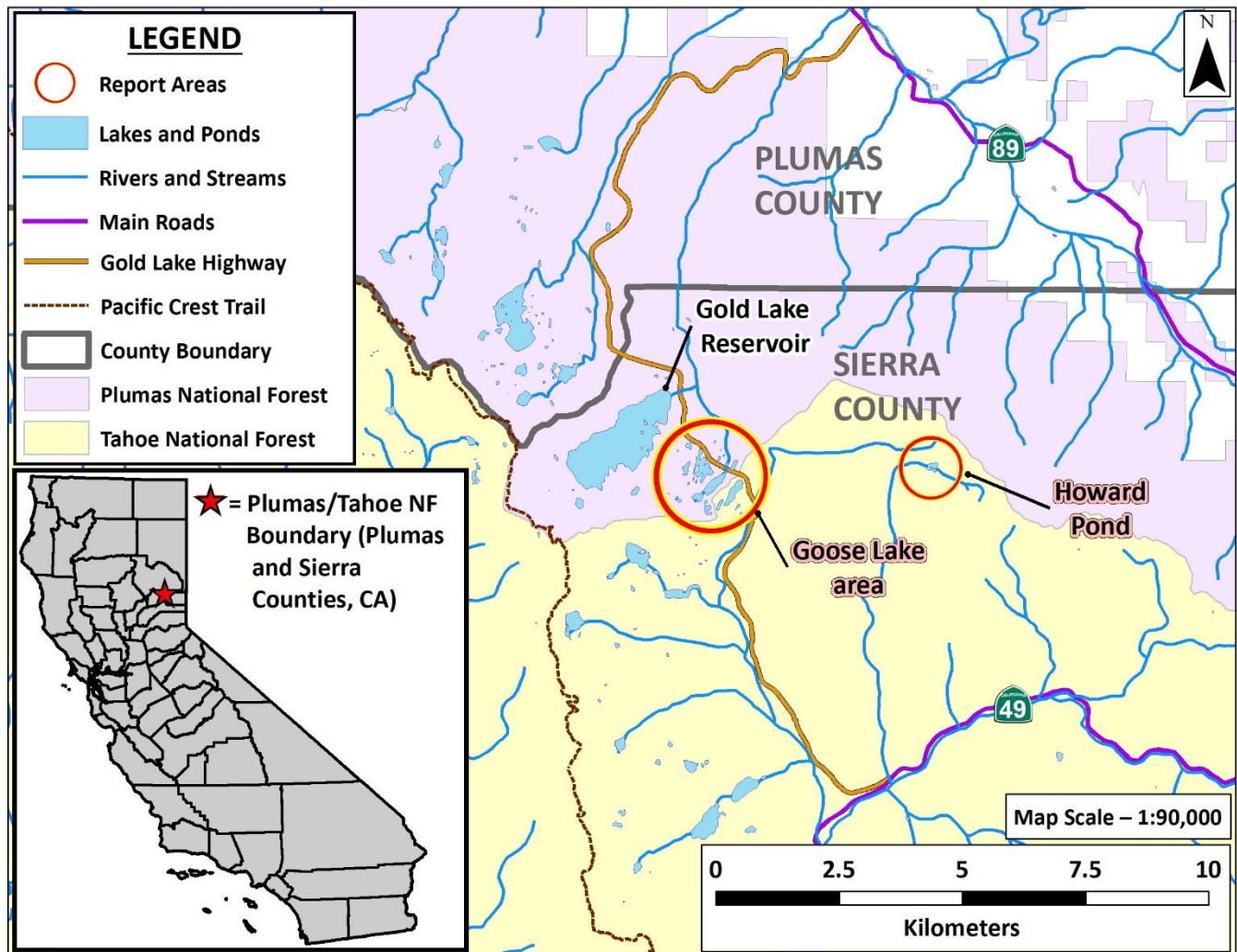


Figure 1. Gold Lake Highway area, Sierra County, CA. Plumas National Forest is shown in light purple and Tahoe National Forest is shown in light yellow. Gold Lake Highway is displayed in orange.

INTRODUCTION

CDFW monitors the Goose Lake area because it contains one of the few known extant SNYLF populations remaining in Sierra County. In 2001, CDFW conducted baseline VES, during which crews observed adult and subadult SNYLF at Site ID 50122, subadult SNYLF at Goose Lake (Site ID 12273), and adult SNYLF at Haven Lake (Site ID 12291) and Site 50123. On 16 and 17 August 2022, CDFW and PNF crews conducted collaborative SNYLF capture-mark-recapture surveys (CMR; see the [SNYLF CAPTURE MARK RECAPTURE](#) section below for details) at five waterbodies, including Goose Lake and the surrounding ponds (Figure 2). Additionally, PNF staff surveyed many other ponds during additional site visits in 2022.

