Lower Columbia River
Invasive Northern Pike Suppression – 2015 Update

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EXECUTIVE SUMMARY

Northern Pike (*Esox lucius*), a non-native invasive species in the Lower Columbia River watershed, were introduced into the Pend d'Oreille River in the US and have recently colonized a significant portion of the Canadian Columbia River below Hugh Keenleyside Dam (HLK) (Baxter and Neufeld, 2015). First detected in the Lower Columbia River (LCR) in 2009, Northern Pike have the potential to significantly impact sport fish populations and SARA listed species' recovery efforts through competition, predation, and introduction of disease. To control the invasion of Northern Pike, the Provincial Government and Teck Metals Ltd initiated a four year (2014 to 2017) Northern Pike gill-netting suppression program as part of the Waneta Dam Upgrade compensation commitments. This report summarizes the 2015 Northern Pike Gill-Net Suppression Program implemented by the MFLNRO, Teck Metals Ltd and Columbia Basin Trust.

In 2015, a total of 116 Northern Pike (NP) were removed during the gill-netting program in the Lower Columbia River all from the Robson Reach area. The total known and recorded Northern Pike removed from the study area in 2015 is 125 based on gill net suppression, large river indexing and angler incentive programs. A simple Lincoln-Petersen mark and recapture estimate was conducted using the PIT tag recaptures and estimated the population of Northern Pike in the Robson Reach area to be 410 with a lower 95% confidence interval (CI) of 151 and an upper 95% CI of 670. When combined with the angler returns and Large River Indexing program the total NP removal for 2015 is approximately 30% of the estimated population. The lengths and weights of captured NP were 15% and 33% lower respectively in 2015 than in 2014, suggesting the majority of large adults have been removed and a new age class is being captured.

The gill-netting average Catch Per Unit Effort (CPUE) in 2015 was 0.20 NP/hr per net or 1.62 NP/day (8 hr) per net. The CPUE for a single crew of two deploying eight nets a day for 8 hours in the Robson Reach area in 2015 was 12.93 NP/day and the catch rates are very similar when compared to the 2014 CPUE average.

Approximately 37% (n=93) of all the NP examined (n=253) contained food in their stomachs and in most cases included whole fish. Northern Pike diet consisted mostly (55%) of native salmonids (Rainbow Trout, Kokanee and Mountain Whitefish) and fish listed under the Species At Risk Act were not consumed. The average fork length of captured NP was 68 cm in 2014 and 58 cm in 2015. The average weight of captured NP was 3.15 kg in 2014 and 2.10 kg in 2015. The gender distribution, determined by dissection, of Northern Pike for both years was 117 males (45%), 101 females (39%) and 41 of unknown sex (16%).

Invasive Northern Pike pose significant threats to the Columbia River ecosystem including predation of native species, introduction of a wide variety of parasites and diseases, and competition with other species for common food resources (Baxter and Neufeld, 2015). The current gill-netting suppression program has successfully eliminated approximately 30 to 40% of the Northern Pike population and continues to be a viable option of control.

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BACKGROUND & STUDY AREA

Recognizing the concerns and threats associated with the Northern Pike introductions in BC, the Ministry of Forest Lands and Natural Resource Operations (MFLNRO) initiated a recent gill netting program, a change to angling regulations (unlimited daily quota) and the implementation of an incentive/education and award program aimed at encouraging anglers to remove Northern Pike from the Columbia River. In addition to the Province of BC mitigation strategies, Teck Metals Ltd implemented a four year (2014 to 2017) Northern Pike gill netting suppression program as part of the Upper Columbia River White Sturgeon Recovery Initiative and Waneta Dam Upgrade compensation commitments to complement the Ministry's efforts and assess the impacts to native fish species (in particular White Sturgeon) by investigating prey through stomach analysis.

The initial gill-netting suppression program in 2014 successfully removed a total of 133 Northern Pike, and when combined with the angling effort and Large River Indexing Program, the total known and recorded Northern Pike removed from the Lower Columbia River in 2014 was 163 or 20% of the estimated population (Baxter and Neufeld, 2015). In 2014, sampling occurred throughout the Columbia River from the HLK dam to the US border and all of the Northern Pike captured were from the Robson Reach area, directly upstream of Castlegar, BC (Figure 1), where Northern Pike spawning was confirmed (Baxter and Neufeld, 2015). Considering the success of the 2014 suppression results, commitments to continue removing invasive Northern Pike from the Columbia River in the Robson Reach area in 2015 were fulfilled.

This report summarizes the data collected during the 2015 Northern Pike gill netting suppression program conducted by the Mountain Water Research (MWR) for MFLNRO and Teck Metals Ltd. Additional funding for the 2015 project was also supported by Columbia Basin Trust and Thompson Rivers University.

