Sierra Nevada Yellow-Legged Frog Habitat Restoration Project In The Desolation Wilderness
2011 Annual Report
USFS Lake Tahoe Basin Management Unit

Mason Bindl and Chris Lemmers checking gill nets in Tamarack Lake, summer 2011.

Non-native Brook Trout

Sierra Nevada Yellow Legged Frog

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Summary

Non-native salmonids have been adversely affecting native amphibians in the Desolation Willderness, specifically Sierra Nevada yellow-legged frogs (Rana sierra). Since 2008 the LTBMU has been working to restore a portion of the Sierra Nevada Yellow-legged frogs habitat to a 'fishless' state. In 2011 the LTBMU Aquatics Crew removed non-native salmonids from seven lakes in Desolation Wilderness. Throughout the season the crews used gill nets to remove a total of 76 fish. Of the seven lakes, six have been rendered ~99% fishless, while Lake Lucille has been cleared of ~95% of its' original fish. The one fish observed in Lake Le Conte since 2008 was caught in November of this year. Amphibian Visual Encounter Surveys in 2011 detected 1 Sierra Nevada yellow-legged frog in the project area.

1. Introduction

Sierra Nevada (mountain) yellow-legged frog (*Rana sierrae*; SNYLF) is a candidate species for listing under the Endangered Species Act (ESA). On June 24, 2007, the US Fish and Wildlife Service (FWS) published a 12-month finding on a petition to list the Sierra Nevada distinct population segment of the SNYLF (Federal Register Vol. 72, No. 121). In its finding, the FWS determined that SNYLF was warranted for listing, but precluded due to higher priority species listing determinations for other candidate species. The Sierra Nevada yellow-legged frog is listed as Sensitive on the Region 5 Regional Forester's Sensitive Species List (USDA Forest Service 1998). Decisions regarding the listing of *R. sierrae* in the Sierra Nevada under both the California and U.S. ESAs are expected by 2012 and 2013, respectively. Because SNYLF has been extirpated from over 90% of its historic range, there is a need to restore the species habitat and prevent its range-wide extinction. To date, range-wide conservation activities for SNYLF have been accomplished in a multi-agency format involving the FWS, National Park Service (NPS), US Forest Service

(USFS), CDFG and academic institutions such as the University of California, Berkeley and Sierra Nevada Aquatic Research Laboratory.

It is recognized that there are numerous factors leading to the rapid decline of this species including, but not limited to, non-native fish introduction (Kats and Ferrer, 2003), disease (Dasak et al. 2003), habitat loss (Dodd and Smith, 2003) ultraviolet (UV) radiation (Blaustein et al. 2003), climate change (Pounds et al. 1999) and pesticide use (Boone and Bridges, 2003). It is also recognized that synergisms between two or more of the above mentioned factors may be driving SNYLF declines (Blaustein and Kiesecker, 2002, Kiesecker, 2002, Ponds et al., 2006). (As found in Vredenburg et al 2007)

Historically, the high-elevation habitat occupied by SNYLF in the Desolation Wilderness was fishless. The wilderness encompasses approximately 25,900 hectares (64,000 acres) of montane and sub-alpine habitats ranging from 1,890 m elevation (6,200 feet) to the summit of Pyrimid Peak at 3,043 m (9,983). Approximately 500 lakes and ponds have been mapped within the wilderness boundary. First attempts at stocking fish in the Desolation Wilderness occurred in lakes and streams beginning in the late 1890s. The first intensive stocking effort to develop recreational fisheries began in 1925 when the Mount Ralston Fishing Club began stocking lakes with trout using pack animals. In 1950, the CDFG assumed this responsibility. All of the large, deep lakes within the wilderness have been stocked (USDA 1998). The most common fish species stocked in the lakes have been brook trout (*Salvelinus fontinalis*), followed by rainbow (*Oncorhynchus mykiss*) and golden trout (*Oncorhynchus aguabonita*).

SNYLFs have a long larval tadpole stage (2 -3 years) and a highly aquatic adult stage, making this species especially vulnerable to introduced aquatic predators (Bradford 1989, Bradford et al. 1993). The manual removal of non-native trout, a known predator, has been documented as having beneficial effects on yellow-legged frog population size and dispersal (Knapp et al. 2007, Bradford et al. 1993; Knapp 1996; Hecnar and M'Closkey 1997; and Knapp and Matthews 2000; Knapp et al.2006).

Seven lakes were selected for SNYLF Restoration due to their proximity to a source population of *R. sierra* in the Desolation Wilderness and therefore offered the greatest opportunity for population expansion by restoring habitat connectivity in this alpine ecosystem. Based on two years of pre-implementation monitoring in 2006 and 2007, it was presumed that Le Conte, Margery, and Jabu Lakes were already fishless as no fish were detected during those monitoring efforts. Additionally, pre-implementation monitoring suggested the remaining four lakes (Tamarack, Cagwin, Ralston, and Lucille) may not have self-sustaining fish populations due to very low numbers of young of year age class sampled. Therefore, it was estimated that Tamarack, Cagwin, Ralston, and Lucille would not support recreational fishing if future stocking efforts were ceased. During the 2006 and 2007 sampling efforts, brook and rainbow trout were the only species sampled. Golden trout were not sampled in any of the seven treatment lakes in 2006 and 2007 despite CDFG attempts to stock this species in Jabu Lake. The CDFG has identified all seven lakes as Native Species Restoration Lakes and do not plan to stock any of these lakes in the future (draft 2008 Desolation Fish Management Plan; section A1).

Implementation activities began in 2008 and continued through 2011. The recovery effort has returned all seven lakes to a ~99 percent fishless state. Project implementation has been funded by South Nevada Public Land Management Act (SNPLMA) funding through an inter-agency agreement with USFWS under project title “Mountain Yellow-Legged Frog Recovery Project A”. Round 12 SNPLMA Science and Research proposal will be submitted November 2011 to conduct a relocation study in two of the restored lakes on the LTBMU.

2. Methods

Working in cooperation with CDFG, the LTBMU crew performed removal of non-native salmonids using gill nets. The 2008 Field Protocol and Data Recording Instructions for Restoration of Sierra Nevada Yellow-legged Frogs in Desolation Wilderness were followed during implementation. The document was amended from protocols written by Dr. Roland A. Knapp of the Sierra Nevada Aquatic Research Laboratory.

Lightweight, monofilament gill nets made with six different size meshes (10, 12.5, 18.5, 25, 33, 38 mm) were used. Each panel is 6 m long and 1.8 m deep, making the nets a total of 64 square meters. These are sinking nets designed to maximize the capture of small fish, but will effectively capture fish of all sizes. In addition, we have a few gill nets of smaller size made with one mesh size panel (10 mm) that is 15 m long and 1.8 m deep. Nets were deployed, using float tubes, around the perimeter of each lake and pulled out towards the deepest areas. A minimum of two crew members were needed for each net set. One crew member would be on shore tying the top of the net to a land anchor while carefully watching the person in the float tube and recording the data. The float tuber would pull the net away from shore, allowing it to flake out into a straight line. Once the net was fully stretched, the person on the float tube would tie off the bottom of the net to a rock to anchor it on the bottom. Parachute cord was tied to the float line and a foam float was attached as a buoy. The net's smallest mesh size was anchored to shore, while the largest mesh size was anchored in deep water, targeting the size class that tends to inhabit each area of a lake. Nets were cleaned by starting at the shore end of the net. Nets were pulled up to the float tube for fish and debris to be removed as well as algae to be scrubbed off (cleaner nets are less visible to the fish). The net was then stretched tight and redeployed at a different angle so fish would not learn where the net was. Time and date was recorded after each cleaning. Additionally, as nets were cleaned, trout were measured (in increments of 0-5, 5-10, 10-20, 20-30, 30+ centimeters), identified if possible, recorded, and then sunk in the deepest portion of the lake. All field data was recorded in a Rite in the Rain® spiral notebook and then input into an Excel database.

