Minnesota
F29 Segment 31 (Year 2)
Study 3
Job 3

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
SECTION OF FISHERIES

SUPPLEMENTAL REPORT

Results of Operating the Juvenile and Adult Fish Trap on the Knife River 2014

Completed by:
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Introduction

The Knife River is an important river for anadromous fish because it contains approximately 43% of the entire spawning and rearing habitat along Minnesota's North Shore (Hassinger et al. 1974, Schreiner et al. 1992), and historically was believed to have a sizeable run of steelhead. The Knife River fish trap is an extremely valuable tool for evaluating steelhead rehabilitation efforts in the Knife River and along the North Shore. The primary goal for steelhead as stated in the 2006 Lake Superior Management Plan is to rehabilitate their stocks using Minnesota strain fish to a level that will allow limited angler harvest largely supported by natural reproduction (Schreiner et al. 2006).

This report is an annual update to the comprehensive juvenile report completed in 2006 (Ward and Blankenheim 2006) and the comprehensive adult report completed in 2007 (Ward 2007). A comprehensive juvenile and adult trap report will be completed on an as-need basis; an abbreviated report will be completely annually. Sampling procedures for the juvenile and adult trap are described in Ward and Blankenheim (2006) and Ward (2007). Specifications of trap design are described in Dexter and Schliep (2007).

Study Area

The Knife River (S-17) is a large tributary that flows for 40.9 kilometers and enters Lake Superior on the boundary of St. Louis and Lake counties (Figure 1). In the spring of 1996 the adult portion of the Knife River fish trap became operational, which samples individuals migrating upstream. Hereafter, this portion of the trap will be referred to as the adult trap. In the spring of 1997 an incline screen fish trap became operational within the trap facility and captures individuals moving downstream, which includes post-spawn adults and juvenile emigrants. Hereafter, this portion of the trap will be referred to as the juvenile trap. The trap is located at kilometer 0.8 upstream from the mouth of the Knife River.

Trap Reconstruction

On June 19th-20th of 2012, approximately 25.4 cm (10 inches) of rain fell in a 24 hour period. Discharge peaked at 337 cubic meters/second (cms) (11,915 cubic feet/second) which caused massive flooding in the Knife River. The Knife River trap sustained massive damage from the floodwaters and was not operational after June 19th for the rest of the year. Measures were undertaken in 2012 to ensure fish passage for fall migrants as well as for the spring Rainbow Trout run in 2013. Both the entrances to the adult trap and to the forebay were sealed off to prevent fish from entering the damaged structure. MN DNR personnel (Lake Superior Area staff

and Detroit Lakes construction crew) removed one of the pinned rocks on the eastern side of the falls to allow fish to ascend the river. Lake Superior Area staff also removed the timber and steel beam from the dam adjacent to the trap on the western side of the falls. Additionally, the Lake Superior Steelhead Association provided funds to excavate the jumping pools on the western side of the falls, which had completely filled in with sediment from the flood. Together the efforts allowed steelhead to bypass the damaged trap and continue their spawning voyage upstream.

After careful consideration, the decision was made to rebuild the trap because of the importance of the data it provides as well as the cost-effectiveness of rebuilding rather than completely demolishing the structure. Northland Constructors of Duluth was awarded the contract with a bid of $407,738. Once other costs were added in, the final cost was approximately $557,938. The cost to rebuild the trap qualified for 75% reimbursement from the U.S. Federal Emergency Management Agency (FEMA) and the remaining 25% was covered by state bonding funds dedicated to flood recovery efforts. The “dirt work” component of the project was completed in the fall of 2013 and consisted of removal of all flood debris and broken trap components, reconstruction of the road, and refilling voids around the trap with rock. The “hardware” component of the project was the fabrication of new water control gates, walkway grating, and other parts used to operate the trap. Despite extremely difficult working conditions during the winter of 2013/14, Northland Constructors of Duluth finished the hardware reconstruction prior to the spring thaw, and trap was operational for the spring run of 2014.

Juvenile Trap Results and Discussion

Daily Operations

The juvenile trap was open for a total of 144 days between April 28th and November 6th, 2014 (Table 1). Due to the cold weather and late spring thaw, the 2014 opening date was 20 days later than average and the latest the trap has been opened. Since 2009, the trap has been closed for the summer and then reopened to capture fall migrants. In 2014 the trap was closed for the summer on July 21st and reopened for the fall season on September 9th.

The French River Coldwater Hatchery (FRCWH) initiated a Knife River brood stock program in 2003 (Schreiner et al. 2003), and between 250-350 juveniles are collected annually from the Knife River and brought to the FRCWH to be reared to adults for the captive brood program. From May 29th to June 24th, a total of 290 unclipped juvenile steelhead were collected at the juvenile trap and brought to the FRCWH to continue this

program. These individuals were primarily age-1 with a mean length and weight of 121 millimeters (mm) and 16 grams.

A juvenile steelhead relocation program was initiated by the Lake Superior Steelhead Assocation (LSSA), with assistance from the MN DNR, in July 2014. The purpose of the pilot program is to determine if age-1 juveniles that have emigrated down the river will remain upstream another year if placed in headwater areas that are deemed to be suitable for their survival. If age-1 emigrants remain in the river an extra year, their chance of survival to adulthood increases over thirtyfold. The goal was to collect and transfer between 500 and 1,000 juveniles the first year, with the potential for more to be relocated in the following two years if feasible. MN DNR personnel collected age-1 juvenile steelhead on July 1st (127), July 2rd (115), July 8th (200), July 9th (105), and July 10th (165) for a total of 712 juveniles. Fish were brought from the Knife River trap back to the French River office where they were given a right pectoral fin clip, and held until the following day. LSSA members then transported the fish in aerated coolers into the headwaters of the West Branch Knife River. None of these relocated fish were observed in the trap the rest of the sampling season.

Trap Efficiency

The Knife River juvenile trap does not capture all juveniles emigrating downstream to Lake Superior, because at certain flows they can bypass the trap by swimming over the concrete weir adjacent to the forebay of the trap. Trap efficiency trials have been used to estimate the proportion of juveniles that are not captured on days when water is flowing around the trap. Knife River juvenile trap efficiency trials were conducted with unclipped juveniles from 1997-2002 and in 2010 (n = 1,892) and clipped juveniles (n = 1,539) from 2003-2006. Throughout these trials a cumulative mean recapture rate of 62% was observed. A detailed explanation of these trials can be found in Ward and Blankenheim (2006). An efficiency trial was conducted on May 31st, 2014. Two-hundred juveniles were given a caudal clip and released upstream of the trap at the location of the former fish trap in the Little Knife River. Forty-two of the 200 juveniles were recaptured between June 1st and July 14th for a recapture rate of 21%. The overall trap efficiency (1997-2014) is used to determine the number of juveniles of each age-class that are likely missed on days when the trap does not capture the entire flow of the river.

Unclipped Juvenile Steelhead

From 1996 through 2014, unclipped juvenile steelhead emigrants have primarily been the result of natural reproduction. However, 463,417 fry were stocked upstream of the trap from 1998 through 2006 (Ward and Blankenheim 2006). These fry were produced in the French River hatchery from both unclipped and clipped Knife River adults that were sampled by the Knife River trap. From 1996 through 2007 all clipped adults sampled by the trap were returned to the hatchery to produce fry that were stocked in various Minnesota tributaries to Lake Superior. Starting in 2007, all unclipped and clipped adults sampled by the trap were passed upstream to reproduce naturally and therefore all juvenile emigrants were offspring of either unclipped or clipped adults.

An estimated 6,019 juveniles emigrated during the 2014 trapping season (Table 1). As previously stated, the trap was not operated in the summer, so some juveniles were not captured. However, previous assessments have shown that in many years relatively few juveniles emigrate during the summer and most are age-0. The estimated 6,019 juveniles was 8,000 below the long-term average and below the interquartile range (7,213-21,249) (Figure 2, Table 1).

The relatively low number of emigrants was mainly due to the lack of age-1 fish, which typically make up 76% of the yearly emigration. Also, on July 7th an improperly seated board in a forebay exhaust gate was discovered. This created a gap of approximately 3 inches where fish could have escaped without being counted. This probably made little difference during higher flows as most of the water went through the juvenile trap, but juveniles may have escaped during low flows. Of the complete year-classes monitored, the 2004, 2008, and 2009 year-classes have had the highest overall number of emigrants (Figure 3). A high overall number of emigrants does not guarantee a high number of returning adults. Age-2 juveniles are approximately 30 times more likely to return as adults compared to age-1 juveniles, making age-2 juveniles critical to future returns of adults. Fortunately, the estimated number of age-2 emigrants in 2014 (2,179) was not much lower than average (2,779).