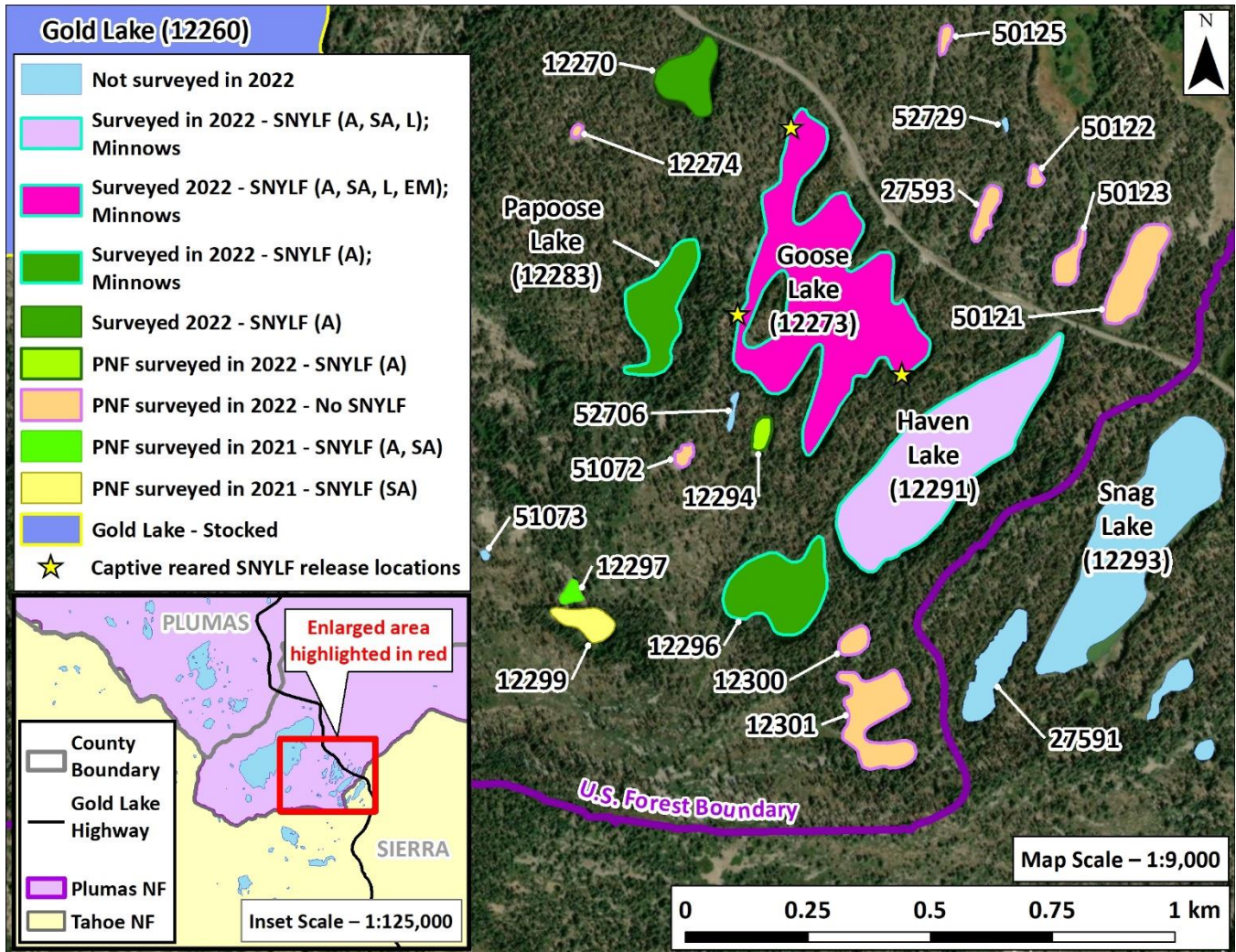


Figure 2: Goose Lake area ponds in Plumas and Tahoe National Forests (PNF and TNF), Sierra County, CA. The purple boundary line demarcates PNF (to the west and north) and TNF (to the east and south). Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations occurred during surveys in 2021 and 2022. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults, “SA” = subadults, “L” = larvae, and “EM” = egg masses. Goose Lake is a consistent breeding site for SNYLF. Minnows are present in most of the larger ponds in the area. CDFW regularly stocks Gold Lake reservoir with trout. Numbers are CDFW Site IDs.

CDFW is also interested in Howard Pond because it contains one of the few known extant SNYLF populations remaining in Sierra County. Historically, Howard Pond was surveyed by TNF field staff (USFS 2016). However, beginning in 2019, CDFW has assisted TNF in surveying the site. In 2022, CDFW and TNF began SNYLF CMR at Howard Pond (see the [SNYLF CAPTURE MARK RECAPTURE](#) section below for details). On 18 August 2022, CDFW and TNF staff surveyed the main body of the pond, but staff did not survey any of the ephemeral inlets. During surveys, CDFW staff only surveyed public lands owned by TNF.