Gillnets were deployed in Tamarack Lake, Ralston Lake, Cagwin Lake, Lake Margery, Lake Lucille, and an adjacent unnamed pond north of Lucille October 2010 and overwintered. Due to heavy spring precipitation and significant snowpack, nets were not removed until July 20-22, 2011 in the lower lakes and August 8-10, 2011 in the upper lakes. Nets were then repaired and redeployed in all lakes for the summer 2011 field season. The crew cleaned a total of 58 nets which had been deployed in the fall of 2010 to overwinter into 2011. An additional 39 nets were set, bringing the total to 97 nets set in all lakes for the summer of 2011. Of the additional nets, 15 were purchased by LTBMU, while 24 nets were supplied by CDFG. Beginning in October 2011 the crew began winterizing each of lakes net sets. A total of 94 nets were set for the winter 2011/2012. (Figure 5)

The fungus *Chytridiomycosis,* or (Bd) for short, has adversely affected amphibian populations within the LTBMU as well as worldwide. This year was the first season that crews collected swabs of individual amphibians to detect the presence of Bd. This was done in the Desolation Willderness project lakes in order to help determine the effectiveness of future translocations. The spread of Bd was also a concern, so to decontaminate equipment QUAT-128 (ammonium compound/hospital grade disinfectant) at a concentration of 1:1000 was used, after carefully removing as much contaminated soil as possible. While the solution concentration is low, and the disinfectant does degrade in the environment, crews still attempted to minimize the use of decontaminate in the wilderness. Additionally, float tubes and fins were then cached for exclusive use at each complex, eliminating the need to decontaminate large gear every week. Large waterproof bags were used as containers to mix disinfectant and decontaminate gear. Water was collected from the nearest water body and moved away from said water body for decontamination. Once gear was decontaminated the solution was poured onto rocks to dissociate.

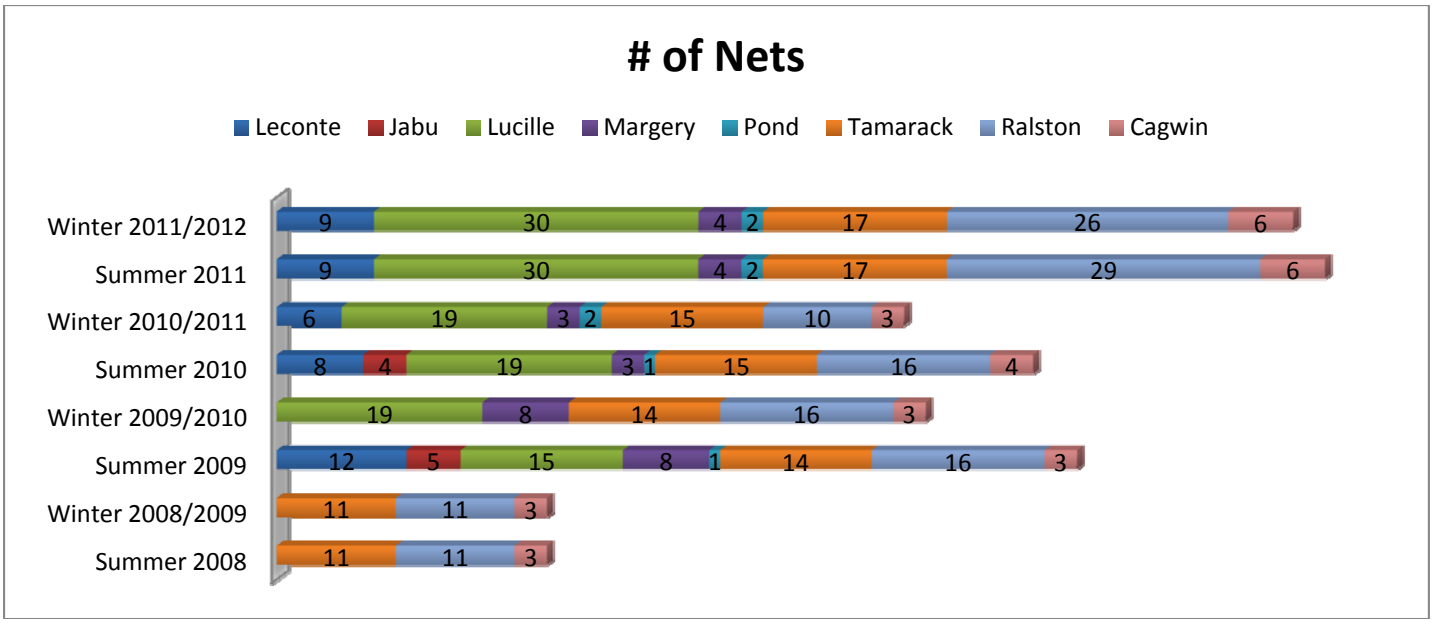

Figure 1. Number of nets in each of the seven project lakes, 2008-2011.

3. Results

During all sampling efforts since July 2008, 3,637 brook trout (*Salvelinus fontinalis*), 28 rainbow trout (*Oncorhynchus mykiss*) and one Lahontan Redside shiner (*Richardsonius egregius*) have been collected. Total fish removed since 2008 is 3,666 (Figure 2).

After four years of active gillnetting, all lakes have shown significant decline or eradication in fish populations. While Margery, Jabu, Cagwin, Ralston, Tamarack and the unnamed pond were rendered presumably fishless by the end of the 2009 season, active gillnetting was still implemented in these lakes throughout the 2010 and 2011 seasons. Lake Lucille and Le Conte were the only lakes where fish were found during the 2011 season. Lake Lucille yielded 75 fish, 72 from the 2010/2011 winter set and 3 throughout the summer. Le Conte Lake had one rainbow trout caught on the final pull in November 2011. Bringing the total fish caught in 2011 to 76. This was the only fish caught in Le Conte since implementation in 2008, and is presumably the fish the crew observed in the lake the year before. No fish have been captured in Lake Margery since the first set in September 2009. Ralston Lake and Tamarack Lake have been fishless since September 2010. Throughout the project, zero fish have been captured in Jabu Lake.