One factor that may influence recruitment is the number of adult females estimated to be upstream of the trap spawning each spring, commonly referred to as the adult/smolt relationship (Figure 4). The relationship shows a positive trend, but is weak and not statistically significant (R^2=0.21, p=0.10). Only 21% of the variability in smolt abundance can be attributed to the number of spawning females, suggesting many other factors play a role in smolt production. Unfavorable environmental conditions such as low summer flows, high water temperature in summer, and stream reaches freezing solid in winter likely negatively influence the number of

smolts produced. Such factors may also contribute to the premature emigration of juveniles prior to undergoing smoltification. The fry stocking that has occurred in the Knife River may confound the adult/smolt relationship as well.

Juvenile steelhead primarily emigrate throughout the mid-May to early July time period during lags in discharge. In 2014 almost no juveniles were captured until the end of May presumably because of the delayed spring and cold, high water conditions (Figure 5). The mid-May through early June time period also generally corresponds with an increase in water temperature. Juveniles began emigrating when the daily average and maximum water temperatures reached 17^{o}C and 20^{o}C (Figure 6). Both stream discharge and temperature play a role in the timing of juvenile emigration.

Juvenile Brook and Brown Trout

Juvenile Brook and Brown Trout typically account for a small percentage of the total juvenile salmonid catch. An estimated 51 Brook Trout emigrated in 2014, which was within the range observed through time (range: 5-176) (Table 1). An estimated 30 Brown Trout emigrated which was also within the range observed through time (range: 26-666) (Table 1). The number of Brown Trout was much lower than average due to the high number of Brown Trout sampled in the late 1990s and early 2000s.

Other species sampled

Non-game species sampled in the juvenile trap in included 3 Black Bullhead, 4 Blacknose Dace, 1 Brook Stickleback, 5 Common Shiner, 4 Creek Chub, 3 Fathead Minnow, 13 Longnose Dace, 5 Pearl Dace, and 2 White Sucker.

In-Stream Environmental Influences

The North Shore entered the winter of 2013/14 mostly free from drought status. Air temperatures were bitterly cold throughout much of the winter. Air temperatures were significantly below average from December 2013 through April of 2014. Snowfall totals were high for the second consecutive winter. The National Oceanic and Atmospheric Administration (NOAA) snowfall total for Duluth was 130.2 inches, making it the third snowiest winter on record. (The winter of 2012/13 was fourth at 129.4 inches.) Adequate snowfall during the winter months can help insulate streams from excessive ice formation that can decrease overwintering habitat for juvenile trout, and help recharge wetlands and other sources of water for streams.

Winter conditions prevailed into the normal spring season for the second consecutive year. Once the ice went out on the Knife River, significantly higher than normal precipitation levels in April and May added to the considerable runoff from the deep snow pack. The combination of snowmelt and rain events kept the river at high flow-conditions for nearly all of April and part of May (Figure 7). The average daily discharge for the month of April was 17.7 cms (626 cfs) and 13.4 cms (475 cfs) for May, which ranked them as the third and first highest average discharges for these respective months during the past 40 years. During the summer, air temperatures were very similar to long-term means from June through August, and precipitation totals were near or above average during these months. The fall months were drier and warmer than average, but despite this, the North Shore remained out of drought status the entire year until mid-November, when some areas of the North Shore entered abnormally dry conditions. Adequate flows and cool water temperatures are important for the survival of juvenile trout.

Adult Trap Results and Discussion

Daily Operations

The adult trap was open for the spring run 70 days between April 28th and July 7th (Table 2). The opening date of April 28th was nearly three weeks later than average and the latest the trap has been opened. The adult trap was not closed until July 7th because adults migrating upstream were still being captured in late June. All steelhead were passed above the trap but Kamloops were released at Blue Bird Landing or downstream of the trap.

Spring Unclipped Adult Steelhead

An estimated 483 (95% CI: 440-529) unclipped steelhead migrated up the Knife River to spawn in the spring of 2014, which ranks as one of the highest estimates of unclipped steelhead since the trap has been used to estimate adult abundance (Table 2, Figure 8). The estimated 483 unclipped steelhead was also above the interquartile range (287-419). The yearly returns of unclipped steelhead rarely remain static and instead display an undulating pattern through time. Three percent of unclipped steelhead had lamprey wounds, which was slightly below the mean of 5% and within the observed range (1%-9%).

Unclipped steelhead ranged from age-3 through age-10 in 2014, with age-4 through age-6 being the most frequently sampled. The age distribution was skewed towards younger age-4 and age-5 fish compared to previous years (Figure 9). The mean length of unclipped steelhead sampled in 2014 was 564 mm (range: 341-738; Table 3) and the mean weight was 1.5 kilograms (kg) (range: 0.3-3.0). Tag returns from previous seasons

suggest that 39% of unclipped steelhead spawn more than once in their lifetimes. Based on tag returns, unclipped steelhead have spawned up to six seasons at the Knife River, although approximately 90% only spawn one or two seasons. Only 12% of unclipped steelhead captured in 2014 had tags from previous years. A lower number of tags than usual was expected because the trap was not operational in 2013 so fish could not be tagged. Spawn checks observed while aging scales has previously been used to determine if fish spawn more than once, and has suggested that 62% of fish spawn more than once. Spawn checks may be less reliable than tagging data because of the interpretation that comes with identifying marks on scales. Steelhead with tags have been observed to lack visible spawn checks on scales, and because tags require no interpretation as to their presence or absence, tags likely provide a better metric for measuring repeat spawning.

A factor that may influence the number of returning adults per year-class is the number of age-2 juveniles that emigrate, referred to as the smolt/adult relationship. At the Knife River this relationship needs more data for conclusions to be reached. A more complete data set at the French River has shown the smolt/adult relationship to be positive, but fairly weak with 35% of the variation in adult abundance explained by the number of emigrating smolts (Blankenheim and Peterson 2014). Factors in Lake Superior likely play a strong role in this relationship, and include biotic factors such as predation of smolts and forage availability, as well as abiotic influences such as water temperature. Nevertheless, age-2 emigrants at the French River continue to return at a rate much higher than age-1 emigrants, returning at a rate 30 times greater than age-1 emigrants. Over 85% of returning adults at the French River were derived from age-2 smolts. The vast majority (86%) of adults sampled in 2014 at the Knife River had spent two years in the stream as juveniles prior to returning as adults.

Spring Clipped Adult Steelhead

An estimated 6 maxillary clipped steelhead migrated up the Knife River to spawn in the spring of 2014 (Table 4, Figure 8). The number of clipped adults returning to the Knife River was elevated from 2006 through 2010 due to “Phase 3” of the Knife River yearling stocking program that took place from 2003 through 2007. Maxillary clipped steelhead captured in 2014 were age-8 to age-10 with an average length of 698 mm (range: 668-721; Table 3) and average weight of 2.3 kg (range: 1.9-3.6). Most stocked yearlings have cycled through the fishery and few, if any, are expected to be seen in 2015. Fifteen percent of clipped steelhead had lamprey wounds, which was considerably higher than the average of 4% and one of the highest rates observed (range:

0%-17%). However, the two highest wounding rates have been observed the past two seasons when only very few fish remained and those that still did return were old specimens.

In addition to the maxillary clipped steelhead produced from yearling stocking, an estimated 15 pelvic clipped steelhead ascended the river to spawn. These fish are the product of stocking 42,011 frylings in 2010, 58.5% of which were given a right pelvic clip. These frylings were intended to be stocked in the French River for evaluation of stocking this life stage, but because of VHS concerns no stocking was allowed above barriers in North Shore streams in 2010. Since the Knife River does not have a barrier as the French River does, the Knife River received the quota of frylings in 2010. All returning pelvic clipped steelhead were age-4 and the average length was 553 mm (range: 484-607) and the average weight was 1.5 kg (0.95-2.08). Refer to the MN DNR internal report #661 for more information on the fryling program.

Kamloops

A total of 29 Kamloops were captured in the spring of 2014. Kamloops catches have ranged from 20 to 120 (Table 4). Twenty-four Kamloops were male and 5 were female. Kamloops ranged from age-3 to age-7 and had an average length of 590 mm (range: 509-712) and average weight of 1.8 kg (range: 1.0-3.0) (Table 3).

Fall Returns

The trap was open for 58 days in the fall from September 9th to November 6th (Table 5). Fall returns were minimal in 2014. Precipitation events are critical for drawing fish into the river during the fall, and relatively few rain events meant few fall-run migratory fish. Totals included 8 unclipped steelhead, 7 Brown Trout, 1 Chinook Salmon, and 1 Brook Trout (Tables 3 and 5).

