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COMPLETION REPORT:
LAKE SUPERIOR SPRING CREEL SURVEY
2016

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BACKGROUND

Minnesota Department of Natural Resources (MNDNR) fisheries assessments and creel surveys provide data needed to implement the MNDNR Fisheries Management Plan for the Minnesota Waters of Lake Superior (LSMP; Goldsworthy et al., *in review*). The LSMP supplements joint strategic documents for lakewide management formed by the Great Lakes Fisheries Commission and other agencies who manage the Lake Superior fishery (GLFC 1997; Horns et al. 2003). Angler creel surveys collect information to supplement data collected in fisheries assessments. Spring creel surveys are used to monitor fishing pressure, catch, catch rates and harvest of fish species in Minnesota waters of Lake Superior, particularly Rainbow Trout.

The first spring creel survey was implemented in 1992 to monitor the rehabilitation of Rainbow Trout in Minnesota waters after the species declined in the 1960s. The survey was designed to target anglers who fished for Rainbow Trout as they migrated upstream in tributaries to spawn. The State of Minnesota currently manages two types of Rainbow Trout in Lake Superior that were introduced from the west coast of North America. This includes steelhead, a migratory life-history form, and Kamloops, a semi-domesticated hatchery strain. Steelhead were first introduced to Lake Superior in the late 1800s (Krueger et al. 1994). Steelhead have naturalized to Lake Superior streams and now provide a sought-after sport fishery in Minnesota waters. Kamloops were originally introduced into Ontario waters of Lake Superior in 1946 (Krueger et al. 1994), and then were introduced in Minnesota waters in 1972 to provide harvest opportunities for Rainbow Trout while steelhead populations were rehabilitated (Close and Hassinger 1981).

The first creel surveys on the North Shore were conducted in 1961 through 1967 (Hassinger et al. 1974), and then in 1981 and 1982 (Close and Siesennop 1984). The MNDNR spring creel survey has been conducted annually since 1985, except in 1991. From 1985 to 1990, the spring creel surveys used a non-uniform probability design that provided good shorewide information but did not permit statistically valid estimates for individual tributaries. In 1992, the survey was changed to a stratified random design to also obtain information from specific tributaries (Ostazeski and Morse 2002). A modified bus-route format was implemented in 1995, 2002, and for part of 2003, to enable a survey with two clerks when three clerks were unavailable. Data in this report are summarized and compared from 1992 to 2016 based on the stratified random design used in the creel survey throughout this time period.

The annual spring creel survey typically begins once tributaries thaw and are fishable. The spring creel survey has provided useful information for many other species in Lake Superior. Brook Trout (*Salvelinus fontinalis*), one of two native sport fish to Lake Superior, are typically the second most reported species in the spring creel survey. Public interest in Brook Trout has increased as agencies around Lake Superior examined protection and restoration strategies for the species (Newman et al. 2003; Schreiner et al. 2008). Many non-native sport fish in Lake Superior also provide angling opportunities in the spring and fall. Brown Trout (*Salmo trutta*), Atlantic Salmon (*Salmo salar*), Chinook

Salmon (*O. tshawytscha*), Coho Salmon (*O. kisutch*), and Pink Salmon (*O. gorbuscha*) are targeted by anglers fishing in the spring, and most are caught by anglers fishing in Lake Superior near rivers. Other than steelhead, very few non-native sport fish are caught in tributaries in the spring because adults return to spawn in the fall. Lake Trout (*Salvelinus namaycush*), White Sucker (*Catostomus commersoni*), Longnose Sucker (*Catostomus catostomus*), and Round Whitefish (*Prosopium cylindraceum*) are also periodically caught in rivers and near river mouths in the spring.

The MNDNR recognized that fishing pressure was often high in winter and early-spring prior to the start of the annual spring creel survey, particularly in years when sufficient ice formed in Lake Superior. Therefore, the first ever early-spring creel survey was initiated in 2013 to evaluate angling pressure and catch of some species, particularly adipose fin clipped Rainbow Trout (hereafter referred to as Kamloops). The early-spring creel survey was completed during the period prior to ice-out when shore anglers fish exclusively in Lake Superior. This survey included five creel locations in the lower shore because most of the pressure for Kamloops occurs along the lower shore, near Duluth. The early-creel survey has also provided useful information for other species (e.g., Coho Salmon). The early-spring creel survey was also completed in 2015 and 2016. In 2015, the Two Harbors break wall accounted for only 8.4% of the total pressure and no Rainbow Trout (steelhead and Kamloops) were caught; therefore, it was removed from the early-spring creel survey in 2016. Two stations not included in previous surveys were added in 2016, which included Blue Bird Landing and Stoney Point.

The Minnesota shore of Lake Superior is divided into two geographic regions. The area from the Lester River to the Split Rock River is referred to as the "Lower Shore," while the area from the Beaver River to the Brule River is referred to as the "Upper Shore." The spring creel survey collects interviews from anglers at nine tributaries in the lower shore and nine tributaries in the upper shore (Figure 1). Estimates from the lower and upper shore are collectively referred to as "shorewide" estimates. Pressure, catch, and catch rates are determined for individual tributaries, and for the lower shore, upper shore, and shorewide. Anglers fishing in tributaries are considered "stream" anglers and anglers shore fishing in Lake Superior near the tributary mouths are considered "lake" anglers. The term "lake" refers to Lake Superior waters near tributary mouths and includes McQuade Harbor.

Separate estimates of catch and catch rate were made for Rainbow Trout 16 inches and greater and Rainbow Trout less than 16 inches to isolate the influence of juvenile steelhead from the analyses. Unless otherwise specified, estimates for Rainbow Trout are summarized and reported only for fish 16 inches or greater. References to a 'long-term' average in this report refer to the time period from 1992 to 2016.

Kamloops possess an adipose fin clip making them legal for anglers to harvest. No adipose-clipped steelhead should still exist in Lake Superior from stocking events in the early 2000s. The majority of unclipped steelhead caught were produced in the wild or were products of MNDNR steelhead fry stocking. Some stocked steelhead, including captive broodstock from French River Coldwater Hatchery released back into Lake Superior, possess a maxillary clip that is difficult for anglers to identify. These fish

were reported by anglers as simply 'steelhead'. Maxillary clipped steelhead could influence the catch and catch-rate in the spring creel at the Knife River, which received all of the (maxillary clipped) steelhead stocked from 2003 to 2007. However, these fish are only rarely caught in the spring at the Knife River fish trap and very few (if any) likely still exist in Lake Superior.

Steelhead are currently maintained as a catch-and-release-only fishery. Kamloops ≥ 16 inches are allowed to be harvested, but 25-40% of Kamloops caught each spring are voluntarily released. Therefore, most fish lengths reported in the creel surveys were estimated by anglers or measured by creel clerks prior to release. Individual fish weights were obtained using regression relationships derived from Knife River adult trap data. All other methods are summarized in Ostazeski (2004).

Angler population estimates were determined using a cumulative total of the number of 'new' anglers (not previously interviewed this spring) and 'recap' anglers (previously interviewed this spring) that were interviewed each day. 'New' or 'Recap' anglers were determined by asking the question "Have you previously been interviewed by a creel clerk this spring?" This question was not asked in 1992 to 1995 creel surveys, so estimates could not be determined before 1996. The Schnabel modification of the Lincoln-Petersen estimator was used to calculate daily estimates of angler abundance and its variance. Angler population estimates generally increase throughout the first half of the survey period, and then stabilize. Therefore, the average of the last nine estimates was used to calculate a final angler population estimates and confidence intervals of the final angler population estimate.

In both the early- and annual spring creel surveys in 2016, anglers were asked "If regulations allowed a limited steelhead harvest, would you keep one?" This question was added to better understand angler's opinions and attitudes toward harvest of steelhead in Minnesota waters. The results from this question provided a baseline of the potential impact that stream anglers who fished in 2016 would have had on the steelhead fishery if regulations allowed harvest. The "yes" and "no" responses to this question were summarized and stratified by shore zone (lower and upper shore), creel station (river or creel location), angling type (lake or stream), primary species sought, age group, and zip code (country, state and county). Steelhead harvest responses were summarized only for 'new' anglers interviewed to eliminate duplicate responses from anglers who were interviewed multiple times in 2016.

RESULTS

Fishing Pressure

The early-spring creel survey went from March 10 through March 24, 2016. A total of 249 interviews were collected, which was higher than 2013 (232) and 2015 (92). Total fishing pressure was 4,369 angler-hours, which was higher than 2013 (4,140) and 2015 (1,037). Seventy-eight percent of interviews and 82% of the total fishing pressure in the early-spring creel was at the French River and McQuade Harbor/Talmadge River. Blue Bird Landing and Stoney Point accounted for 10% of the total fishing

pressure, and Lester River and Sucker River accounted for only 8%. All anglers interviewed in the early-spring creel were fishing the lower shore in the lake.

The annual spring creel survey went from March 26 through May 23, 2016. A total of 1,918 interviews were collected shorewide, which was significantly more than in 2014 (977) and 2015 (1,005). The majority (80%) of anglers interviewed in the annual spring creel were fishing in the lower shore, and most (75%) were fishing streams. The most interviews in the lower and upper shore were collected at the Lester (295) and the Baptism (93) rivers, respectively. The number of 'new' (first time interviewed this year) angler interviews in 2016 (1,372) was much higher than average (793). From this total, 203 were interviewed during the early-spring creel and 1,067 interviewed during the annual spring creel. Eighty-three percent (1,144) of 'new' angler interviews were collected in the lower shore, and 68% (939) were from anglers fishing in a stream.

