



Lower Columbia River Invasive Northern <u>Pike Suppression – 2017 Update</u>

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EXECUTIVE SUMMARY

Invasive Northern Pike were first detected in 2009 in the Canadian portion of the Lower Columbia River (LCR) after illegal introductions to US tributaries of the Columbia drainage (Pend D'Oreille River) upstream of BC. This species is now consistently observed in the LCR near Castlegar, BC throughout the Robson Reach downstream of Hugh L. Keenleyside Dam (HLK). Northern Pike have the potential to significantly impact sport fish populations and the recovery of species listed under the Federal Species-at-Risk Act (SARA) through competition, predation, and introduction of disease. To control the invasion of Northern Pike, the Province of British Columbia's Ministry of Forest Lands and Natural Resource Operations (MFLNRO) and Teck Metals Ltd. initiated a four year (2014 to 2017) Northern Pike gill-netting suppression program. This report summarizes the 2017 Northern Pike Gill-Net Suppression Program implemented by the MFLNRO, Teck Metals Ltd. and Columbia Basin Trust.

A total of 372 Northern Pike (NP) have been successfully removed during the gill-netting (n=323), large river indexing (n=20) and angler incentive programs (n=29) in the Lower Columbia River since 2014. Over 86% of the NP removed were during the gill netting efforts. The number of NP removed by gill-nets decreased substantially in 2017 (n=35) and 2016 (n=39) when compared to 2015 (n=116) and 2014 (n=133). To provide an indication of abundance, a simple Lincoln-Petersen mark and recapture estimate was conducted in 2017 using tag recaptures and estimated the population of NP in the study area to be 99 with a lower 95% confidence interval (CI) of 25 and an upper 95% CI of 172.

The gill netting effort occurred over 15 days with 676 net hours in 2017, 10 days and 407 net hours in 2016, 15 days with 659 net hours in 2015, and 15 days with 475 net hours in 2014. The gill-netting average Catch-Per-Unit-Effort (CPUE) in 2017 was the lowest observed since the program began in 2014 at 0.05 NP/hr per net or 0.43 NP/day (8 hr) per net. The highest CPUE in 2017 was during two days of targeted juvenile sampling in mid-September (0.14 NP/hr per net or 1.11 NP/day (8 hr) per net). The 2017 average CPUE for a single crew of two deploying eight nets a day for 8 hours in the Robson Reach area was 3.41 NP/day and the catch rates are much lower when compared to the 2014-2016 CPUE averages.

For all study years (2014-2017) approximately 51% (n=165) of the NP stomachs examined (n=323) contained food and in most cases included whole fish. NP diet consisted primarily of native salmonids (Rainbow Trout, Kokanee and Mountain Whitefish) and other native fish species (Sucker, Sculpin, Northern Pikeminnow, and Dace). Fish listed under SARA were not observed in the stomachs of the NP captured during this study. However, the stomachs of juvenile NP captured in 2017 contained Sculpin and Dace which could not be identified by species and may have included Umatilla Dace, Columbia Sculpin and Shorthead Sculpin, which are listed as species of Special Concern under SARA; these species have overlapping habitat with juvenile NP habitat identified during this project.

The average fork length of captured NP was 68 cm in 2014, 58 cm in 2015, 62 cm in 2016, and 51 cm in 2017. The average weight of captured NP was 3.15 kg in 2014, 2.04 kg in 2015, 2.38 kg in 2016, and 2.05 kg in 2017. The NP fork length range for all years was 26.0 cm to 105 cm and the NP weight range was 0.15 kg to 10.40 kg. A total of 306 NP were dissected from 2014-2017, and the gender distribution for all four years was 141 males (46%), 134 females (44%) and 31 of unknown sex (10%). A total of 1,416 fish were caught as bycatch in gill-nets during the four year suppression program, 1,087 of which were released alive (76.7%). Seven SARA listed White Sturgeon were captured as bycatch (<0.5% of total) since 2014 and all were released unharmed, alive and healthy.