Run Timing

Since 1996, the majority (62%) of steelhead have been captured at the Knife River between April 8th and May 5th, when stream water temperature and discharge were suitable. The date when most steelhead were sampled over the past 19 years has been April 24th. The spring run was late in 2014. The first steelhead was not captured until April 30th, and May 5th was the peak day for upstream migrants. Approximately half of all steelhead were captured in the 8 days starting May 5th, but fish continued to migrate upstream until June 30th. Recent research has shown that steelhead that arrive early in the run are the ones that successfully reproduce (Miller et. al 2014). Anecdotal reports of steelhead spawning in some rivers in July were reported, and the Knife

River trap data suggests this probably did occur in some rivers. Significant numbers of adults were captured when the average water temperature reached 5.0°C (41°F) for the first time in the spring; after this initial pulse of fish the number of daily migrants was relatively steady the rest of the sampling season (Figure 10). Discharge also plays an important role in the run timing of steelhead. Adults are frequently captured at the trap on days when water levels are decreasing after peaks in discharge have occurred. The biggest pulse of steelhead occurred as high flows decreased for the first time of the spring (Figure 11). Real-time discharge is available from the USGS at: **http://waterdata.usgs.gov/mn/nwis/rt**.

Summary

The winter of 2013/14 was bitterly cold and the third snowiest on record in Duluth. The runoff provided by the deep snowpack, in conjunction with frequent rain events, kept the Knife River at high flow conditions for much of the spring. The Knife River fish trap, which had been partially reconstructed in 2013 after the flood of 2012 caused extensive damage, was opened the latest it ever had been due to the high water conditions. The trap was operated as it had been prior to the flood, with the structure operational in the spring and fall but shut down for the summer.

An estimated 6,019 unclipped juvenile steelhead emigrated in 2014 which was 8,000 fewer than average and below the interquartile range (7,213-21,249). The emigration of juveniles began later in the spring than usual, likely due to the cold water temperatures and high flows. Eighty-six percent of adult unclipped steelhead were derived from age-2 emigrants, making these juveniles critical to maintaining the fishery.

The Lake Superior Steelhead Association, with assistance from the MN DNR, began a pilot project in which age-1 emigrants were collected at the Knife River trap, marked, and relocated to the headwaters of the West Branch Knife River. The purpose of the project is to determine if relocated juveniles will stay in the stream until age-2, which would greatly increase their chance to survive to adulthood.

An estimated 483 unclipped steelhead and 21 clipped steelhead migrated up the Knife River to spawn in 2014. Twenty-nine Kamloops were also captured. The unclipped estimate was one of the highest seen at the Knife River fish trap. Age distribution was age-3 to age-10, although a higher percent than usual were younger age-4 and age-5 fish. Few maxillary clipped steelhead were captured because they have not been stocked since 2007, and even fewer are expected to return in 2015. A small number of pelvic clipped age-4 adults from fryling stocking in 2010 were also sampled. Fall returns were minimal mainly due to the absence of precipitation events to draw fish into the river.

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SUPPLEMENTAL REPORT

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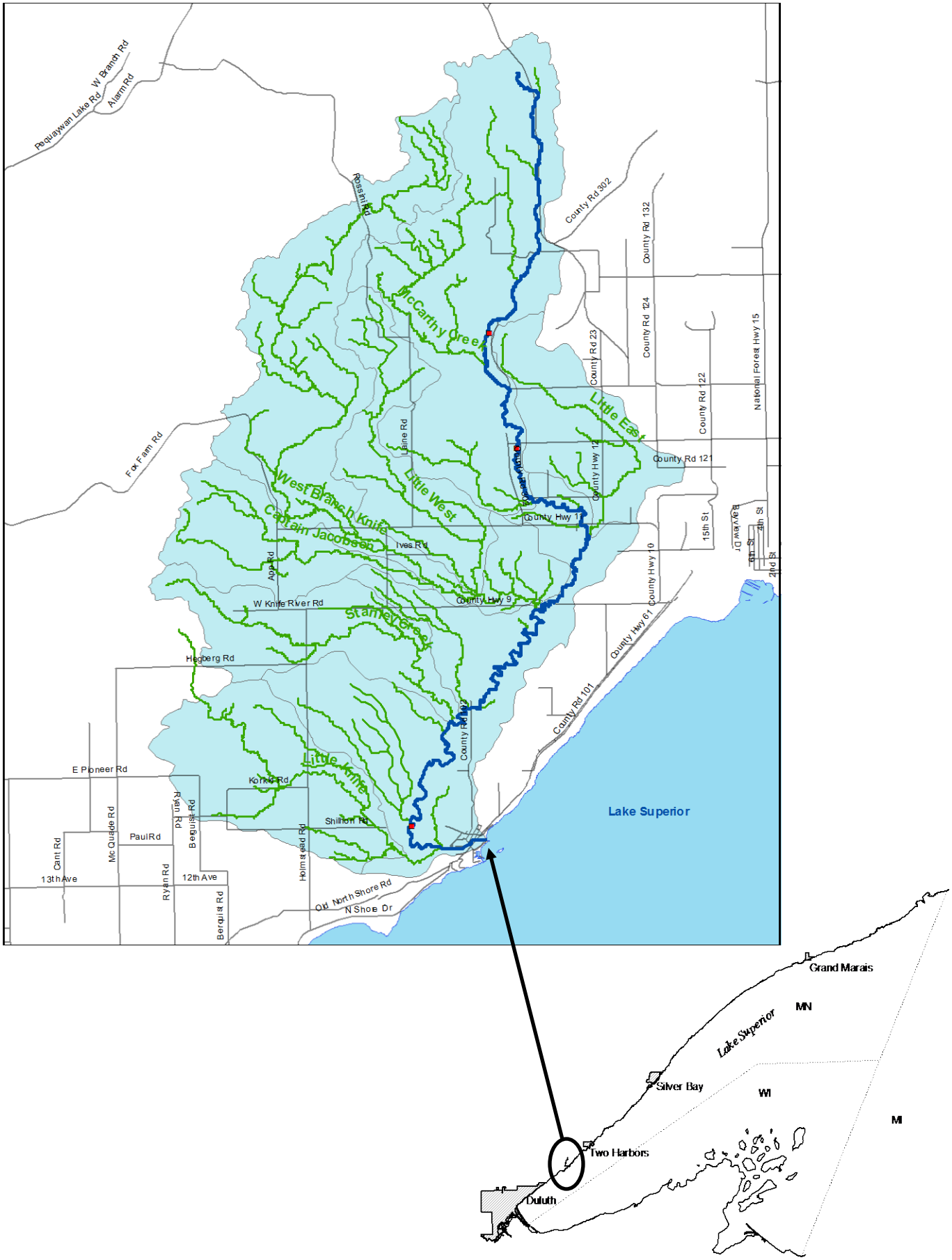

Figure 1. The Knife River watershed and its location along the Minnesota shore Lake Superior.

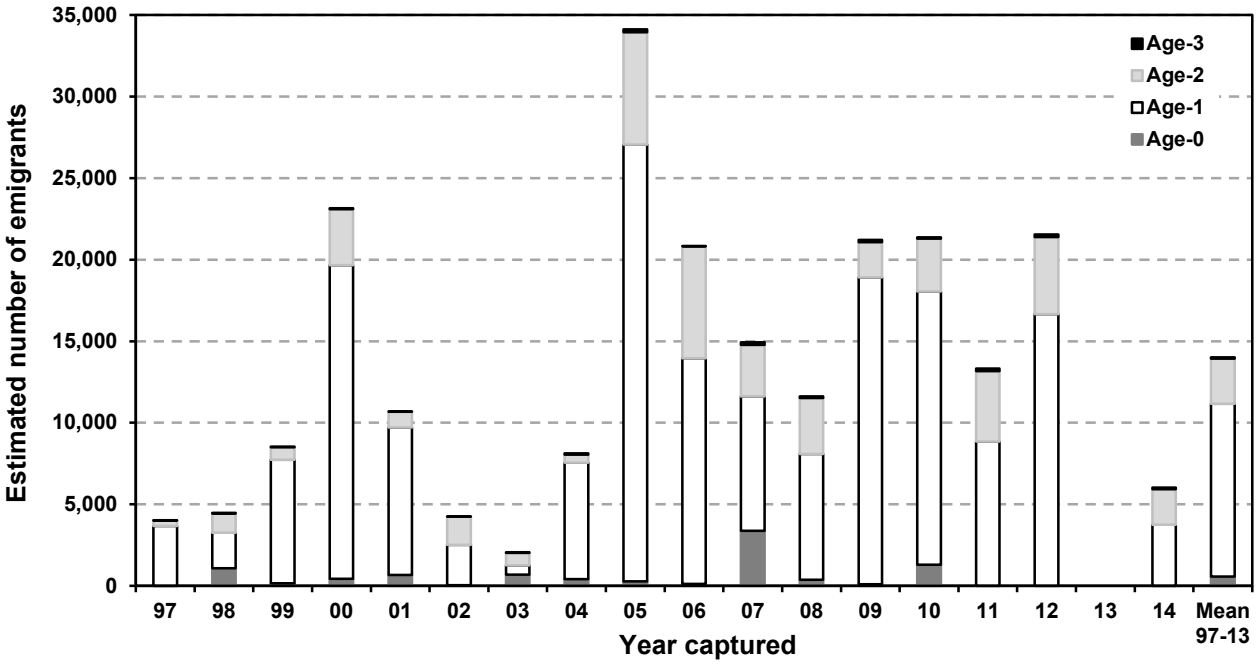

Figure 2. Estimated number of unclipped juvenile steelhead that emigrated down the Knife River from 1997 through 2014. The trap was not operated in 2013.