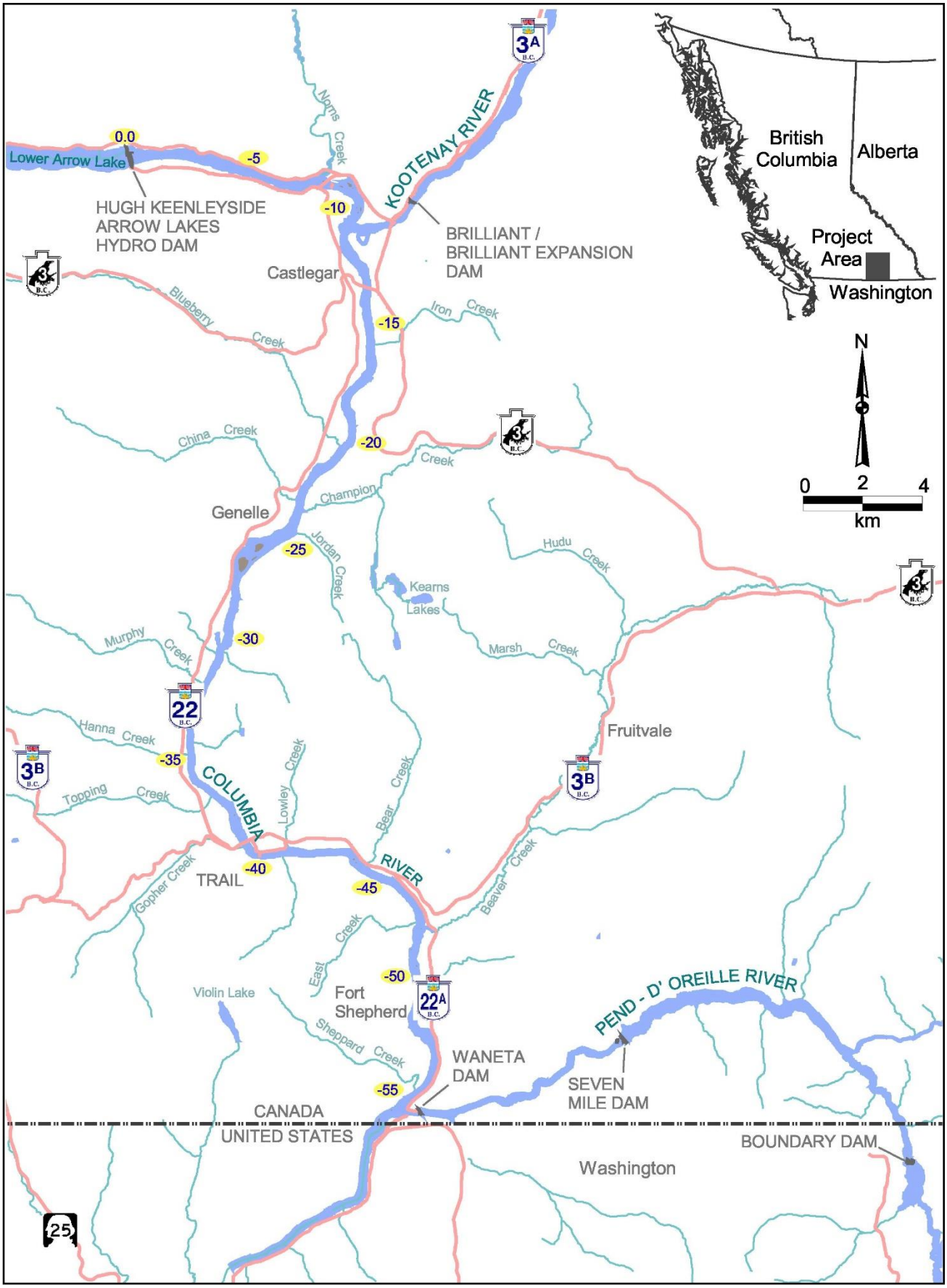

Figure 1. LCR Northern Pike Gill Net Suppression study area.

METHODS

Angler Incentive Program

In 2015, an angler incentive program was implemented to encourage the removal of invasive Northern Pike. The MFLNRO made a request to anglers to drop off their captured Northern Pike heads to a ministry office and each pike head gave the angler an opportunity to be entered into a draw, with the winners receiving a $500 prize. The heads were also used to gather information about distribution and abundance as 41 pike (30 in 2013, and 11 in 2015) were marked with Passive Integrated Transponder (PIT) tags by MFLNRO and released.

Gill Net Suppression

As a result of the 2014 sampling program (Baxter and Neufeld, 2015), all of the gill-netting in 2015 was completed where the highest concentrations of pike are known to occur, which is in the Robson Reach area downstream of HLK dam. Monofilament gill nets with the same specifications in 2014 were used and have also been identified in the US as being highly effective for NP removal (Table 1).

Table 1. Gill-net dimensions used for the LCR NP mechanical suppression in 2015.

Panel Number	Length (m)	Depth (m)	Mesh Size (cm)
1	9.1	1.8	2.5
2	9.1	1.8	3.2
3	9.1	1.8	3.8
4	9.1	1.8	4.5
5	9.1	1.8	5.0
Total Net Length	**46 m**	-	-

Sets were selected in shallow water bays known to have high NP abundance, and in locations that limited bycatch of salmonids and white sturgeon. Gill nets were set for a maximum of 4 hrs to limit native bycatch and mortality. All bycatch was released alive if possible. All subsequent net-sets were completed during daylight hours and checked frequently. All captured NP were euthanized and then measured for weight and length, scanned for a PIT tag, and assessed for sex/maturity. The stomach contents of all captured NP were examined in the field at time of capture and recorded, with the exception of 43 stomachs which were preserved and sent to the Thompson Rivers University (TRU) lab for analysis. All of the heads from each NP were removed and kept frozen for age analysis of the cleithrum by the TRU lab. Cleithra are paired, flat bones, and are components of the pectoral girdle. In Northern Pike the cleithrum is located below the skin of the posterior edge of the operculum opening and is used for aging individual fish (Euchner, 1988). The cleithrum samples are currently being aged. Total gill-netting effort in 2015 was distributed throughout the year over 17 days with a crew of two deploying 8 nets twice a day if possible (Table 2). Staff from both the MFLNRO and MWR deployed the nets in 2015.

Table 2. LCR NP gill-netting schedule and effort, 2015.

NP gill-netting date	Number of Nets Deployed	Total Set Hours
May-04-15	8	11.45
May-11-15	11	22.30
May-14-15	16	43.65
May-15-15	16	49.73
May-16-15	16	45.12
May-17-15	16	51.87
May-18-15	8	32.85
May-25-15	14	39.97
May-26-15	13	43.57
May-27-15	12	44.80
May-28-15	12	53.27
May-29-15	8	27.75
Aug-28-15	16	51.87
Aug-31-15	13	41.22
Sep-01-15	8	20.47
Sep-18-15	13	44.05
Sep-19-15	8	35.15
Total	**208**	**659.07**

As in 2014, the following table describes the gill netting data collected for each net-set in 2015.

Table 3. LCR NP gill-netting data collection description, 2015.

• Date	• Set ID	• Location (UTM)
• Time in	• Time out	• Total Hours Deployed
• Float Number	• Area Description	• System and Water Temperature
• Species Captured	• Bycatch Count	• Bycatch Released Alive
• Fork Length of all NP	• Weight of all NP	• PIT Tag Number
• NP Gender	• NP Maturity	• NP Stomach Contents

