Lower Columbia River Invasive Northern Pike Suppression and Stomach Analysis – 2014

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Prepared for:

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EXECUTIVE SUMMARY

Northern Pike (*Esox lucius*), a non-native invasive species in the Lower Columbia River watershed, were introduced in the US and have recently colonized a significant portion of the Canadian Columbia River below Hugh Keenleyside Dam (HLK). First detected in the Lower Columbia River 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. This report summarizes the 2014 Northern Pike Gill-Net Suppression Program implemented by the MFLNRO and Teck Metals Ltd.

A total of 133 Northern Pike were removed during the 2014 gill-netting program. The total known and recorded Northern Pike removed from the Lower Columbia River in 2014 is 163. A simple Lincoln-Petersen mark and recapture estimate was conducted using the PIT tag recaptures and estimated the population of Northern Pike in the Lower Columbia River to be 725 with a lower 95% confidence interval (CI) of 478 and an upper 95% CI of 2,759. A total of 69% of the Northern Pike catch occurred in May with an average CPUE of 0.44 NP/hr per net or 3.48 NP/day (8 hr) per net. Twelve species or species groups of fish were captured during the gill-netting and total bycatch was 327 with 85% being released alive.

Approximately 75% of Northern Pike captured had empty stomachs and 25% contained native fish species (particularly salmonids) as their primary prey. White Sturgeon were not found to be consumed by any of the captured Northern Pike in 2014. Northern Pike growth rates are high in the Lower Columbia River, averaging 1.42 kg/yr. The average fork length of captured Northern Pike was 68 cm with a range of 37 cm to 96 cm. The average Northern Pike weight was 3.15 kg with a range of 0.45 kg to 9.85 kg. They were caught primarily in shallow water habitat less than 4 m deep. The gender distribution, as determined by dissection, of Northern Pike was 60 males (45%), 46 females (35%) and 27 of unknown sex (20%).

Assuming the population is 725, the gill-netting suppression program in 2014 removed approximately 18% of the Northern Pike. When combined with the angler returns and the BC Hydro Large River Indexing Program the total Northern Pike removal for 2014 is approximately 20% of the estimated population. This was corroborated by the 20% percent of PIT tags recaptured in 2014.

The increase of Northern Pike poses 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. The current gill-netting suppression program has helped to eliminate approximately 20% of the Northern Pike population, but more rigorous efforts may be required to control this invasive species before they get significantly established. Given the unexpectedly low population estimate and high rate of removal (20%) in a pilot level program, it is likely that if operational level control measures are implemented soon, there is a high chance of suppressing pike populations at a level that will have limited effects on the native fish population.

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BACKGROUND & STUDY AREA

Invasive Northern Pike (*Esox lucius*) recently colonized 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, and have now moved downstream into the Columbia River near Trail, and upstream to the Hugh Keenleyside Dam (HLK) (Figure 1). In the US portion of the Pend D'Oreille River (Box Canyon Reservoir), Northern Pike (NP) populations increased from 400 in 2006 to > 5,500 NP in 2010, while most other species have declined significantly (J. Olson, pers comm). To control the Northern Pike populations in the Box Canyon Reservoir, gill netting suppression and angler removal programs were established under a joint initiative between the Kalispel Natural Resources Department and the Washington Department of Fish and Wildlife in 2010. The US netting and angler removal programs have successfully reduced Northern Pike numbers by almost 90% in the Box Canyon Reservoir and ongoing efforts will continue in 2015. Northern Pike were first detected in the BC section of the Columbia River downstream of Hugh L. Keenleyside Dam in 2009, and multiple hydroelectric facilities on the Pend D'Oreille River may have slowed the invasion, but have also provided habitat suitable for colonization (Ford et al. 2014). Northern Pike are a highly piscivorous fish and can be troublesome for 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 species, introduction of a wide variety of parasites and diseases (e.g. *Triaenophorus* tapeworm is a high risk parasite, 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, Shorthead Sculpin, and Umatilla Dace in the Columbia River.