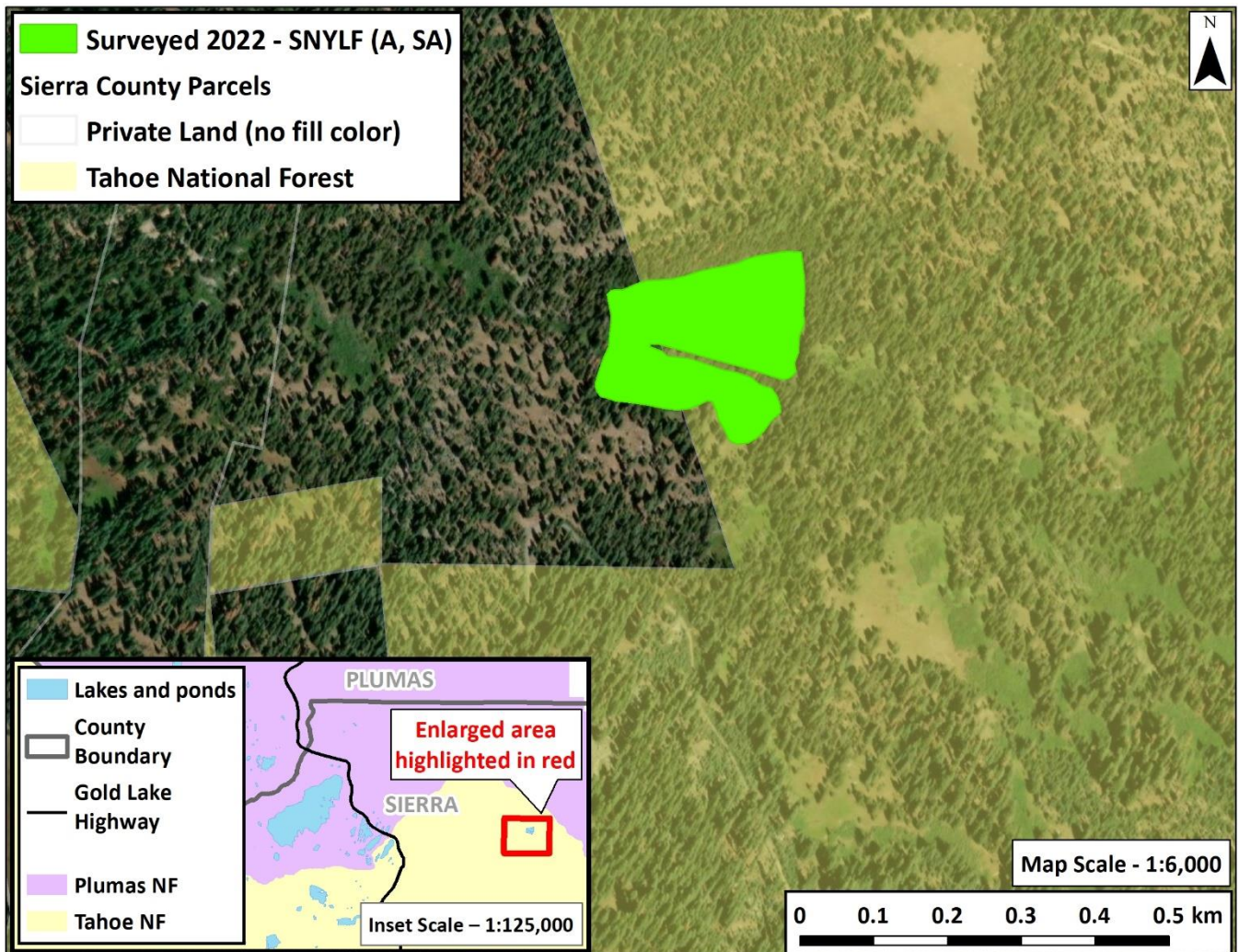


Figure 3. Howard Pond, Tahoe National Forest (TNF), Sierra County, CA. Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observations occurred during California Department of Fish and Wildlife (CDFW) capture-mark-recapture (CMR) surveys in 2022. SNYLF letter codes in the legend, which indicate the life stages observed during the most recent survey, are as follows: “A” = adults and “SA” = subadults. Land shaded in yellow is owned by TNF and land without shading is privately owned. The parcel situated on the western side of Howard Pond is owned by Graeagle Land and Water Company. CDFW only surveyed areas owned by TNF.

THREATS

Marginal Habitats

The Goose Lake area and Howard Pond SNYLF populations are relatively small and isolated. Most ponds, including those occupied by SNYLF, have a maximum depth of 4 m or less. Water levels at Howard Pond will occasionally drop to the point where less than half of full pool surface water remains (e.g., Google Earth aerial imagery from August 2012). The exception is Haven Lake, which has a maximum depth of 6 m. However, Haven Lake formerly contained Brook Trout (*Salvelinus fontinalis*; BK), which may still be present. Any disturbance, natural or otherwise, that threatens overwintering habitats presents a potential extirpation risk for SNYLF. Among the habitat risks are human disturbance, exposure to severe winter conditions, and desiccation from drought conditions, any of which threaten these SNYLF populations.

Introduced Fish

Golden Shiner (*Notemigonus crysoleucas*), Lahontan Redside (*Richardsonius egregius*), and Speckled Dace (*Rhinichthys osculus*) are present at most ponds in the Goose Lake area. These minnow species may compete with, or directly harm, smaller life stages of SNYLF (e.g., eggs and larvae). However, little information is available regarding effects of minnows on SNYLF (for more in-depth discussion of potential interactions between early life stage SNYLF and minnows, please refer to the discussion section of the [previous memorandum](#) (CDFW 2021a).

Brook Trout may also be present in Haven Lake: BK were last captured in the lake during an overnight gill net set in 2001. In 2020, CDFW staff again set a gill net overnight in Haven Lake and did not capture any BK. This suggests that BK have likely died out in the absence of stocking, but is not conclusive evidence that BK are entirely absent from the lake. Nearby Snag Lake contains self-sustaining Brown Bullhead (*Ameiurus nebulosus*), and possibly BK and Rainbow Trout (*Oncorhynchus mykiss*; RT). CDFW stocked Snag Lake with BK until 2000 and RT until 2017. The persistent fish populations in Snag Lake may preclude any SNYLF reproduction and reduce the likelihood of post-metamorphic frog occupancy (Knapp and Matthews 2000). CDFW regularly stocks the largest lake in the area, Gold Lake, with RT and Brown Trout (*Salmo trutta*). As of spring 2023, CDFW most recently stocked BK into Gold Lake reservoir in 2019. Angler survey data reveal that Gold Lake reservoir also contains self-sustaining populations of Lake Trout (*Salvelinus namaycush*; CDFW 2021b).