Total angling pressure in 2016 was 46,868 angler-hours, which was 16,173 angler-hours higher than the historic average (Table 1, Figure 2). Most (80%) angling pressure was at lower shore rivers, which ranged from 7,293 angler-hours at the Lester River to 582 angler-hours at Silver Creek. Angling pressure was the highest ever observed in the upper shore (9,533 angler-hours), and ranged from 2,285 angler-hours at the Baptism River to 370 angler-hours at the Temperance River. McQuade Harbor/Talmadge River, Knife River, Devil Track River and Kadunce Creek experienced the highest angling pressure on record (Table 2, Figure 3).

Rainbow Trout were by far the most sought after species in the spring 2016, and steelhead or Kamloops were the primary target species in 96% of all interviews. Other primary species included Coho Salmon at 2%, Brook Trout at 1%, and others at less than 1.0%. Twenty-two percent of anglers listed steelhead as their secondary target species and 53% listed Kamloops as their secondary species. Other secondary species included Coho Salmon at 14.6%, Brook Trout at 6.0%, and other species at <1.0%.

Catch, Catch-Rates and Harvest

Steelhead

An estimated 22 steelhead were caught in early-spring creel survey. The shorewide catch-rate was 0.005 fish per angler hour which was similar to 2013 (0.0159) and 2015 (0.003). The catch-rate at the French River (0.007 fish per angler hour) was low, similar to 2013 (0.015) but similar to 2015 (0.005). The average length was 25 inches (range: 24–26) and all were released.

An estimated 6,008 steelhead were caught in the annual spring creel survey, which was much higher than the historic average (2,610). Catch in the lower shore (4,251) and upper shore (1,757) were above their historic averages (Figure 4). The highest catch in the lower shore was at the Knife River (918), followed by the Lester River (905) and the Sucker River (721). The highest catch in the upper shore was at the Baptism River (449), followed by the Kadunce Creek (371) and the Cascade River (190). An estimated 39 steelhead were illegally harvested, 10 from the Lester River and 29 from the Cascade River. Small steelhead (<16 inches) were reported at eleven creel stations with estimated shorewide catch of

518 (Table 3). The average length was 25 inches (range: 3-30) and average weight was five pounds (Table 4).

The shorewide catch-rate for steelhead (0.128 fish per angler-hour) was higher than the historic average (Figure 5). Catch-rates in the lower shore (0.114 fish per angler-hour) and upper shore (0.184 fish per angler hour) were both above historic averages (Figure 6). The highest catch-rates (fish per angler-hour) in the lower shore were at the Gooseberry River (0.357), Stewart River (0.233), and Split Rock River (0.169), and the highest catch-rates in the upper shore were at the Beaver River (0.400), Kadunce Creek (0.263), and the Cascade River (0.222) (Table 3). Approximately 98% of all steelhead were caught in a stream, and catch-rates in tributaries (0.172 fish per angler-hour) was significantly higher than in the lake (0.010 fish per angler-hour).

Kamloops

An estimated 224 Kamloops were caught during the early-spring creel survey. All Kamloops were reported at the French River (183) and McQuade Harbor/Talmadge River (41). The shorewide catch-rate was 0.051 fish per angler hour, which was lower than 2013 (0.062) and higher than 2015 (0.015). Catch-rates at the French River (0.068 fish per angler hour) were lower than 2013 (0.090) and higher than 2015 (0.013). Catch-rates at McQuade Harbor/Talmadge River (0.045 fish per angler hour) was higher than 2013 (0.037) and 2015 (0.021). The average length was 23 inches. The majority (97%) of Kamloops caught in the early-spring creel were harvested.

The estimated shorewide catch of Kamloops in the annual spring creel survey was 1,967, which was lower than the long-term average (2,464). Catch of Kamloops was similar in the lake (995) and streams (972) (Figure 7). Catch in both the lower shore (1,885) and the upper shore (82) were below historic averages (Figure 8). In the lower shore, most Kamloops were caught at the French River (533), McQuade/Talmadge River (473), and the Lester River (387). In the upper shore, Kamloops were only reported at the Cascade River (27) and the Brule River (13). An estimated 58 sub-legal Kamloops (<16 inches) were caught and released at four stations in the lower shore. Approximately 80% of all legal sized Kamloops caught in the annual spring creel were harvested (Table 3). Averaged length was 24 inches (range: 14-29) and average weight was five pounds (Table 4).

The shorewide catch-rate for Kamloops was 0.042 fish per angler-hour (23 angler-hours per fish) (Figure 5). The catch-rate in the lower shore was 0.050 fish per angler-hour (20.0 angling-hours per fish), which was the fourth lowest on record since 1992. Catch-rates were highest at the French River (11.3 angler-hours per fish), McQuade Harbor/Talmadge River (11.5 angler-hours per fish), and the Sucker River (16.4 angler-hours per fish). Catch-rates at the Lester River rebounded slightly in 2016 to 18.9 angler-hours per fish, from 35.8 angler-hours per fish in 2015 (Table 3). Catch-rates for Kamloops was higher in the lake (12.5 hours per fish) than in tributaries (35.7 hours per fish).

Brook Trout

No Brook Trout were reported in the early-spring creel survey. An estimated 1,078 Brook Trout were caught in the annual spring creel survey, which was much higher than the historic average (411) (Figure 9). The shorewide catch-rate was 0.023 fish per angler-hour (43.4 angler-hours per fish), 0.016 (62.5 angler-hours per fish) in the lower shore and 0.051 (19.6 angler-hours per fish) in the upper shore. Forty-five Brook Trout were illegally harvested. Average length was 10 inches (range: 5-19) and average weight was one pound (Table 4).

Other Species

An estimated 32 Coho salmon were caught in the early-spring creel, with a shorewide catch-rate of 0.007 fish per angler hour. Twenty-eight were caught at French River with a catch-rate of 0.011 fish per angler hour, and four were caught at the Sucker River with a catch-rate of 0.049 fish per angler hour. An estimated 55 Coho Salmon were caught during the annual spring creel survey with a shorewide catch-rate of 0.001 fish per angler-hour; no salmon were reported in the upper shore. The average length was 18 inches (range: 16–18) and average weight was 2 pounds. All Coho salmon were harvested. Other species reported in the annual spring creel survey included Brown Trout, Northern Pike, and suckers (White Sucker and Longnose Sucker) (Table 4).

Angler Population Estimates and Demographics

An estimated 2,743 anglers participated in the Lake Superior spring fishery in 2016, which was the highest number of anglers observed in the history of the spring creel survey. The number of anglers who fish Lake Superior in the spring has increased over time (Figure 10).

The majority (96%) of all anglers interviewed in spring 2016 were residents of Minnesota. Only 4% (N=93) were from other states or countries (Table 5). Anglers from 49 of the 87 counties in Minnesota were interviewed. Among Minnesota residents, 61% (N=801) were from counties in the North Shore Area (Carlton, Cook, Lake and St. Louis counties), 21% (N=270) were from the seven county Twin Cities Metro Area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties), and 18% (N=235) were from all other counties. Only 5% (N=63) of anglers were female, 60 were from Minnesota and three were from Wisconsin.

Steelhead Harvest Response

Approximately 71% (145 of 203) of anglers interviewed the early-spring creel would have harvested a steelhead. In total, 54% (742 of 1,372) of anglers interviewed in both creel surveys would have harvested a steelhead, of which 46% (428 of 939) were stream anglers and 73% (314 of 433) were lake anglers. A higher proportion of anglers fishing in the lower shore (57%, 652 of 1,144) would have harvested a steelhead than in the upper shore (39%, 90 of 228). At least 60% of anglers interviewed at Stoney Point, Blue Bird Landing, French River, and McQuade Talmadge, and the Cascade River would have harvested a steelhead in 2016. At least 60% of anglers interviewed at the Gooseberry River, Beaver River, Baptism

River, Cross River, Devil Track River, Kadunce River, and Brule River would have continued to catch and release. Responses were similar (between 40-60%) at the other stations (Table 6; Figure 11).

The 25 to 34 age group provided the most 'new' angler interviews in spring 2016. Nearly half (49%) of 'new' anglers interviewed in 2016 were under the age of 34, and approximately 54% of this group would have harvested a steelhead. Similarly, 54% of anglers over the age of 34 would have harvested a steelhead (Table 7).

Overall, 93% of anglers interviewed were primarily fishing for Rainbow Trout (steelhead or Kamloops). Approximately 41% of anglers primarily fishing for steelhead said they would have harvested a steelhead if regulations allowed. The majority of anglers primarily fishing for Kamloops (73%) or Coho Salmon (71%) would have harvested a steelhead. Approximately half of all anglers who targeted Brook Trout and other species (Lake Trout, Chinook Salmon, Smallmouth Bass, and Suckers) would have harvested a steelhead, but the number of anglers targeting these species were low (Table 8).

DISCUSSION

Fishing pressure and catch during the 2016 early-spring creel survey was very similar to the early-spring creel 2013, and much higher than early-spring 2015. Almost all of the Kamloops caught in previous early-spring creel surveys were harvested. In these three years combined, the estimated number of Kamloops caught in the early-spring creel survey was 495 and in the annual spring creel survey was 4,251. This shows that Kamloops catch in the annual spring creel was likely underestimated by approximately 11%, on average; however, within years this ranged from 4.4% (31 of 709) in 2015 to 14.5% (240 of 1,657) in 2013. Depending on fishing conditions, Kamloops harvested in the annual spring creel survey could be underestimated without accounting for catch during the early-spring season. The annual spring creel survey should encompass the early-spring period whenever possible, particularly in years with environmental conditions similar to 2013 and 2016.