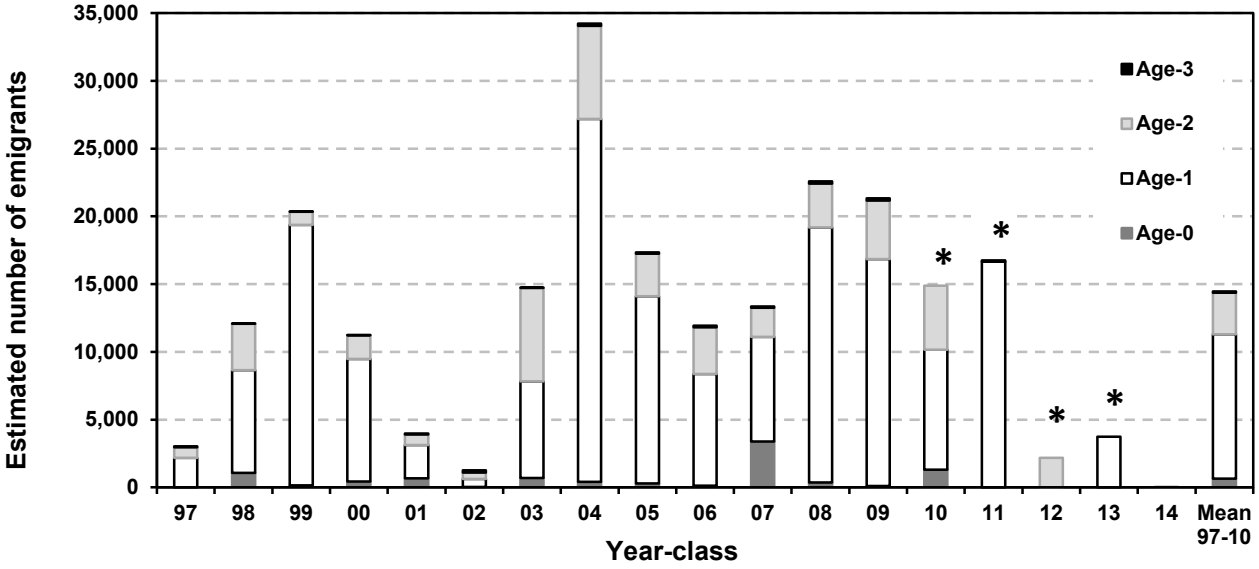

Figure 3. Estimated number of unclipped juvenile steelhead per year-class that emigrated down the Knife River from 1997 through 2014. The trap was not operational in 2013 so the year-classes from 2010-2013 (*) were incompletely sampled.

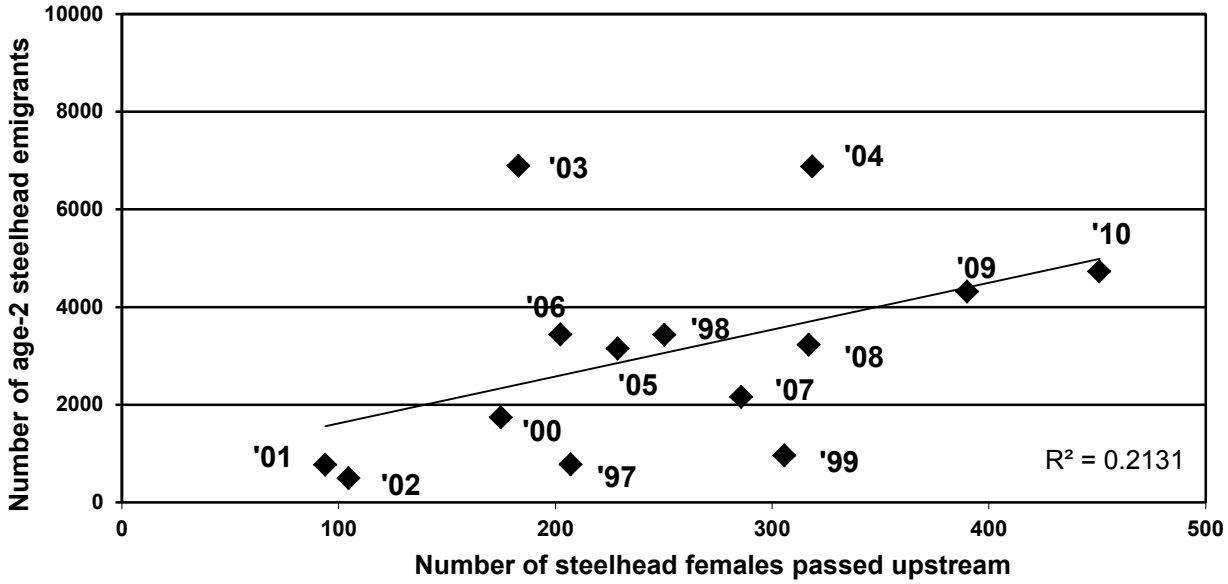

Figure 4. The relationship between the estimated number of female adult steelhead spawning upstream in the Knife River and the estimated number of age-2 unclipped juvenile emigrants by year-class for the Knife River from 1997 through 2010 (adult/smolt relationship).

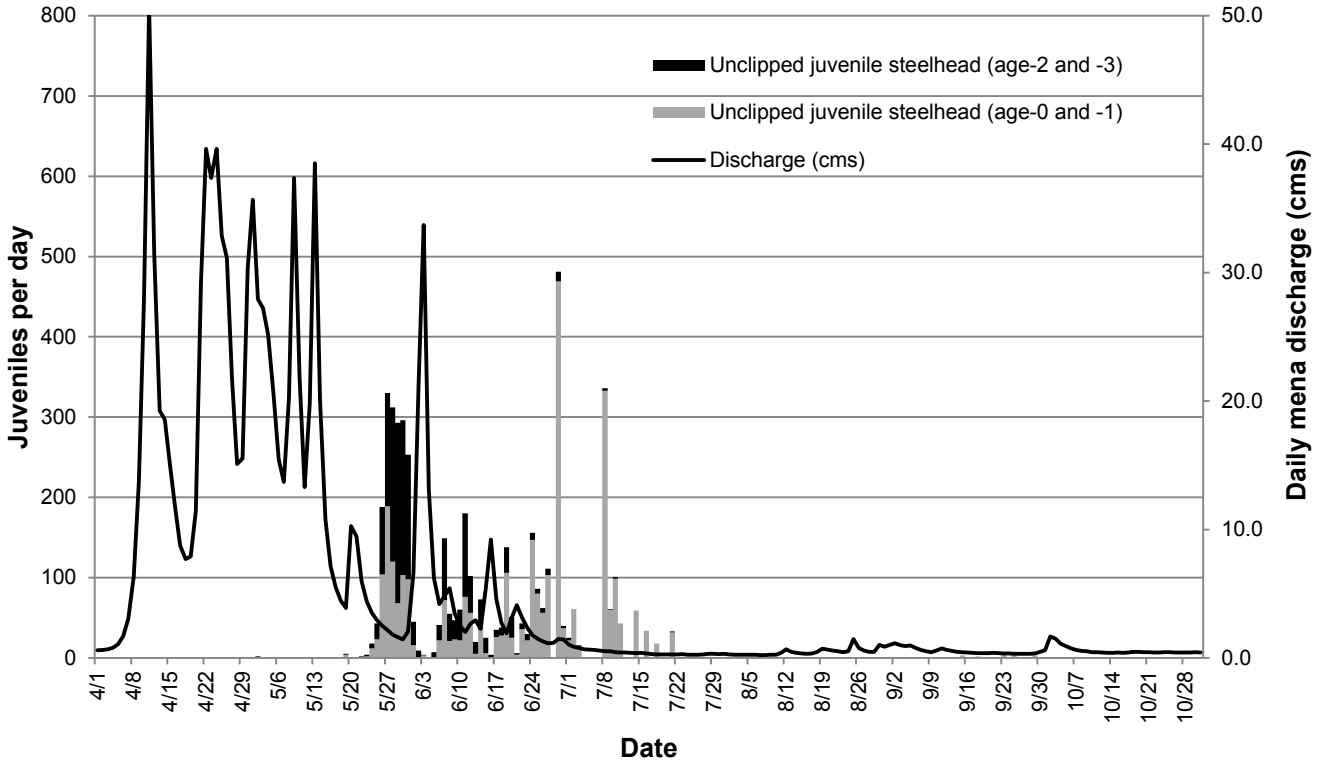

Figure 5. The number of juvenile steelhead captured by day in 2014 at the Knife River fish trap and the mean daily discharge (cms) on the Knife River. The trap was not operated between July 22 and September 8.