Disease

All SNYLF populations in Sierra County are chytrid fungus (*Batrachochytrium dendrobatidis*; *Bd*) positive. In 2008, 2010, and 2020 field crews genetically sampled SNYLF collected at Goose Lake with epithelial swabs and screened them for the presence of *Bd* DNA using real-time quantitative polymerase chain reaction (qPCR). Crews collected two swabs in 2008, four swabs in 2010, and one swab in 2020. Results for the three years were highly variable: *Bd* zoospore loads were zero in some samples, light in most, and one was heavy. Additionally, at Goose Lake, CDFW staff observed three dead SNYLF during surveys in 2017, four dead SNYLF adults

during surveys in 2019, and one dead SNYLF subadult during surveys in 2020. The cause of death cannot be determined, but these observations may suggest that there is consistent, low-level *Bd*-induced mortality in this population. However, other causes may also be contributing to the consistent low abundance observed in this SNYLF population, including overwinter mortality in 2016–2017 and 2018–2019 (during both of which there were high precipitation totals and late season snowpack) and the other factors discussed in this THREATS section.

Loss of Genetic Diversity

The Goose Lake area and Howard Pond SNYLF populations are highly isolated from the nearest robust SNYLF populations. Outside of the Gold Lake Highway corridor, the closest known extant SNYLF population is located about 30 km southeast, in the Independence Creek area. The closest large SNYLF metapopulation is over 35 km away in Nevada County. This geographic isolation effectively eliminates gene flow between populations and increases risk for local extirpation. Isolated populations can also suffer from inbreeding depression, genetic drift, fixation of deleterious alleles, and loss of genetic diversity, all of which are population genetic factors exacerbated when the population is small (Frankham et al. 2009).

SNYLF POPULATION SUPPLEMENTATION

In recent years, CDFW and PNF staff have observed isolated locations in Goose Lake (Site ID 12273) with relatively large numbers of SNYLF egg masses (2019–2022 range is 21 to 94 egg masses). These detections were in stark contrast to post-metamorphic frog detections, which have historically been highly limited in the Goose Lake area (2001–2017 range of observed adults was 0 to 10). However, habitat composition in the area results in challenging survey conditions, particularly in late spring and early summer, when SNYLF breeding typically occurs. During that time of year, water levels in the local lakes and ponds are often high, causing the water levels to fall within dense, shrubby shoreline vegetation. In part due to these challenging survey conditions, staff often detect few adult SNYLF. However, during more consistent surveys of the Goose Lake area from 2019–2022, PNF and CDFW staff have detected comparatively large numbers of SNYLF egg masses (**Figure 4**). These results demonstrate that more SNYLF are present in the area than staff detect through standard visual encounter surveys. These more recent egg mass detections were part of the catalyst for initiating CMR ([see below](#)), which will provide the opportunity to gain a better understanding of SNYLF abundance, growth, movement, and other population demographic factors. Additionally, detecting multiple SNYLF egg masses has provided an opportunity to collaborate with partner scientists at the San Francisco (SF) Zoo to collect portions of egg masses for captive rearing (a.k.a., “headstarting”) SNYLF. These population supplementation efforts are one of the techniques recommended in the Interagency Conservation Strategy for Mountain Yellow-legged Frogs in the Sierra Nevada (hereafter “Strategy”; MYLF ITT 2018). The Strategy highlights captive rearing as one of the primary actions to restore SNYLF populations (MYLF ITT 2018, pgs. 17–19).



Figure 4. A cluster of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) egg masses at Goose Lake on 19 May 2021. (CDFW)

On 19 May 2021, staff from PNF Beckwourth Ranger District and CDFW collaborated on an effort to collect portions of SNYLF egg masses observed in Goose Lake (**Figure 4**). Staff collected approximately 20 eggs from each of 10 different egg masses, for a total of approximately 200 SNYLF eggs (**Figure 5**). Staff collected, housed, and transported eggs using methods similar to those recommended by Grasso (2017). In brief, staff housed the SNYLF eggs and water collected from the site in food grade containers modified to accommodate portable aerators (**Figure 6**). Staff securely stored these containers within a cooler packed with insulation and ice. CDFW staff then drove for approximately five hours to deliver the eggs to the SF Zoo. Once at the SF Zoo, staff placed the eggs within prepared aquaria used for captive rearing (**Figures 7 and 8**). From the original cohort of approximately 200 SNYLF eggs, SF Zoo staff raised a total of 164 SNYLF through metamorphosis. Once large enough (~40 mm snout-to-urostyle length [SUL]), SF Zoo staff inserted a passive integrated transponder (PIT) tag beneath the dorsal skin of each frog. PIT tags are an 8 x 1.4 mm, glass-coated chip that biologists insert under the frog's dorsal skin (using methods recommended by McAllister et al. 2004) that can be scanned by a handheld PIT tag reader, which displays a unique identifying code for each PIT tag. Therefore, all PIT-tagged frogs can be individually identified through CMR techniques (Williams et al. 2001).