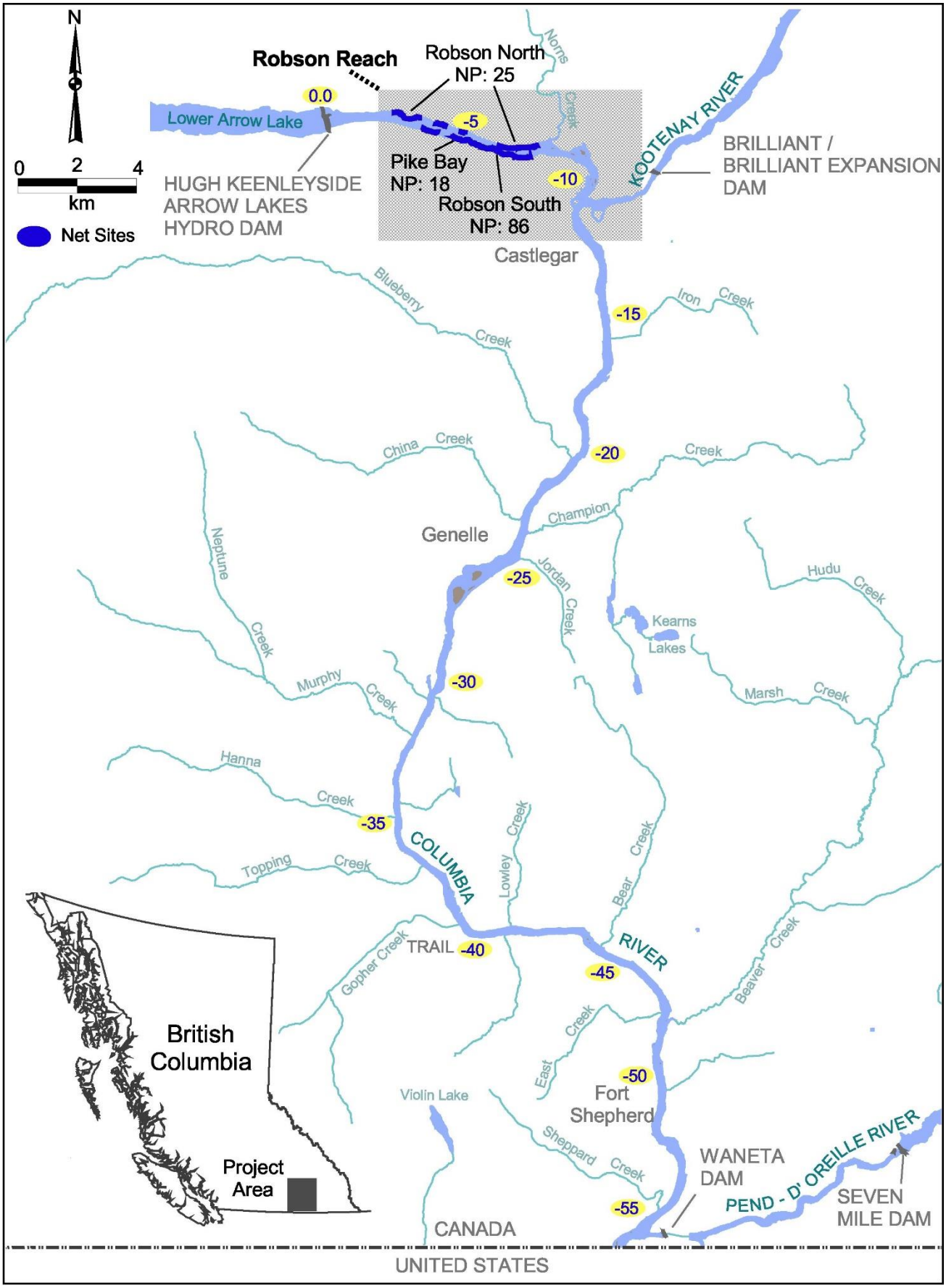

Figure 2. LCR NP Gill Netting Set Sites, 2015.

Data Analysis

The data were entered into a custom designed Access database and were screened for typographical errors through plotting and data summaries prior to plotting and analysis.

Two primary pieces of information collected during the gill netting were analyzed: the total amount of effort (net hours) and the average catch rate which is referred to as Catch Per Unit Effort (CPUE) in this report. A parallel calculation was done for each net set to expand the CPUE/hr by an 8 hour day to achieve a CPUE/8 hr day for each net-set.

In addition to the catch rates, analysis of other data included: A Lincoln-Petersen mark and recapture NP population estimate based on the number of PIT tags recaptured, length and weight frequencies of captured Northern Pike, Northern Pike gender distribution, Northern Pike stomach analysis by prey species, and bycatch rates.

Pathology Sampling

In 2015, the Northern Pike were not screened for parasites. However, a total of nine pike samples collected during the 2014 gill-net surveys were submitted to the Provincial Freshwater Fisheries Society of BC (FFSBC) Fish Health Lab for standard disease screening (Baxter and Neufeld, 2015). Screening included viral tests (IHNv, IPNv and VHSv), bacterial tests (various pathogenic bacteria) and parasites (*Triaenophorus crassus* and others of interest) following standard Canadian Fish Health Protection Regulation (CFHPR) methods. The results of the 2014 disease screening can be found in the 2014 report (Baxter and Neufeld, 2015).

RESULTS

Angler Incentive Program and PIT Tag Returns

Anglers have returned a total of 33 Northern Pike heads to date (21 in 2014, and 12 in 2015), and two PIT tags were present in the 2015 angler catch. In 2015, the angler catch was distributed throughout the watershed with six being caught in the Robson Reach area, four being caught in the Pend D'Oreille reservoir, and one each being caught in the Waneta Dam area and Genelle area. All of the angler returns from 2014 were caught in the Robson Reach area.

The gill-netting program has successfully removed 249 Northern Pike (133 in 2014, and 116 in 2015), and 11 PIT tags (six in 2014, and five in 2015) were present in the catch. One of the gill-netting tag returns in 2015 was a tag which was marked in 2013. Based on the PIT tag returns and overall numbers, the gill netting program continues to be the most successful way to remove Northern Pike from the system. However, the angler return program is an effective means to communicate and engage with anglers, relay the importance of pike removal, and provides useful information about pike distribution.

Gill Net, Boat Electrofishing and Angler Suppression and Analysis

In 2015, a total of 116 Northern Pike were removed during the gill-netting program in the Robson Reach area (Figure 3). An additional nine Northern Pike (six from anglers and three from the BC Hydro Large River Indexing program) were confirmed to be removed from the LCR in 2015 in the Robson Reach. The total known and recorded Northern Pike removed from the study area in 2015 is 125. The Northern Pike gill-netting suppression program in 2015 focused on the Robson Reach Area only (upstream of river km 7) based on capture rates established in 2014 (Baxter and Neufeld, 2015). Therefore, the data collected from the Robson Reach area was only included in the analysis (Figures 4 to 8). The total number of NP caught by gill-netting each year can be found in Table 4 below. The average CPUE in 2015 was 0.20 NP/hr per net or 1.62 NP/day (8 hr) per net. The CPUE for a single crew of two deploying eight nets a day for 8 hours in the Robson Reach area in 2015 was 12.93 NP/day and the catch rates are very similar when compared to the 2014 CPUE averages (Table 4). The initial suppression CPUE results in May of 2014 were

much higher (0.44 NP/hr per net or 3.44 NP/day (8hr) per net) than subsequent sampling, which has since stabilized and is now consistently around 0.20 NP/hr per net.

Table 4. Northern Pike gill-netting Catch Per Unit Effort (CPUE) and totals for 2014 and 2015 in the Robson Reach Area of the Lower Columbia River.

