Experimental Removal of Lake Trout in Swan Lake, MT: 2014 Annual Report

Prepared for the Swan Valley Bull Trout Working Group

By:

Leo Rosenthal, Fisheries Biologist
Montana Fish, Wildlife & Parks

Wade Fredenberg, Fisheries Biologist
U.S. Fish and Wildlife Service

Amber Steed, Fisheries Biologist
Montana Fish, Wildlife & Parks

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Background

The Swan Valley has historically been one of Montana's strongest bull trout populations. However, in 1998, anglers began to occasionally catch adult sized (20-30 inch) lake trout from Swan Lake and the Swan River. This caused alarm because lake trout are not native and are notorious for rapidly expanding and dominating fish communities in lakes with *Mysis* shrimp, particularly at the expense of bull trout and kokanee salmon (Martinez et al. 2009). In 2003, the level of concern was compounded when biologists gillnetted juvenile lake trout from Swan Lake during standard low-intensity sampling efforts, indicating that wild reproduction was occurring. Since 2003, lake trout catch by anglers as well as during Montana Fish, Wildlife & Parks (FWP) biological sampling continued to increase, another indication that the population was expanding. Research efforts from 2006-2008 focused on lake trout population demographics and exploring potential techniques to reduce lake trout numbers while minimizing bull trout bycatch. Based on case histories from nearby waters, managers determined that developing long-term management actions to control this increasing lake trout population was necessary in order to maintain the popular bull trout and kokanee fisheries.

In 2009, FWP released an environmental assessment (EA) for a three-year experimental removal of lake trout in Swan Lake. This removal experiment was a feasibility study to determine the effectiveness of using targeted gillnetting as a technique to reduce the number of lake trout and thus minimize threats to kokanee and bull trout. From 2009-2011, over 20,000 lake trout were removed from Swan Lake. Modeled total annual mortality rates for lake trout year classes vulnerable to the nets (Age classes 3, 4, and 5) were higher than literature suggests are sustainable (50%). FWP released another EA in May 2012 for a five-year extension of the project to further evaluate the long-term effectiveness of the current lake trout suppression effort relative to measurable goals and specific success criteria outlined in the original 2009 EA. Based on this assessment and other relevant considerations, FWP, with recommendations from the Swan Valley Bull Trout Working Group (SVBTWG), will consider whether changes are warranted in fisheries management of Swan Lake. Long-term sustainability of bull trout in Swan Lake, a threatened species under the ESA, is an additional and important consideration.

Previous annual reports can be found at:
http://montanatu.org/resources/swan-valley-bull-trout/

Methods

The five-year extension of the lake trout suppression project (2012-2016) closely mirrors the methods employed from 2009-2011. This consistency has allowed researchers to continue to remove lake trout from Swan Lake at a level that we believe should lead to long-term decline, while providing repeatable data for year-to-year comparisons and analysis.

Consistent with 2009-2011, the current project is composed of two distinct netting events. The first event (Juvenile Netting) is aimed at removing juvenile and some subadult lake trout throughout the two deep (>60 ft) basins of Swan Lake. This removal is carried out using small-mesh (1.5 – 2.75 inch stretch) gill nets, set by professional fisheries contractors over a three-week period in late August. This netting is conducted during a time in which most adult bull trout are upstream in the Swan River drainage in preparation for fall spawning and also occurs during the period in which Swan Lake is thermally stratified. Netting occurs only below the thermocline (>60 ft), in order to reduce incidental bycatch of bull trout and other fish species which occupy shallower depths.

Since 2009, netting for juvenile lake trout has been contracted to Hickey Brothers Research of Baileys Harbor, Wisconsin. Each year the boat has been cleaned and disinfected following a Hazard Analysis and Critical Control Point Plan (HACCP) to minimize the risk of spreading aquatic invasive species. The boat is inspected annually by FWP personnel prior to entering Swan Lake to ensure proper cleaning procedures have been followed.

Juvenile netting took place from August 10-29, 2014 consistent with the period fished since 2012, but a week earlier than in 2009-2011. This change in timing provided lake conditions similar to previous years, and ensured that post-spawning bull trout would not have returned to Swan Lake during the tail-end of netting operations. The amount of netting effort and the locations of nets set for juvenile lake trout has been consistent since 2009. The contract with the Hickey Brothers provides 30 lifts, with one lift being described as an event in which nets are set and retrieved. While the number of lifts has not changed since 2009, the number of net panels set has varied since the beginning, as more panels of small mesh net were set to increase the catch of juvenile lake trout (Table 1). Although the number of net panels has varied since inception of the project, the locations of the nets have remained constant (Figure 1).

Table 1: Dates and numbers of nets set for Juvenile Netting 2009-2014.

Year	Netting Dates	# Lifts	# 900’ Net Panels
2009	Aug 24-Sept 11	30	248
2010	Aug 23-Sept 10	30	311
2011	Aug 22-Sept 9	30	399
2012	Aug 13-Aug 31	30	382
2013	Aug 11-Aug 30	30	347
2014	Aug 10-Aug 29	30	354