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. In addition to the Province of BC mitigation strategies, Teck Metals Ltd has implemented a Northern Pike gill netting suppression program as part of the Upper Columbia River White Sturgeon Recovery Initiative to complement the Ministry's efforts and assess the impacts to native fish species (in particular White Sturgeon) by investigating prey through stomach analysis. This report summarizes the data collected during the 2014 Northern Pike gill netting suppression program conducted by the Mountain Water Research (MWR) for MFLNRO and Teck Metals Ltd.

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.

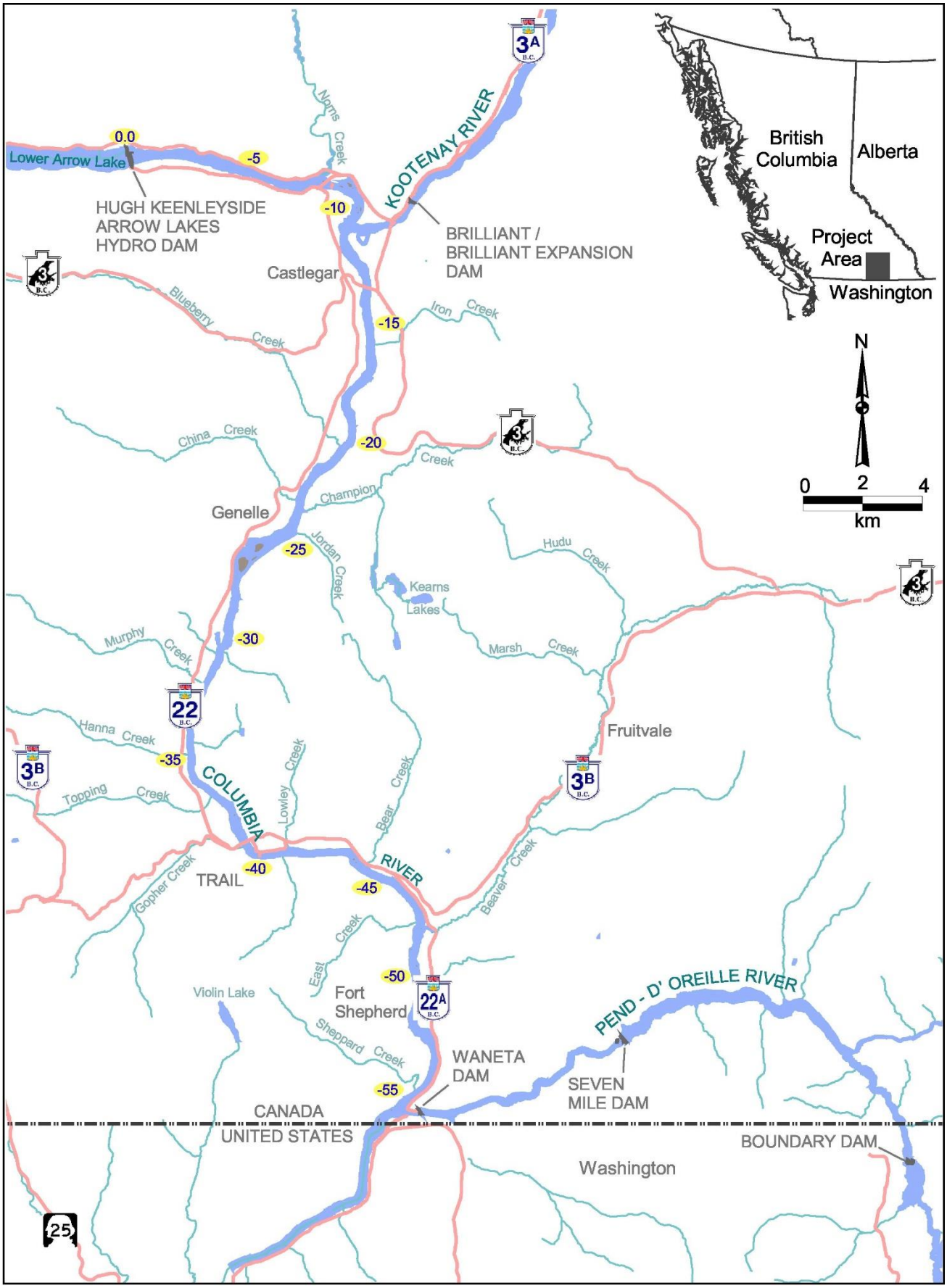


Figure 1. LCR Northern Pike Gill Net Suppression study area.

METHODS

Angler Incentive Program

In 2013, 30 Northern Pike were Passive Integrated Transponder (PIT)-tagged and released by MFLNRO and Golder Associates as part of a MFLNRO angler tag reward program. The angler incentive program included PIT tagging pike in the head, and requesting that anglers return heads of captured pike to a Ministry office. PIT tag returns were worth $500 to the angler (Figure 2).

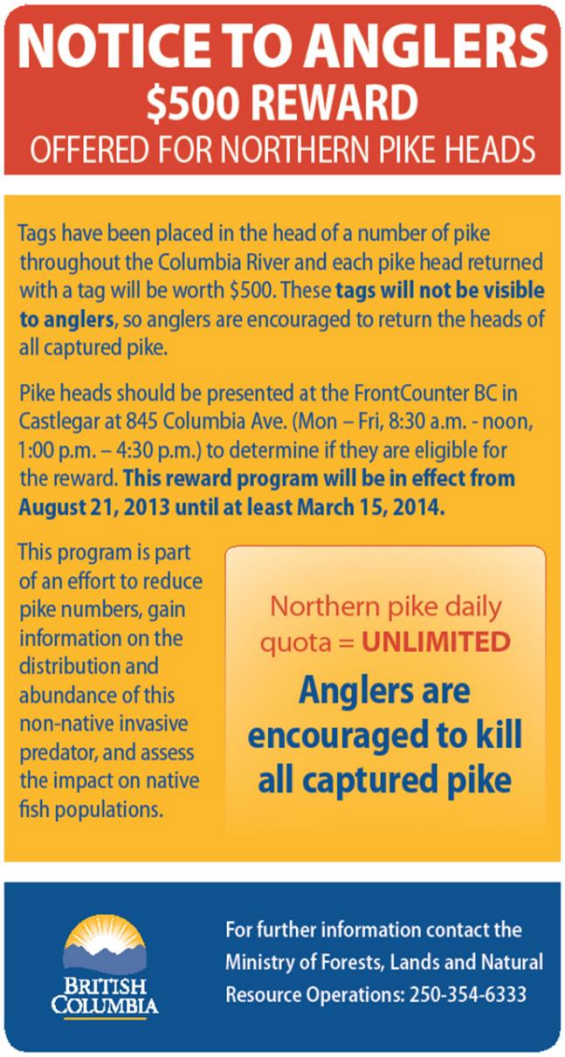


Figure 2. MFLNRO angler tag reward program poster.

Gill Net Suppression

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 and mainstem LCR (Fort Shepard Area) near Beaver Creek and the Waneta dam (see Figure 3). Monofilament gill nets with the same specifications identified in the US as being highly effective for NP removal were used (Table 1).

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

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 randomly selected in shallow water bays known to have high NP abundance, and in locations that limited bycatch of salmonids and sturgeon. Gill nets were set for a maximum of 4 hrs to limit native bycatch and mortality. All bycatch was released alive if possible. Two nighttime sets were tested and it was determined that the bycatch and mortality of native species was too high and pike CPUE was lower than day sets, so 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. Initially the stomach contents were going to be sent to a lab to be analysed, but it was determined that the contents were easily identified in the field and recorded onsite. Approximately 30 cleithrum samples were taken from NP of various sizes and kept frozen. 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 2014 was distributed throughout the year over 16 days with a crew of two deploying 2 to 8 nets twice a day if possible (Table 2). Staff from both the MFLNRO and MWR deployed the nets in 2014.