Year	NP CPUE/hr per net	NP CPUE/8hr net	NP Total	NP Per day (8 nets)
2014	0.19	1.50	133	11.98
2015	0.20	1.62	129*	12.93

*total includes all NP caught by gill-nets. Fish marked and released (11), fish euthanized (116), & fish lost at net (2).

Twelve species or species groups of fish were captured during the gill-netting including; Sucker spp., Lake Whitefish, White Sturgeon, Small Mouth Bass, Walleye, Eastern Brook Trout, Northern Pike Minnow, Longnose Sucker, Kokanee, Rainbow Trout, Mountain Whitefish, and Northern Pike. Our analysis focuses on the Northern Pike since these fish were the primary target species and the ones for which biometric data were collected. Throughout 2015, gill nets captured 396 non-target individuals and 76% were released alive. Bycatch mortalities included Kokanee (10), Mountain Whitefish (45), Rainbow Trout (26), Sucker sp. (4), Northern Pike Minnow (5), Eastern Brook Trout (1), Bull Trout (1), Walleye (5), and Lake Whitefish (30). All other bycatch was released alive. The percentage of gill-net catch by species for 2014 and 2015 can be found in Figure 9 below.

Northern Pike length and weight frequencies for both years are presented in Figure 10. The average fork length of captured NP was 68 cm in 2014 and 58 cm in 2015. The average weight of captured NP was 3.15 kg in 2014 and 2.10 kg in 2015. The NP fork length range for both years was 29.5 cm to 101 cm and the NP weight range was 0.25 kg to 9.85 kg (Figure 10). Northern Pike were caught primarily in shallow water habitat less than 4 m deep and abundant in aquatic vegetation in both years. The gender distribution of NP for both years was 117 males (45%), 101 females (39%) and 41 of unknown sex (16%).

Figure 3. A Northern Pike caught on gill-net set in May, 2015.

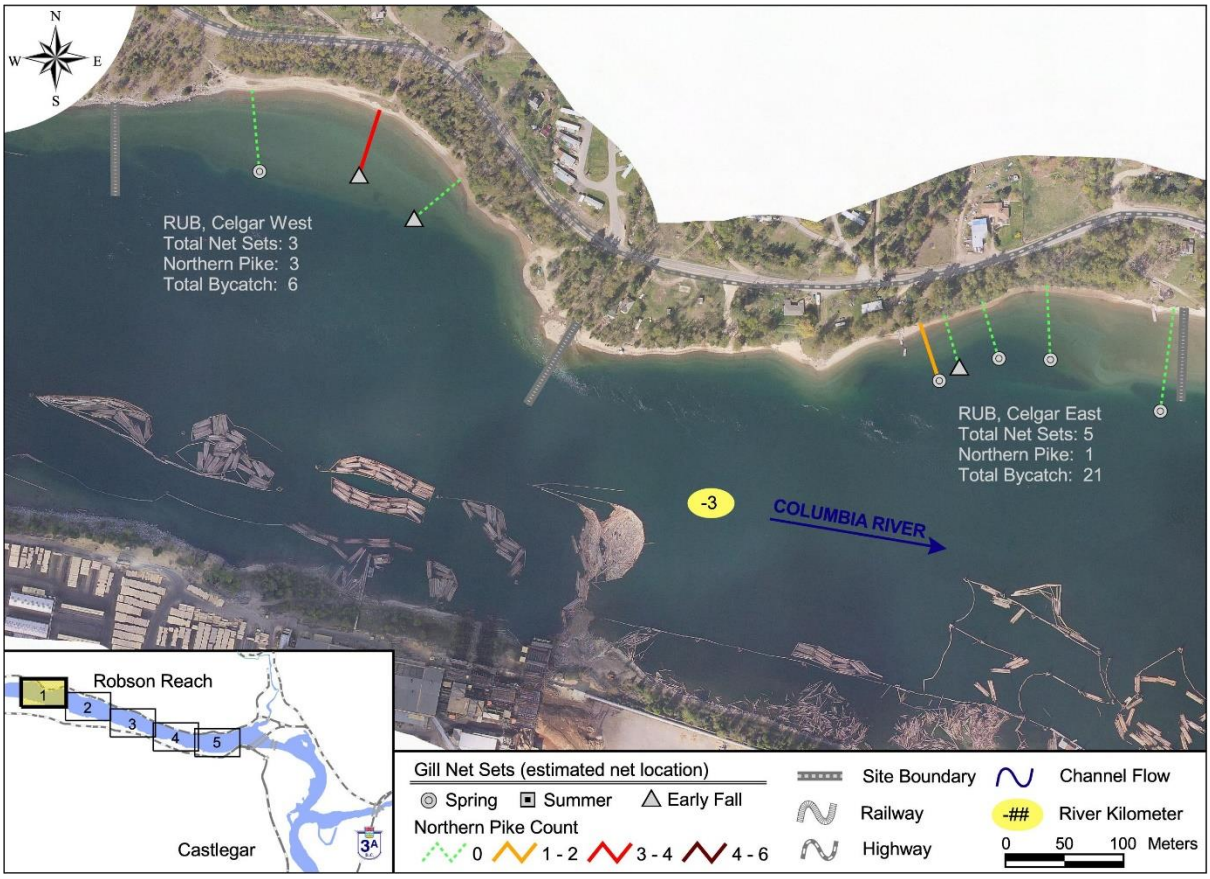

Figure 4. LCR NP gill netting set sites by season and catch per net in the Celgar Area of Robson Reach, 2015.