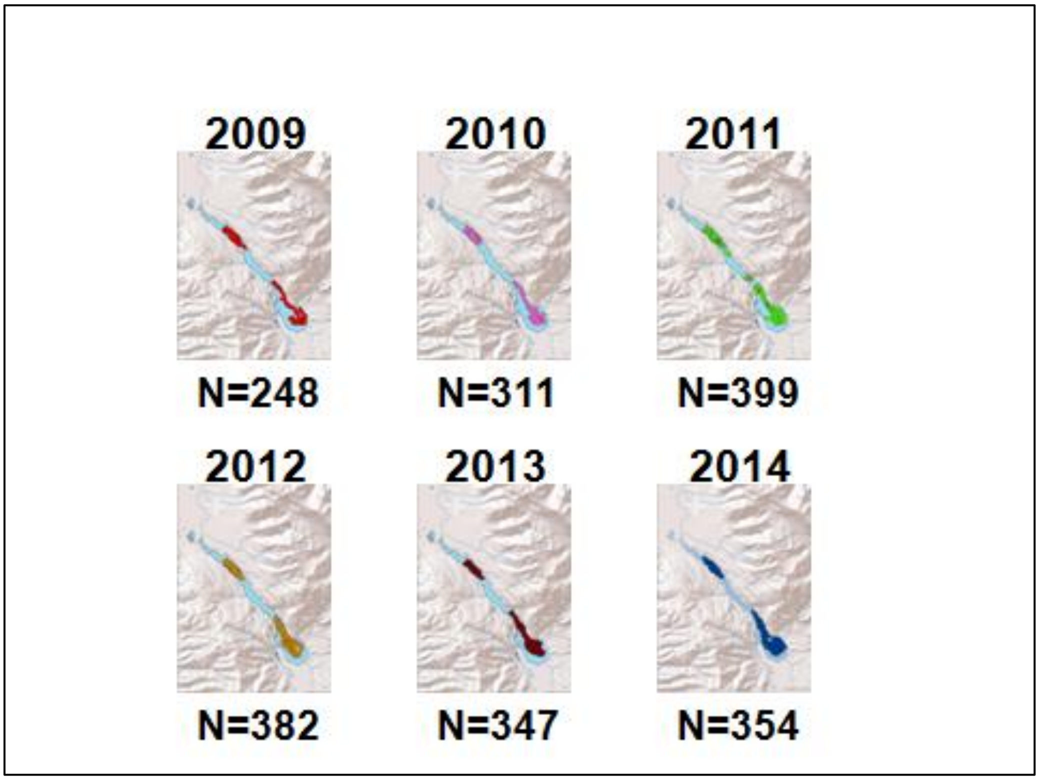

Figure 1: Netting locations and numbers of net panels for Juvenile Netting in Swan Lake 2009-2014.

The second netting event (Spawner Netting) is directed at removal of adult lake trout during spawning and thus is targeted to directly affect further recruitment. This portion of the project is carried out largely by SVBTWG members (with contractor assistance) and takes place during the month of October. Large-mesh gill nets (4.5 – 5 inch stretch) are set at night and during early morning hours, along spawning areas. Netting for spawning lake trout in 2014 was conducted from October 6-31, with nets being set and lifted twice daily, Monday-Friday. While netting did not occur twice every day (Friday afternoons, Saturdays, Sundays, and Monday mornings were not fished), the schedule and subsequent effort was similar to previous years of the project.

Because information on lake trout spawning distribution information was becoming somewhat dated, another acoustic telemetry study was initiated by FWP in 2014. Spawning behavior had been previously documented using acoustic telemetry in 2007-2008, identifying locations where adult lake trout could be targeted using gill nets (Cox 2010). After five years of gillnetting, adult lake trout movements were reevaluated to identify any changes in spawning location and behavior. Thirty-two adult lake trout captured using gill nets were tagged with two-year acoustic transmitters in August 2014. Fish were tracked by boat for 1-5 days/week from September through November 2014. Crews concurrently gillnetting for spawning adults in October used fish locations to inform a subset of netting locations.

Results and Discussion

Juvenile Netting

A total of 6,934 lake trout ranging in total length from 4-22 inches were removed during the 2014 Juvenile Netting period (Figure 2). This represented a slight decrease from 2013. All fish less than 22 inches total length were cleaned, packed on ice, and sent to local area food banks for distribution. Fish longer than 22 inches total length were not retained for food bank distribution because of human consumption guidelines related to mercury content. Those fish were either given to local wildlife rehabilitation centers or were used by FWP wildlife personnel for bear trapping lure. The length frequency distribution of lake trout caught during the Juvenile Netting period continues to be heavily skewed toward smaller fish, a result of targeting high-use locations and fishing smaller mesh nets (Figure 3). The majority of the juvenile lake trout catch is composed of age-3 and age-4 lake trout (Cox 2010). Soak times of each panel of net and the depth of nets fished have remained relatively constant since 2009. The depth was maximized and duration of these net sets was minimized in an effort to reduce bycatch and associated mortality of non-target species. Bycatch of other fish species during the Juvenile Netting period can be found in Table 2.

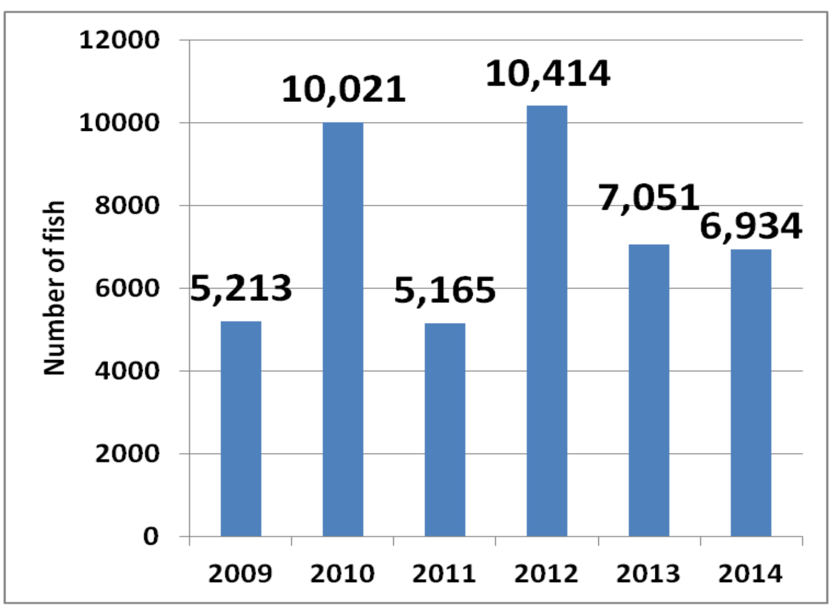

Figure 2: Total number of lake trout removed during Juvenile Netting 2009-2014.