Table 2. LCR NP gill-netting schedule and effort, 2014.

NP gill-netting date	Number of Nets Deployed	Total Set Hours
April-16-14	3	2.45
May-09-14	2	7.72
May-13-14	4	18.10
May-19-14	14	28.10
May-20-14	13	68.53
May-21-14	12	53.15
May-22-14	13	50.07
May-23-14	8	37.62
August-22-14	14	43.52
August-23-14	16	43.72
August-24-14	16	55.93
August-25-14	8	28.77
November-17-14	8	32.17
November-18-14	8	42.03
November-19-14	8	38.17
November-20-14	8	33.48
Total	**155**	**583.53**

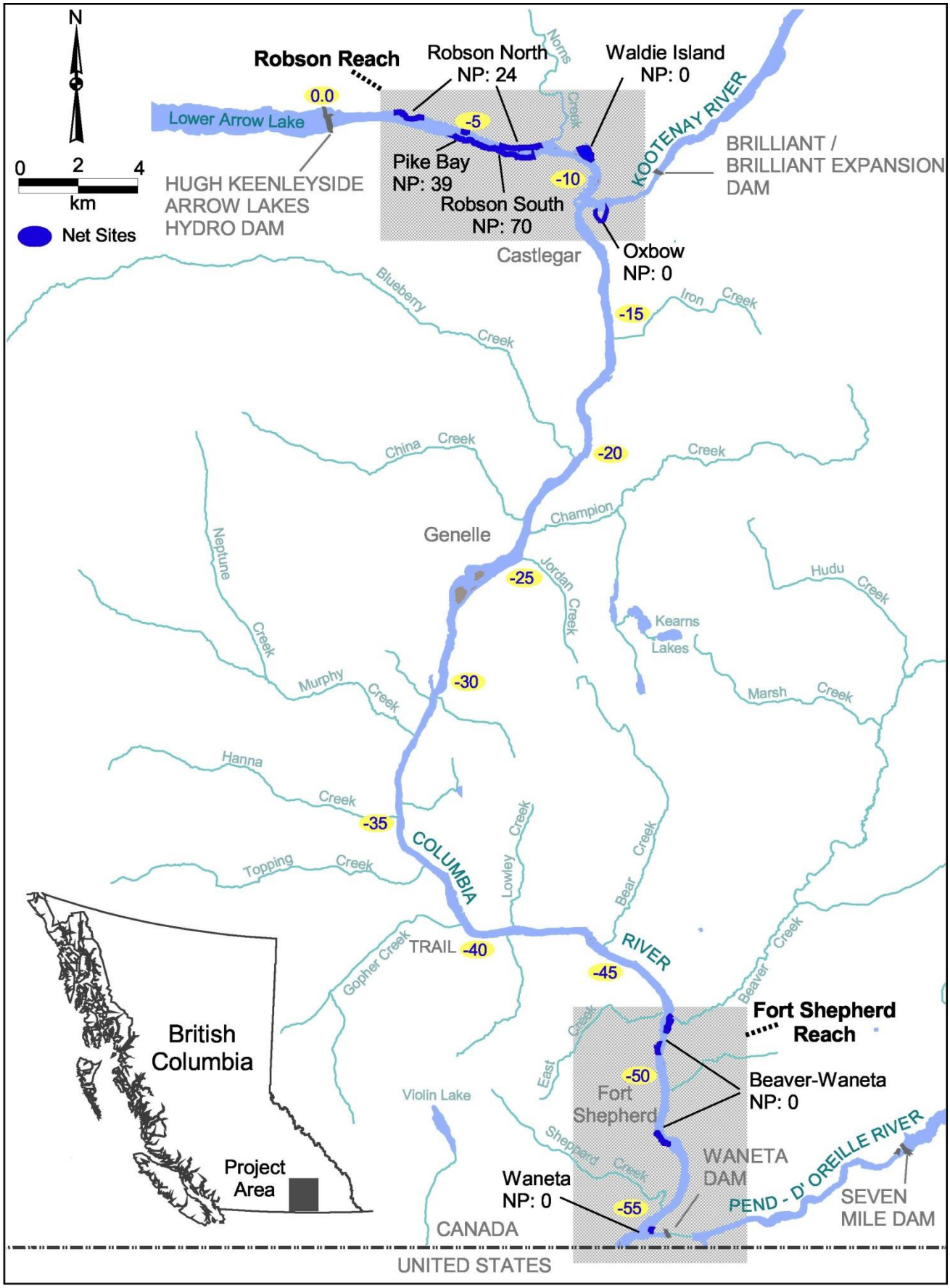


Figure 3. LCR NP Gill Netting Set Sites, 2014.

The following table describes the gill netting data collected for each net-set.

Table 3. LCR NP gill-netting data collection description, 2014.

• 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

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, catch rates by season, length and weight frequencies of captured Northern Pike, growth rates of recaptured Northern Pike, Northern Pike gender distribution, Northern Pike stomach analysis by prey species, and bycatch rates.

Pathology Sampling

A total of nine pike samples collected during gill-net surveys were submitted the Provincial Freshwater Fisheries Society of BC (FFSBC) Fish Health Lab for standard disease screening. 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.

RESULTS

Angler Incentive Program and PIT Tag Returns

Anglers have returned a total of 21 Northern Pike heads to date, and no PIT tags were present. However, the gill-netting program returned a total 6 PIT tags or 20%. Based on the PIT tag returns and overall numbers, the gill netting program seems to be the most successful way to remove Northern Pike from the system. However, the angler return program was an effective means to communicate and engage with anglers, and relay the importance of pike removal.

Gill Net, Boat Electrofishing and Angler Suppression and Analysis