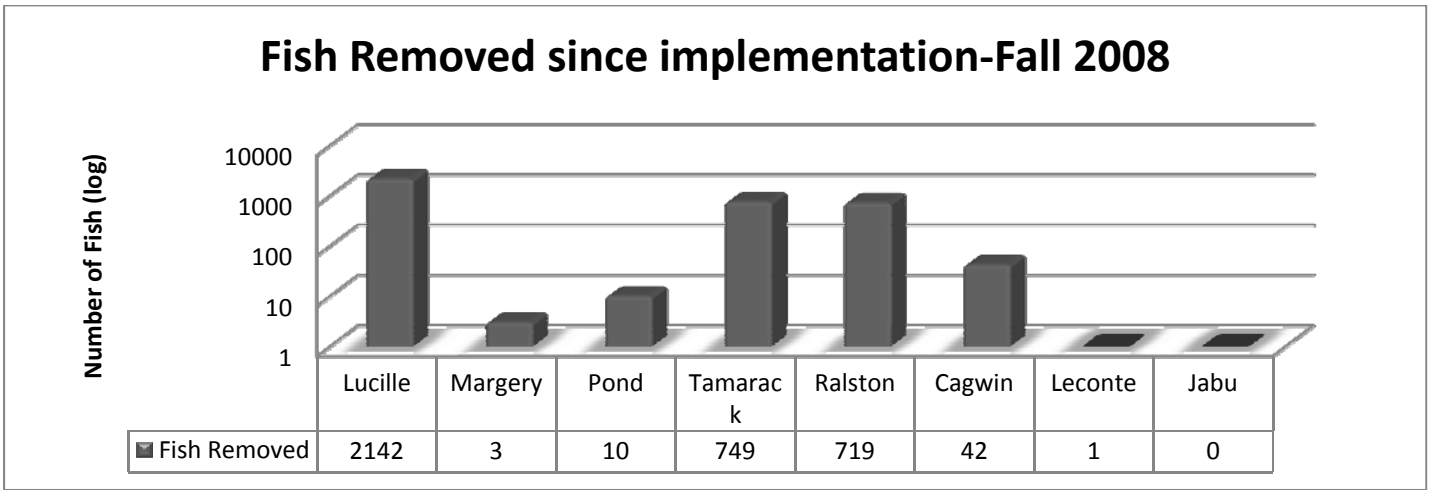

Figure 2. Fish removed in all lakes since implementation in 2008.

Ralston Lake

A total of 719 fish have been removed from Ralston Lake since the start of the project in 2008, 692 brook trout and 27 rainbow trout. All Rainbow trout were caught in 2008. No fish have been caught in Ralston Lake since July 2010. (Figure 3)

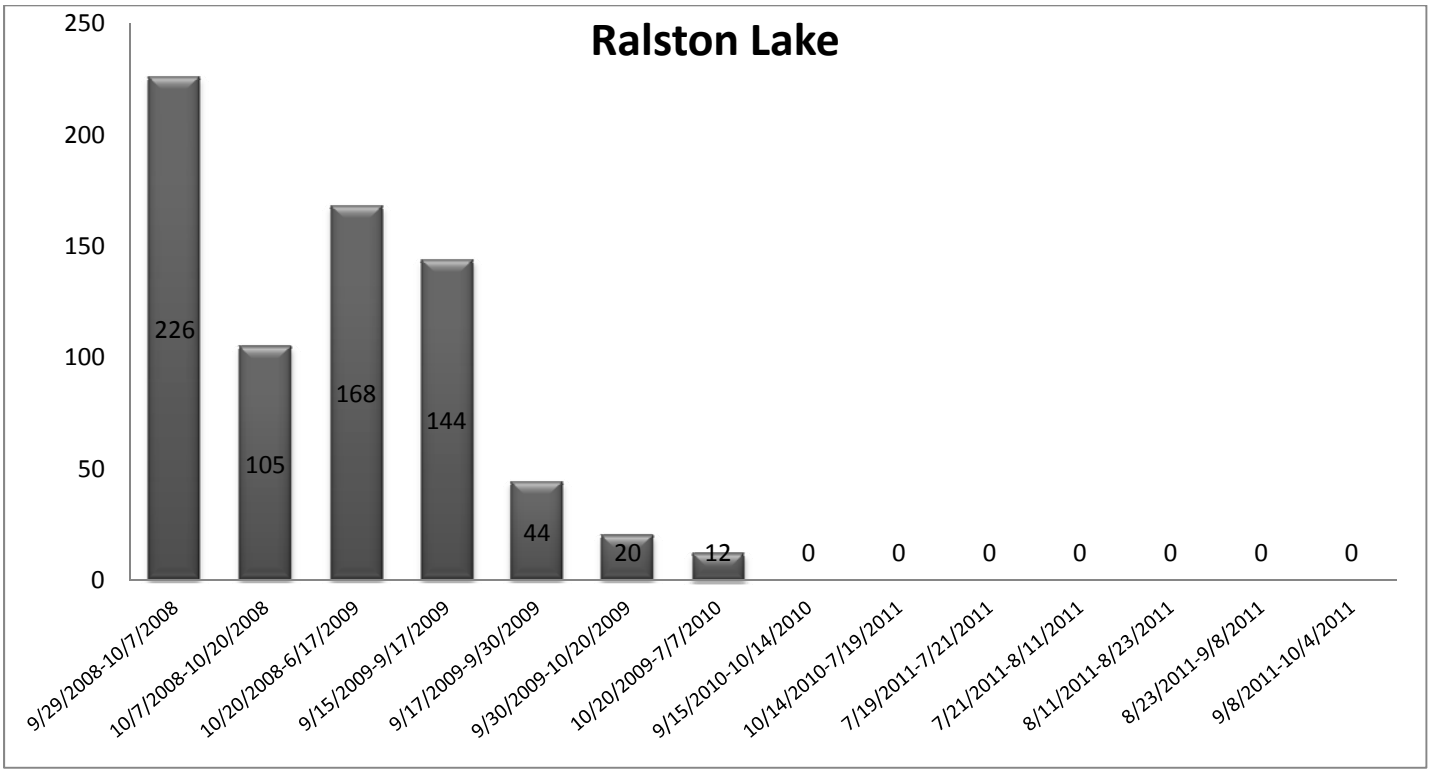

Figure 3. Depletion of fish in Ralston Lake from 2008 - 2011.

Cagwin Lake

A total of 42 fish have been eradicated from Cagwin Lake since implementation of the project in 2008. One brook trout, size class 5-10cm, was caught in the 2009 overwinter. No fish have been caught in Cagwin Lake since July 2010. (Figure 4)

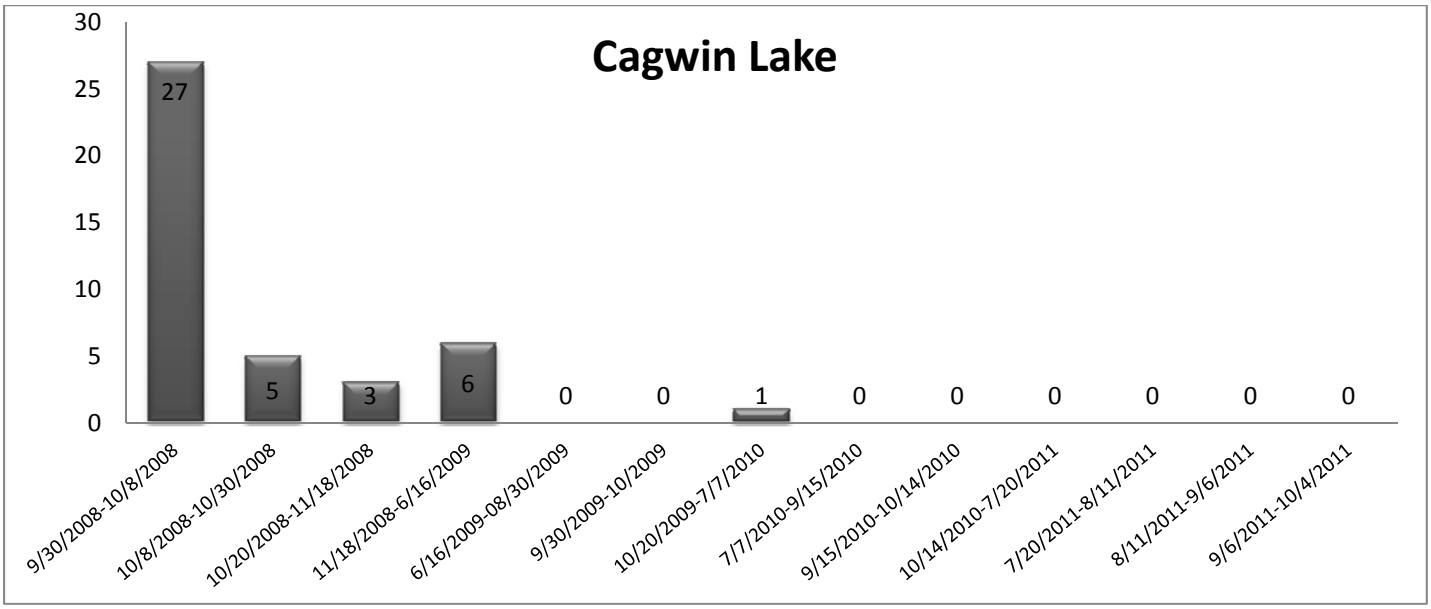

Figure 4. Depletion of fish in Cagwin Lake from 2008 - 2011.