The 2014-2017 gill-netting suppression program has successfully eliminated approximately 86% of the estimated NP population in the LCR study area from 725 NP in 2014 to less than 100 NP in 2017 and has proven to be an effective method for controlling the NP population.

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BACKGROUND & STUDY AREA

Northern Pike (*Esox lucius;* NP), a non-native invasive species in the Columbia River watershed, have been introduced in the US and have more recently colonized a significant portion of the Canadian Columbia River below Hugh L. Keenleyside Dam (HLK). Northern Pike are a highly piscivorous fish and can be troublesome for fisheries managers given their ability to exert top-down effects and alter fish communities (Flinders and Bonar 2004). The increase of Northern Pike poses several threats to the Columbia River ecosystem including: predation of native fish species; introduction of a wide variety of parasites and diseases (e.g. *Triaenophorus* tapeworm is a high-risk parasite, that is not native to the Columbia system and significantly affects the table quality of salmonids); and, competition with other species for common food resources (reducing growth and survival). Northern Pike could also impact opportunities to recover SARA-listed species such as White Sturgeon (*Acipenser transmontanus*), Shorthead Sculpin (*Cottus hubbsi*) and Umatilla Dace (*Rhinichthys umatilla*) in the Columbia River (Baxter and Neufeld 2015).

Recognizing the concerns and threats associated with the NP introductions in the Canadian Columbia River, the British Columbia Ministry of Forest Lands and Natural Resource Operations (MFLNRO) made changes to angling regulations (unlimited daily quota effective 2011), implemented an incentive/education program aimed at encouraging anglers to remove NP from the Columbia River (2013) and initiated the adult gill-netting program in 2014. In addition to MFLNRO mitigation strategies, Teck Metals Ltd. implemented a four-year (2014 to 2017) NP gillnet 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 impacts to native fish species (in particular White Sturgeon) by investigating prey through stomach analysis. Additional support from Columbia Basin Trust (CBT) in 2015 and 2017 also contributed to the gill-netting suppression effort. Other strategies to inventory and suppress the LCR NP population have included acoustic telemetry, otolith geochemistry, eDNA method development, habitat reduction and juvenile detection programs (Lawrence and Baxter 2017).

The initial suppression program completed in 2014 successfully removed 133 NP, and when combined with the angling effort and BC Hydro's Large River Indexing Program (Golder and Poisson 2013), the total known and recorded NP 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 HLK Dam to the US border and all of the NP captured were from the Robson Reach area, directly upstream of Castlegar, BC (Figure 1), where NP spawning was confirmed (Baxter and Neufeld, 2015). In 2015 and 2016 the gill-netting suppression program removed an additional 116 NP and 39 NP, respectively (Baxter 2016, Baxter and Doutaz 2017). Capture efforts have been most successful in the spring when NP move into shallow water spawning habitat. A juvenile NP (n=1) was captured during fyke net sampling that targeted juvenile NP habitat in July 2016 confirming that NP are successfully recruiting in the Robson Reach (ONA 2016). Controlling NP in the LCR before they can spawn is a priority for fisheries managers and as a result the gill-netting suppression program continued in 2017 with ten days of effort during the spawning period and five days of effort during late summer.

This report summarizes the data collected during the 2014-2017 NP gill-netting suppression program conducted by Mountain Water Research (MWR) for MFLNRO, Teck Metals Ltd., and CBT.

The following key objectives are the focus of the current LCR NP Suppression program:

- 1) Reduce the number of Northern Pike present in the Lower Columbia River in British Columbia downstream of the HLK Dam and assess the feasibility of longer term control.
- 2) Assess Northern Pike prey species, in particular determine if White Sturgeon and other native fish are being consumed by Northern Pike.



Figure 1. Lower Columbia River (LCR) Northern Pike Gill Net Suppression study area.