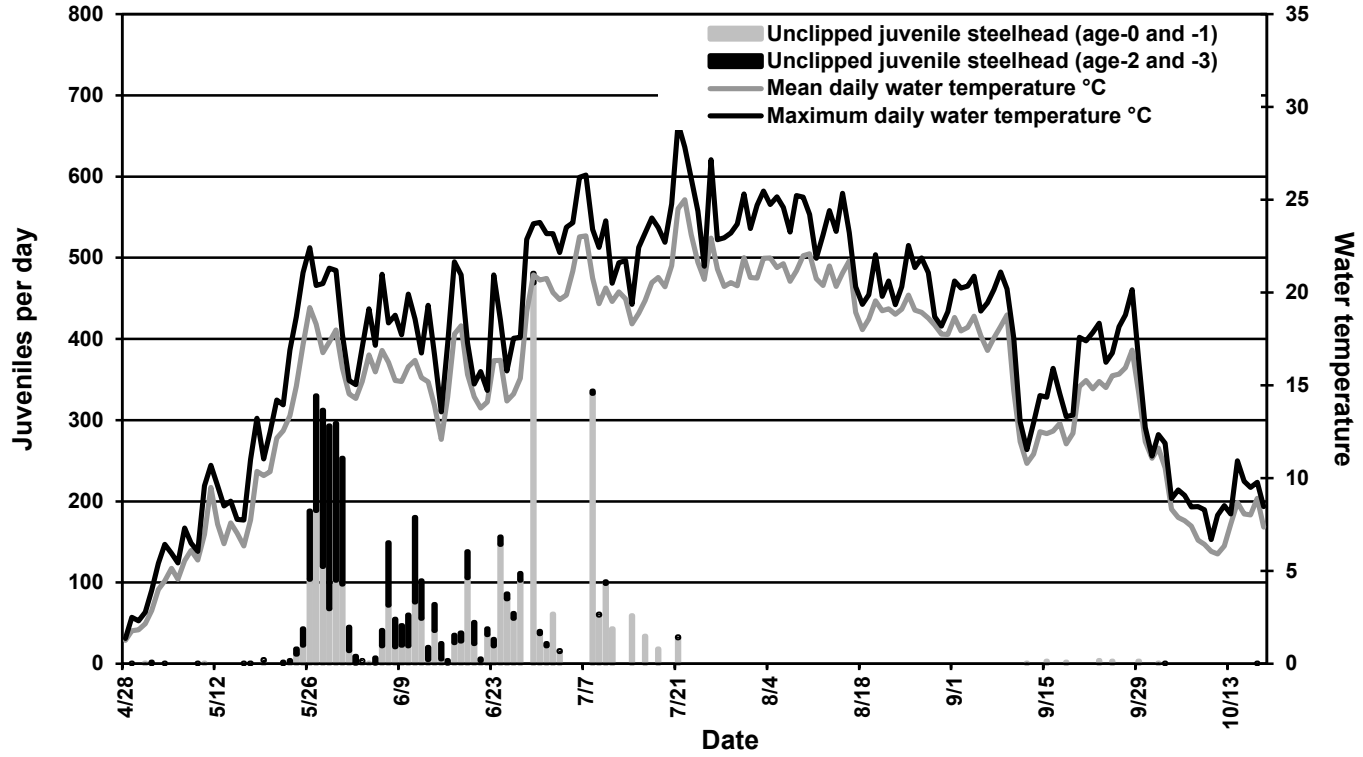

Figure 6. The number of juvenile unclipped steelhead captured by day in the Knife River juvenile trap compared with the mean and maximum daily water temperature (°C), 2014. The trap was not operated between July 22 and September 8.

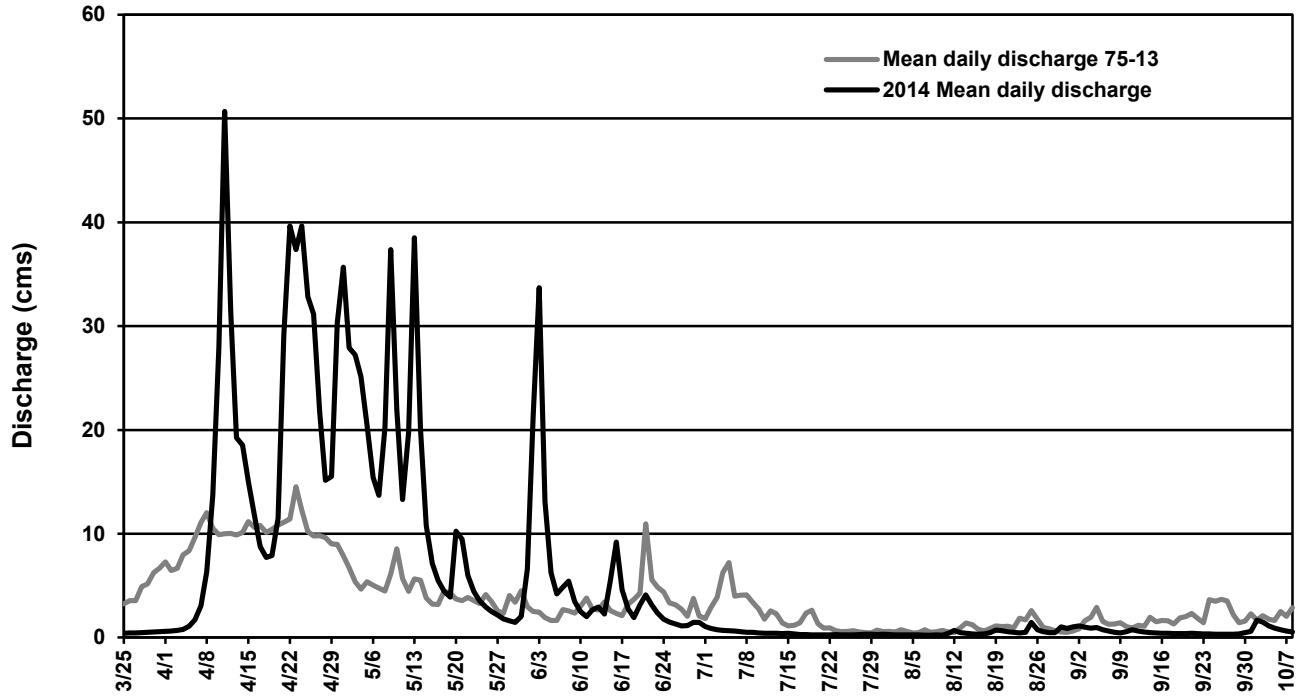

Figure 7. Comparison of the 2014 Knife River mean instantaneous discharge (cms) by day and the 1996-2013 mean.

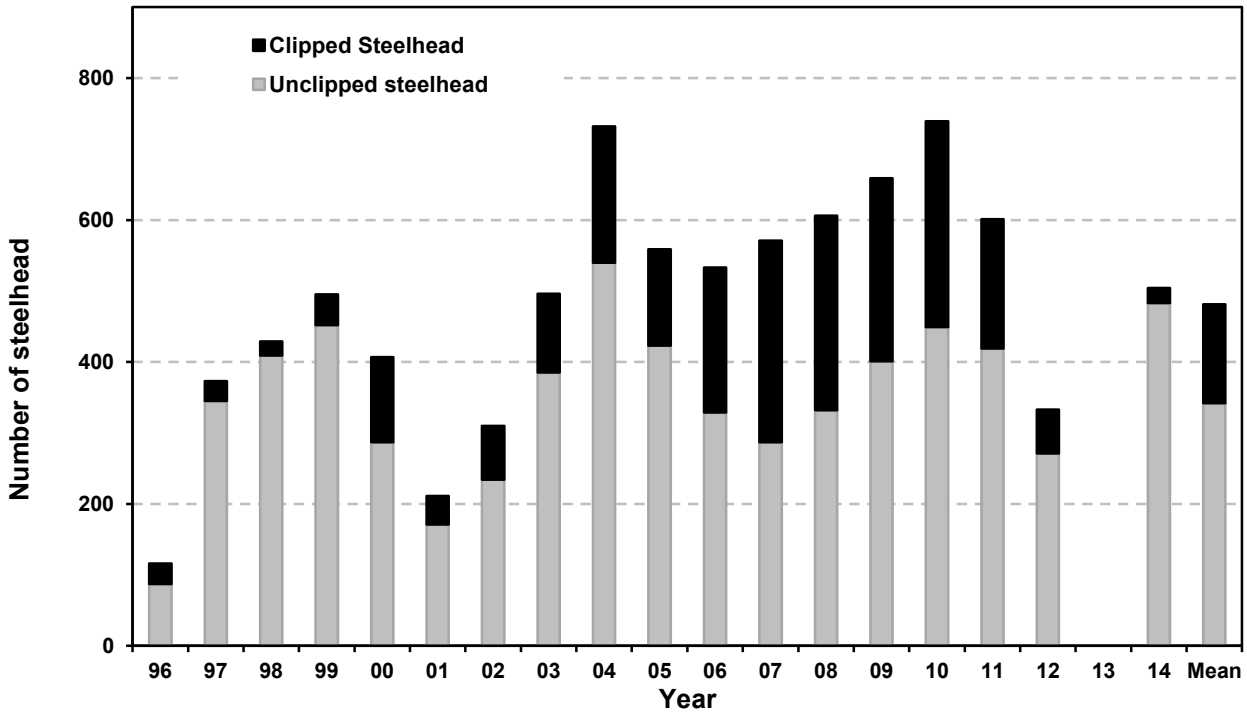

Figure 8. The estimated number of unclipped and clipped steelhead by year that have migrated up the Knife River to spawn, 1996-2014.