North Shore rivers experienced above average fishing pressure in 2016. The lower shore saw much higher angling pressure than the upper shore, however, angling pressure was the third highest on record in the lower shore and was the highest on record in the upper shore. McQuade/Talmadge River, Knife River, Devil Track River and Kadunce Creek all experienced the highest angling pressure in the history of the spring creel survey. The angler population estimate showed that more anglers fished the North Shore in spring 2016 than ever before, which included nearly double the historic average of 'new' anglers interviewed. The above average fishing pressure and numbers of anglers who fished the North Shore in 2016 was most likely driven by ideal fishing conditions. Ice cleared rivers in early-April of 2016 and the lake and streams provided suitable fishing conditions for most of the spring season. There also was a noticeable increase in attention toward the steelhead fishery via social media and newspapers in spring 2015 and 2016. A significant number of steelhead returned to north shore rivers in these years, particularly at the Knife River. There was a noticeable increase social media posts made by North Shore

stakeholder groups in 2016 to promote the MNDNRs Steelhead Genetics Project, which was also featured in Duluth/Superior area and the Twin Cities newspapers. Although somewhat speculative, the increase in media attention could have led more anglers to fish the North Shore in 2016.

Shorewide catch and catch-rates for steelhead were above average in 2016 and have continued to improve over the last decade. Catch-rates in the upper shore have remained higher than lower shore rivers, and the upper shore catch-rate has now remained above 0.15 fish per angler-hour (6.6 hours per fish caught) in 14 of the last 15 years. Shorewide, the catch-rate of steelhead increased from the late 1990's until 2006. Since 2006, the shorewide catch-rate has remained consistently high but more variable among years which could be an indication that steelhead abundances have reached (or are close to reaching) equilibrium with the available forage base and other predators in Lake Superior. Unlike many other limiting factors, such as prey availability or environmental conditions, stream habitat is something that can be addressed to improve steelhead populations. Poor spawning and rearing habitat in North Shore streams has long been a limitation to steelhead production (Smith and Moyle 1944). Future management strategies for steelhead will prioritize fish habitat restoration and enhancement, particularly spawning and nursery habitat in tributaries (Goldsworthy et al., *in review*).

The catch-and-release regulation for steelhead has been in effect since August 1997. Regulation compliance was moderate in 2016, with an estimated 39 steelhead that were illegally harvested (0.6% of all steelhead caught). The catch-and-release regulation was discussed with the Lake Superior Advisory Group (LSAG) on February 15, 2015 during meetings to revise the 2006 Fisheries Management Plan for the Minnesota Waters of Lake Superior (Schreiner et al. 2006). Feedback from the LSAG included both the desire to maintain the catch-and-release regulation and to establish new criteria that would initiate discussions on changes to harvest regulations. Based on this feedback, the MNDNR developed criteria for the lower shore and upper shore, which will be outlined in Goldsworthy et al. (*in review*).

Kamloops catch and catch-rates were higher in 2016 than the previous two years, but still remained well below the historic average. The catch-rate in the lower shore was the fourth lowest on record since 1992. Catch and catch-rates have decreased over time but have remained relatively consistent since 2006 with no marked increase nor decrease. The majority of Kamloops were caught in the lower shore, with few reported in the upper shore. Stocking locations explain most of the catch distribution of Kamloops in the spring creel survey. The low catch of Kamloops in recent years could be a function of environmental and lake conditions, intra- or interspecific competition for resources (prey), and/or changes to the hatchery production and stocking protocols. Spring creel survey data shows that the angling effort for Kamloops in the lake is very dependent on the daily lake conditions, whereas fishing is often not effective with strong northeast winds and/or floating ice. This also could be a function of competition for resources (prey) with steelhead or other predators in Lake Superior. Recent diet analyses found that Kamloops had a higher percentage of fish in their diet than previously estimated by Negus et al. (2008), which indicated that competition for prey with other predators in Lake Superior might be more

than previously assumed (Negus and Hoffman 2013). The survival of all fish species in Lake Superior, including Kamloops, is largely dictated by lake conditions (e.g., water temperature) that fluctuate from year-to-year and are impossible to control.

At the Lester River, Kamloops catch and catch-rates improved in 2016 but were still lower than historic averages. The MNDNR and some anglers are still concerned that the low catch and catch rates in recent years could have resulted from recent changes to the hatchery production and stocking protocols that potentially increased straying and/or decreased survival in Lake Superior. Reports of Kamloops straying to other jurisdictions have increased in recent years, and the MNDNR has had reports of adipose clipped Rainbow Trout caught in the St. Mary's River in Michigan, the Brule River in Wisconsin, and rivers both on the upper North Shore of Minnesota and into Canada. Some straying of stocked Kamloops has and will always occur. However, increased reports of straying and decreased catch and catch-rates have become more apparent in recent years. The increased reports of straying beyond the Lester and French rivers are concerns shared by MNDNR and anglers, particularly regarding potential impacts of introgression with naturalized steelhead. Negus (1999) found poorer survival of eggs from Kamloops x steelhead crosses compared to steelhead x steelhead crosses. If male Kamloops spawn unsuccessfully with female steelhead, then steelhead gametes are wasted. Kamloops have been shown to successfully spawn with steelhead in the wild and produce juvenile hybrids (Close 1999). Juvenile hybrids survive significantly less well compared to juvenile steelhead in the stream environment (Miller et al. 2004), which is simply another form of gamete wastage. If hybrids did survive to reproduce, genetic introgression could occur which would decrease the fitness of wild steelhead. More recently, Page et al. (2011) modeled the effects of Kamloops stocking on wild steelhead populations and concluded that continual stocking of Kamloops greatly increases the risk of extinction of wild steelhead through non-introgressive hybridization.

The number of Brook Trout caught in 2016 was approximately 38% higher than average. Brook Trout were the second most commonly caught species after Rainbow Trout, and have been reported in the spring creel survey every year since 1992. Though many Brook Trout are caught each year, very few anglers actively target them below barriers in the spring probably because shorewide catch and catch rates for Brook Trout (44 angler-hours per fish) are much lower than for steelhead (7.8 angler-hours per fish) at this time of year. Coaster Brook Trout rehabilitation is a management priority for the MNDNR, and regulation compliance is essential for this to occur. Some illegal harvest of Brook Trout was observed by the creel census clerks in 2016.

Catch and fishing pressure for Coho salmon remains sporadic and is largely dependent on the fishing conditions of Lake Superior and year-class abundances. All Coho Salmon caught in Minnesota waters are naturally-produced because the last Coho Salmon stocking event occurred in Michigan in 2006. Due to limited spawning habitat on Minnesota's North Shore, most Coho Salmon caught in

Minnesota waters are likely wild fish that migrated from other jurisdictions (e.g., Wisconsin, Michigan, and Ontario, Canada).

Most anglers interviewed in 2016 would have harvested a steelhead if regulations allowed, and most steelhead would have been harvested in rivers during the spring creel season. By proportion, more anglers interviewed in the early-spring creel would have harvested a steelhead (71%) than anglers interviewed in the annual spring creel (54%). However, significantly more anglers fished during the annual spring creel period (after ice thawed) than in the early-spring period. By comparison, approximately 80% (597) more anglers would have harvested a steelhead in the annual spring creel than in the early-spring creel. Anglers fishing in the lake, particularly those fishing the lake prior to ice out in rivers, were more 'harvest orientated' (would have harvested a steelhead) than anglers who were fishing in rivers. Typically, very few steelhead are caught by shore anglers fishing in the lake, especially during early-spring creel period (22 caught in 2016).

If steelhead harvest was allowed in 2016, the take would have been spread among anglers from all age-groups. The majority of all age-groups would have harvested a steelhead, and a slightly higher proportion of anglers from the 25 to 34 age-group (28%) would have harvested steelhead compared to other age-groups. These responses were provided from hundreds of interviews, with a relatively high number of anglers per age-group.

The percent of responses to steelhead harvest differed among the primary species sought. Most (93%) anglers who fish the North Shore in the spring primarily target Kamloops or steelhead. It has been assumed that most anglers fishing for steelhead are not 'fishing for harvest' because currently the regulations does not allow harvest. However, 326 (41%) of steelhead anglers interviewed in 2016 would have harvested a steelhead if regulations allowed. It has also been assumed that most anglers fishing for Kamloops or Coho salmon are 'fishing for harvest' given that regulations allow harvest. Among Kamloops and Coho salmon anglers, 355 (73%) and 45 (71%) of anglers would have harvested a steelhead. If all steelhead, Kamloops or Coho salmon anglers who responded 'yes' caught and harvested one steelhead in 2016, 726 steelhead would have been harvested. It's important to consider that anglers who targeted Kamloops and Coho salmon may revert to targeting steelhead if steelhead harvest was allowed, which would add to the proportion of steelhead anglers who support steelhead harvest.