Tamarack Lake

A total of 749 fish, all brook trout and one Lahontan Redside shiner, have been eradicated from Tamarack Lake since implementation of the project in 2008. No fish have been caught in Tamarack Lake since September 2010. (Figure 5)

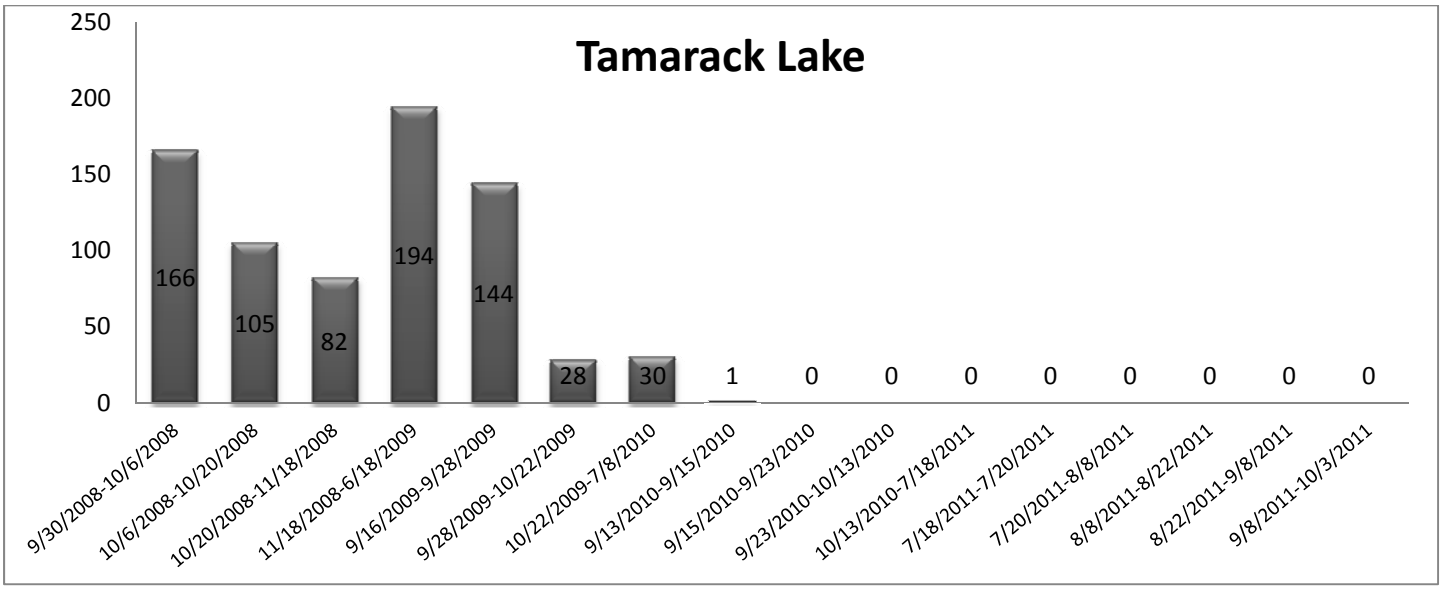

Figure 5. Depletion of fish in Tamarack Lake from 2008 - 2011.

Lake Lucille

A total of 2142 fish, all brook trout, have been eradicated from Lake Lucille since implementation of this project in 2009. There were 72 fish caught in the most recent 2010/2011 winter set, with three more caught in the 2011 summer season. The final 2011 net pull yielded zero fish. (Figure 6) 41 of a possible 75 fish caught in Lake Lucille in 2011 were greater than ten centimeters in length. Thirty three fish caught during the winter of 2010/2011 were of unknown size due to decomposition, but anecdotal evidence from the crew indicated that the majority of these were greater than ten centimeters as well. (Figure 7)

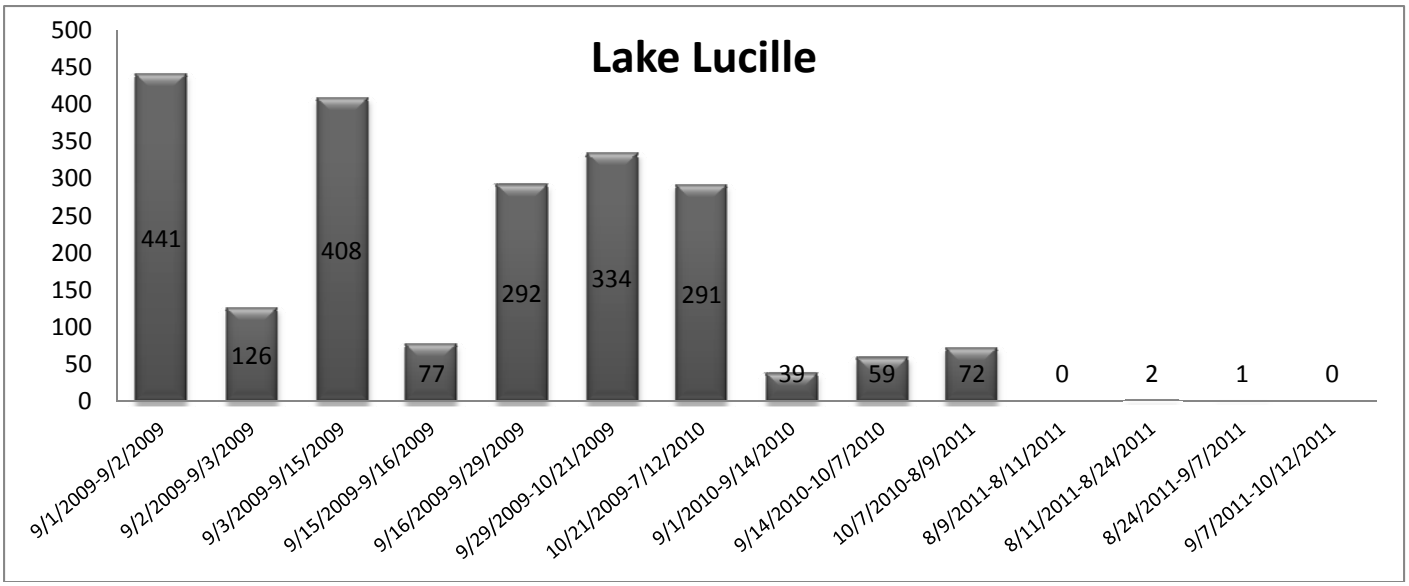

Figure 6. Depletion of fish in Lake Lucille from 2009 - 2011.