METHODS

Mark and Recapture Population Estimate

A population estimate has been generated during each year of the suppression program, which was based initially on the recapture of 30 NP captured and tagged with Passive Integrated Transponders (PIT) by MFLNRO and Golder Associates in 2013 (Baxter and Neufeld 2015, Baxter 2016). In 2016 and 2017 the estimate incorporated an additional 15 NP that were affixed with internal sonic tags in early spring 2016 by Thompson Rivers University Masters student Dan Doutaz (Baxter and Doutaz 2017). By the spring of 2017 only 11 sonic tags were remaining in the study area and these tags were used to estimate the population using a simple Lincoln-Petersen mark and recapture equation. The following formula was used:

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

n₁ = number of marked and released individuals: 11 (known tags remaining in 2017).

n₂ = total number of individuals captured in 2017: 36 (only includes gill-netting program).

m₂ = number of marked re-captured individuals during the 2017 sampling: 4 (1 released alive for research).

Gill Net Suppression

For all years (2014-2017) gill netting was primarily completed in areas of known concentrations of Northern Pike; near Castlegar in the Robson Reach area downstream of HLK Dam. Other areas with similar habitat characteristics containing a combination of shallow water and abundant aquatic vegetation were also sampled in the Kootenay River Oxbow and Zuckerberg Island areas. Monofilament gill nets with the same specifications identified in the US as being highly effective for NP removal were used (Table 1).

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	-	-

Table 1. Gill-net dimensions used for the LCR NP mechanical suppression in 2014 to 2017.

Two of the sampling days in September focused on juvenile habitat that was identified by conducting shallow water boat surveys prior to net sets. Additional gill-nets supplied by BC Hydro were used in 2017 to target juvenile young-of-the-year (YOY) NP. Juvenile gill-nets were 1.5 m deep by 46 m long, with all the panels containing 2.5 cm mesh.

An 18-foot aluminum jetboat was used during this program from 2014 to 2017. Gill nets were set in shallow water bays known to have high NP abundance, and in locations that limited bycatch of salmonids and White Sturgeon. Short duration, daytime sets were used (maximum of 4 hrs) to limit native fish bycatch and mortality. All bycatch was released alive when possible. All captured NP were euthanized and then measured for weight (to nearest gram) and fork length (mm), scanned for a PIT tag, and assessed for sex/maturity. Stomach contents of all captured NP were examined in the field at time of capture and recorded, with the exception of 43 stomachs from 2015 that were preserved and sent to the TRU lab for analysis. Prey was identified to species when possible. All of the heads from each NP in 2014 and 2015 were removed and kept frozen for age analysis of the cleithrum and otolith stream chemistry analysis by the TRU lab. Cleithra are paired, flat bones, and are components of the pectoral girdle. In NP the cleithrum is located below the skin of the posterior edge of the operculum opening and is used for aging individual fish (Euchner, 1988).

Total gill-netting effort in 2017 was conducted in May (10 days) during the projected spawning period and in September (5 days) during the Kokanee (*Oncorhynchus nerka*; primary NP prey species) spawning period with a crew of two deploying 8 nets twice a day, when possible (Table 2). Table 3 describes the gill netting data collected for each net-set for all years (2014-2017).

Date	Nets Deployed	Total Set Hours
10-May-17	6	28.78
11-May-17	16	48.25
12-May-17	16	49.00
13-May-17	16	53.75
14-May-17	8	33.82
17-May-17	8	36.87
18-May-17	16	50.03
19-May-17	16	55.02
20-May-17	16	49.00
21-May-17	8	29.15
11-Sep-17	16	51.23
12-Sep-17	16	60.90
13-Sep-17	8	44.67
14-Sep-17	8	56.42
15-Sep-17	8	29.43
Total	182	676.32

Table 2. Lower Columbia River Northern Pike gill-netting schedule and effort, 2017.

Table 3. Lower Columbia River Northern Pike gill-netting data collection description, 2014-2017.