If regulations allowed, the majority of anglers interviewed in 2016 would have harvested a steelhead. These results can be viewed as encouraging or a cause of concern. This shows that a limited steelhead harvest regulation would be supported by the majority of anglers who fished the North Shore in 2016. On the other hand, if steelhead harvest were allowed in 2016, even at a limited capacity (i.e., harvest tag-one per year), it would have substantially increased harvest mortality for steelhead. For example, if everyone who responded 'yes' in 2016 caught and harvested one steelhead, a minimum of 742 steelhead would have been harvested in 2016. This would have exceeded the annual return of steelhead at the Knife River, the largest spawning run of steelhead on the North Shore, in most years. It

is likely that harvest, even if limited, could greatly influence annual steelhead returns on the North Shore. Given that angler's responses to harvest varied among rivers, the potential impact of harvest would likely be different among streams.

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Segment 32-2
Study 4
Job 1004

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISHERIES

COMPLETION REPORT:


LAKE SUPERIOR SPRING CREEL SURVEY

2016

Completed by:
Nick R. Peterson

 2/21/2017

Area Supervisor \ Date

 5/11/2017

Regional Fisheries Approval \ Date

Table 1. Fishing pressure estimates (angler-hours) from the annual Lake Superior spring creel survey by shore location, station and year.

Station	Year												Mean	Range
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016			
Lester River	5,312	5,105	5,315	10,476	9,892	6,644	4,928	3,588	2,580	3,699	7,293	5,995	2,580 - 10,476	
McQuade/Talmadge	—	—	—	—	1,399	2,996	3,938	2,407	1,340	1,659	5,453	2,290	1,340 - 3,938	
French River	2,112	4,610	2,456	6,068	6,505	3,206	3,015	3,544	3,080	2,409	6,014	4,096	2,112 - 8,544	
Sucker River	7,066	3,385	3,823	6,376	6,824	4,620	6,008	3,566	2,880	2,265	4,914	5,513	2,880 - 12,990	
Knife River	2,887	2,635	2,508	6,253	4,885	3,565	3,308	1,903	1,540	1,629	6,597	2,967	1,225 - 6,253	
Stewart River	3,134	2,808	3,991	3,957	4,079	5,782	1,557	1,885	1,280	1,653	3,385	2,352	720 - 5,782	
Silver Creek	880	1,299	1,256	1,230	930	1,996	818	131	312	577	582	861	131 - 1,996	
Gooseberry River	887	886	493	1,728	1,418	1,994	1,076	325	257	532	1,105	995	257 - 2,475	
Split Rock River	2,798	3,956	1,973	2,050	3,212	5,400	2,087	1,940	1,200	1,217	1,993	2,171	1,145 - 5,400	
Beaver River	466	594	362	481	776	824	820	304	233	473	436	633	233 - 1,159	
Baptism River	2,198	1,046	1,506	1,198	3,570	2,771	2,662	866	630	1,173	2,285	1,375	448 - 3,570	
Cross River	260	151	432	444	559	900	383	525	339	338	700	285	53 - 900	
Temperance River	181	198	472	651	434	488	170	630	83	359	370	349	77 - 788	
Poplar River	338	548	580	291	439	888	383	420	330	357	645	498	168 - 1,347	
Cascade River	455	774	767	346	675	488	905	296	309	438	846	511	194 - 939	
Devil Track River	242	1,089	818	447	1,264	1,050	1,163	857	677	1,355	1,421	594	75 - 1,264	
Kadunce Creek	228	79	502	581	259	746	500	642	770	448	1,420	423	79 - 1,365	
Brule River	560	557	796	800	1,059	1,283	1,206	963	767	539	1,410	754	207 - 1,505	
Lower Shore	25,075	24,684	21,816	38,137	39,142	36,203	26,735	19,289	14,469	15,641	37,336	25,272	14,469 - 39,994	
Upper Shore	4,927	5,036	6,235	5,238	9,035	9,438	8,192	5,503	4,138	5,479	9,533	5,408	3,046 - 9,438	
Shorewide	30,003	29,719	28,051	43,375	48,177	45,641	34,927	24,792	18,607	21,120	46,868	30,695	18,607 - 48,177	

Table 2. Fishing pressure estimates (angler-hours \pm standard error [SE]) from the 2016 Lake Superior spring creel survey by shore location and station.

Station	Stream Pressure	(SE)	Lake Pressure	(SE)	Total Pressure	(SE)
Lester River	6,485	1,040	808	194	7,293	1,058
McQuade/Talmadge	808	178	4,645	943	5,453	960
French River	0	0	6,014	1,095	6,014	1,095
Sucker River	4,600	796	314	134	4,914	807
Knife River	6,597	1,008	0	0	6,597	1,008
Stewart River	3,334	784	51	51	3,385	785
Silver Creek	582	223	0	0	582	223
Gooseberry River	1,105	309	0	0	1,105	309
Split Rock River	1,693	389	300	144	1,993	414
Beaver River	436	173	0	0	436	173
Baptism River	2,285	564	0	0	2,285	564
Cross River	642	191	58	41	700	195
Temperance River	370	170	0	0	370	170
Poplar River	645	174	0	0	645	174
Cascade River	649	185	198	97	846	208
Devil Track River	1,421	387	0	0	1,421	387
Kadunce Creek	1,420	352	0	0	1,420	352
Brule River	1,410	304	0	0	1,410	304
Lower Shore	25,203	1,916	12,132	1,472	37,336	2,416
Upper Shore	9,277	919	256	105	9,533	925
Shorewide	34,480	2,125	12,388	1,476	46,868	2,587

Table 3. Rainbow Trout catch and catch-rate (fish per angler-hour) estimates in the 2016 Lake Superior spring creel survey by station.

Station		Unclipped Steelhead						Clipped Rainbow Trout (Kamloops)					
		Catch			Catch-rate			Catch			Catch-rate		
		All	inches	(SE)	All	inches	(SE)	All	inches	(SE)	All	inches	(SE)
Lester River	Harvested	10	10	11	0.001	0.001	0.002	306	306	98	0.042	0.042	0.015
	Released	997	895	252	0.137	0.123	0.030	92	81	41	0.013	0.011	0.006
	Total	1,007	905	254	0.138	0.124	0.030	398	387	110	0.055	0.053	0.016
McQuade Harbor	Harvested	0	0	0	0.000	0.000	0.000	378	378	123	0.069	0.069	0.025
	Released	78	78	39	0.014	0.014	0.011	117	96	50	0.021	0.018	0.010
	Total	78	78	39	0.014	0.014	0.011	495	473	155	0.091	0.087	0.029
French River	Harvested	0	0	0	0.000	0.000	0.000	492	492	124	0.082	0.082	0.014
	Released	33	25	13	0.005	0.004	0.002	57	41	19	0.010	0.007	0.003
	Total	33	25	13	0.005	0.004	0.002	550	533	124	0.091	0.089	0.013
Sucker River	Harvested	0	0	0	0.000	0.000	0.000	243	243	70	0.049	0.049	0.012
	Released	731	721	182	0.149	0.147	0.034	68	58	24	0.014	0.012	0.004
	Total	731	721	182	0.149	0.147	0.034	311	301	82	0.063	0.061	0.013
Knife River	Harvested	0	0	0	0.000	0.000	0.000	56	56	29	0.008	0.008	0.004
	Released	952	918	180	0.144	0.139	0.017	45	45	20	0.007	0.007	0.003
	Total	952	918	180	0.144	0.139	0.017	101	101	36	0.015	0.015	0.005
Stewart River	Harvested	0	0	0	0.000	0.000	0.000	27	27	18	0.008	0.008	0.005
	Released	804	786	281	0.237	0.232	0.064	63	63	51	0.018	0.018	0.015
	Total	804	786	281	0.237	0.232	0.064	89	89	50	0.026	0.026	0.013
Silver Creek	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	93	93	55	0.160	0.160	0.069	0	0	0	0.000	0.000	0.000
	Total	93	93	55	0.160	0.160	0.069	0	0	0	0.000	0.000	0.000
Gooseberry River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	519	390	131	0.470	0.353	0.064	0	0	0	0.000	0.000	0.000
	Total	519	390	131	0.470	0.353	0.064	0	0	0	0.000	0.000	0.000
Split Rock River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	352	336	116	0.177	0.169	0.048	0	0	0	0.000	0.000	0.000
	Total	352	336	116	0.177	0.169	0.048	0	0	0	0.000	0.000	0.000
Lower Shore Total	Harvested	10	10	11	0.000	0.000	0.000	1,502	1,502	215	0.040	0.040	0.006
	Released	4,559	4,241	493	0.122	0.114	0.015	442	384	90	0.012	0.010	0.003
	Total	4,569	4,251	494	0.122	0.114	0.015	1,943	1,885	249	0.052	0.050	0.007

Table 3 continued. Rainbow Trout catch and catch-rate (fish per angler-hour) estimates in the 2016 Lake Superior spring creel survey by station.