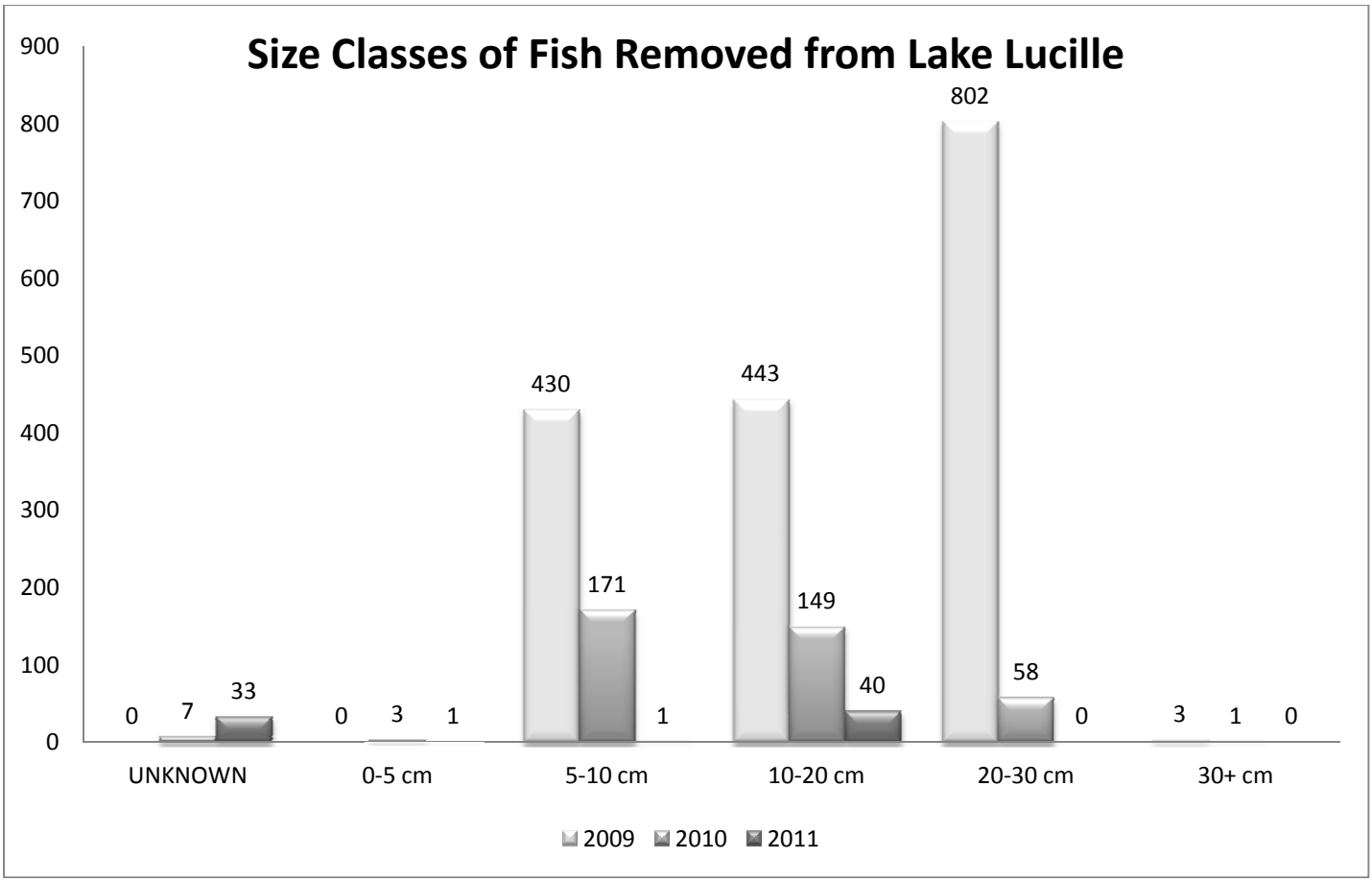

Figure 7. Size class of fish removed from Lucille.

Lake Margery

A total of three fish, all brook trout, have been eradicated from Lake Margery since 2009; a fish from each size class, 10-20 cm, 20-30 cm, and 30+ cm was caught. This was recorded on September 2009, with zero fish caught in the last 10 net sets. (Figure 8)

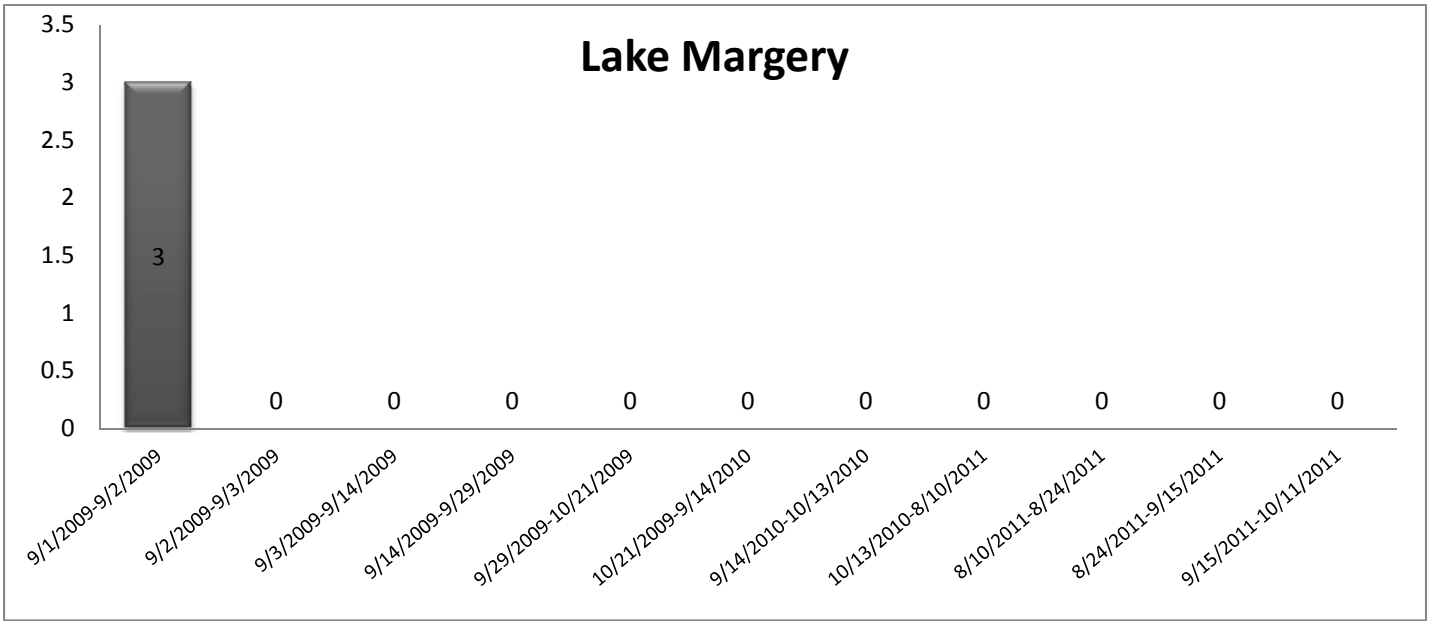

Figure 8. Depletion of fish in Lake Margery from 2009 - 2011.