•	Date	٠	Set ID	٠	Location (UTM)
•	Time in	•	Time out	•	Total Hours Deployed
٠	Float Number	•	Area Description	•	System and Water Temperature
٠	Species Captured	•	Bycatch Count	•	Bycatch Released Alive
•	Fork Length of all NP	•	Weight of all NP	٠	Tag Number
٠	NP Gender	•	NP Maturity	•	NP Stomach Contents

Data Analysis

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

Two primary pieces of information collected during the gill netting program were analyzed: the total amount of effort (net hours) and the average catch-rate which is referred to as Catch-Per-Unit-Effort (CPUE). 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. The CPUE for a crew of two deploying 8 nets a day was also calculated.

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 floy tags recaptured, length and weight frequencies of captured NP, NP gender distribution, NP stomach analysis by prey species, and bycatch rates.

Pathology Sampling

In 2015, 2016 and 2017, the NP were not screened in the lab for parasites. However, a total of nine NP 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 (i.e., IHNv, IPNv and VHSv), bacterial tests (various pathogenic bacteria) and parasites (e.g., *Triaenophorus crassus*) following standard Canadian Fish Health Protection Regulation (CFHPR) methods. The results of the 2014 disease screening are presented in Baxter and Neufeld (2015). Field observations made each year estimate approximately 10% of NP sampled contained parasitic worms.

RESULTS

Gill Netting and Analysis

In 2017, a total of 36 NP were captured during the gill-netting program, of which 4 were TRU's sonic tagged study fish. One of the sonic tagged NP captured was released alive and healthy and three were removed due to mortality from the gill-nets. Therefore, the total gill-net NP removal in 2017 was 35. An additional four NP were confirmed to be removed from the LCR in 2017 by Golder Associates Ltd. during the BC Hydro Large River Indexing Program (D. Roscoe, Golder Associates Ltd., Biologist, pers. comm. 2017). A total of 19 NP captured were mature adults and 17 NP were juveniles ranging in size from 260 mm to 390 mm; 14 of the pike captured were ripe adults and removed prior to spawning along with 5 additional adult NP removed in September. A total of 14 NP YOY (age 0+ fish) were captured in the Kootenay River Oxbow area in less than 30 cm of water. The total number of NP caught by gill-netting each year is summarized in Table 4. The average CPUE in 2017 was 0.05 NP/hr per net or 0.43 NP/day (8 hr) per net. However, the CPUE during two days of sampling that targeted juvenile habitat was much higher at 0.14 NP/hr per net or 1.11 NP/day (8 hr) per net. The 2017 average CPUE for a single crew of two deploying eight nets a day for 8 hours in the study area was 3.41 NP/day and the catch-rates are much lower when compared to the 2014-2016 CPUE averages (Table 4).

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
2016	0.13*	1.02*	49	8.17*
2017 (Average)	0.05	0.43	36	3.41
2017 (Robson Reach)	0.04	0.30	22	2.44
2017 (Juvenile Habitat)	0.14	1.11	14	8.9

Table 4.Northern Pike (NP) gill-netting Catch-Per-Unit-Effort (CPUE) and totals for 2014 to 2017 in the Lower
Columbia River study area.

*2016 CPUE has been updated based on a calculation error in the 2016 report analysis.

The average fork length of captured NP was 68 cm in 2014, 58 cm in 2015, 62 cm in 2016, and 51 cm in 2017. The average weight of captured NP was 3.15 kg in 2014, 2.04 kg in 2015, 2.38 kg in 2016, and 2.05 kg in 2017. The NP fork length range for all years was 26 cm to 105 cm and the NP weight range was 0.15 kg to 10.40 kg. A total of 306 NP were dissected from 2014-2017, and the gender distribution for all four years was 141 males (46%), 134 females (44%) and 31 of unknown sex (10%).