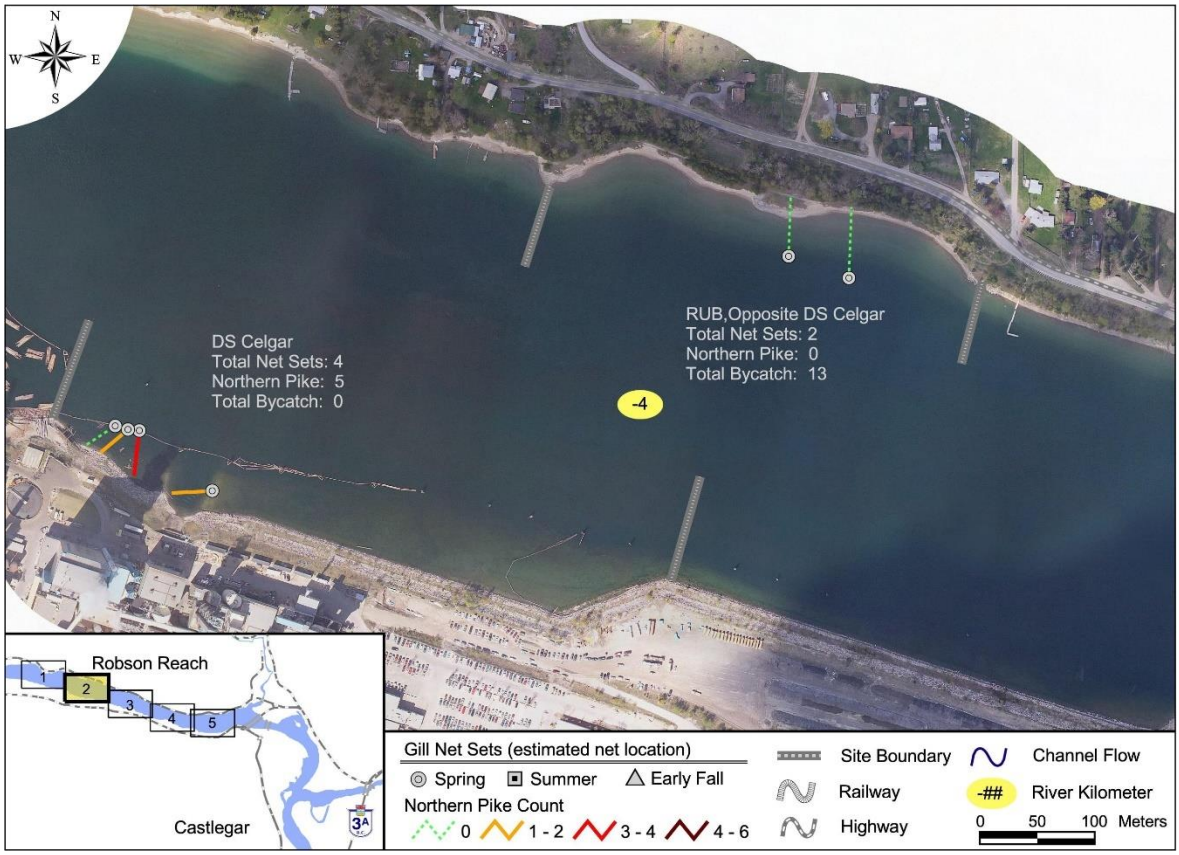

Figure 5. LCR NP gill netting set sites by season and catch per in the Celgar DS Area of Robson Reach, 2015.

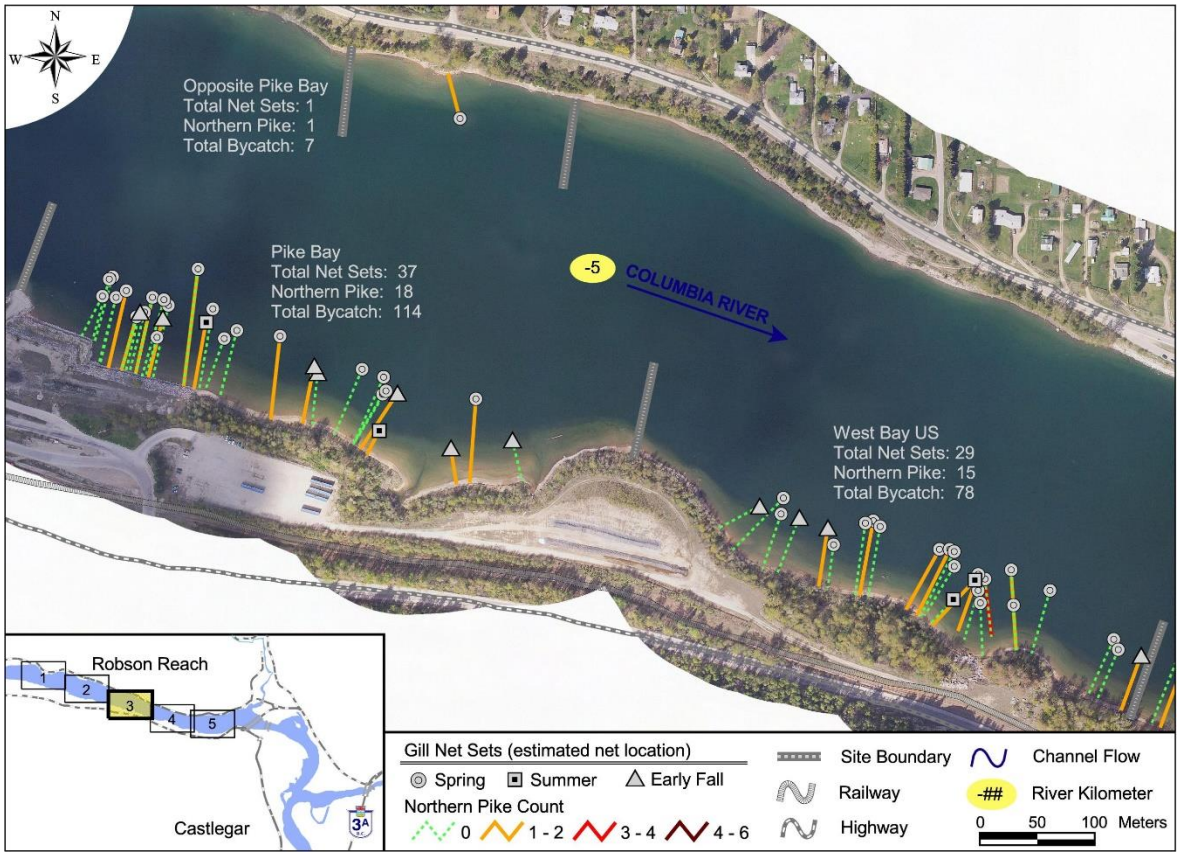

Figure 6. LCR NP gill netting set sites by season and catch per net in the Pike Bay Area of Robson Reach, 2015.