Figure 5. Staff from the Plumas National Forest Beckwourth Ranger District collecting Sierra Nevada Yellow-legged Frog (*Rana sierrae*) eggs at Goose Lake on 19 May 2021. (CDFW)



Figure 6. A subset of Sierra Nevada Yellow-legged Frog (*Rana sierrae*) eggs, collected from Goose Lake on 19 May 2021, housed within a food grade plastic transport container filled with water collected from the natal site. (CDFW)



Figure 7. Staff from the San Francisco Zoo gently placing Sierra Nevada Yellow-legged Frog (*Rana sierrae*) eggs collected from Goose Lake into early life stage rearing aquaria on 19 May 2021. (CDFW)

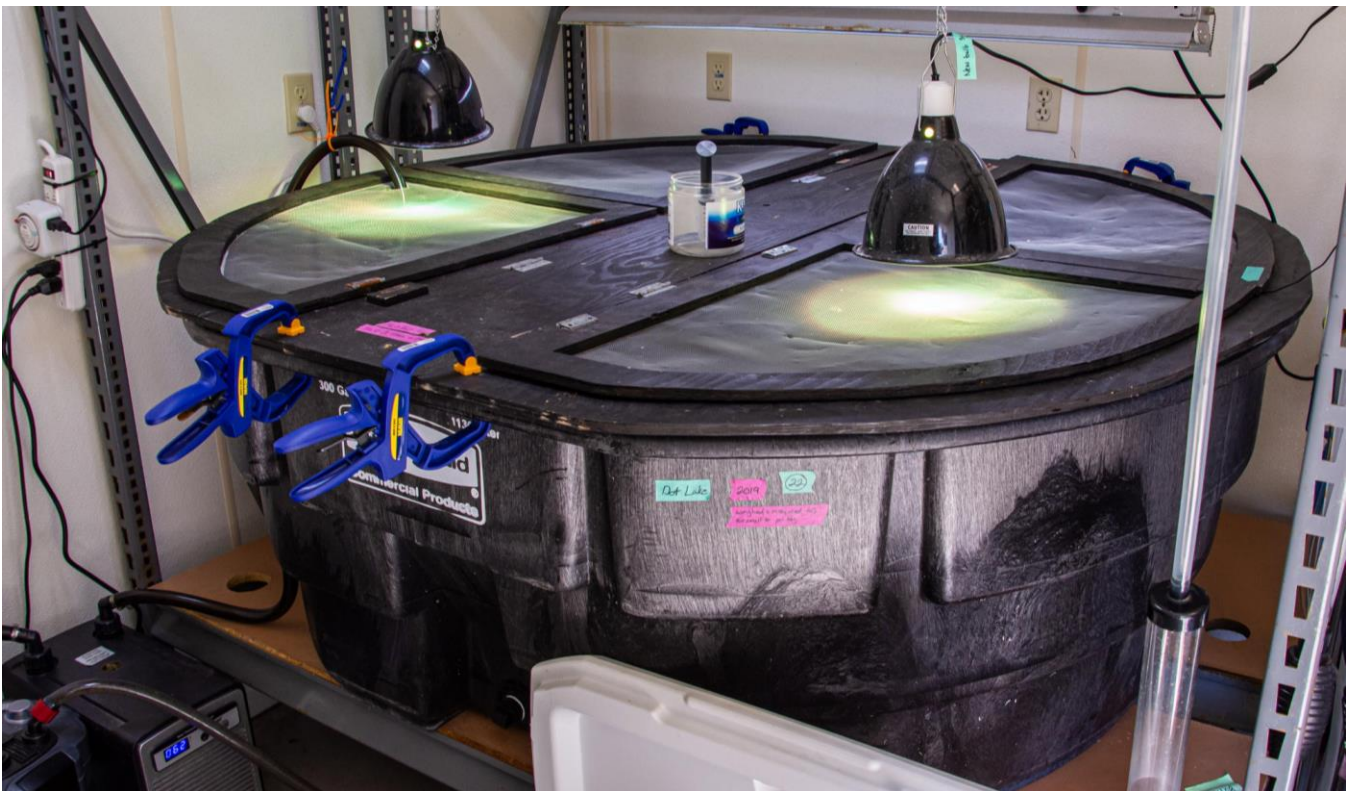


Figure 8. A 300-gallon stock tank modified to house post-metamorphic Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) at the San Francisco Zoo. (CDFW)

On 13 June 2022, CDFW staff collected all 164 metamorphosed SNYLF from SF Zoo staff and drove to Goose Lake to release the frogs back to their natal habitat. Once arriving at the site, CDFW met up with PNF staff from the Beckwourth and Mt. Hough Ranger Districts (**Figure 9**). CDFW and PNF staff divided up the SNYLF into three groups, composed of 1) 22 females, 30 males, and eight of unknown sex (i.e., metamorphosed frogs still too young to confidently determine sex); 2) 23 females and 29 males; and 3) 23 females and 29 males (**Figure 10**). Staff released these three groups of frogs into three separate areas of Goose Lake (**Figure 2**).



Figure 9. The team of biologists from Plumas National Forest (Beckwourth and Mt. Hough Ranger Districts) and California Department of Fish and Wildlife who collaborated to release captive-reared Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) back into Goose Lake on 13 June 2022. (CDFW)



Figure 10. Plumas National Forest staff organizing containers housing captive-reared Sierra Nevada Yellow-legged Frogs (*Rana sierrae*) soon before releasing the frogs back into Goose Lake on 13 June 2022. (CDFW)

VES IN THE GOOSE LAKE AREA

CDFW performed baseline VES in the Goose Lake area in 2001, during which staff encountered a small breeding SNYLF population occupying four ponds. Twenty-two years of occasional monitoring data suggest the Goose Lake area SNYLF population is currently stable (**Figure 11**), despite being relatively small when compared with populations in the core of the species range (i.e., in the central Sierra Nevada; Knapp et al. 2016). The primary location of interest for SNYLF conservation is Goose Lake (**Figure 12**), in which CDFW and PNF personnel have occasionally observed egg masses (**Figure 4**). Detections remained relatively consistent, albeit low, between 2001 and 2020 (**Figure 11**). However, observer bias, variation in survey effort, weather conditions, habitat complexity, and the low number of detections all make deriving trends difficult. For example, in 2019, CDFW surveyed 17 ponds in the Goose Lake area, compared to only three ponds in 2017.