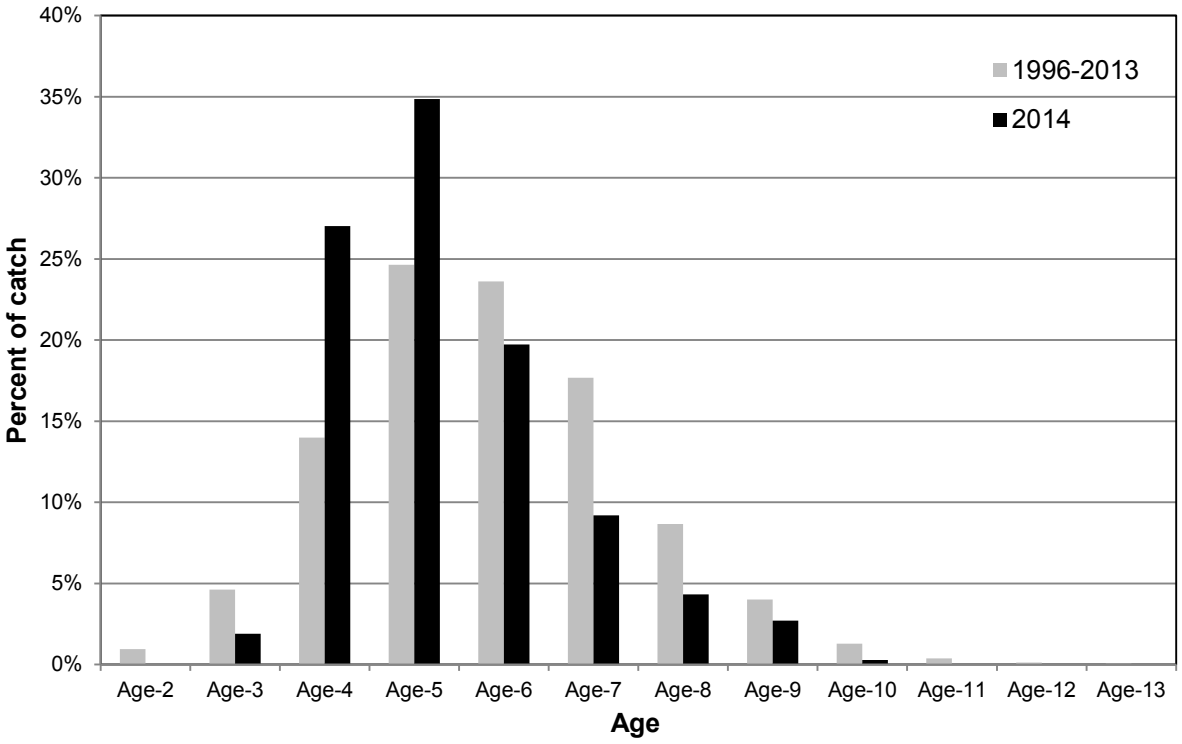

Figure 9. The age distribution of unclipped steelhead captured in the Knife River in 2014 compared to 1996-2013.

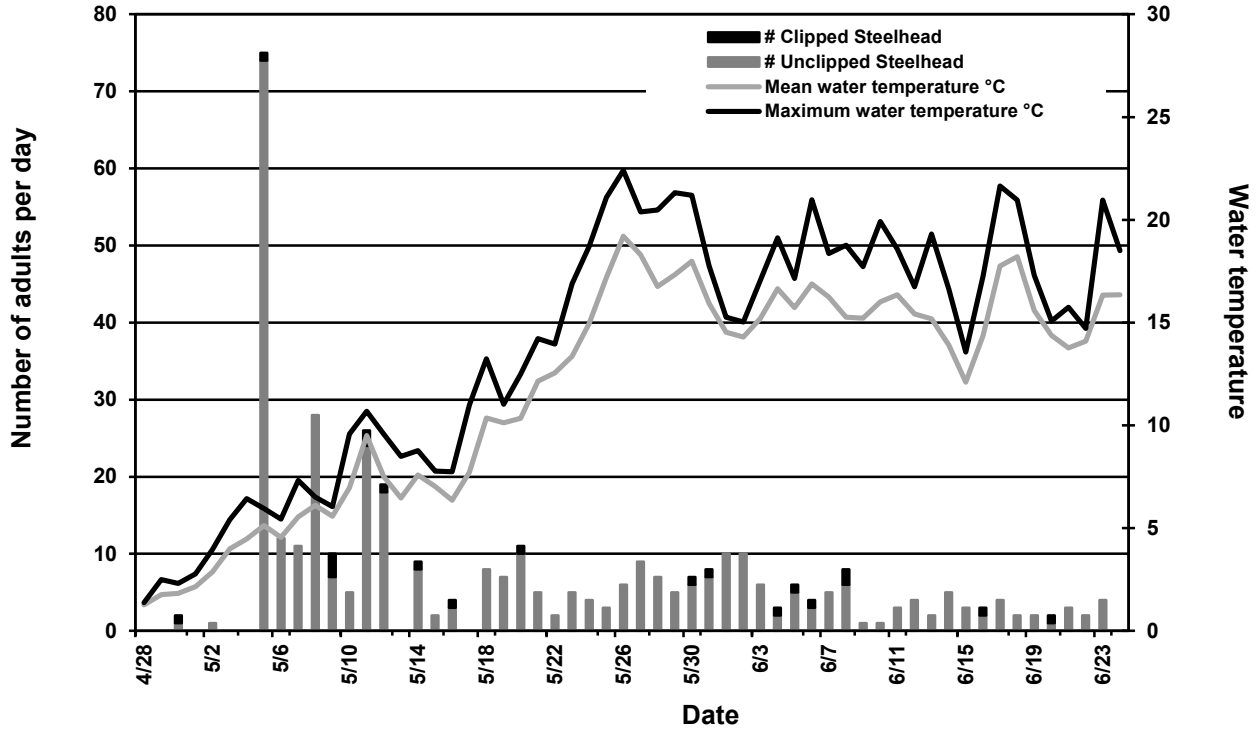

Figure 10. Number of unclipped and clipped adult steelhead sampled at the Knife River adult trap compared with the mean and maximum daily water temperature (Celcius) throughout the spring of 2014.