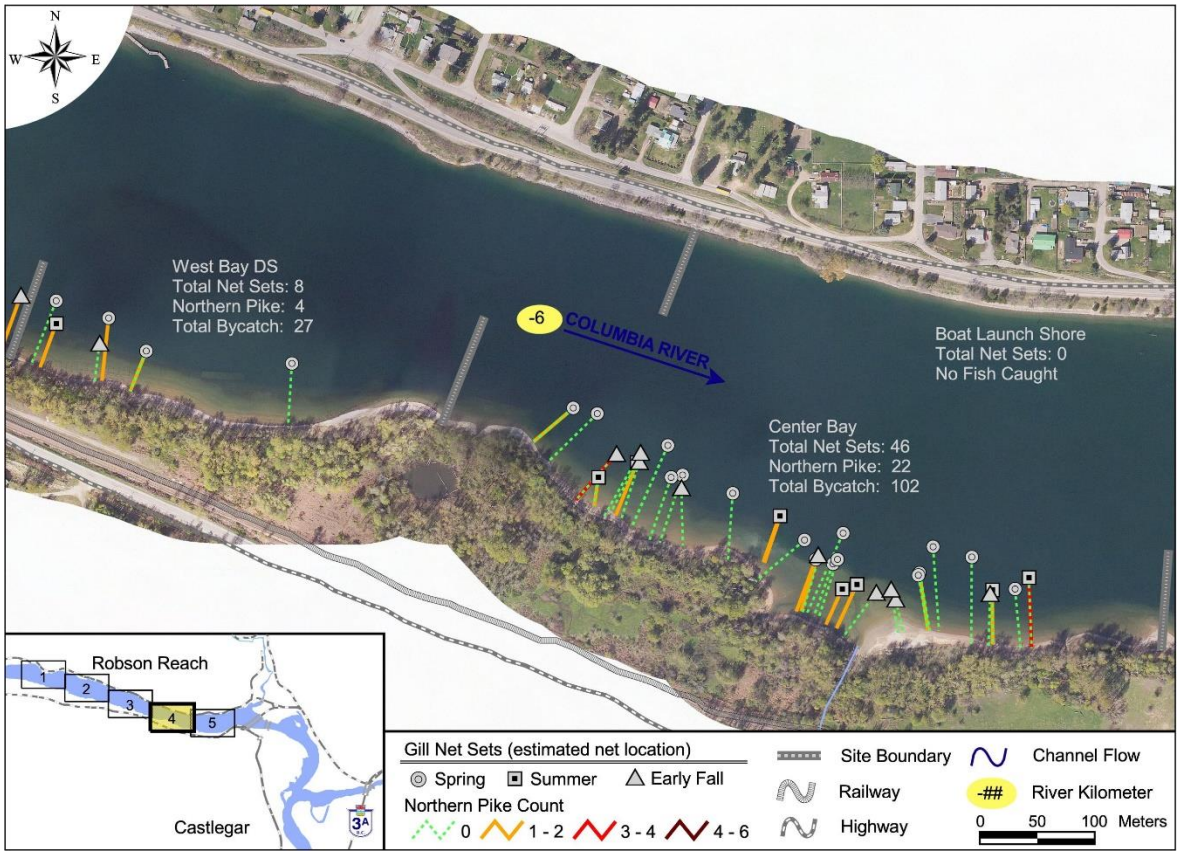

Figure 7. LCR NP gill netting set sites by season and catch per net in the Center Bay Area of Robson Reach, 2015.

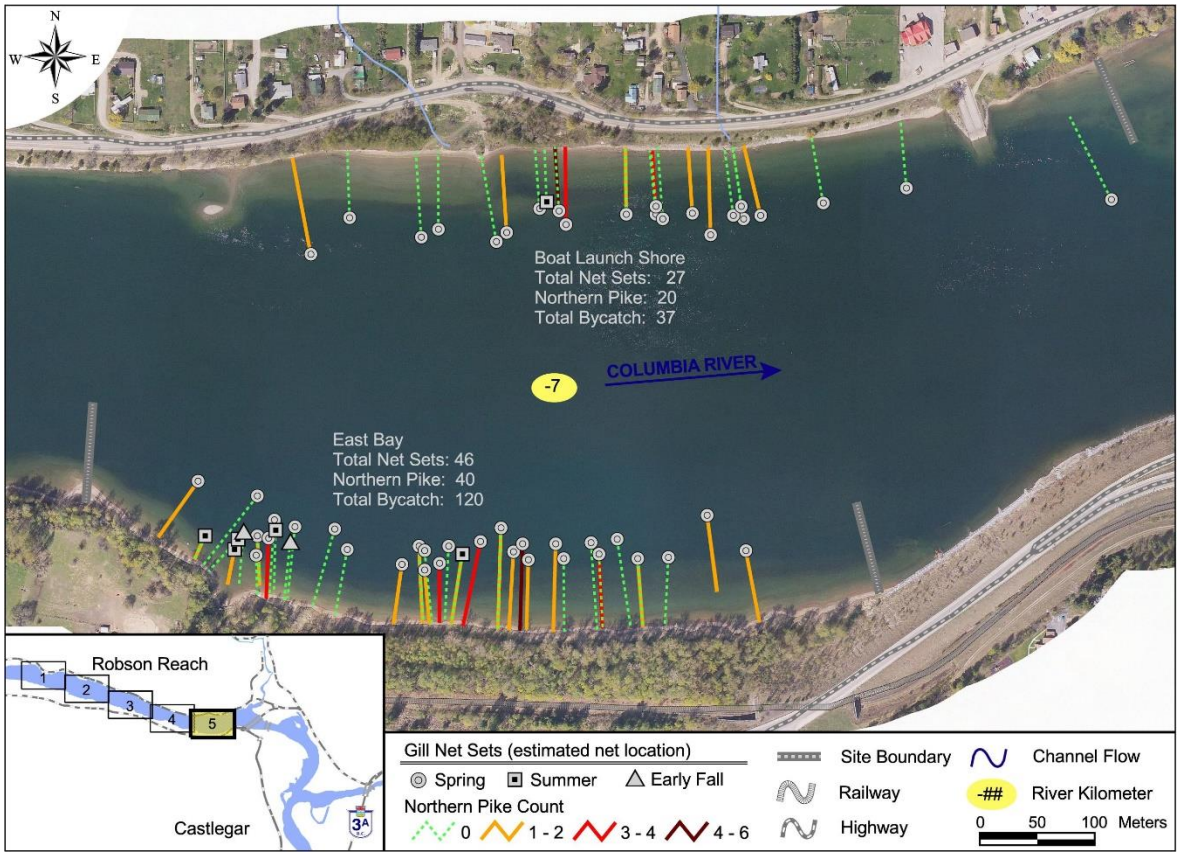

Figure 8. LCR NP gill netting set sites by season and catch per net in the Robson Boat Launch Area, 2015.