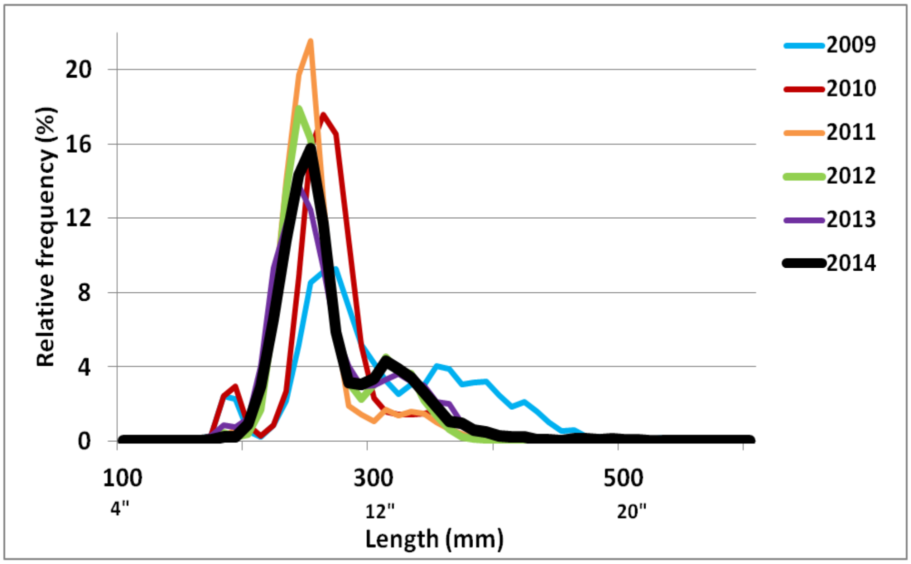

Figure 3: Relative length frequency of lake trout less than 500 mm (20 inches) total length caught during Juvenile Netting in Swan Lake 2009-2014.

Table 2: Bycatch of non-target fish species captured during Juvenile and (Spawner) netting events 2009-2014. Most fish were released alive.

Fish Species	2009	2010	2011	2012	2013	2014
bull trout	238 (26)	212 (87)	237 (104)	334 (103)	168 (135)	146 (161)
kokanee	205 (23)	414 (110)	159 (46)	521 (114)	388 (300)	138 (431)
mountain whitefish	107 (0)	28 (5)	31 (2)	67 (0)	104 (2)	93 (4)
pygmy whitefish	139 (0)	63 (0)	9 (0)	79 (0)	27 (0)	11 (0)
longnose sucker	86 (50)	49 (306)	65 (145)	17 (207)	7 (157)	31 (213)
northern pikeminnow	27 (36)	14 (136)	31 (131)	2 (68)	1 (132)	4 (147)
largescale sucker	0 (58)	0 (109)	0 (111)	0 (54)	0 (96)	0 (147)
rainbow trout	6 (3)	5 (10)	7 (11)	0 (11)	1 (11)	6 (16)
northern pike	0 (2)	0 (0)	0 (7)	0 (2)	1 (7)	0 (3)

Acoustic Telemetry

Results of acoustic tracking of 32 potential spawners in 2014 indicated that although some lake trout in Swan Lake continued using sites previously identified, locations that had been less frequently used in the past now attracted the majority of spawning adults (Figure 4). Further, fish tagged in 2014 were rarely relocated in the area predominantly used by tagged lake trout during 2007-2008. These results demonstrate the dynamic nature of lake trout behavior and underscore the broader importance of reevaluating assumptions through time in order to maximize conservation efforts and inform fisheries management.