Unnamed Pond north of Lake Lucille

A total of 10 fish, all brook trout over 20 cm, have been eradicated from the pond north of Lake Lucille since 2009. One fish was caught during the Sept-Oct 2010 net set, while all other net sets have resulted in zero fish caught since September 2009. (Figure 9)

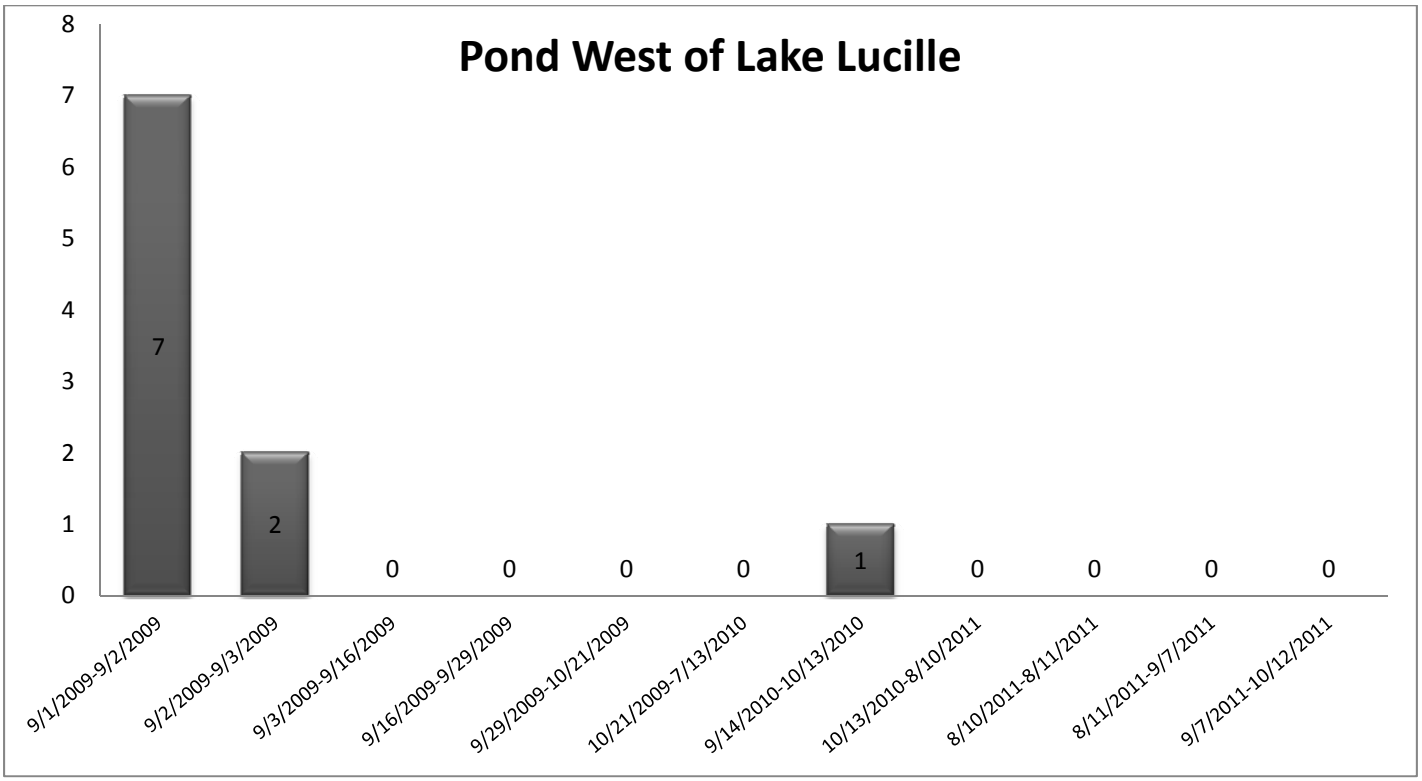

Figure 9. Depletion of fish in unnamed pond from 2009 - 2010.

Lake LeConte

One rainbow trout of 30+ cm size class was removed from Lake LeConte on October 31, 2011. This is the only fish that has been caught in Lake LeConte during implementation. (Figure 10)

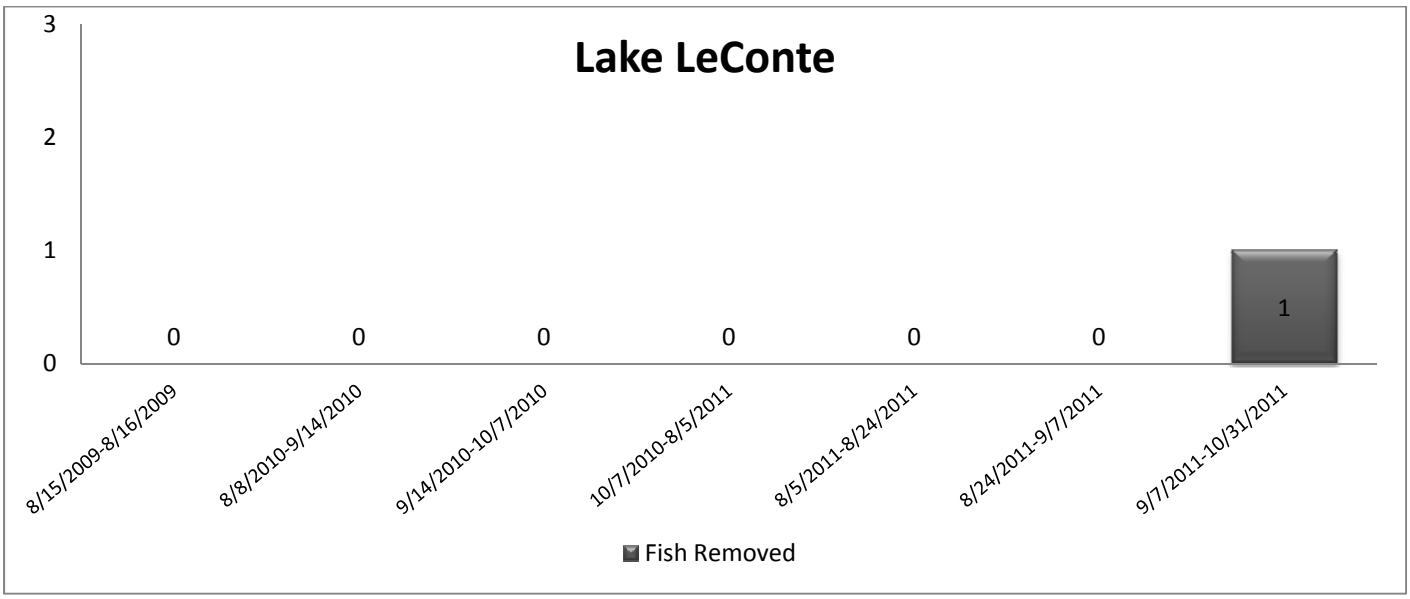

Figure 10. Depletion of fish in Lake LeConte from 2009-2011.

4. Discussion

Four years after implementation six of the seven project lakes have been rendered ~99% fishless. Given the size (Figure 11) and number of nets used in each of these lakes, zero fish after three full seasons was to be expected (Vredenburg 2004). Jabu Lake was originally fishless. Lake LeConte was also presumed to be fishless, until last year when crew members spotted a large Rainbow trout. This fish is thought to have been transferred from Lake Aloha by humans. After intensive gill netting this season a large Rainbow trout (30+ cm) was caught in Lake LeConte, just before the winter net set. Lake Lucille has yielded 75 fish within the last calendar year, but for the last three months zero fish have been detected. The majority of fish detected recently in Lake Lucille were greater than 10 cm in length, indicating that the project has broken spawning in the lake. With help from CDFG we were able to increase the total number of nets in Lake Lucille, as well as most of the other lakes. (Figure 1) This increase in nets and the lack of spawning should ensure ~99% eradication in Lake Lucille by the summer of 2012.