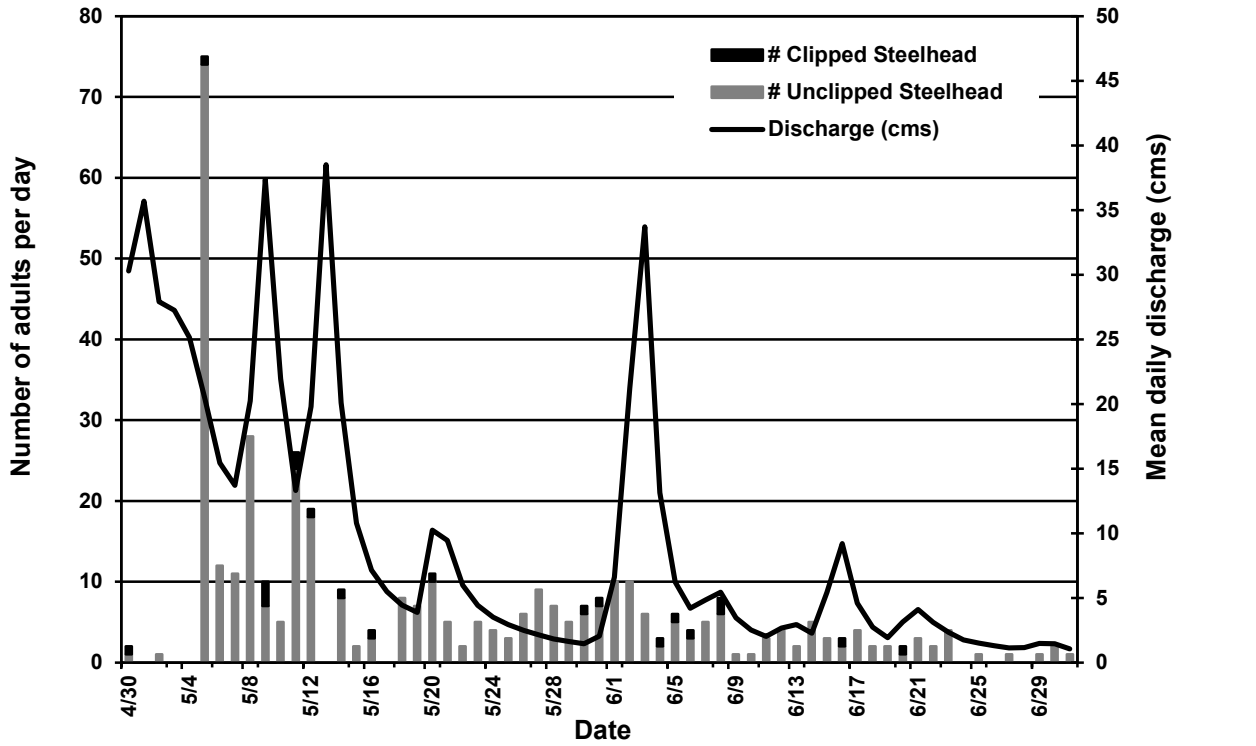

Figure 11. Number of unclipped and clipped adult steelhead sampled at the Knife River adult trap compared with the discharge rate (cubic meters per second) throughout the spring of 2014.

Table 1. Descriptive statistics (number (n) and percentage (%)) for Knife River unclipped juvenile steelhead, Brown Trout, and Brook Trout emigrants from 1997 through 2014.

Unclipped Juvenile Steelhead

Year	2010	2011	2012	2013	2014	Mean 97-13
Date trap was opened	3/28 and 9/15	4/18 and 9/16	3/25	N/A	4/28 and 9/9	**4/8**
Date trap was closed	7/9 and 11/5	6/30 and 11/4	6/19	N/A	7/21 and 11/6	**11/2**
Number days trap open	156	124	87	N/A	144	**186**

Estimated emigrants by year	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Age-0	1,302	6%	0	0%	0	0%			9	0%	**569**	**4%**
Age-1	16,748	78%	8,854	66%	16,649	77%			3,739	62%	**10,590**	**76%**
Age-2	3,229	15%	4,313	32%	4,727	22%			2,179	36%	**2,779**	**20%**
Age-3	95	0%	155	1%	170	1%			92	2%	**79**	**1%**
	21,374		**13,322**		**21,546**				**6,019**		**14,017**	

Est. emigrants by year-class	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n*** [1]	**(%)**[1]
Age-0	1,302	9%	0	0%	0		??		9		**606**	**4%**
Age-1	8,854	59%	16,649	99%	??		3,739		**		**11,052**	**76%**
Age-2	4,727	32%	??	0%	2,179		**		**		**2,863**	**20%**
Age-3	??	0%	92	1%	**		**		**		**84**	**1%**
	14,883		**16,741**		**2,179**		**3,739****		**9****		**14,605**	

Juvenile Brown Trout

	2010		2011		2012		2013		2014		Mean 97-13	
Estimated emigrants by year	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Age-0	0	0%	0	0%	0	0%			0	0%	**8**	**3%**
Age-1	219	71%	16	10%	7	11%			2	7%	**132**	**52%**
Age-2	86	28%	139	84%	47	73%			28	93%	**110**	**43%**
Age-3	2	1%	10	6%	10	16%			0	0%	**4**	**1%**
	307		**165**		**65**				**30**		**253**	

Est. emigrants by year-class	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n*** [1]	**(%)**[1]
Age-0	0	0%	0		0		??		0		**9**	**4%**
Age-1	16	25%	7		??		2		**		**139**	**54%**
Age-2	47	75%	??		28		**		**		**104**	**41%**
Age-3	??	0%	0		**		**		**		**3**	**1%**
	63		**7****		**28****		**2****		**0****		**255**	

Juvenile Brook Trout

	2010		2011		2012		2013		2014		Mean 97-13	
Estimated emigrants by year	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Age-0	0	0%	0	0%	0	0%			0	0%	**1**	**1%**
Age-1	128	73%	2	2%	13	53%			7	14%	**25**	**56%**
Age-2	26	15%	53	61%	4	16%			31	61%	**13**	**30%**
Age-3	22	13%	32	37%	8	32%			13	25%	**5**	**12%**
	176		**87**		**24**				**51**		**44**	

Est. emigrants by year-class	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n*** [1]	**(%)**[1]
Age-0	0	0%	0	0	0		??		0		**1**	**1%**
Age-1	2	33%	13	1	??		7		**		**24**	**57%**
Age-2	4	67%	??	0	31		**		**		**11**	**27%**
Age-3	??	0%	13	1	**		**		**		**6**	**15%**
	6		**26**		**31****		**7****		**0****		**42**	

[1] numbers and percentages reflect the year-classes that have completely emigrated (97-12)

*individuals of this age for this year-class have not emigrated

Table 2. The estimated number of unclipped steelhead migrating up the Knife River, spring 1996-2014.

Spring Sample period	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Totals 96 - 14			Mean 96 - 13		
Date trap was opened	4/23	4/14	3/25	4/7	3/26	4/18	4/14	4/21	4/7	4/10	4/6	4/15	4/16	4/12	3/28	4/18	3/25	N/A	4/28				4/9		
First Stt up (KRAT)	4/24	4/15	3/28	4/8	3/27	4/19	4/16	4/22	4/13	4/11	4/7	4/16	4/18	4/14	3/29	4/19	3/26	N/A	4/30				4/11		
Most Stt (KRAT)	4/25	4/23	4/12	4/13	4/24	4/26	4/24	4/27	4/14	4/11	4/11	4/21	4/22	4/24	4/1	4/22	3/28	N/A	5/5				4/17		
Last Stt up (KRAT)	5/22	6/19	6/5	6/6	6/21	5/23	5/31	6/12	6/16	5/19	5/22	6/18	6/19	6/13	5/25	6/12	5/27	N/A	6/30				6/5		
Date trap was closed	6/5	6/30	6/22	6/30	6/30	6/30	6/30	6/28	6/30	6/30	5/25	6/26	6/30	6/22	5/31	6/20	6/1	N/A	7/7				6/21		
Days trap was open	43	77	89	84	96	73	77	68	84	81	49	72	75	71	64	63	68	N/A	70				73		
Unclipped steelhead	87	345	409	452	287	171	234	385	540	423	329	287	332	401	449	419	271		483	2,690	3,614	6,304	141	201	342
(year-class)																									
1988	8	3	1																	2	10	12	1	3	4
1989	14	14	6	5																10	29	39	2	7	10
1990	13	28	15	10	2															25	43	68	5	9	14
1991	17	57	41	40	10	5	1													68	102	170	10	15	24
1992	19	147	119	123	48	24	6	3	1	1										118	374	492	12	37	49
1993	16	95	194	174	85	30	21	11	2	4										261	371	632	26	37	63
1994		1	30	56	33	27	14	9	5	2										53	124	177	6	14	20
1995			2	25	44	24	19	19	19	2	1									52	104	156	6	12	17
1996				20	58	38	36	31	27	4	1									93	121	214	12	15	27
1997					7	16	29	42	69	41	16	6	3		1					83	148	231	8	15	23
1998						7	78	197	233	150	77	28	13	4	2	1				347	443	790	32	40	72
1999						1	30	65	146	122	105	26	15	7	4	1				239	283	522	22	26	47
2000								8	34	66	76	34	16	12	3	1				111	141	251	12	16	28
2001									4	31	21	43	30	32	19	5				60	125	185	8	16	23
2002											19	59	72	89	55	28	8			159	171	330	23	24	47
2003											12	56	107	147	145	64	26			228	328	556	33	47	79
2004												35	72	99	145	95	25		1	210	262	472	35	44	78
2005													4	10	37	55	32		13	73	78	150	13	14	28
2006														1	36	98	62		21	112	106	218	26	24	49
2007															2	64	83		44	103	90	193	28	22	50
2008																7	27		95	74	54	129	12	5	17
2009																	7		167	90	84	174	6	1	7
2010																			133	109	24	133	0	0	0
2011																			9	9	0	9	0	0	0

Table 3. The length-frequency distribution of salmonids sampled in the Knife River adult trap, 2014.