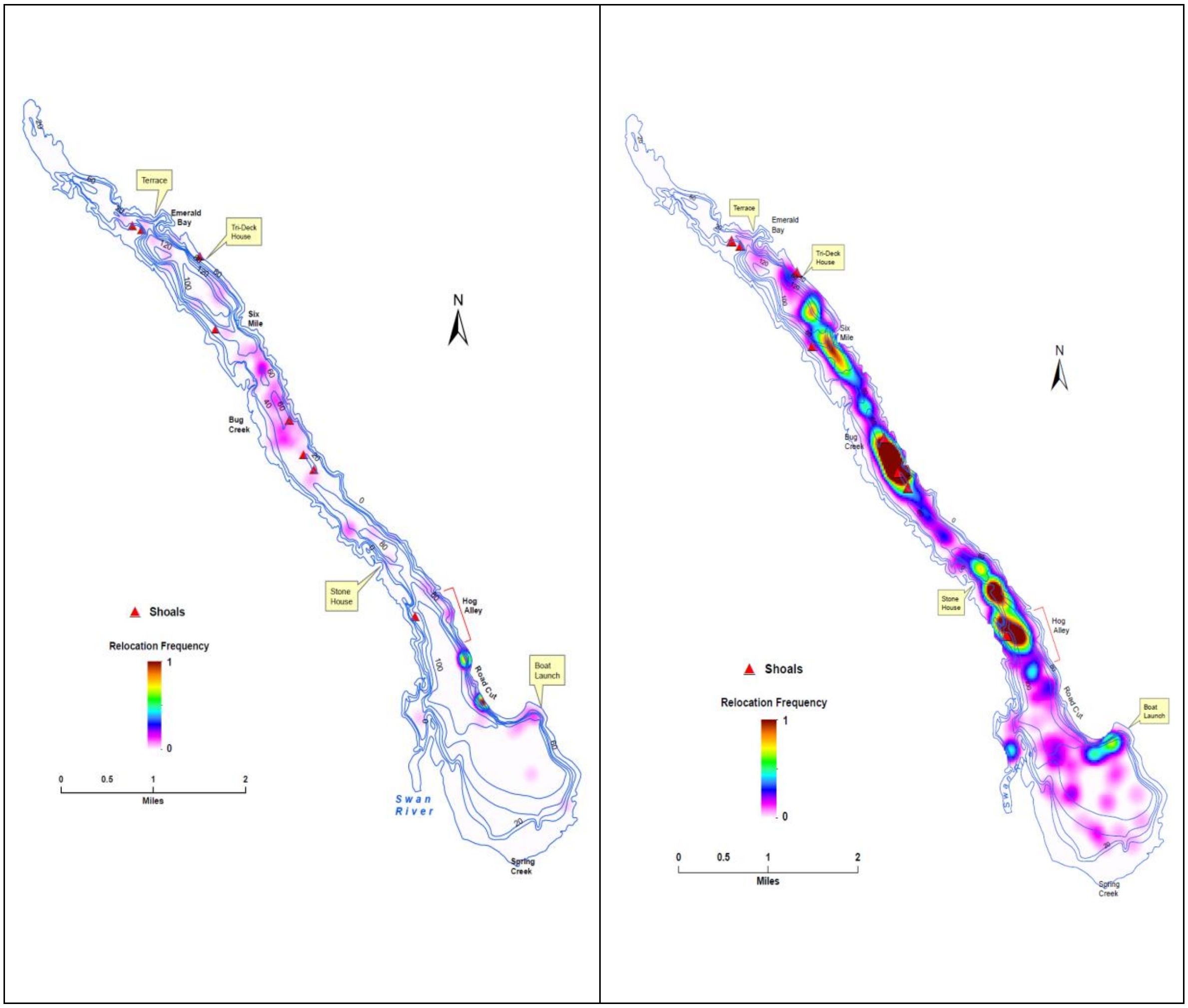

Figure 4: Relative relocation frequencies for adult lake trout implanted with acoustic telemetry tags and tracked in Swan Lake 2007-2008 (left) and 2014 (right). Darker red areas indicate locations where transmittered adult lake trout were found on a more frequent basis, during October and November (prior to and during the spawning season). Intensity is higher in 2014, due in part to greater frequency of relocations and larger sample size, not necessarily due to greater numbers of spawning fish.

Spawner Netting

The removal of adult lake trout to directly reduce recruitment continues to be an important aspect of the project. Adult lake trout catch in 2014 was 348 fish, a considerable increase from the 216 captured in 2013 (Figure 5).

As mentioned previously, the 2014 Spawner Netting season was also accompanied by a second crew tracking tagged adult lake trout. While the majority of nets (114) set for adult lake trout were placed along the same area fished from 2009-2013 (Highway 83 road cut), a subset of nets (41 nets) were fished in areas informed by acoustic telemetry. Gillnetting on these tagged fish aggregations in 2014 produced catch rates more than twice that of the historically targeted location, with 204 fish caught along the road cut and 144 fish caught along the newly identified areas. Most of that catch occurred in the area of shoals depicted by the highest density of relocations (see Figure 4).

Relative length frequency of lake trout captured along the Highway 83 road cut during Spawner Netting continues to be skewed to smaller individuals, suggesting that previous efforts effectively exploited larger, older fish from that area (Figure 6). In contrast, netting over the newly identified areas produced a relative length frequency similar to that of the unexploited spawning population in 2009, with many large adult fish being caught (Figure 7). Bycatch of fish species other than lake trout during Spawner Netting was similar to past years (Table 2).

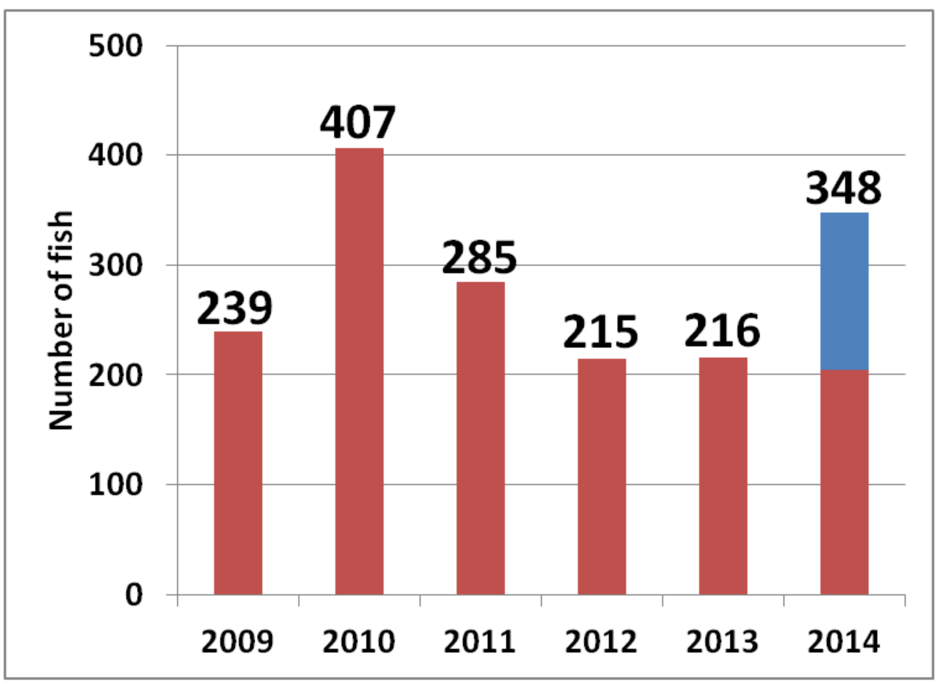

Figure 5: Total number of lake trout removed during Spawner Netting in Swan Lake 2009-2014. The red bars represent adult lake trout removed along the "traditional" spawning area and the blue bar represents adult lake trout removed over areas identified during 2014 telemetry efforts.