The next step for the project is either independent re-colonization or active translocation of individual *R. sierrae* sub-adults. The original plan was for adjacent meta-populations of frogs to re-colonize each of the treatment lakes, but only two individuals have been seen within 1 km of the sites within the last four years (Appendix 2). Recent research has increased the survivability of translocated *R. sierrae.* (Vreedenburg 2004).

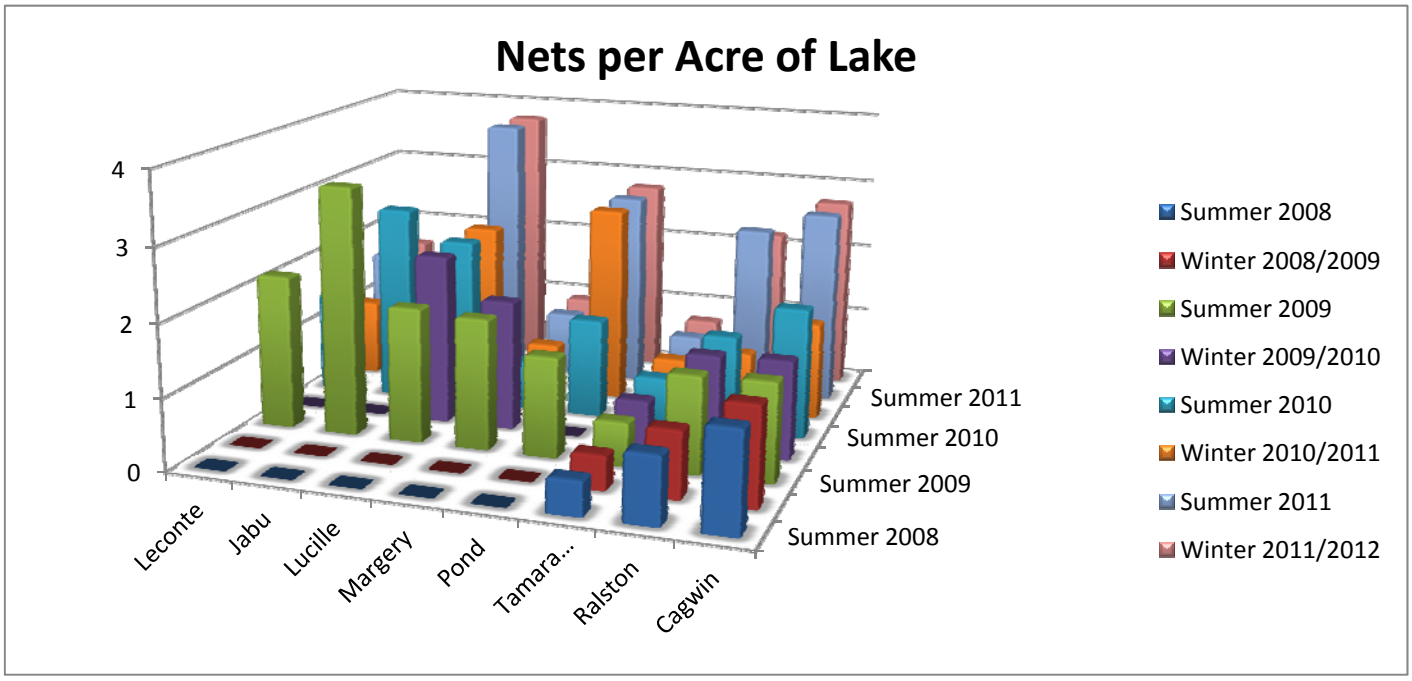

Figure 11. Density of nets in each of the eight project lakes, 2008-2011.

Although numerous efforts are now underway to recover SNYLF populations by removing non-native fish, ongoing *chytridiomycosis* in remaining frog populations presents a major challenge for recovery efforts. This disease typically causes recruitment failure, which has resulted in small populations with little ability to recolonize nearby habitats. As a consequence, reintroducing frogs obtained from persistent populations into nearby suitable habitats will often be necessary to overcome these dispersal barriers (Knapp et al. 2001b). However, because of the recruitment failures that characterize Bd-infected *R. sierrae* populations, the success of translocations in reestablishing frog populations may be low unless actions are taken to reduce the impact of chytridiomycosis. The proposed Round 12 Science and Research proposal will determine whether the success of *R. sierra* reintroduction efforts can be increased by augmenting the microbial communities living on the skin of translocated frogs with probiotic bacteria that are known to suppress the growth of Bd. Specifically,

the research will test the hypothesis that *Janthinobacterium lividum*, a species that occurs commonly in water and soil, and is also found in low densities on the skin of *R. sierra,* will increase the success of relocation of Bd positive frogs. In a recent laboratory experiment, augmentation of the microbial community on the skin of *R. sierra* with *J. lividum* decreased Bd infection intensities and dramatically increased the survival of treated frogs compared to untreated controls (Harris et al. 2009). If the treatments are successful, the experiment could result in the reestablishment of *R. sierrae* at two locations in the Lake Tahoe Basin and provide the basis for reestablishing additional populations on the LTBMU. More generally, the results of this experiment will provide critically needed guidance for similar reintroductions being planned by the USFWS, NPS, USFS, CDFG, and U.S. Geological Survey (USGS) as part of a larger effort to recover MYL frogs across their historical ranges.

5. Recommendations for Future Efforts

A continuing problem this season was losing and/or damaging nets. In Ralston Lake, many of the nets would get tangled in the bottom of the lake on rocks and logs. Deploying nets on a sunny day is also imperative to avoid the problems with setting them over snags and shelves. In Tamarack Lake, Cagwin Lake, and Lake Lucille nets were lost from either possible tampering by humans or animals. It is necessary to tie the nets to heavy rocks close to the water level on the shore where possible.

More frequent cleanings will allow nets to function optimally. If fish and algae are frequently removed from the nets then their visibility to the fish in the water column will decrease, allowing the nets to catch fish more efficiently. Two people cleaning nets with a third taking data are very efficient and make redeploying nets easy but, two people are capable of accomplishing the task nearly as quickly as three. Continuous cleaning is the key to high catch rates and efficient depletion of fish populations.

Informing the public and stakeholders of the issues and project scope would go a long way in dispelling rumors surrounding the lake restoration. An annual meeting with the Echo Chalet staff would help ensure that the boat taxi drivers and staff on Echo Lakes are providing accurate information to the public. Informational brochures briefly describing the project (including information about *R. sierra*) as well as information on which lakes provide recreational fishing opportunities will help to inform the public and alleviate conflicts in the future. This effort should be coordinated with California Department of Fish and Game staff.