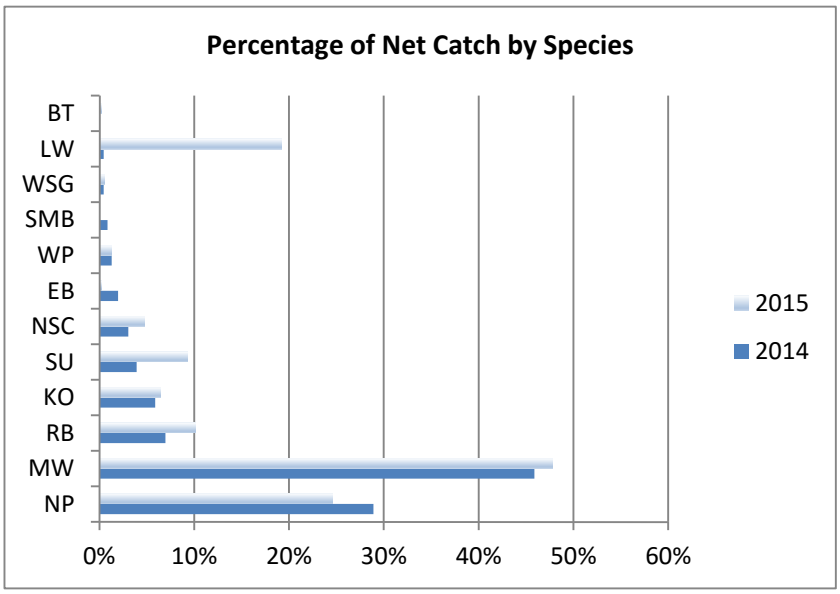

Figure 9. **Percentage of gill-net catch by species in 2014 and 2015. BT = Bull Trout, LW = Lake Whitefish, WSG = White Sturgeon, SMB = Smallmouth Bass, WP = Walleye, EB = Eastern Brook Trout, NSC = Northern Pike Minnow, SU = Sucker sp., KO = Kokanee, RB = Rainbow Trout, MW = Mountain Whitefish, and NP = Northern Pike.**

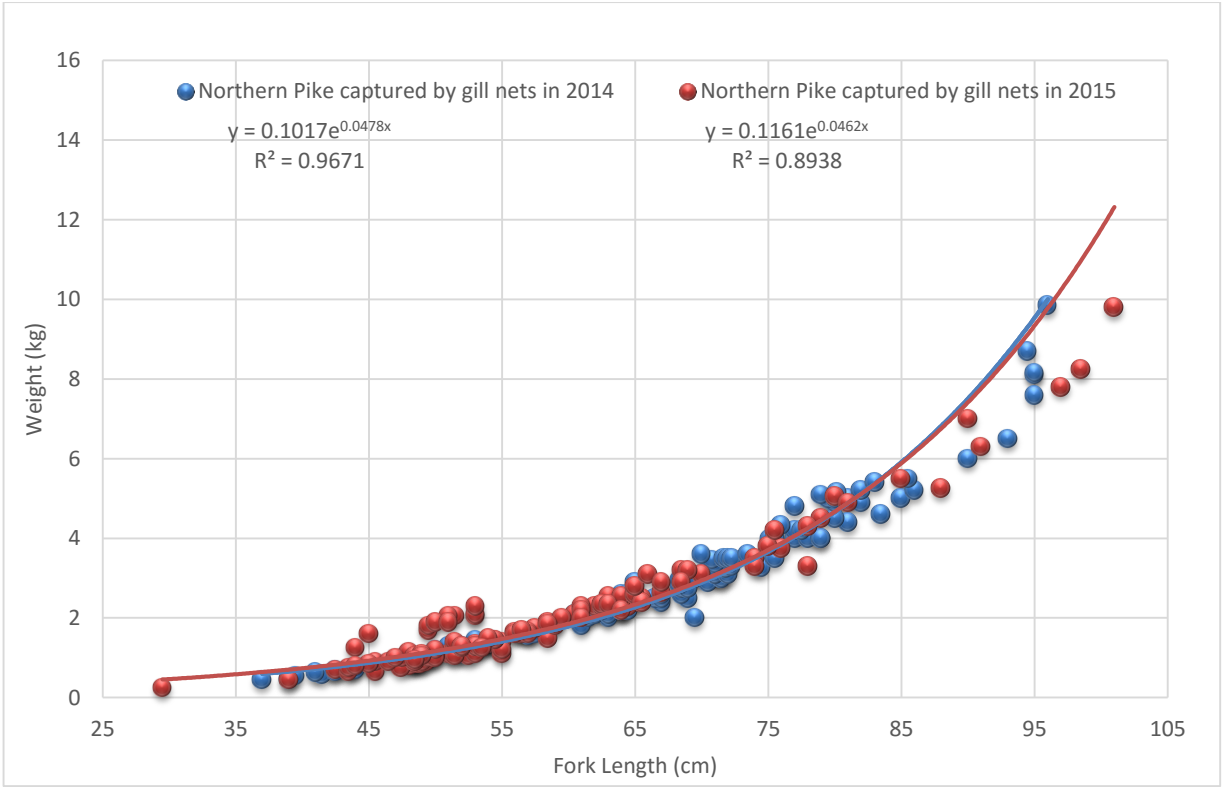

Figure 10. **Length-weight regression of Northern Pike captured by gill-nets in the LCR in 2014 and 2015.**

Population Estimate

A simple Lincoln-Petersen mark and recapture estimate was conducted using the PIT tag recaptures and all of the known caught Northern Pike in 2015. The following formula was used:

$$N = \left[\frac{(n_1+1)(n_2+1)}{m_2+1}\right] - 1$$

n_1 = number of marked and released individuals: 23 (assumes 50% mortality of tags remaining from 2014).
n_2 = total number of individuals captured in 2015: 125 (includes gill-nets (116), angler returns (6), and Indexing (3).
m_2 = number of marked re-captured individuals during the 2015 sampling: 7 (5 from gill nets and 2 from anglers).

The population of NP in the Robson Reach Area is estimated to be 410 with a lower 95% CI of 151 and an upper 95% CI of 670 (Figure 11).

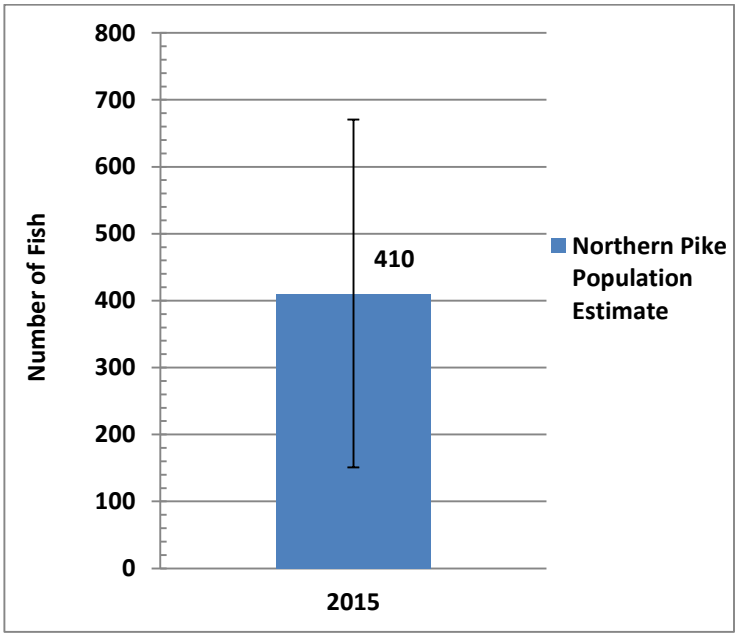

Figure 11. 2015 LCR NP population estimate in the Robson Reach area, based on a Lincoln-Petersen mark and recapture. The error bars represent the upper and lower 95% CI.