A total of 1,416 fish were caught as bycatch in gill-nets in the four years of the suppression program, 1,087 of which were live releases (76.7%). Bycatch species caught in gill-nets included Rainbow Trout (*Oncorhynchus mykiss*), Kokanee, Bull Trout (*Salvelinus confluentus*), Brook Trout (*Salvelinus fontinalis*), Mountain Whitefish (*Prosopium williamsoni*), Lake Whitefish (*Coregonus clupeaformis*), Northern Pikeminnow (*Ptycheilus oregonensis*), Sculpin spp. (*Cottus spp.*), Sucker spp. (*Catostomus* spp.), Tench (*Tinca tinca*), Smallmouth Bass (*Micropterus dolomieu*), Yellow Perch (*Perca flavescens*), Walleye (*Sander vitreus*) and White Sturgeon. Seven SARA listed White Sturgeon were captured as bycatch (<0.5% of total) since 2014 and all were released unharmed, alive and healthy. Our analysis focuses on the NP since these fish were the primary target species and the ones for which biometric data were collected. In 2017, gill-nets captured 386 non-target individuals and 70% were released alive. Bycatch mortalities in 2017 included Kokanee (n=36), Mountain Whitefish (n=13), Rainbow Trout (n=12), Lake Whitefish (n=10), Sucker sp. (n=6), Tench (n=2), Yellow Perch (n=1), and Walleye (n=1). All other bycatch was released alive.

Population Estimate

The 2017 NP population in the study area is estimated to be 99 with a lower 95% CI of 25 and an upper 95% CI of 172 (Figure 2). The Lincoln–Petersen method for estimating the NP population in the study area is not precise, as the system is not closed, but it does provide an indication of the NP population trend for each year. The population estimates for all four years and the total NP removed by year can be found in Table 5 below.



- Figure 2. 2017 Lower Columbia River Northern Pike population estimate in the study area, based on a Lincoln-Petersen mark and recapture. The error bars represent the upper and lower 95% CI.
- Table 5.Northern Pike (NP) population estimates based on the mark and recapture results and the total NP
removed by year.

Year	NP Population Estimate	NP Removed*	
2014	725 (95% CI 478-2,759)	163	
2015	410 (95% CI 151-670)	125	
2016	107 (95% CI 59-155)	43	
2017	99 (95% Cl 25-172)	41	

*Confirmed and reported NP removed for each year using all suppression techniques (gill-netting, electrofishing, and angling).

Northern Pike Stomach Analysis

The stomach contents of all NP captured by gill-nets from 2014 to 2017 were examined either in the field (n=280) or in the TRU lab (n=43). For all study years (2014-2017) approximately 51% (n=165) of all the NP examined (n=323) contained food in their stomachs and in most cases included whole fish. Fish listed under SARA were not observed in the stomachs of any of the NP captured during this study. However, the stomachs of juvenile NP captured in 2017 contained Sculpin and Dace which may have included SARA-listed Umatilla Dace, Columbia Sculpin and Shorthead Sculpin (AMEC 2014) but specimens could not be identified to species. Some stomachs contained residual bones (vertebrae and operculum) of what was believed to be salmonid species, but almost half (49%) of the stomachs sampled were completely empty. Leech species were found in two of the NP stomachs sampled, and 57% of NP stomachs contained Rainbow Trout (RB), Kokanee (KO) (Figure 3) and Mountain Whitefish (MW). The size range (length) of NP prey fish species was 2 cm to 38 cm and included Dace spp. (*Rhinichthys* sp.), Sculpin spp., Redside Shiner (*Richardsonius balteatus*), Longnose Sucker (*Catostomus catostomus*), Rainbow Trout, Mountain Whitefish, Kokanee, Northern Pikeminnow, Northern Pike and unidentified species.



Figure 3. Example stomach dissection from captured Northern Pike (84 cm FL) containing a female Kokanee (24 cm FL) in spawning condition, September 12, 2017. The NP was a recapture (floy tag number 364) and had grown 21 cm in one year.