6. Literature Cited

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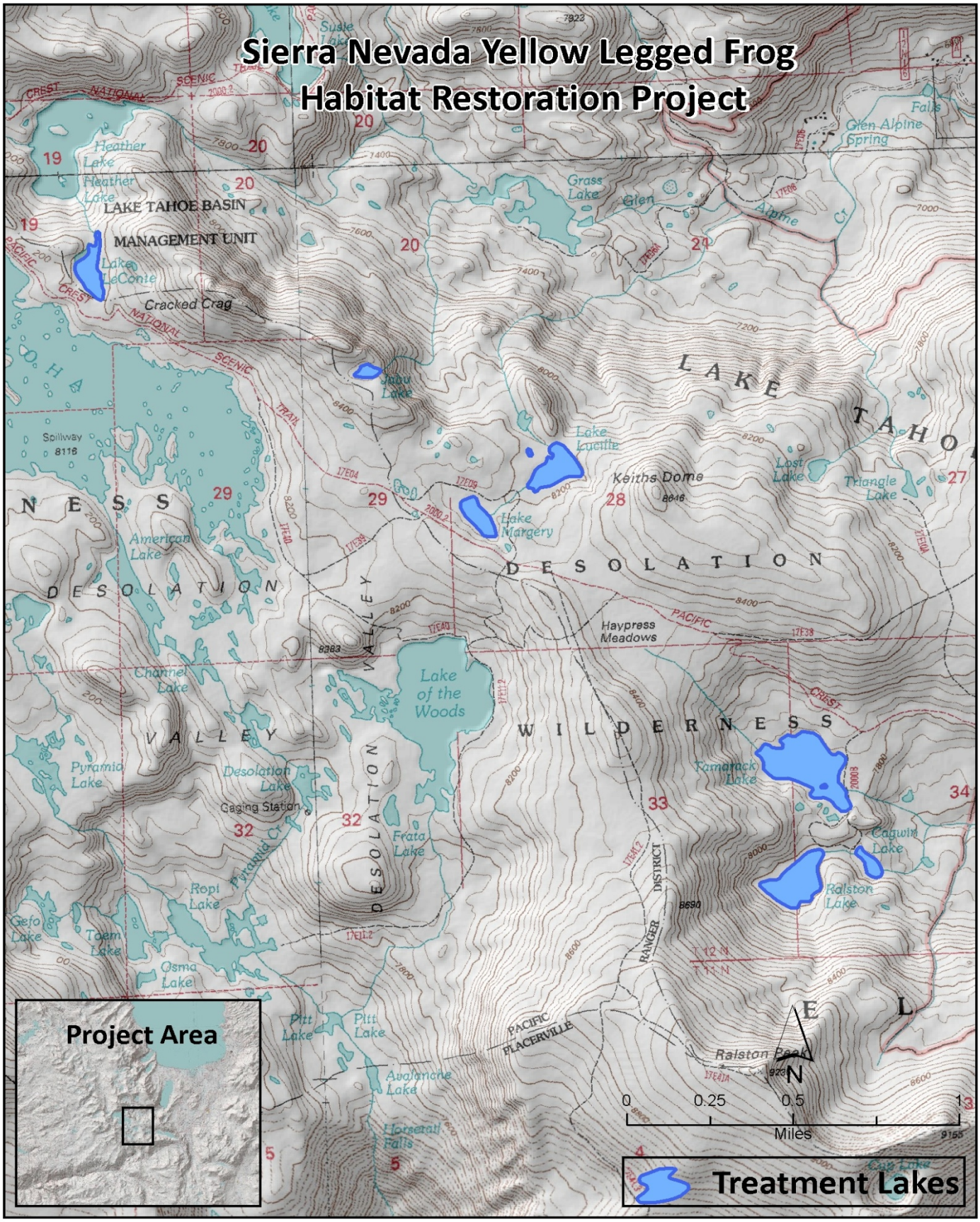
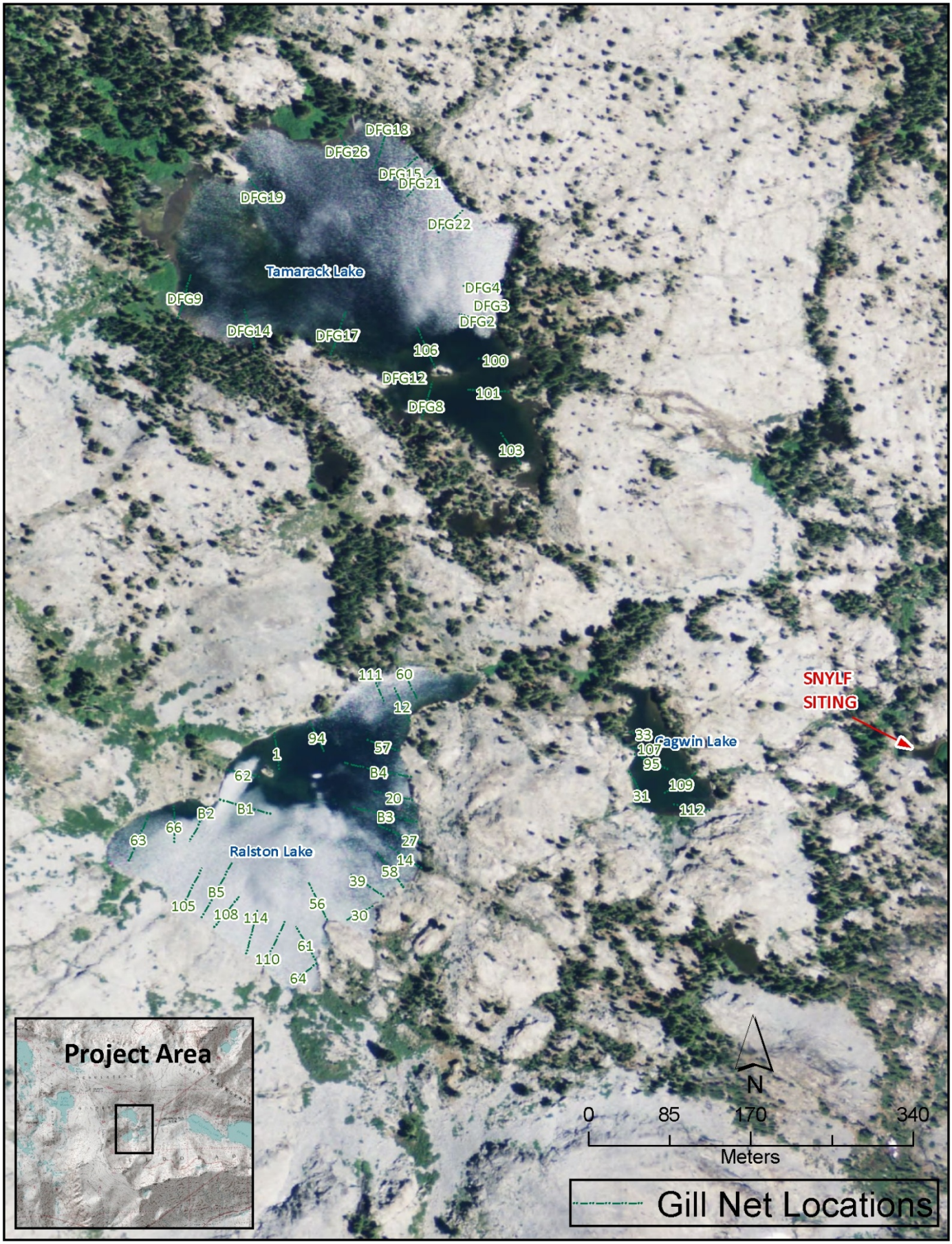
Appendices

(Maps)

Appendix 1. Locations of the seven treatment lakes.



Appendix 2. Distribution of nets in lower lakes for winter 2011/2012.



Appendix 3. Distribution of nets in Uppers Lakes for winter 2011/2012.

Appendix 4. Distribution of nets in Lake Le Conte for winter 2011/2012.