Station		Unclipped Steelhead						Clipped Rainbow Trout (Kamloops)					
		Catch			Catch-rate			Catch			Catch-rate		
		All	inches	(SE)	All	inches	(SE)	All	inches	(SE)	All	inches	(SE)
Beaver River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	176	176	86	0.403	0.403	0.138	0	0	0	0.000	0.000	0.000
	Total	176	176	86	0.403	0.403	0.138	0	0	0	0.000	0.000	0.000
Baptism River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	466	449	167	0.204	0.196	0.056	0	0	0	0.000	0.000	0.000
	Total	466	449	167	0.204	0.196	0.056	0	0	0	0.000	0.000	0.000
Cross River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	166	119	66	0.237	0.169	0.084	0	0	0	0.000	0.000	0.000
	Total	166	119	66	0.237	0.169	0.084	0	0	0	0.000	0.000	0.000
Temperance River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	45	45	33	0.122	0.122	0.090	0	0	0	0.000	0.000	0.000
	Total	45	45	33	0.122	0.122	0.090	0	0	0	0.000	0.000	0.000
Poplar River	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	93	93	64	0.145	0.145	0.091	0	0	0	0.000	0.000	0.000
	Total	93	93	64	0.145	0.145	0.091	0	0	0	0.000	0.000	0.000
Cascade River	Harvested	29	29	32	0.034	0.034	0.067	29	29	30	0.034	0.034	0.059
	Released	161	161	61	0.190	0.190	0.056	0	0	0	0.000	0.000	0.000
	Total	190	190	69	0.224	0.224	0.087	29	29	30	0.034	0.034	0.059
Devil Track River	Harvested	0	0	0	0.000	0.000	0.000	17	17	18	0.012	0.012	0.013
	Released	219	152	92	0.154	0.107	0.058	0	0	0	0.000	0.000	0.000
	Total	219	152	92	0.154	0.107	0.058	17	17	18	0.012	0.012	0.013
Kadunce Creek	Harvested	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
	Released	385	371	104	0.271	0.261	0.035	0	0	0	0.000	0.000	0.000
	Total	385	371	104	0.271	0.261	0.035	0	0	0	0.000	0.000	0.000
Brule River	Harvested	0	0	0	0.000	0.000	0.000	36	36	28	0.026	0.026	0.019
	Released	218	164	119	0.155	0.116	0.081	0	0	0	0.000	0.000	0.000
	Total	218	164	119	0.155	0.116	0.081	36	36	28	0.026	0.026	0.019
Upper Shore	Harvested	29	29	32	0.003	0.003	0.003	82	82	45	0.009	0.009	0.005
	Released	1,929	1,728	287	0.202	0.181	0.035	0	0	0	0.000	0.000	0.000
	Total	1,957	1,757	289	0.205	0.184	0.035	82	82	45	0.009	0.009	0.005
Shorewide	Harvested	39	39	34	0.001	0.001	0.001	1,584	1,584	219	0.034	0.034	0.005
	Released	6,487	5,969	571	0.138	0.127	0.014	442	384	90	0.009	0.008	0.002
	Total	6,526	6,008	572	0.139	0.128	0.014	2,025	1,967	252	0.043	0.042	0.006

Table 4. Yield, average length (inches) and average weight (pounds) of select species caught in the 2016 Lake Superior spring creel survey.

Species	Yield			Average Length (inches)			Average Weight (pounds)		
	Number Caught	Number Harvested	Pounds Harvested	Harvested	Released	All (SE)	Harvested	Released	All (SE)
Brook Trout	1,078	45	20	9.0	10.8	10.7 0.24	0.5	0.9	0.9 0.07
Brown Trout	31	0	0	0.0	11.0	11.0 1.53	--	1.0	1.0 0.24
Coho Salmon	55	55	103	18.4	0.0	18.4 0.53	1.9	0.0	1.9 0.16
Kamloops ($\geq 16"$)	1,967	1584	7,590	23.7	23.0	23.6 0.20	4.8	4.5	4.7 0.11
Kamloops ($< 16"$)	58	0	0	0.0	13.3	13.3 1.85	--	--	-- --
Northern Pike	40	0	0	0.0	26.0	26.0 6.00	0.0	4.4	4.4 2.79
Sucker species	622	45	123	18.4	16.9	17.7 0.53	2.7	2.9	2.2 0.38
Unclipped Steelhead ($\geq 16"$)	6,008	39	161	22.6	25.2	25.2 0.12	4.1	5.0	5.0 0.06
Unclipped Steelhead ($< 16"$)	518	0	0	0.0	9.8	9.8 0.49	--	--	-- --

Table 5. The number of 'new' (first time interviewed in 2016), 'recap' (already interviewed in 2016), and total number of anglers who were interviewed in the 2016 Lake Superior spring creel survey by state or country of origin.

State/Country	'New' Anglers	'Recap' Anglers	All Anglers
Alaska	1	0	1
Colorado	3	2	5
Iowa	3	0	3
Illinois	1	0	1
Michigan	2	0	2
Minnesota	1,286	764	2,050
Montana	5	1	6
North Dakota	1	0	1
New York	1	0	1
South Dakota	1	1	2
Texas	1	1	2
Wisconsin	45	17	62
Canada	2	0	2
Germany	2	0	2
Sweden	2	0	2
Norway	1	0	1
All States/Countries	1,357	786	2,143
Outside Minnesota	71	22	93

Table 6. The number and percent of responses by anglers to 'If regulations allowed a limited steelhead harvest, would you keep one?' by shore zone and location. Summary includes only 'new' (first time interviewed this spring) interviews collected in the 2016 Lake Superior spring creel survey and the 2016 early-spring creel survey.

Shore Zone	Location	No	(%)	Yes	(%)	Total
Lower Shore	Lester River	82	(42%)	114	(58%)	196
	McQuade/Talmadge	34	(25%)	102	(75%)	136
	French River	66	(29%)	159	(71%)	225
	Blue Bird Landing	3	(27%)	8	(73%)	11
	Sucker River	73	(47%)	83	(53%)	156
	Stoney Point	1	(11%)	8	(89%)	9
	Knife River	105	(55%)	85	(45%)	190
	Stewart River	53	(49%)	55	(51%)	108
	Silver Creek	11	(55%)	9	(45%)	20
	Gooseberry River	23	(72%)	9	(28%)	32
	Split Rock River	41	(67%)	20	(33%)	61
Upper Shore	Beaver River	4	(67%)	2	(33%)	6
	Baptism River	38	(69%)	17	(31%)	55
	Cross River	12	(67%)	6	(33%)	18
	Temperance River	6	(50%)	6	(50%)	12
	Poplar River	7	(58%)	5	(42%)	12
	Cascade River	9	(28%)	23	(72%)	32
	Devil Track River	21	(72%)	8	(28%)	29
	Kadunce River	19	(61%)	12	(39%)	31
	Brule River	22	(67%)	11	(33%)	33
Totals	Lower Shore	492	(43%)	652	(57%)	1,144
	Upper Shore	138	(61%)	90	(39%)	228
	Shorewide	630	(46%)	742	(54%)	1,372

Table 7. The number and percent of responses by anglers to 'If regulations allowed a limited steelhead harvest, would you keep one?' by age group. Summary includes only 'new' (first time interviewed this spring) interviews collected in the 2016 Lake Superior spring creel survey and the 2016 early-spring creel survey.

Age Group	No	(%)	Yes	(%)	Total	(%)
0 - 15	19	(34%)	37	(66%)	56	(4%)
16 - 24	100	(43%)	132	(57%)	232	(17%)
25 - 34	192	(50%)	193	(50%)	385	(28%)
35 - 44	83	(49%)	88	(51%)	171	(13%)
45 - 54	85	(44%)	110	(56%)	195	(14%)
55 - 64	100	(46%)	118	(54%)	218	(16%)
Over 64	49	(45%)	61	(55%)	110	(8%)
Total	628	(46%)	739	(54%)	1367	(100%)

*Age was not reported for 5 anglers.

Table 8. The number and percent of responses by anglers to 'If regulations allowed a limited steelhead harvest, would you keep one?' by the primary species sought. Summary includes only 'new' (first time interviewed this spring) interviews collected in the 2016 Lake Superior spring creel survey and the 2016 early-spring creel survey.

Primary Species Sought	No	(%)	Yes	(%)	Total	(%)
Brook Trout	10	(53%)	9	(47%)	19	(1%)
Brown Trout	1	(33%)	2	(67%)	3	(0%)
Coho Salmon	18	(29%)	45	(71%)	63	(5%)
Kamloops Rainbow Trout	132	(27%)	355	(73%)	487	(35%)
Steelhead Rainbow Trout	464	(59%)	326	(41%)	790	(58%)
Other species*	5	(50%)	5	(50%)	10	(1%)
Total	630	(46%)	742	(54%)	1,372	(100%)

*Other species includes Lake Trout, Chinook salmon, Smallmouth Bass, and Suckers

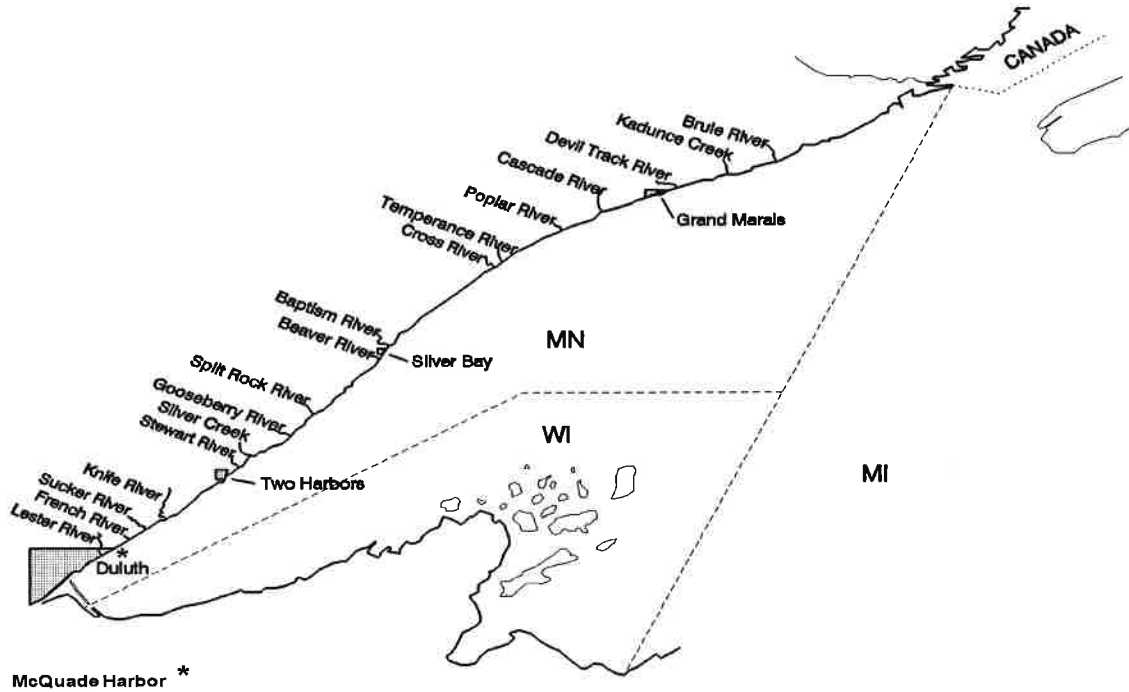


Figure 1. Sampling stations for the annual Lake Superior spring creel survey.