DISCUSSION

Following the discovery of NP in the Columbia River, provincial fisheries managers responded quickly with removal and research programs which were initiated in 2014 and aimed at suppressing and evaluating the population (Baxter and Doutaz 2017). A complementary program has been conducted in the US Columbia River since 2015 (Lee and King 2015). In Canada, the gill-net suppression program has investigated areas suitable for NP that are found in the Robson Reach downstream of HLK Dam, near Waldie Island, Zuckerberg Island, the Fort Shepard area near Beaver Creek and below the Waneta Dam, as well as in the lower Kootenay River near Kootenay oxbow. Suppression sessions have occurred in spring, summer and fall (Baxter and Neufeld 2015). Initially NP were only captured in the Robson Reach and catch-rates were highest in spring (Baxter and Neufeld 2015). Based on these results, gill net suppression has primarily been conducted in the Robson Reach in spring with additional locations and seasons added where time and budget allows. In 2016 and 2017, NP were also captured near Zuckerberg Island and in the Kootenay River oxbow near Castlegar, BC. Since the suppression program began in 2014, the NP catch-rate has been reduced by over 70%.

The Invasive Northern Pike Suppression Program has successfully removed 372 NP from the study area, with over 86% (n=323) of the total NP removal coming from the gill-nets. The number of NP removed by gill-nets in 2017 (n=35) was similar to 2016 (n=39), but was much lower than the number removed in 2015 (n=116) and 2014 (n=133). The lower catch-rates in the last two years seem to confirm that the NP adult population is being controlled, however capture of juvenile life stages now indicate NP are successfully recruiting within the LCR, which is concerning and steps to control the juvenile NP cohort are warranted. The 2017 mark and recapture data estimate the current NP population in the study area to be 99 (95% CI 25-172).

Invasive NP continue to have the potential to significantly impact native salmonids, Dace and Sculpin species in the Lower Columbia River based on their stomach contents. Approximately 60% of the prey is made up of salmonids (44% MW, 8% RB, and 8% KO). Sculpin and Dace species accounted for 20% of the prey species and are mostly found in juvenile NP stomachs. To-date, SARA-listed White Sturgeon juveniles have not been identified in NP stomachs, however, SARA-listed Sculpin and Dace may be at risk of predation as they have been identified in NP stomachs though classification to the species level was not possible (AMEC 2014). TRU sampling in the Canadian portion of the Pend d'Oreille River above Waneta Dam has confirmed that NP are quite abundant, but it is currently unknown to what extent and how frequently NP may invade the LCR from this source.

Thompson Rivers University (TRU) initiated the Columbia River Northern Pike Removal – Risk and Feasibility of Control project in 2015. The TRU work is being conducted as part of a TRU master's thesis that is currently ongoing and estimated to be completed in 2018. Telemetry data is being collected from the 15 NP that were captured and internally tagged with Vemco (V13 1x-A69-1303 69 KHz) acoustic tags in early spring 2016 in the Robson Reach. Preliminary results indicate that 11 of the 15 tags remain functional as of early 2017 and tagged fish remain downstream of HLK Dam. Tracking of these tagged fish during the 2016 and 2017 spawning period, demonstrated NP moving up to 7 km upstream from as far away as the Kootenay Oxbow to the Robson Reach near the Zellstoff Celgar Pulp Mill, about 1 km downstream of HLK Dam (Dan Doutaz, Master's Student, TRU, pers. comm. 2017). This area was identified during other studies as the most likely NP spawning area in the Canadian Columbia River. One of the tagged NP moved downstream 50 km into the US in February 2017 and returned to the Kootenay River Oxbow area in September 2017 (Dan Doutaz, TRU, pers. comm. 2017). Recent microchemistry analysis of 50 otolith samples collected from NP captured during the 2014 gill-net suppression program indicated that the origin of 49 NP was from the Columbia River and 1 NP originated from the Pend d'Oreille River (Dan Doutaz, TRU, pers. comm. 2017). This data, coupled with the capture of NP juveniles, indicate that NP are successfully recruiting in the Columbia River.