A total of 133 Northern Pike were removed during the 2014 gill-netting program. An additional 30 Northern Pike (21 from anglers and 9 from the BC Hydro Large River Indexing program) were confirmed to be removed from the LCR in 2014. The total known and recorded Northern Pike removed from the LCR in 2014 is 163. During the gill netting program, Northern Pike were only captured in the Robson Reach Area (upstream of river km 7), and although other

areas were sampled with no captures, the CPUE in the Robson Reach area was only included in the analysis (Figures 5-14) because a lack of pike capture and low habitat suitability suggests that these area will not be included in future programs. Gill netting trials in April did not capture any pike, and the seasonal catch rates of NP were highest in the spring during May when Northern Pike were concentrated in shallow water spawning areas. A breakdown of the number of NP caught per season can be found in Figure 15. A total of 69% of the NP catch occurred in May with an average CPUE of 0.44 NP/hr per net or 3.48 NP/day (8 hr) per net (Figure 16 and 17). The CPUE for a single crew of two deploying eight nets a day for 8 hours in the Robson Reach Area is 27.86 NP/day in May, 13.55 NP/day in August, and 6.52 NP/day in November, with an average CPUE of 11.98 NP/day for all of 2014 (Figure 18). Although catch rates were much higher in May, which corresponded with spawning and associated congregation in the Robson reach (this area may provide the only suitable spawning habitat), we could not separate the effect of season, and the effect of reductions in density from removal efforts.

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 (Figure 19). Our analysis focuses on the Northern Pike (Figure 4) since these fish were the primary target species and the ones for which biometric data were collected. Throughout 2014, gill nets captured 327 non-target individuals and 85% were released alive. Bycatch mortalities included Kokanee (8), Mountain Whitefish (38), Rainbow Trout (3), and Smallmouth Bass (4). All other bycatch was released alive.