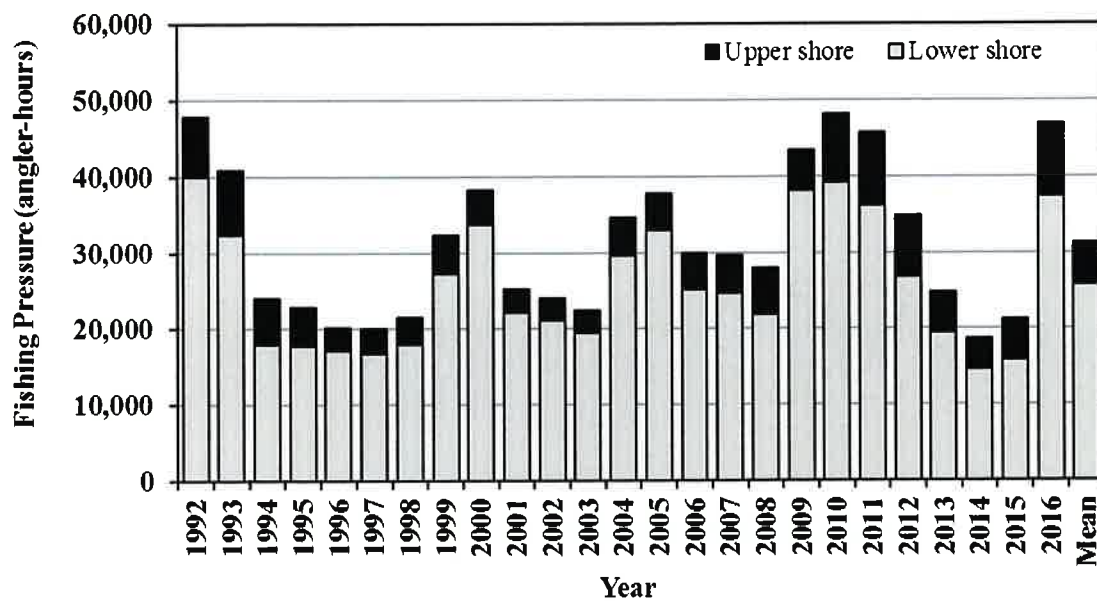


Figure 2. Fishing pressure (angler-hours) in the lower shore, upper shore, and shorewide from the Lake Superior spring creel survey by year, including the historic average from 1994 to 2016 (Mean).

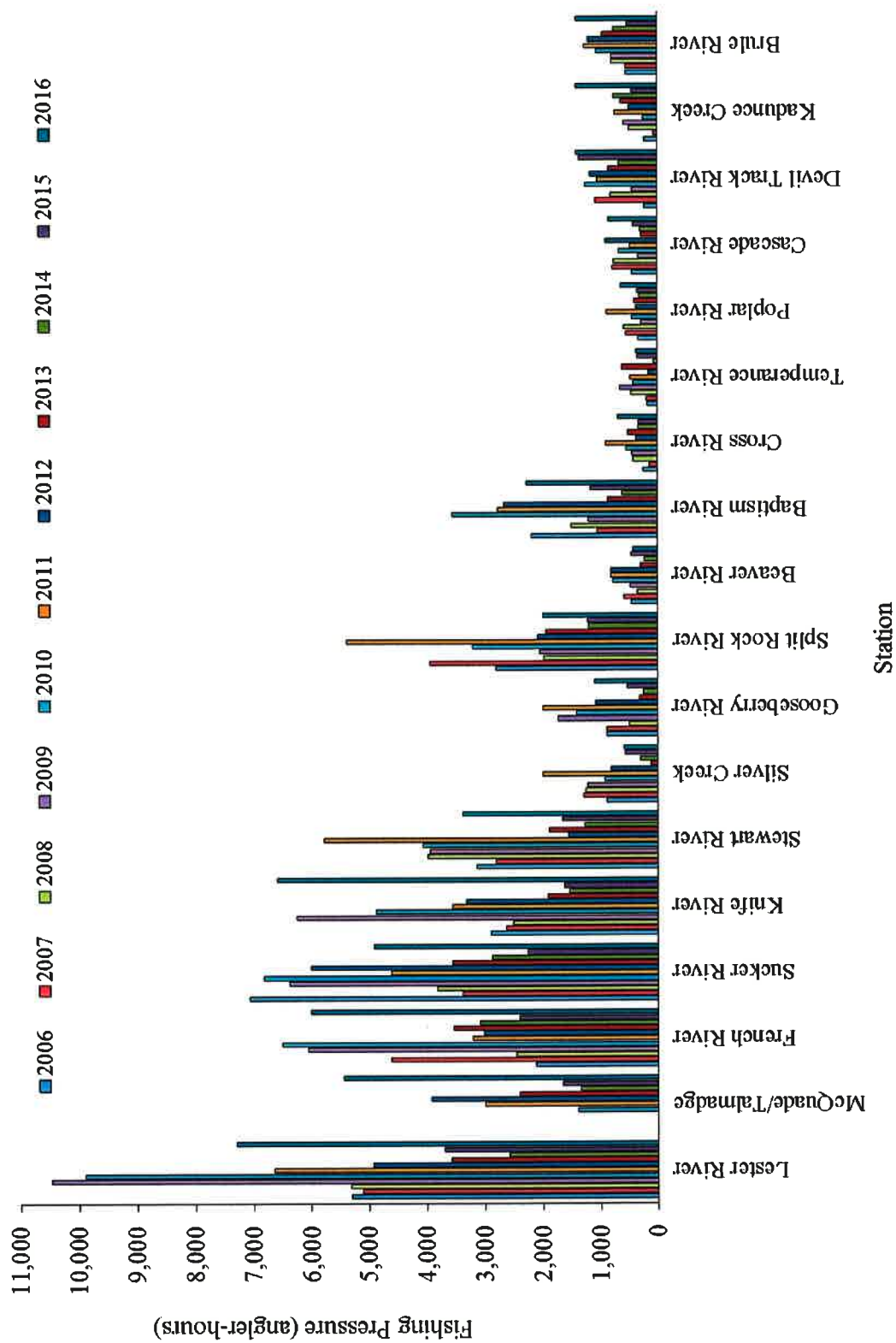


Figure 3. Fishing pressure (angler-hours) by station in the Lake Superior spring creel survey from 2006 to 2016.

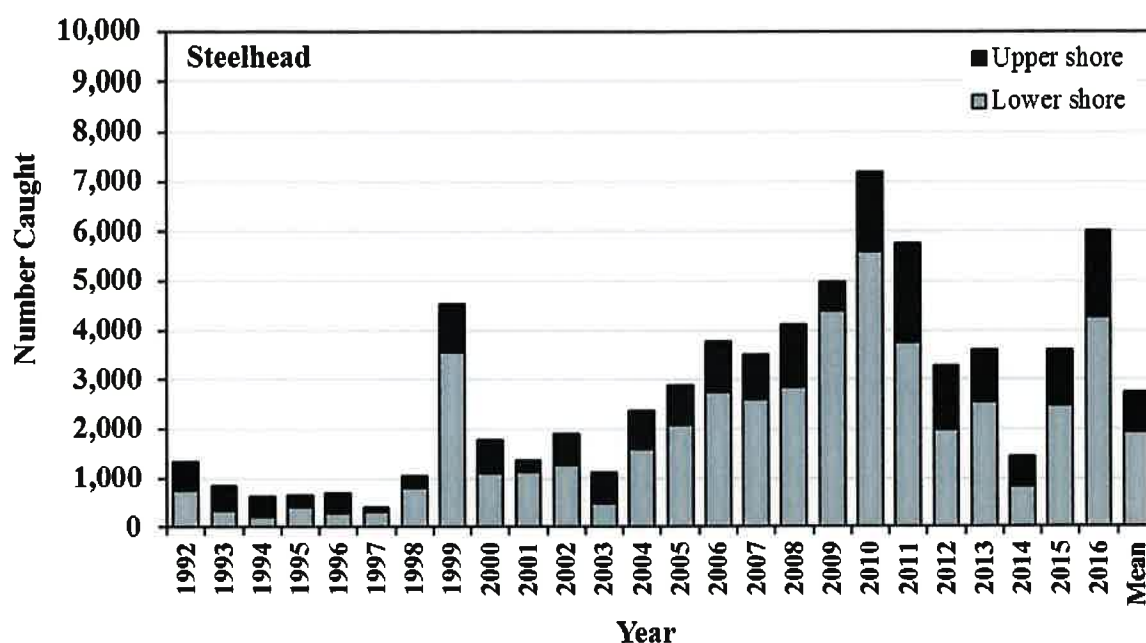


Figure 4. Number of steelhead ≥ 16 inches caught in the lower shore, upper shore, and shorewide from the Lake Superior spring creel survey by year from 1992 to 2016, including the historic average (Mean).