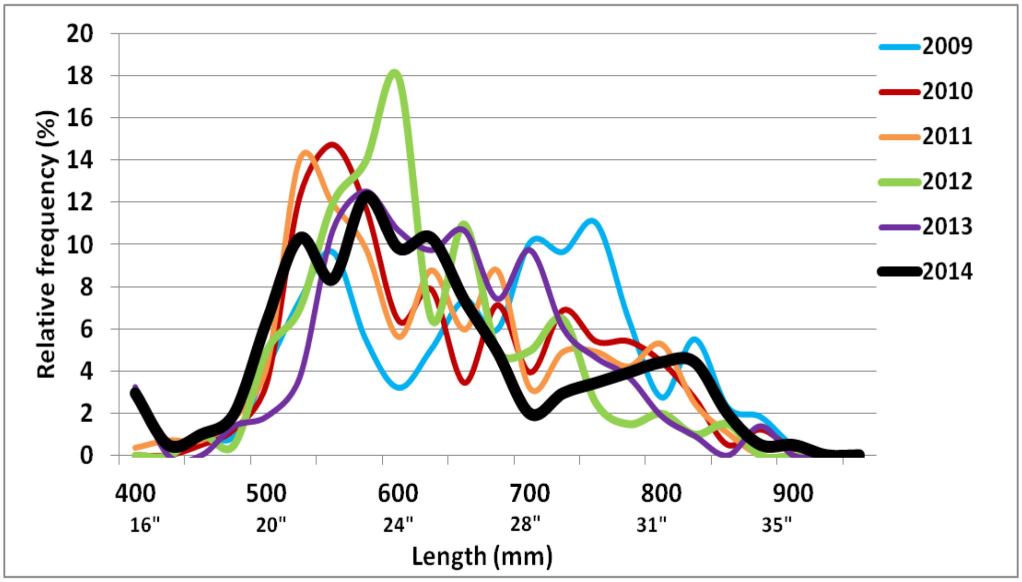

Figure 6: Relative length frequency of lake trout captured during Spawner Netting 2009-2014.

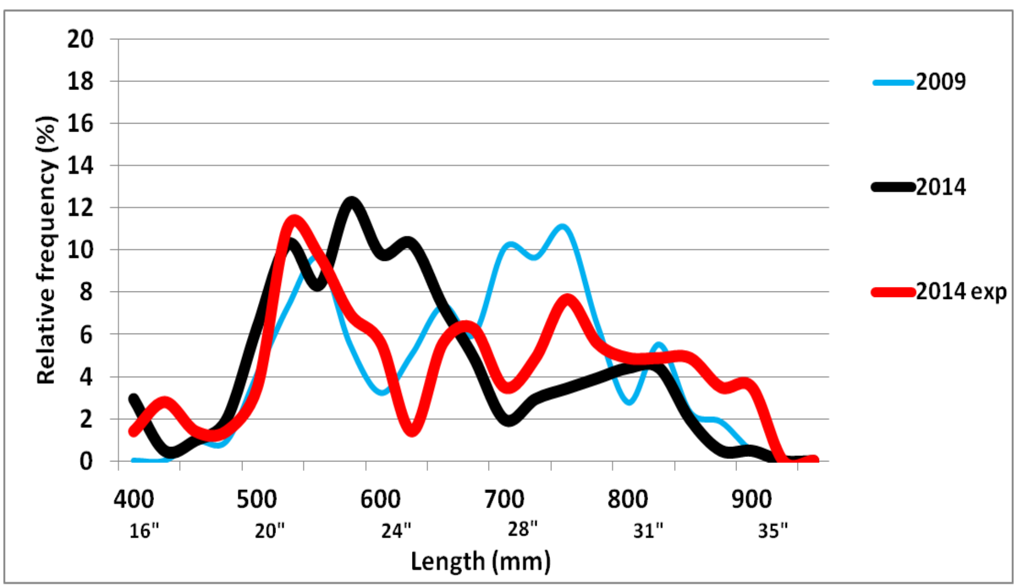

Figure 7: Relative length frequency of adult lake trout removed over "traditional" spawning areas in 2009 and 2014. The red line represents the adult lake trout removed over areas identified during 2014 telemetry efforts ("2014 exp").

Bycatch of Bull Trout and Kokanee

As in the past, bull trout bycatch continues to be closely monitored. Since the inception of the project, reducing the amount of bull trout bycatch and minimizing the mortality rates of inadvertently caught bull trout have been priorities, due in part to their Threatened status and accompanying ESA regulatory concerns.

A total of 307 bull trout were inadvertently captured as bycatch during netting activities in 2014. The Juvenile Netting period resulted in 146 bull trout being captured with 61 direct mortalities (41.8%). These are the lowest totals both captured and killed in Juvenile Netting, during the six years (2009-2014) that experimental suppression netting has occurred. The favorable trend is likely a result of ongoing efforts to adjust mesh sizes and further refine methodology to avoid netting in depths and locations where non-target species are concentrated.

The Spawner Netting period in October added 161 bull trout to the capture total. While Juvenile Netting bycatch of bull trout has been declining, the bycatch of bull trout during Spawner Netting in October has been increasing in recent years. This is likely a result of increasing effort (more nets and longer soak times), since the general protocol has not changed. Of the 161 bull trout captured during Spawner Netting, 66 were direct mortalities (41.0%).

During the 2014 Juvenile Netting, we also set an additional group of large mesh nets in deep water near known kokanee concentrations to capture large adult lake trout for sonic tag implantation. This effort caught an additional 17 bull trout. These data are not included in Figure 8 to maintain consistency and comparability among years.

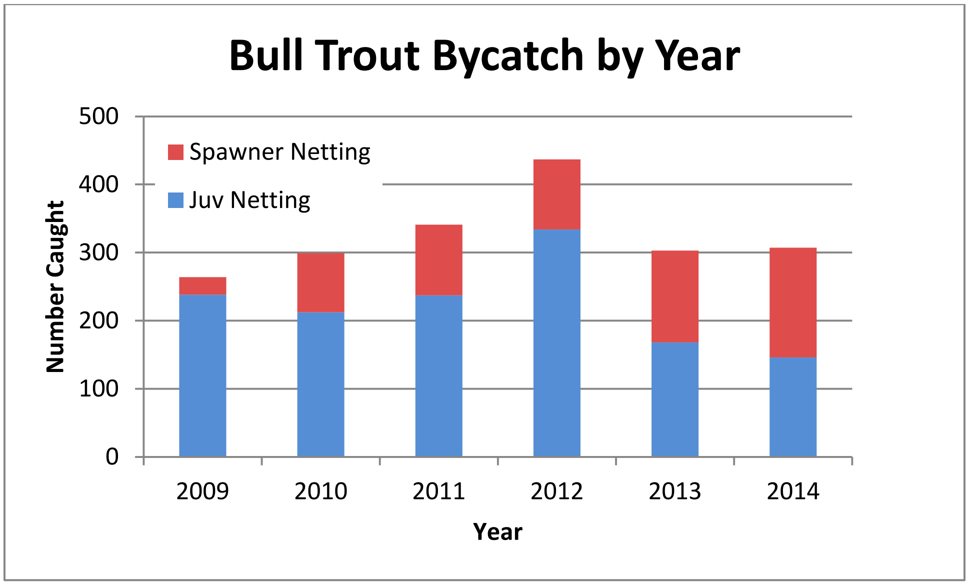

Figure 8: Bull Trout bycatch captured in Juvenile and Spawner gillnetting activities on Swan Lake 2009-2014.