Length category (mm)	Spring			Fall			
	Unclipped steelhead	Clipped steelhead	Kamloops	Unclipped steelhead	Brown Trout	Chinook Salmon	Brook Trout
340-349	1						1
350-359	1						
360-369							
370-379							
380-389	1						
390-399	1						
400-409	2						
410-419	2						
420-429	2				1		
430-439	8						
440-449	6						
450-459	9						
460-469	2					1	
470-479	13						
480-489	18	1					
490-499	18	1		1			
500-509	12	1	1	1			
510-519	14						
520-529	14			1	1		
530-539	11	3	3				
540-549	15		1		1		
550-559	20	1	4				
560-569	18	3	2	1	1		
570-579	15		3	1			
580-589	15		4	1			
590-599	23	1		1	1		
600-609	20	3	2	1			
610-619	18		2				
620-629	19		1		1		
630-639	8		2		1		
640-649	16						
650-659	11		1				
660-669	11	2					
670-679	8	1					
680-689	8						
690-699	2		1				
700-709	2						
710-719	1	1	2				
720-729	4	1					
730-739	1	1					
Totals	**370**	**20**	**29**	**8**	**7**	**1**	**1**

Table 4. The estimated number of clipped steelhead migrating up the Knife River and the number of Kamloops sampled in the Knife River trap, spring 1996-2014.

Spring Sample period	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	Totals 96 - 14			Mean 96 - 13		
Date trap was opened	4/23	4/14	3/25	4/7	3/26	4/18	4/14	4/21	4/7	4/10	4/6	4/15	4/16	4/12	3/28	4/18	3/25	4/28				4/9		
First Stt up (KRAT)	4/24	4/15	3/28	4/8	3/27	4/19	4/16	4/22	4/13	4/11	4/7	4/16	4/18	4/14	3/29	4/19	3/26	4/30				4/11		
Most Stt (KRAT)	4/25	4/23	4/12	4/13	4/24	4/26	4/24	4/27	4/14	4/11	4/11	4/21	4/22	4/24	4/1	4/22	3/28	5/5				4/17		
Last Stt up (KRAT)	5/22	6/19	6/5	6/6	6/21	5/23	5/31	6/12	6/16	5/19	5/22	6/18	6/19	6/13	5/25	6/12	5/27	6/30				6/5		
Date trap was closed	6/5	6/30	6/22	6/30	6/30	6/30	6/30	6/28	6/30	6/30	5/25	6/26	6/30	6/22	5/31	6/20	6/1	7/7				6/21		
Days trap was open	43	77	89	84	96	73	77	68	84	81	49	72	75	71	64	63	68	70				73		
Clipped steelhead	29	28	20	43	120	40	76	111	201	136	204	284	274	258	290	182	62	21	1,055	1,324	2,379	62	77	139
(year-class - clip)																								
1991 - AdLmLf[1]	1		1																1	1	2	1	1	1
1992 - AdLmRf[1]			1																0	1	1	0	1	1
1997 - AdLmLr[1]					1	4	2	1											6	2	8	2	1	2
1999 - AdLmRr[1]								1	1		4								2	4	6	1	1	2
2001 - AdLmLr[1]									12	15	5								21	11	32	7	4	11
1989 - AdLm[2]	2	1																	1	2	3	1	1	2
1989 - AdRmRf[2]	0	0																	0	0	0	0	0	0
1990 - AdRmLr[2]	4	3	4																2	9	11	1	3	4
1990 - AdRmRr[2]	6	6	0																4	7	12	1	2	4
1991 - AdRmLf[2]	9	8	3	3															7	16	23	2	4	6
1992 - AdRmRf[2]	7	10	5	1															7	17	23	2	4	6
1996 - AdRmLr[2]			6	35	111	4	7	3											69	96	165	12	16	28
1998 - AdRmRr[2]						26	42	14	8	2									46	46	92	9	9	18
2000 - AdRmLr[2]							17	80	165	76	43	2	5	1					172	218	390	21	27	49
2002 - Lm[2]									5	30	105	124	68	46	32	8			201	219	420	25	27	53
2003 - Lm[2]											20	25	14	31	26	13	4		82	52	134	12	7	19
2004 - Rm[2]											27	125	156	115	121	61	21	3	247	382	629	35	54	89
2005 - Lm[2]												6	26	36	49	49	17	1	82	102	184	14	17	30
2006 - Rm[2]													4	29	61	52	20	2	64	104	168	13	21	33
2010 - RR[5]																		15	7	8	15	0	0	0
1996 - AdRm[3,4]				4	7		1												8	4	12	3	1	4
1997 - AdRmRf[3,4]					0	2	0	1											2	1	3	1	0	1
1998 - AdRmLf[3,4]					1	4	3	5	2										9	7	16	2	1	3
1999 - AdRm[4]							2	5	3	6									7	9	16	2	2	4
2000 - AdRm[4]							2	1	5	5									7	6	13	2	2	3
2001 - AdRm[4]										1		1							2	0	2	1	0	1
Kamloops	37	48	48	82	65	108	44	72	120	97	27	22	21	46	26	29	20	29	455	486	941	25	27	52

[1] stocked in French River

[2] stocked in Knife River

[3] stocked in Silver Creek

[4] stocked in Gooseberry River

[5] stocked in Knife River as frylings

Table 5. The number of trout and salmon sampled with the Knife River adult trap, fall 1996-2014.

Fall Sample period	1996	1997	1998	1999	2000	2001	2002	2003	2004 [5]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Totals	Mean
Date trap was opened	8/19	8/18	8/17	8/9	8/4	8/13	8/16	9/8	9/8	9/5	9/5	9/5	9/2	9/21	9/13	9/19	N/A	N/A	9/9		8/28
Date trap was closed	11/8	11/7	11/6	11/12	11/10	11/16	11/8	11/7	11/5	11/4	11/4	11/2	11/7	11/7	11/5	11/4	N/A	N/A	11/6		11/7
Days trap was open	81	81	81	95	98	95	84	60	58	60	60	58	66	47	53	46			58		70
Rainbow- unknown [6]									14											14	
Unclipped steelhead	60	16	105	17	37	19	23	6	49	9	1	50	49	21	18	2			8	490	30
(year-class)																					
1988																					
1989	1																			1	
1990																					
1991	4		4																	8	
1992	25		24	1	1															51	
1993	28	13	37	3	2															83	
1994	2	2	22	2																28	
1995		1	7	3																11	
1996			11	6	14															31	
1997				2	7	2		1												12	
1998					13	12	10	1												36	
1999						5	7	3		1										16	
2000							6	1		1		1								9	
2001												2		2						4	
2002										2		6	1	2	1					12	
2003										5	1	20	35	7	1					69	
2004												20	8	5	3					36	
2005												1	2	1	2					6	
2006													3	3	5					11	
2007														1	6					7	
2008																1				1	
2009																1			2	3	
2010																			5	5	
2011																			1	1	
Clipped steelhead	2	0	16	6	9	0	2	0		7	0	22	10	5	2	0			0	81	5
(year-class - clip)																					
1991 - AdLmLf[1]																					
1992 - AdLmRf[1]																					
1997 - AdLmLr[1]																					
1999 - AdLmRr[1]																					
1989 - AdLm[2]																					
1989 - AdRmRf[2]																					
1990 - AdRmLr[2]																					
1990 - AdRmRr[2]																					
1991 - AdRmLf[2]	1		2																	3	
1992 - AdRmRf[2]	1																			1	
1996 - AdRmLr[2]			14	6	1															21	
1998 - AdRmRr[2]					8															8	
2000 - AdRmLr[2]							2													2	
2002 - Lm[2]										1			1	1						3	
2003 - Lm[2]										6		3								9	
2004 - Rm[2]												18	5	1	1					25	
2005 - Lm[2]												1		1	1					3	
2006 - Rm[2]													4	1						5	
1996 - AdRm[3,4]																					
1997 - AdRmRf[3,4]																					
1998 - AdRmLf[3,4]																					
1999 - AdRm[3,4]																					
2000 - AdRm[3,4]																					
Kamloops	4	0	12	1	4	1	0	0	0	0	0	5	7	0	3	10			0	47	3
Brown trout	32	67	43	61	58	20	45	30	27	26	9	7	17	8	7	1			7	465	29
Brook trout	0	2	3	1	0	3	2	0	3	2	0	1	1	0	0	1			1	20	1
Chinook salmon	4	1	9	9	2	0	2	0	0	0	0	11	5	0	0	0			1	44	3
Coho salmon	6	16	37	10	5	1	16	0	3	3	0	9	11	9	71	0			0	197	12
Pink salmon	0	9	20	39	48	0	3	0	0	2	7	10	0	2	258	103			0	501	31

[1] stocked in French River; [2] stocked in Knife River; [3] stocked in Silver Creek; [4] stocked in Gooseberry River

[5] Fishway was operated in fall instead of the adult trap; [6] Specific clips/strains were not identifiable on videotape