In 2020, CDFW staff detected SNYLF (a single subadult) in Snag Lake (Site ID 12293) for the first time. All egg masses observed in Goose Lake in 2020 were either the remnants of hatched out eggs or non-viable egg masses that had not fully developed. When compared with the year before—during which CDFW observed far more SNYLF egg masses than staff had observed during previous years—2020 was warmer and drier, following a winter with below average snowpack. Due to these conditions, SNYLF bred earlier in 2020 than 2019, and CDFW surveys missed the primary window during which fresh egg masses would have been available for detection.

In 2021, CDFW staff did not visit the Goose Lake area for surveys. However, PNF staff visited the area for surveys, which also included the commencement of SNYLF PIT-tagging and CMR ([discussed in more detail below](#)). The initiation of PIT-tagging in 2021 (which allows biologists to uniquely identify every marked adult) and more concerted survey effort resulted in a large increase in the total number of adult individuals detected (**Figure 4**). In 2022, CDFW and PNF staff continued more consistent SNYLF survey work than during years past. This increase in effort was for two primary reasons: 1) undertaking consistent monitoring of the SF Zoo-reared frogs and 2) continuing monitoring and CMR of the wild frog population. PNF Beckwourth Ranger District staff conducted most surveys in 2022. However, CDFW staff joined PNF staff in August 2022 for a two-day survey effort of the area, which was highly successful in recapturing many SF Zoo-reared and wild SNYLF, plus additional tagging of newly captured individuals.

CDFW and PNF plan to continue surveying the Goose Lake area to monitor SNYLF population trends over time. CDFW plans to next survey the Goose Lake area in 2023.

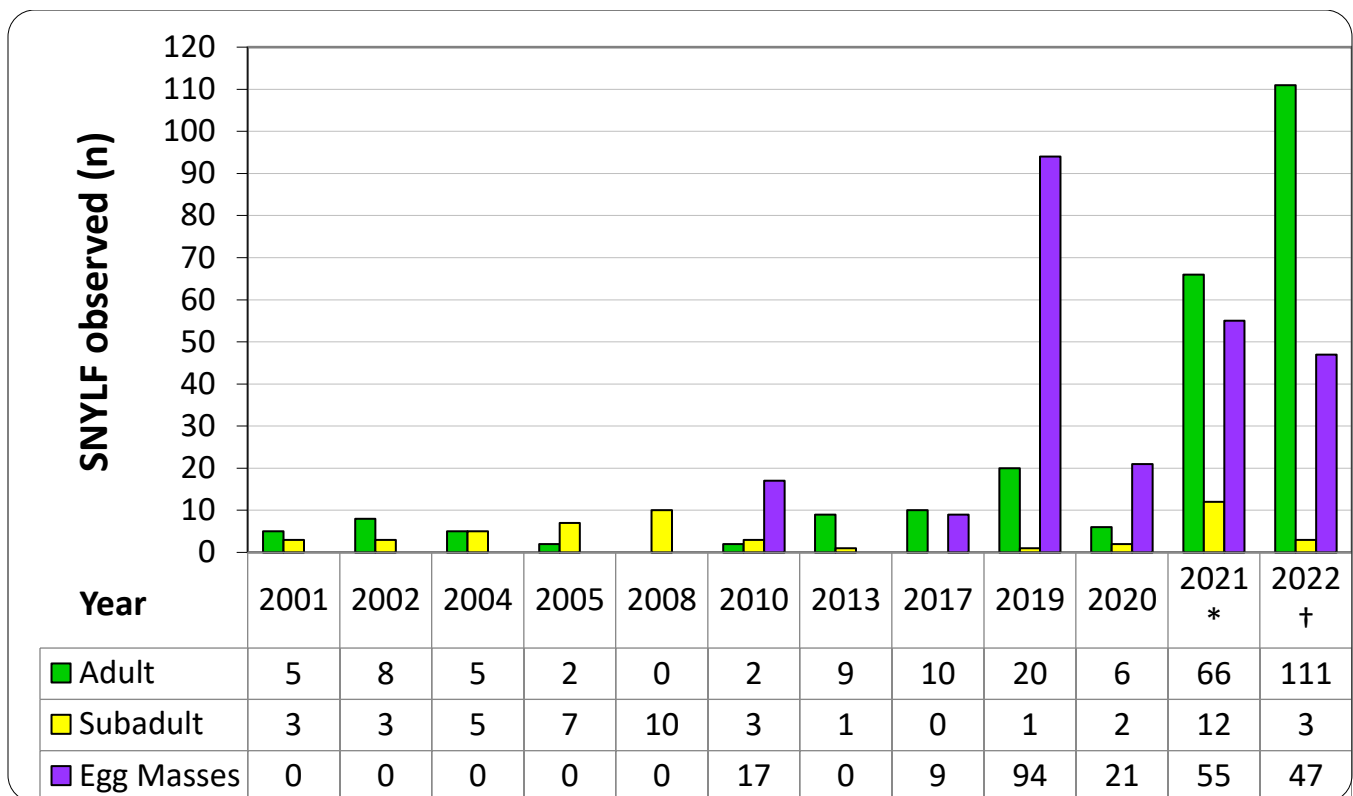


Figure 11: Counts of Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) detected during surveys of Goose Lake area from 2001 through 2022. Goose Lake (Site ID 12273) is the only waterbody in which California Department of Fish and Wildlife (CDFW) and Plumas National Forest (PNF) staff have observed SNYLF egg masses and the only waterbody surveyed during every visit to the area. Survey effort, as measured by the number of sites surveyed in the Goose Lake area each season, varied over time.