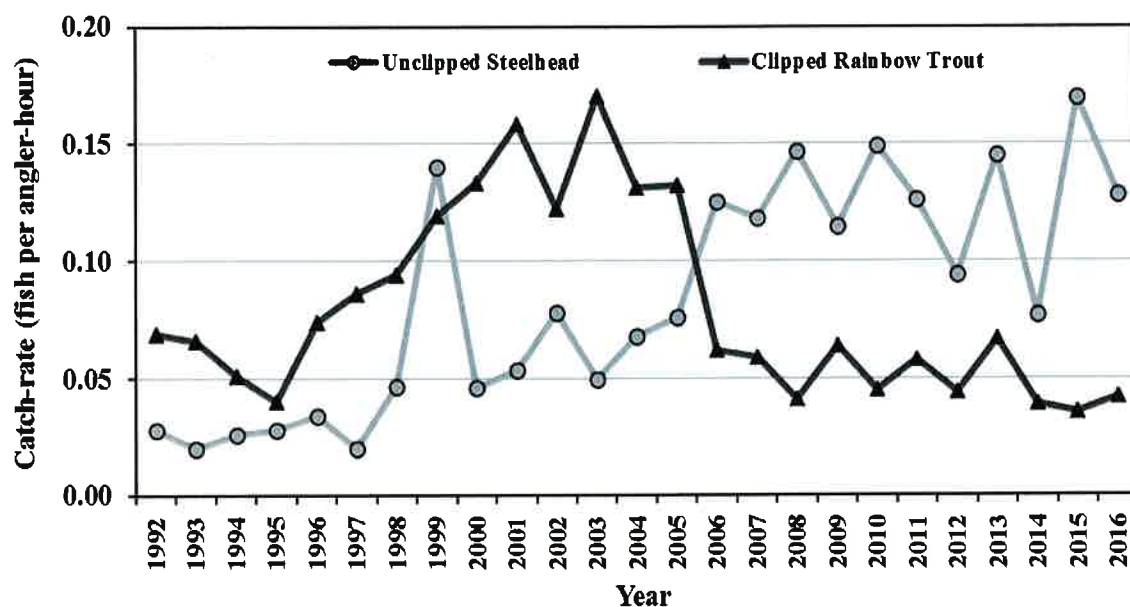


Figure 5. Shorewide catch-rate (fish per angler-hour) of steelhead and clipped Rainbow Trout (Kamloops and clipped steelhead) ≥ 16 inches from the Lake Superior spring creel survey by year.

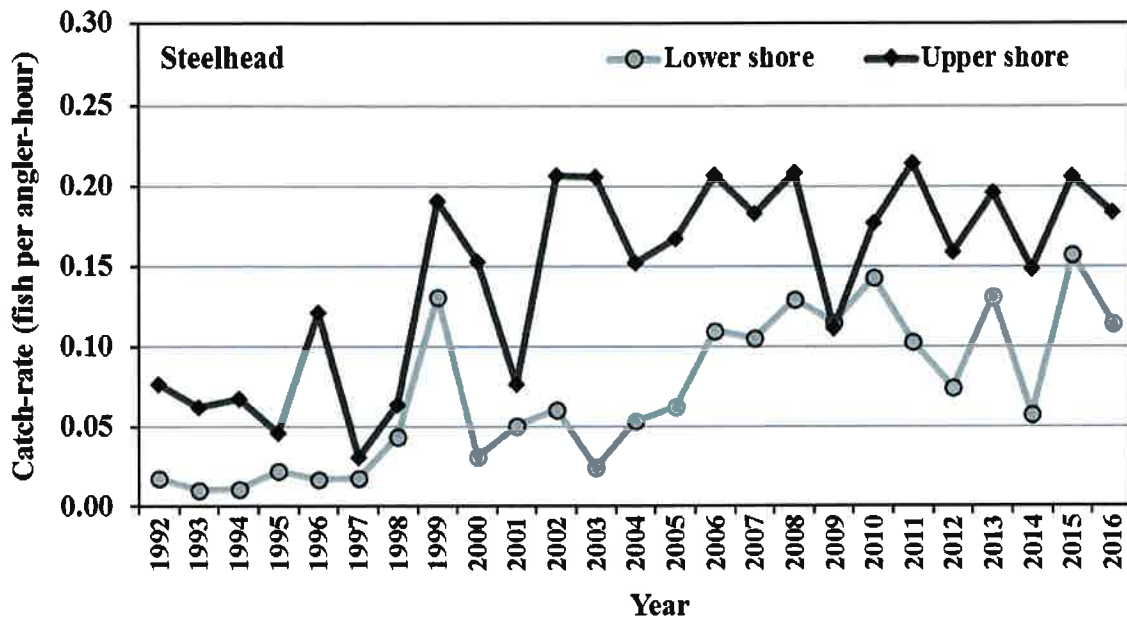


Figure 6. Catch-rate (fish per angler-hour) of steelhead ≥ 16 inches from the Lake Superior spring creel survey by year.

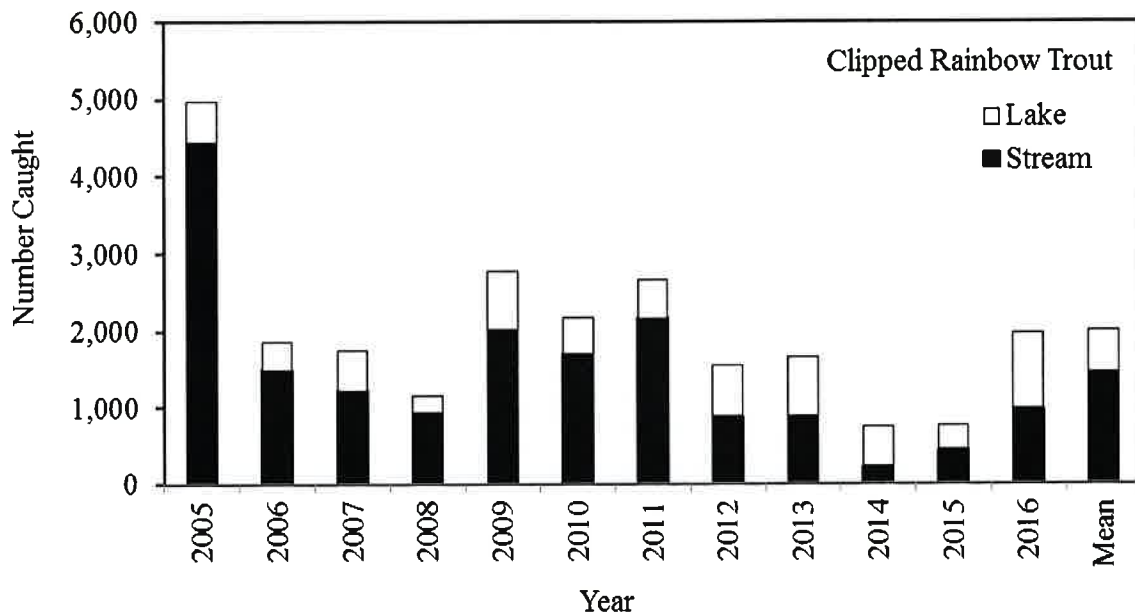


Figure 7. The number of clipped Rainbow Trout (Kamloops) ≥ 16 inches caught in the lake and stream from 2005 to 2016, and the average (Mean) from these years.