Northern Pike length and weight frequencies are presented in Figure 20. The average fork length of captured NP was 68 cm with a range of 37 cm to 96 cm. The average weight of captured NP was 3.15 kg with a range of 0.45 kg to 9.85 kg. Northern Pike were caught primarily in shallow water habitat less than 4 m deep (Figure 21). The gender distribution of NP was 60 males (45%), 46 females (35%) and 27 of unknown sex (20%).

Figure 4. Six Northern Pike caught on one gill-net set on November 17, 2014. Catch includes three females and three males ranging in lengths from 48 cm to 96 cm and weights from 1.0 kg to 9.85 kg.

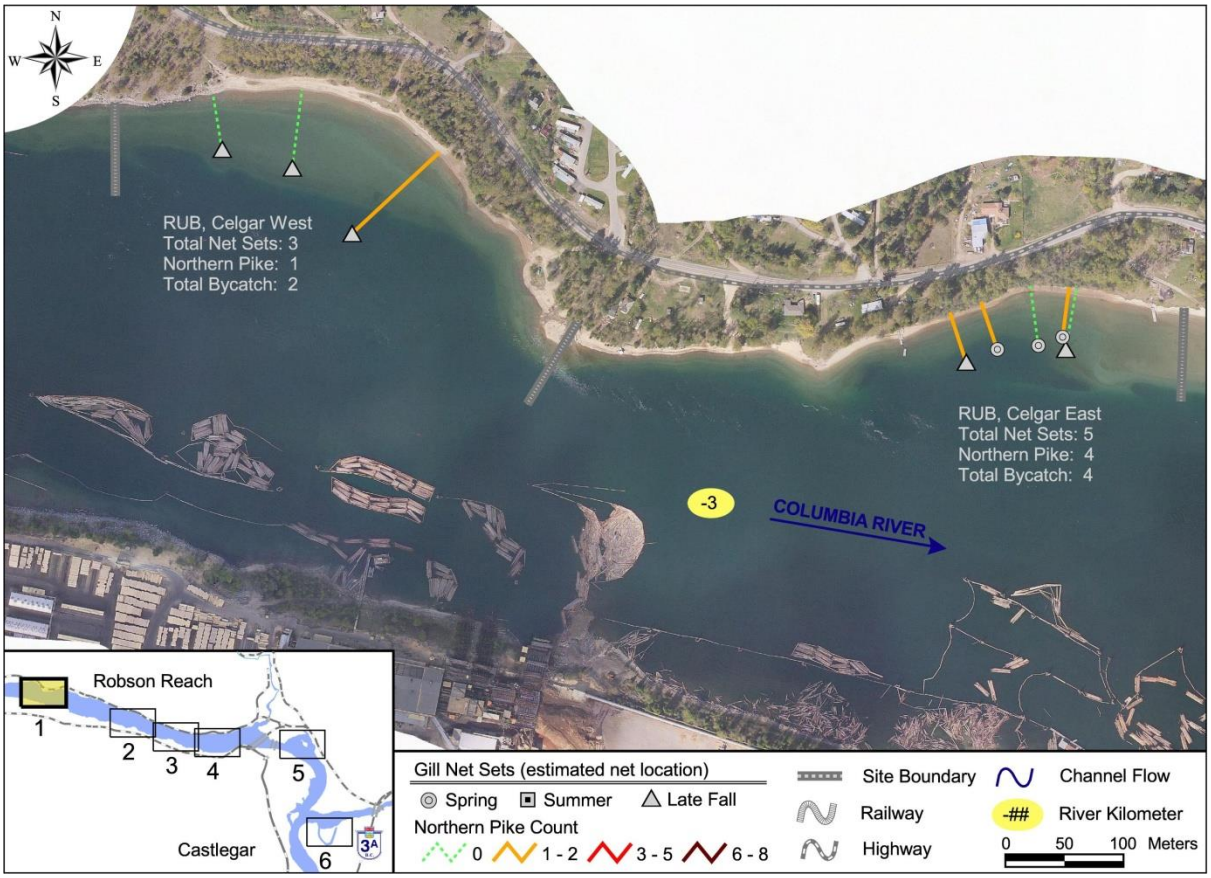


Figure 5. LCR NP gill netting set sites by season and catch per net in the Celgar Area, 2014.