*Data from 2021 are exclusively from PNF surveys. During summer 2021, PNF staff from the Beckwourth and Mt. Hough Ranger Districts began PIT-tagging SNYLF to obtain more precise data on abundance, growth, and movement of frogs in the Goose Lake area. Therefore, the 2021 count of adults in this histogram is based on the number of PIT-tagged frogs tagged in 2021. PIT-tagging allowed the identification of unique individuals captured between multiple survey periods in May, June, August, and September 2021. Additionally, on 19 May 2021, PNF and CDFW staff collected approximately 200 eggs from among 10 different egg masses located in Goose Lake for captive rearing at the San Francisco (SF) Zoo. CDFW staff transported the eggs to the SF Zoo, where the eggs were raised through metamorphosis.

†On 13 June 2022, CDFW and PNF staff released 164 SF Zoo-reared adult and subadult SNYLF (originally collected as eggs in May 2021) back into Goose Lake. The 2022 count of adults in this histogram includes PIT-tagged wild individuals and recaptured captive-reared individuals (i.e., the total only includes unique PIT-tagged adults born in the wild or SF Zoo-reared frogs captured at least once during follow-up surveys undertaken by staff after the 13 June 2022 release day). In 2022, CDFW and PNF staff observed 62 unique wild frogs and recaptured 49 unique SF Zoo-reared frogs during multiple site visits from May through September.

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Figure 12: Goose Lake (Site ID 12273), looking south from the northern shore, on 10 June 2020. (CDFW)

SNYLF CAPTURE-MARK-RECAPTURE

In 2021, Plumas National Forest personnel from the Beckwourth and Mt. Hough Ranger Districts began PIT-tagging adult SNYLF in the Goose Lake area for CMR. In 2022, CDFW staff began assisting with PIT-tagging effort in the basin, as part of a State Wildlife Grant for long term SNYLF monitoring (federal grant # F22AF01541). As part of this work, CDFW and PNF seek to PIT tag all newly captured (untagged) adults in the Goose Lake area. Data summarized here include collaborative work between CDFW and PNF, plus independent surveys by PNF staff. PIT-tagging allows CDFW and PNF to more accurately keep track of SNYLF population demographics through time by using CMR analyses. Additionally, PIT-tagging allows biologists to learn more about the potential benefits of the recent SNYLF headstarting work, [discussed in the SNYLF POPULATION SUPPLEMENTATION section](#).

A brief summary of PIT-tagging effort by PNF and CDFW in 2021 to 2022 is below (**Table 1**).

Overall, among the SNYLF that have been marked and released since 2021, recapture rates have been relatively high. During summer and early fall 2022, CDFW and PNF staff recaptured 49 of the 164 SF Zoo-reared frogs at least once (i.e., staff recaptured 30% of SF Zoo-reared frogs during follow-up surveys later in the same summer and fall of the year staff released frogs). Recapture rates have also been better than expected among wild frogs (when compared with some other areas, such as SNYLF populations in Bucks Lake Wilderness; CDFW 2023). In total, CDFW and PNF staff have marked and released 102 wild frogs in the Goose Lake area. Of those 102 frogs, staff have recaptured 49 individuals at least once during follow-up surveys (staff have recaptured 48% of PIT tagged wild frogs). Breaking down the wild frog captures further: of 66 wild frogs tagged by PNF staff in 2021, PNF recaptured 14 (21% of the PIT tagged wild frogs) during that same summer. In 2022, CDFW and PNF staff recaptured 26 of the 66 wild SNYLF originally PIT tagged in 2021 (i.e., in 2022, staff recaptured 40% of wild frogs tagged the previous year). Finally, of the 36 wild frogs tagged by CDFW and PNF staff in 2022, staff recaptured nine during subsequent surveys (i.e., of all wild frogs originally PIT tagged in 2022, staff recaptured 25% later that same summer).

Continued CMR work will improve CDFW’s understanding of abundance and survival among the captive-reared and wild-caught SNYLF in the Goose Lake area. This work will also provide useful information on movement, growth, and longevity of SNYLF in this important northern Sierra Nevada population. Therefore, CDFW and PNF staff plan to continue this work annually.

Table 1. Summary of released and wild caught Sierra Nevada Yellow-legged Frogs (*Rana sierrae*; SNYLF) PIT-tagged in the Goose Lake area in 2021 and 2022. Data are divided into SNYLF captive-reared at the San Francisco Zoo (Zoo Frogs), and wild caught SNYLF (Wild Frogs). The “# Same summer recaps” tallies include the total number of SNYLF individuals, of those individuals that were released (zoo frogs) or newly tagged (wild frogs) in the given year, that were recaptured during the same summer. The remaining column of data shows the number of recaptured SNYLF individuals that were originally marked in a previous year. Therefore, individuals from the last column 1) survived winter 2021–2022, 2) were available for detection during survey periods in 2022, and 3) were detected by observers.

**Note: the number contained in each cell is the number of unique SNYLF individuals within each category, not the number of capture events within that category (i.e., some frogs were recaptured more than once in the same summer, but those repeat recapture events are excluded from this table).*

ZOO FROGS	Released in Goose Lake	# Same summer recaps – Goose Lake area	# Recaps released in a previous year – Goose Lake area
2022	164	49	N/A
WILD FROGS	Newly tagged – Goose Lake area	# Same summer recaps – Goose Lake area	# Recaps tagged in a previous year – Goose Lake area
‡2021	66	14	N/A
2022	36	9	26

‡Although CDFW staff assisted with collection and transport of SNYLF eggs for captive rearing at the San Francisco Zoo, staff from Plumas National Forest conducted all subsequent amphibian surveys in 2021.