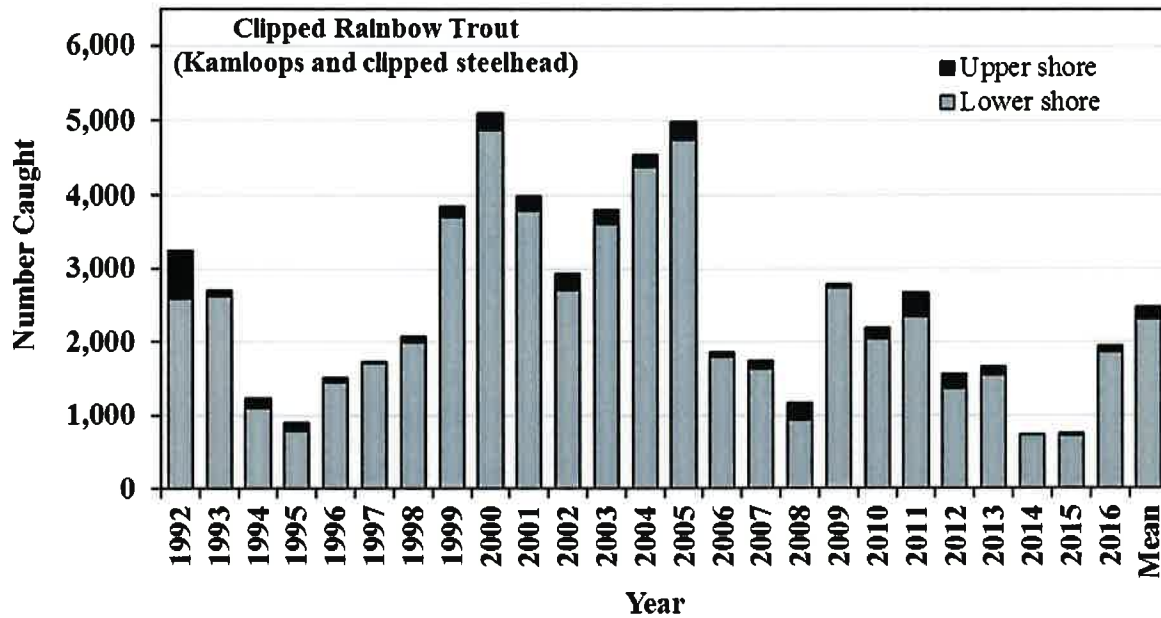


Figure 8. Number of clipped Rainbow Trout (Kamloops and clipped steelhead) ≥ 16 inches caught in the lower shore, upper shore, and shorewide from the Lake Superior spring creel survey by year from 1992 to 2016, including the historic average (Mean).

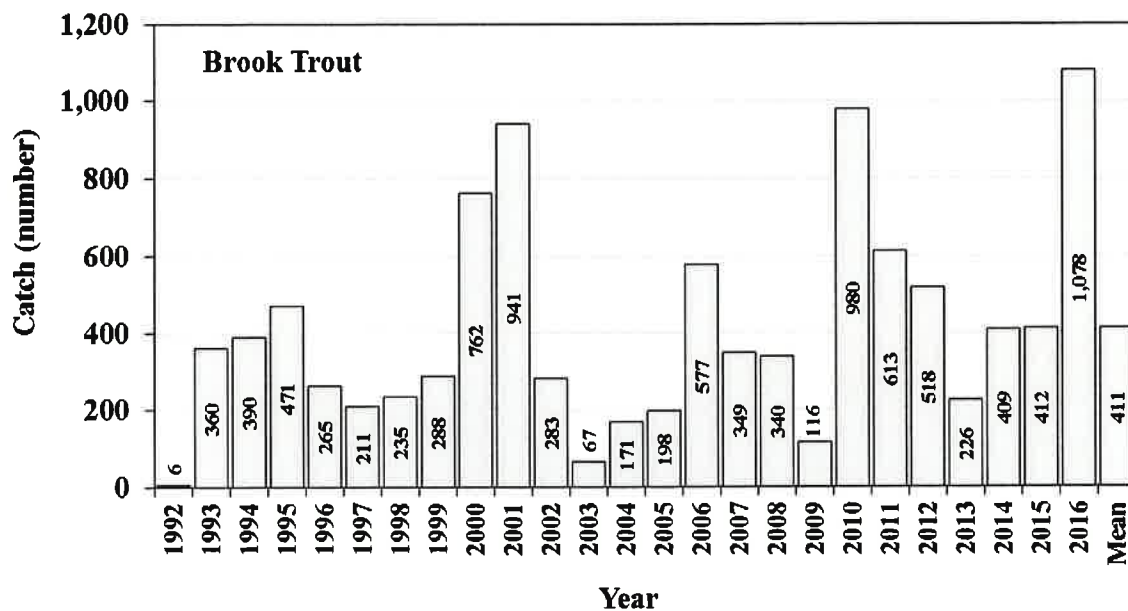


Figure 9. Number of Brook Trout caught by year during the Lake Superior spring creel survey from 1992 to 2016, including the historic mean (Mean).

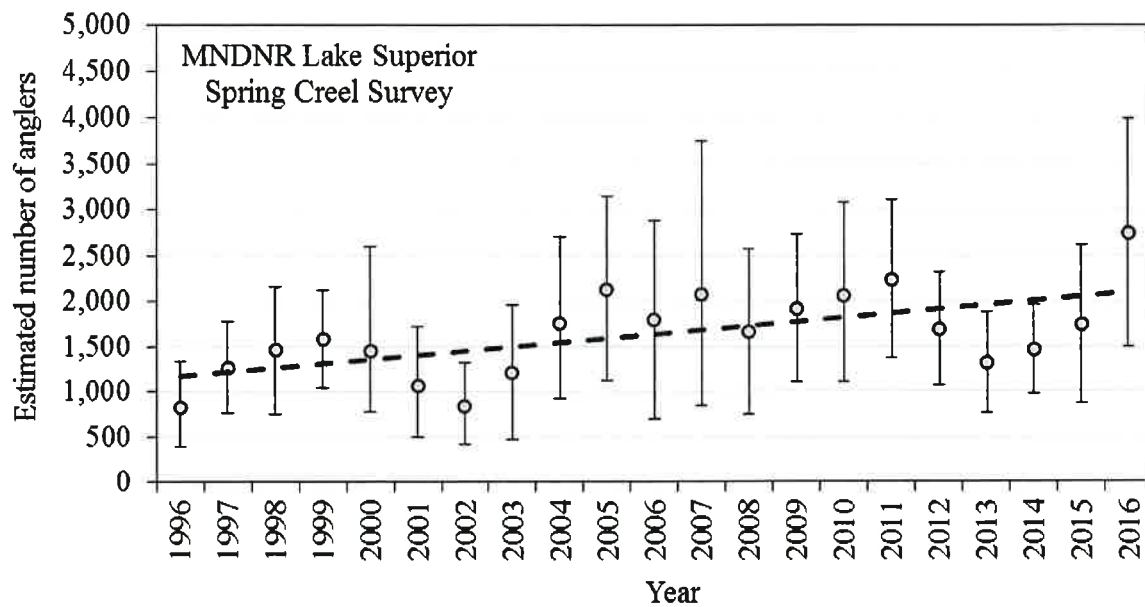


Figure 10. The estimated number of anglers that have participated in the Lake Superior spring fishery by year from 1996 to 2016. The dashed line shows the linear trendline for all years.

"If regulations allowed steelhead harvest, would you keep one?"

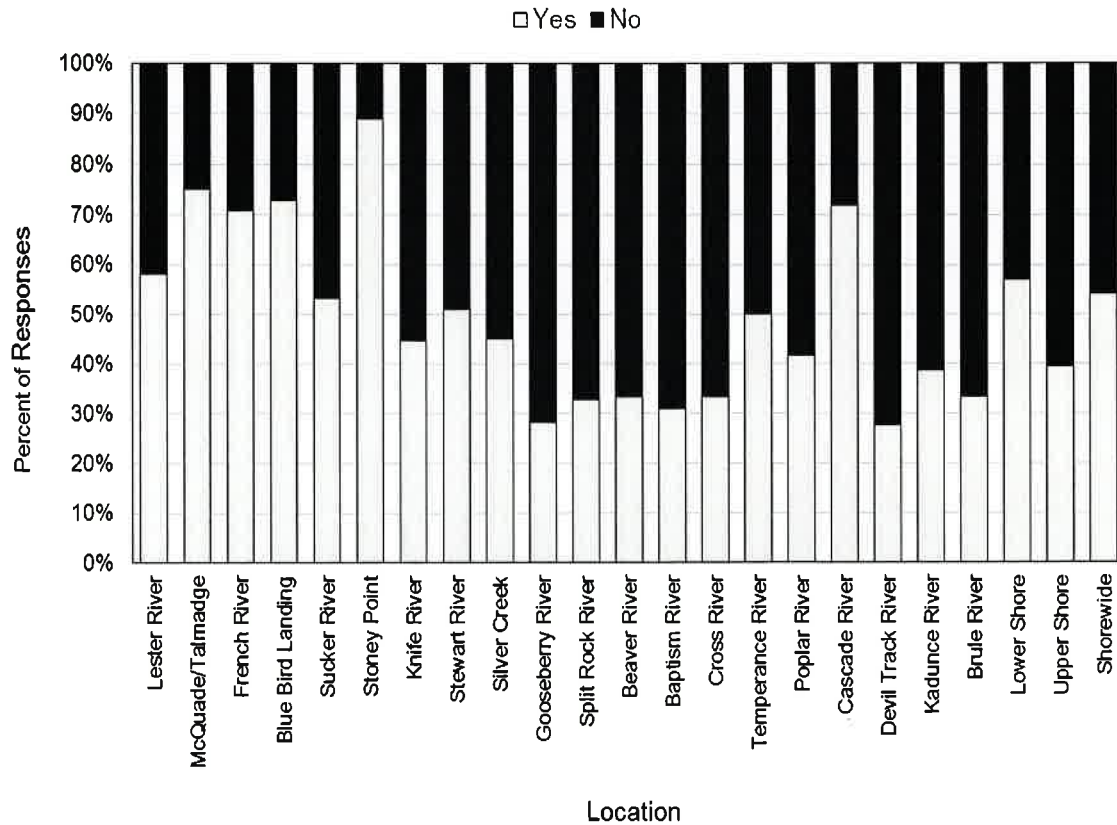


Figure 11. The percent of responses to 'If regulations allowed a limited steelhead harvest, would you keep one?' by creel location. This includes responses from 1,372 'new' (first time interviewed this spring) anglers interviewed during the Lake Superior early-spring creel survey and annual spring creel survey in 2016.