Efforts to capture juvenile NP began in 2015 in an attempt to confirm if the adult population of NP in the Canadian Columbia River was successfully recruiting. The Castlegar and District Wildlife Association in collaboration with Golder Associates Ltd., the West Kootenay Fly Fishing Association and the 10th Avenue Volunteers attempted to collect larval NP in June and July 2015 in the Robson Reach. Backpack electrofishing, dip netting, beach seining, plankton towing, minnow trapping and light trapping were used day and night and no NP were captured (Golder 2015). However, a spent female NP was captured by gill-nets during the 2015 spawning season confirming spawning did occur and stomach content analysis of NP captured during the program included age 0+ NP (n=4; <130 mm fork length) confirming spawning was successful and juveniles were present in the Robson Reach in 2015 (Baxter 2016). It may be that juveniles were not present in the areas sampled in 2015 (Golder 2015) or that the sampling methodology was not successful at capturing juvenile NP.

The ONA conducted a juvenile detection program in the spring and summer 2016 using fyke and seine nets to try to capture NP YOY within the Robson Reach. One YOY NP (12.5 cm fork length, 11.8 g) was captured by fyke net on July 27, 2016 (ONA 2016). Habitat at the capture location consisted of low velocity (0.09 cm/s), shallow (0.2 - 1.2 m), well oxygenated (10.25 mg/L) water with primarily sand substrate and trace amounts of vegetation and pebbles (ONA 2016). The juvenile's stomach contained one partially digested small fish suspected to be a Redside Shiner.

In September 2017 boat surveys were conducted in less than 30 cm of water, in habitat with little to no flow to identify juvenile NP habitat and use. The boat surveys confirmed YOY NP (n=32) observations in the Kootenay River Oxbow. Two days of gill-netting using 2.5 cm mesh (Figure 3) captured 14 of the 32 observed juvenile YOY pike (Figure 4) from the Kootenay River Oxbow. Future juvenile habitat surveys, combined with juvenile gill-net suppression and boat electrofishing techniques that have been successful in the US at removing juvenile pike (Holly McLellan, Principle Fish Biologist, Colville Confederated Tribes, pers. comm. 2017) should be a priority.



Figure 4. Lower Columbia River Northern Pike juvenile gill-netting using 2.5 cm mesh in the Kootenay River Oxbow on September 13, 2017.



Figure 5. Juvenile Northern Pike captured in the Kootenay River Oxbow on September 13, 2017.

Northern Pike suppression in Lake Roosevelt, the U.S. portion of the Columbia River downstream of the international boundary, began in 2016. Suppression efforts were focused in the Kettle Falls region of Lake Roosevelt and approximately 1,200 NP were removed during the initial year of the program using gill net suppression and boat electrofishing methods. In 2017, nearly 5,000 NP were removed from Lake Roosevelt using various methods including daytime gill nets (n= 132), overnight gill nets (n= 2,684), seine nets (n=102), fyke nets (n=100), daytime boat electrofishing (n=633), juvenile White Sturgeon indexing gill net surveys (n=92), fall NP indexing gill net surveys (n=89) and an angler incentive program (n=1,095; Elliott Kittel, Fisheries Biologist, Spokane Tribe of Indians, pers. comm. 2017). The fisheries co-managers of Lake Roosevelt (Colville Confederated Tribes, Spokane Tribe of Indians and the Washington Department of Fish and Wildlife) have proposed to expand and continue their suppression program between 2018 and 2022 (Holly McLellan, pers. comm., 2017). Transboundary stakeholders met in Castlegar, BC in June 2017 to share information, identify data gaps and discuss priority actions and recommendations to strengthen suppression efforts (Lawrence and Baxter 2017).

The 2014-2017 gill-netting suppression program in Canada has successfully eliminated approximately 86% of the estimated NP population in the Robson Reach Area from 725 NP in 2014 to less than 100 NP in 2017 and continues to be a viable option of control, however more NP can continue to move into the Canadian portion of the LCR from the Pend D'Oreille River or Lake Roosevelt at currently unknown rates.

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