Despite employing every available technique to reduce mortality of accidentally netted bull trout, roughly 40% of these fish did not survive, in both netting events. Research led by the USFWS (Rosenthal and Fredenberg 2014) suggests that total bycatch mortality is likely higher than what is directly observed, as some released bull trout may swim off but perish later. Therefore, an empirically derived estimated mortality rate of 53.6% has been applied to gillnetted fish throughout this project. Applying this formula, the estimated bycatch mortality of bull trout in 2014 was 174 fish (146 + 161 + 17 = 324 X .536 = 174). Bull trout bycatch from 2009-2014 has averaged 328 fish/year, resulting in an estimated average annual mortality of 176 fish/year. Bycatch mortality estimates from 2014 are consistent with the annual average.

At least 45 bull trout of the total 324 captured in 2014 (a minimum of 13.9%) were previously caught during this project and implanted with passive integrated transponder (PIT) Tags. This information documents that post-release survival of gillnetted bull trout is occurring. Valuable insight on growth and survival of PIT-tagged fish continues to be accumulated. Bull trout redd counts (i.e., spawning beds) in the Swan drainage in 2014 were higher than in 2013 (Figure 9) and juvenile abundance surveys conducted in select streams indicated that the juvenile numbers remain at least stable.

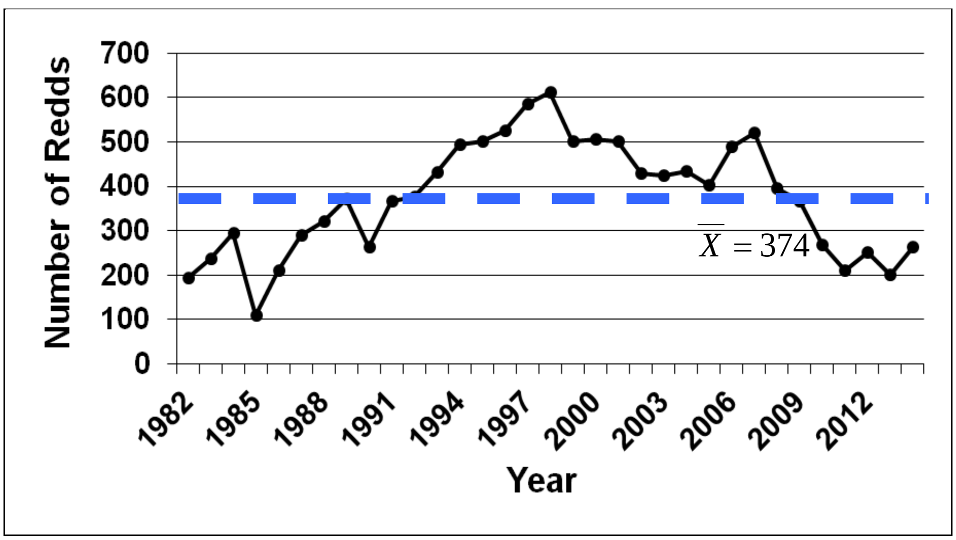

Figure 9: Bull trout redd counts from the Swan River index tributaries 1982-2014. Dashed line indicates the average number of index redds for the period of record.

Nonnative kokanee salmon are another important fish species in Swan Lake. Kokanee provide one of the more popular angling opportunities in Swan Lake for both ice and open-water fishermen and represent an important food resource for adult bull trout and lake trout. Case histories from surrounding area lakes have demonstrated that the combination of *Mysis*, kokanee, bull trout, and lake trout typically results in decreased abundance of bull trout and elimination of kokanee. Therefore, kokanee represent a potentially sensitive indicator of lake trout abundance, as increases in kokanee abundance may suggest a reduction in predatory lake trout density.

Kokanee abundance in Swan Lake is monitored annually through redd counts along an index reach of Swan Lake shoreline. Similar to adult bull trout trends, kokanee spawner abundance had declined from 2005-2011 (Figure 10). Kokanee redd count surveys in 2011 revealed the lowest abundance throughout the period of record. Redd counts have incrementally increased since 2011, reaching 739 redds in 2014. This positive trend will continue to be monitored, in part to determine if the lake trout suppression project may be effective in relieving predation from lake trout on kokanee. In addition to the slight increase in kokanee redd numbers, the total number of kokanee caught as bycatch in both netting periods has also increased since 2011. While bycatch of nontarget species is not typically viewed as favorable, this increase in catch could be representative of increased abundance of kokanee in Swan Lake. As mentioned previously, netting locations and effort have remained relatively constant throughout the project, so the kokanee bycatch data can potentially be viewed as a standardized index.

Length frequency analysis of kokanee inadvertently captured during the 2014 netting reveals no missing age classes in Swan Lake (Figure 11). Kokanee in the bycatch ranged from 7-20 inches (172-505 mm) and peaks at 225 and 325 mm probably represent ages 2+ and 3+ kokanee, respectively. Kokanee smaller than 7 inches were likely not captured as a result of the mesh sizes used for the netting. The observation of small kokanee should be viewed as positive, as these fish are likely to be most affected by an increasing lake trout population. However, it does appear that the 225 mm peak length frequency is less pronounced than in past years and could represent a weak year class coming through the population. Changes in relative length frequency will be closely followed in upcoming years.