Northern Pike Stomach Analysis

The stomach contents (Figure 12) of all NP captured by gill-nets in 2014 and 2015 were examined in the field (n=210) and in the lab (n=43) by Thompson Rivers University. Prey was identified to species when possible. Only 37% (n=93) of all the NP examined (n=253) contained food in their stomachs and in most cases included whole fish. Some stomachs contained residual bones (vertebrae and operculum) of what was believed to be salmonid species, but the majority of stomachs were completely empty. Leech species were found in two of the NP sampled, and 55% of NP diet consisted of native salmonids (Rainbow Trout, Kokanee and Mountain Whitefish). The size range (length) of NP prey fish species was 5 cm to 38 cm and included Dace spp. (DC), Sculpin spp. (CC), Redside Shiner (RSC), Longnose Sucker (LSU), Rainbow Trout (RB), Mountain Whitefish (MW), Kokanee (KO), Northern Pike Minnow (NSC), Northern Pike (NP) and unidentified species (SP). Due to decomposition and digestion, the identification of smaller Dace and Sculpin species was challenging even in the lab. A sub-sample of five Sculpin (Figure 13) found in the stomach of one

Northern Pike was sent to a Sculpin specialist (Crystal Lawrence) at AMEC Foster Wheeler and her identification can be found in Table 5 below. It was determined that the identifiable Sculpin species were not SARA listed and were either Prickly Sculpin or Torrent Sculpin (Table 5).

Figure 12. A 22 cm Mountain Whitefish found in the stomach of a 63 cm, 2.35 kg Northern Pike on September 18, 2015.

Figure 13. Five Sculpin species (50 mm to 100 mm) found in the stomach of a 52 cm, 1.3 kg NP on May 29, 2015.

Table 5. Lab identification results of five Sculpin species found in the stomach of a NP (AMEC Foster Wheeler).

Sample	Length (mm)	Species	Common Name (s)	Notes
1	90	*Cottus asper*	Prickly Sculpin	Based on prickles and length of the anal fin
2	80	*Cottus asper* or *Cottus rhotheus*	Prickly Sculpin or Torrent Sculpin	Prickles observed on limited skin remaining; anal fin decomposed
3	60	*Cottus asper* or *Cottus rhotheus*	Prickly Sculpin or Torrent Sculpin	Prickles observed; anal fin decomposed
4	100	*Cottus sp.*	Sculpin sp.	Too decomposed to ID
5	50	*Cottus sp.*	Sculpin sp.	Too decomposed to ID

DISCUSSION

It was estimated that 725 Northern Pike were present in the Lower Columbia River downstream of the HLK dam in 2014. In two years, the Invasive Northern Pike Suppression Program has successfully removed 288 Northern Pike from the Robson Reach Area, with 87% of the total capture coming from the gill-nets. The 2015 mark and recapture data estimate the current NP population in the Robson Reach area to be 410 with 125 of those being removed during the current years sampling. Based on the mark and recapture data, the NP population could be as low as 151 and as high as 670. Assuming the population is 410, the gill-netting suppression program in 2015 removed approximately 28% of the NP. When combined with the angler returns and Large River Indexing program the total NP removal for 2015 is approximately 30% of the estimated population. At this point it seems that the program has successfully removed between 30-40% of the estimated population over two years in the Robson Reach area. The lengths and weights of captured NP were 15% and 33% lower respectively in 2015 than in 2014, suggesting the majority of large adults have been removed and a new age class is being captured. Future cleithrum age analysis being conducted by TRU will provide more information with regards to size and age cohorts present in the LCR.

Northern Pike larval sampling (Golder, 2015) in the Robson Reach area did not confirm recruitment; however, the stomach analysis conducted in the lab by TRU confirmed age 1+ NP (4 NP < 130 mm fork length) presence and the success of spawning production in the Robson Reach. Large adult Northern Pike have also been observed in suitable spawning habitat in the Robson Reach area and have been dissected to reveal thousands of developed ripe eggs (Figure 14) and milt. Subsequent sampling post spawning also revealed spent NP suggesting that spawning was successful in the Robson Reach area in both 2014 and 2015.

Figure 14. A fully ripe NP female with thousands of developed eggs caught by gill-net on May 25, 2015.

The highest CPUE/net-day (3.48) occurred in the spring of 2014 and 69% (n=92) of the NP total catch for that year were removed in the month of May. Since the initial suppression in the spring of 2014, the CPUE has consistently been around 1.60 NP/net-day or approximately 13 NP/day (8 nets). As mentioned in Baxter and Neufeld 2015, the the Kalispel Natural Resources Department and the Washington Department of Fish and Wildlife have successful removed approximately 90% of the NP population through gill-netting efforts in the Box Canyon Reservoir in the US (Kalispel data summary, 2014). However, the amount of gill-netting effort (1,207 nets in 2013) in the Box Canyon Reservoir is substantially higher than the effort under this current program (155 nets in 2014 and 208 nets in 2015).

Invasive Northern Pike have the potential to significantly impact native salmonids, dace and sculpin species in the Lower Columbia. Approximately 55% of the prey is made up of salmonids (38% MW, 8% RB, and 9% KO) and 10% of the prey were sculpin and dace species. SARA listed species have not been confirmed as prey. It is currently unknown how abundant the populations of Northern Pike are in upstream reservoirs in the Canadian portion of the Pend D'Oreille River, but confirmation from the angler captures is increasing. TRU has implemented a Masters Student program for further investigation to better understand the source of the invasive Northern Pike in the Lower Columbia River. The Washington Department of Fish and Wildlife, the Spokane Tribe of Indians and the Colville Confederated Tribes have implemented a similar collaborative Northern Pike suppression program on Upper Lake Roosevelt and the lower Kettle River and have successfully removed 21 pike during a 5-day pilot study in 2015 (Lee and King, 2015). As mentioned in last year's report, anecdotal accounts of anglers catching Northern Pike in the Arrow Lakes Reservoir (ALR) suggest that NP could have migrated above the HLK dam through the navigation lock, however this anecdotal fish presence data has not been authenticated and creel survey technicians have not observed pike in angler catch from ALR. The current suppression program in the LCR downstream of the HLK dam in the Robson Reach area has been a collaborative effort at successfully controlling the invasive Northern Pike population and gill-netting efforts in 2016 should continue.

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