VES AND CMR AT HOWARD POND

Biologists from TNF have been monitoring the SNYLF population at Howard Pond (**Figure 13**) and its tributaries since 2001. Depending on the survey, TNF biologists observed up to 15 SNYLF adults and nearly 100 larvae. Therefore, available records suggest a small, yet stable, breeding SNYLF population (TNF, unpubl. data).



Figure 13. Howard Pond (Site ID 12285) on 11 June 2020.

On 2 July 2019, CDFW staff observed seven adult SNYLF, three larvae, and 30 egg masses. On 11 June 2020, CDFW staff observed four adult SNYLF (**Figure 14**), five metamorphs, eight larvae, and 34 egg masses (**Figure 15**). On 31 August 2021, CDFW and TNF observed three adult SNYLF, two subadults, and no early SNYLF life stages. The lack of egg mass observations was expected, given the timing of surveys, which occurred well after the SNYLF breeding season during a dry water year. The number of SNYLF adults and larvae CDFW staff observed from 2019 to 2021 was consistent with observations by TNF in earlier years, which suggests that the Howard Pond SNYLF population may be stable.

In 2019 and 2020, CDFW observed SNYLF egg masses in the same location and the number of egg masses was very similar during both surveys. The egg mass counts were an approximation because many of the egg masses were located underneath cover, where they could only be detected by touch and not observed directly. However, staff found it effective to use tactile sensation to gently estimate the number of egg masses located under cover.

In 2022, CDFW and TNF staff visited the Howard Pond area for surveys on 18 August. During the survey, staff began PIT-tagging adult frogs to better understand SNYLF population demographic trends in the Howard Pond area. CDFW and TNF used the same methods described above in the [SNYLF CAPTURE-MARK-RECAPTURE](#) section of the Goose Lake area. In total, staff detected and PIT-tagged 14 adult SNYLF. Additionally, staff observed 14 subadult SNYLF and 18 larvae. CMR work will improve CDFW and TNF's understanding of abundance and survival among SNYLF in the Howard Pond area. This work will also provide useful information on movement, growth, and longevity of SNYLF in this important northern Sierra Nevada population. Therefore, CDFW and TNF staff plan to continue this work annually.



Figure 14. An adult male Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) observed at Howard Pond on 11 June 2020. CDFW staff observed several adult male SNYLF in the same small area, close to recently laid SNYLF egg masses. (CDFW)



Figure 15. A dense cluster of recently laid Sierra Nevada Yellow-legged Frog (*Rana sierrae*; SNYLF) egg masses CDFW staff observed at Howard Pond on 11 June 2020. During the survey, CDFW staff observed all SNYLF egg masses in the same location. CDFW staff also observed several adult male SNYLF and larval SNYLF in the same area. (CDFW)

DISCUSSION

SNYLF mortalities at Goose Lake

Occasional observations of dead SNYLF adults at Goose Lake are disconcerting, but not unusual. CDFW staff have observed low numbers of SNYLF mortalities during multiple seasons in other locations (e.g., Dot Lake in Bucks Lake Wilderness; CDFW 2023). The causes of death may be the result of many possible factors, including disease (Briggs et al. 2010, Smith et al. 2017), environmental conditions (Bradford 1983, CDFW 2023), attempted predation (Feldman and Wilkinson 2000), or breeding competition (i.e., drownings during amplexus caused by overzealous males; Sztatecsny et al. 2006). Mortalities in SNYLF are often attributed to *Bd*, which has been present in this location since at least 2008 (see [Disease](#) section above).

Plans for 2023 and beyond

CDFW, in close partnership with the U.S. Forest Service (USFS), will continue monitoring the Goose Lake and Howard Pond area SNYLF populations every year to assess population statuses (i.e., determine relative abundance, look for signs of continued breeding and recruitment, and assess distribution of SNYLF on the landscape). CDFW and USFS will also continue PIT-tagging adult SNYLF to obtain more meaningful abundance and survival data on wild and SF Zoo-reared frogs.

Additionally, CDFW may work with local zoo and university partners to develop a research project (e.g., a graduate research assistantship) on the interactions between cyprinids and SNYLF, especially early life stages, such as eggs and recently hatched larvae. The interactions of large predatory fish (e.g., trout) and SNYLF are well-studied, but there is much less currently known about the interactions of smaller forage fish and Sierra Nevada amphibians, especially studies investigating potential sublethal effects on frog populations (e.g., limited breeding success, reduced size at metamorphosis, limb damage).

CDFW may also work with PNF and zoo partners to collect additional early life stage SNYLF for future captive rearing efforts in the Goose Lake area. Success of captive rearing efforts may be determined in several ways, including staff observing, 1) released adult SNYLF persisting after overwintering, 2) additional signs of breeding (higher counts of egg masses, tadpoles, and/or recently metamorphosed frogs), and 3) evidence of new recruitment into the adult population. Augmenting these populations through captive rearing will help increase the odds of long-term SNYLF persistence in the Gold Lake Highway corridor.

Finally, if monitoring and CMR suggest a stable or increasing SNYLF population in the Goose Lake area, CDFW will consider using this population as a source for SNYLF reintroductions (including captive rearing of early life stages, followed by release into another location; or direct translocations, if enough adult frogs are detected) within SNYLF critical habitat on public lands in the northern Sierra Nevada. These conservation actions are a critical tool for assisting with species recovery, and highlighted in the Strategy (MYLF ITT 2018, pgs. 15–18).

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