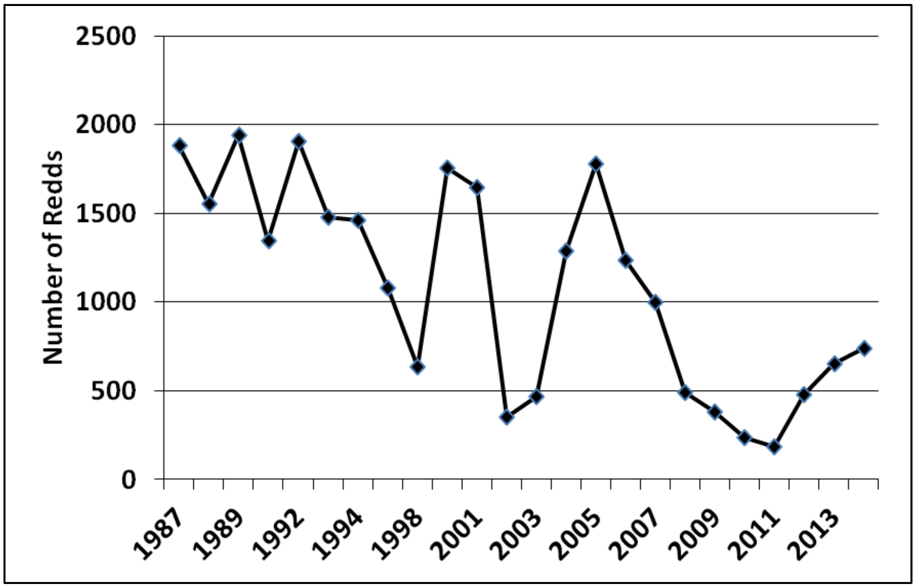

Figure 10: Kokanee redd count data from Swan Lake 1987-2014.

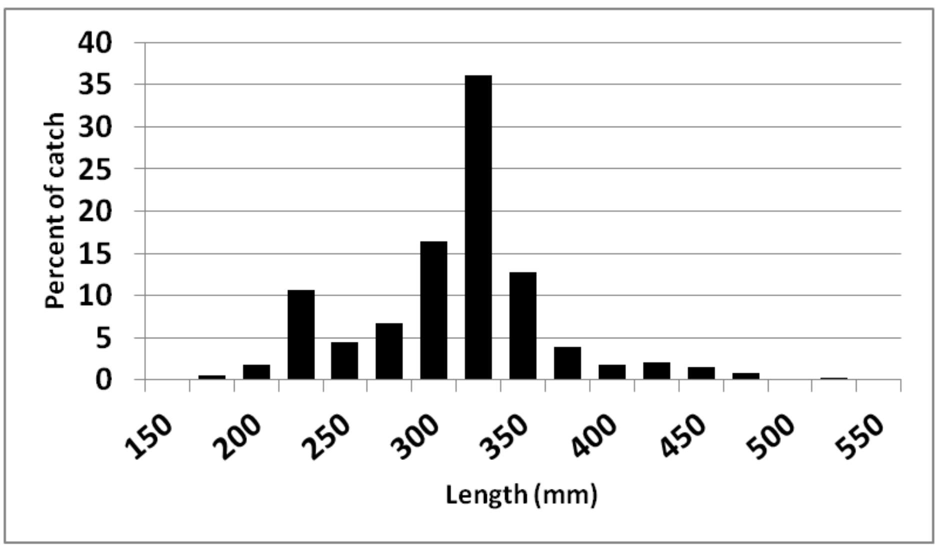

Figure 11: Length frequency of kokanee captured during both Juvenile and Spawner Netting in 2014.

Evaluation Criteria

This lake trout removal project in Swan Lake was initiated to evaluate the efficacy of using gill nets to control the expansion of the lake trout population and simultaneously benefit bull trout and kokanee. Criteria to evaluate this project were outlined in the original 2009 EA, and continue to be monitored throughout the study. An in-depth review of these criteria with regard to the 2009-2011 efforts can be found in the 3-year Summary Report (Rosenthal et al. 2012).

Netting mortality of lake trout during Juvenile Netting continues to be evaluated on an annual basis. Total annual lake trout mortality rates in excess of 50% have been shown to cause population declines in traditional lake trout fisheries (Healey 1978). Conservative estimates of exploitation (mortality) of age-3 and age-4 lake trout have exceeded 50% in most years since 2009, typically approaching 60-70% (Figure 12). These modeled estimates are most accurate for age-3 and age-4 fish, as they are the most vulnerable to the nets being deployed and the locations being sampled. While the estimated mortality rates are encouraging, indicating that the lake trout population should be declining, model validation is still required by future empirical results.

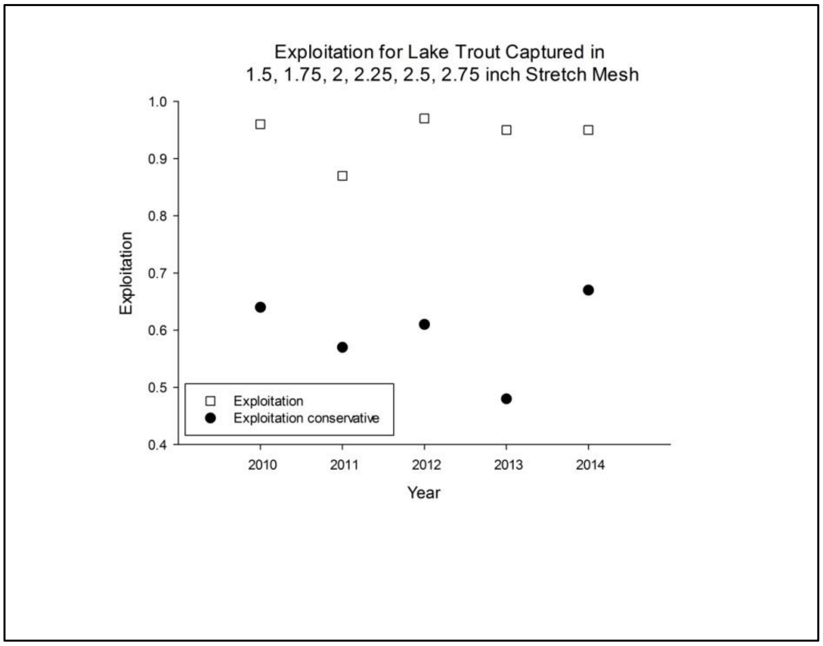

Figure 12: Modeled exploitation rates for Juvenile Netting 2010-2014.

Lake trout length frequency data from fish captured along the highway cut during Spawner Netting, continues to be skewed toward smaller fish. This shift in length suggests that netting has been effective in removing many of the older, larger fish traditionally using that area. Initial netting in 2009 resulted in the capture of many fish greater than 700 mm (27.5 inches), with the mode of the distribution centered on 750 mm (29.5 inches). However the mode of the fish caught on the spawning grounds was 575 mm (22.6 inches) in 2014. A decrease in the observed length of spawning fish was one of the original evaluation criteria. Unfortunately, the identification of additional spawning areas in 2014 and the subsequent length frequency analysis of fish captured on those new areas suggest that some large lake trout have likely been spawning on unexploited areas. If netting is effective, we will look toward a similar length frequency shift toward smaller individuals for the newly identified areas in upcoming years. At this time, we know little about site fidelity and movement of adults between these areas, but the size of Swan Lake and distance of only a couple of miles between sites would seem to make some degree of interchange likely.

Lake trout catch per net during Spawner Netting activities has been consistent since 2011 (Figure 13). After an initial decrease in catch per net in both 4.5” and 5.0” nets from 2010-2011, catch appears to have stabilized at this lower level. This trend in catch per net suggests that while Spawner Netting has been effective at truncating the length frequency, mortality rates from Juvenile Netting have not been sufficient to reduce recruitment of adult lake trout to the spawning grounds.

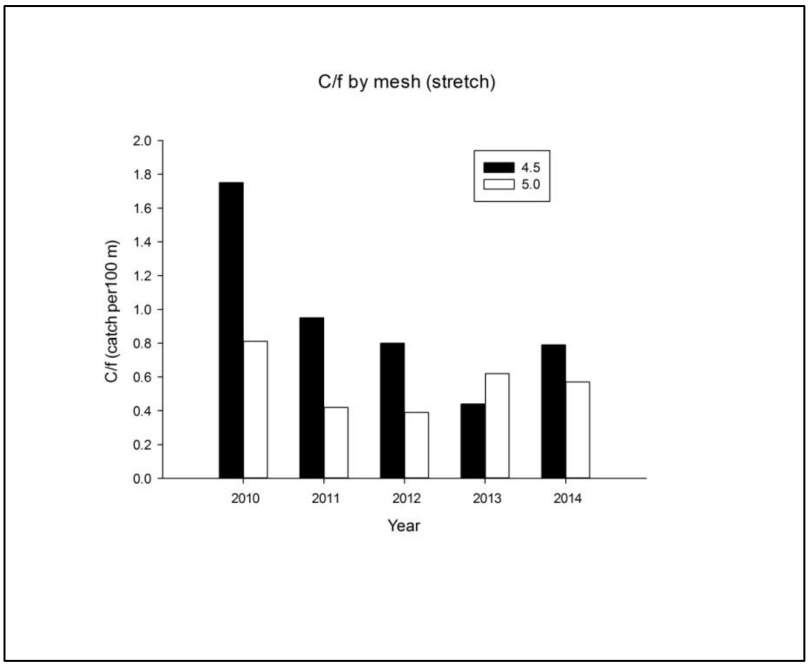

Figure 13: Lake trout catch per unit effort during Spawner Netting 2010-2014.

Juvenile Netting in 2013 provided researchers the first glimpse of how past efforts have affected the overall lake trout population. Spawner Netting for adult lake trout began in 2009. Progeny of adult lake trout that spawned in the fall of 2009 would be age-0 fish during Juvenile Netting in 2010, age-1 in 2011, and age-2 in 2012. Because of fish behavior and the mesh size of nets being used for this project, lake trout do not fully recruit to the nets until they are age-3. Therefore, netting in 2013 represented the first year of sampling lake trout that may have been affected by previous Spawner Netting. Because 2010 was the first year the commercial equipment was used during Spawner Netting, 2014 would be the first year of Juvenile Netting representing this increase in effort. A considerable reduction in lake trout catch was observed in 2013 but that trend did not continue in 2014. In fact the 2014 Juvenile Netting total of 6,934 fish is similar to the 6-year average of 7,466. The identification of additional spawning areas and subsequent recruitment from those sites might explain why the number of juvenile fish has not significantly declined in recent years. Netting over the newly identified spawning areas should result in reduced juvenile catch in future netting, unless other significant spawning sites are still being missed.

2015 Plans

Netting in 2015 will follow the same schedule as 2009-2014. Juvenile Netting will be conducted the last three weeks in August. The arduous schedule of the Juvenile Netting has been identified as problematic. Netting occurs every weeknight, often lasting past midnight. The same crew is then back on the water by 5:00 AM to set nets for the morning shift, leading to exhausted employees and potentially unsafe work environments. Therefore in 2015, a modified Juvenile Netting schedule will be implemented that allows staff alternating nights off. This modified schedule will reduce the number of total lifts, but also increase soak time on some nets and in total, potentially increasing the catch. Alternating this routine with the standardized past approach will provide enough consistency for data comparisons. Spawner Netting will continue to follow the same schedule as 2009-2014.

Thirteen fish implanted with acoustic transmitters are still at large from 2014, and will continue to provide tracking information in 2015. During Spawner Netting in 2014, 13 of the tagged adult lake trout were recaptured and their tags were saved for future use. Another tagged lake trout was subsequently caught by an angler and the tag returned to FWP. Therefore, an additional 14 adult lake trout will be surgically implanted with these tags to further refine our knowledge of spawning locations. Netting effort during Spawner Netting will be split between the “traditional” Highway 83 road cut, and the newly identified “experimental” areas. It is important to maintain effort on the “traditional” spawning area to continue evaluation of trends in catch per unit effort.

Monitoring of the other aquatic organisms will also continue in the Swan Lake system. Annual *Mysis* sampling occurs in early June, bull trout juvenile estimates in select spawning tributaries occurs in August, bull trout redd counts are conducted in October, and kokanee redd counts are completed in early December. Additionally, spring gill net monitoring will be conducted in Swan Lake, Lindbergh Lake, and Holland Lake to look at trends of all fish species.

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