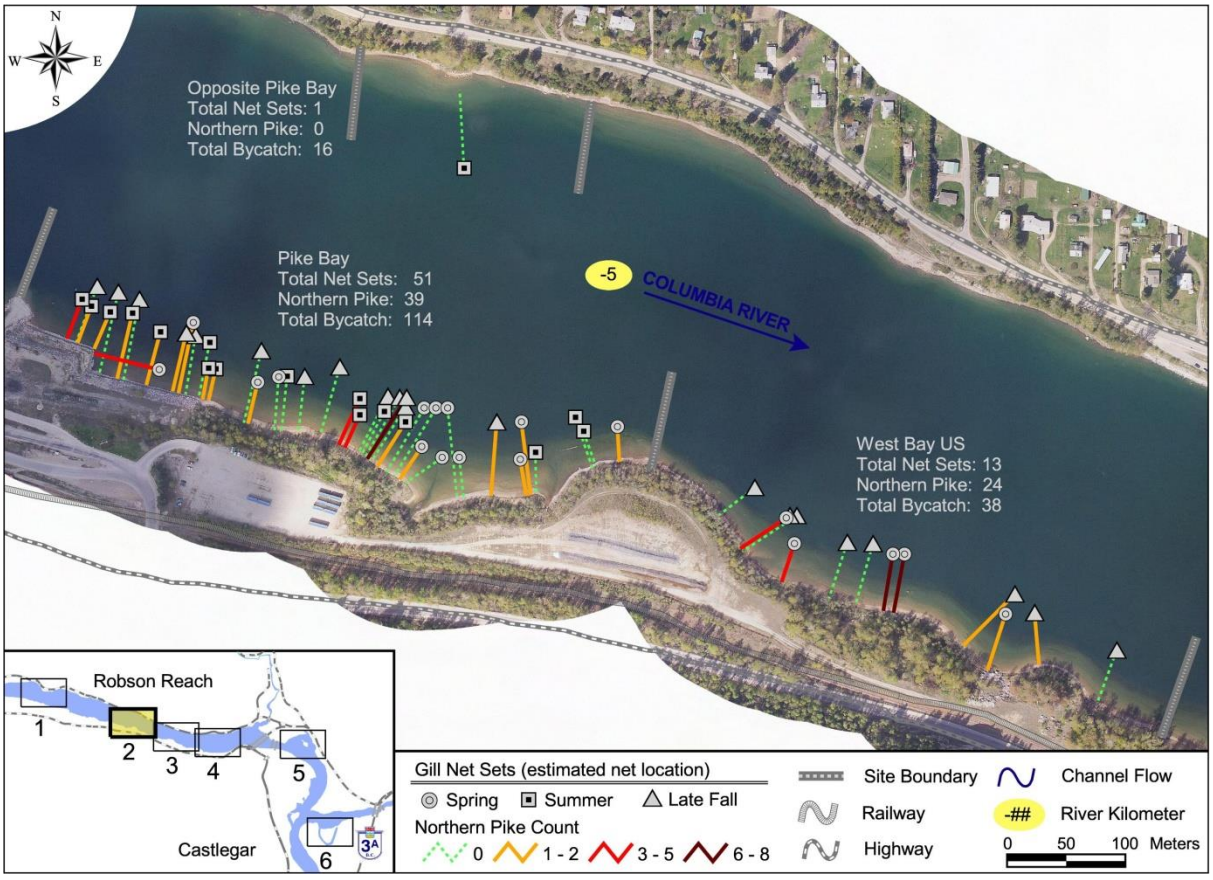


Figure 6. LCR NP gill netting set sites by season and catch per net in the Pike Bay Area, 2014.

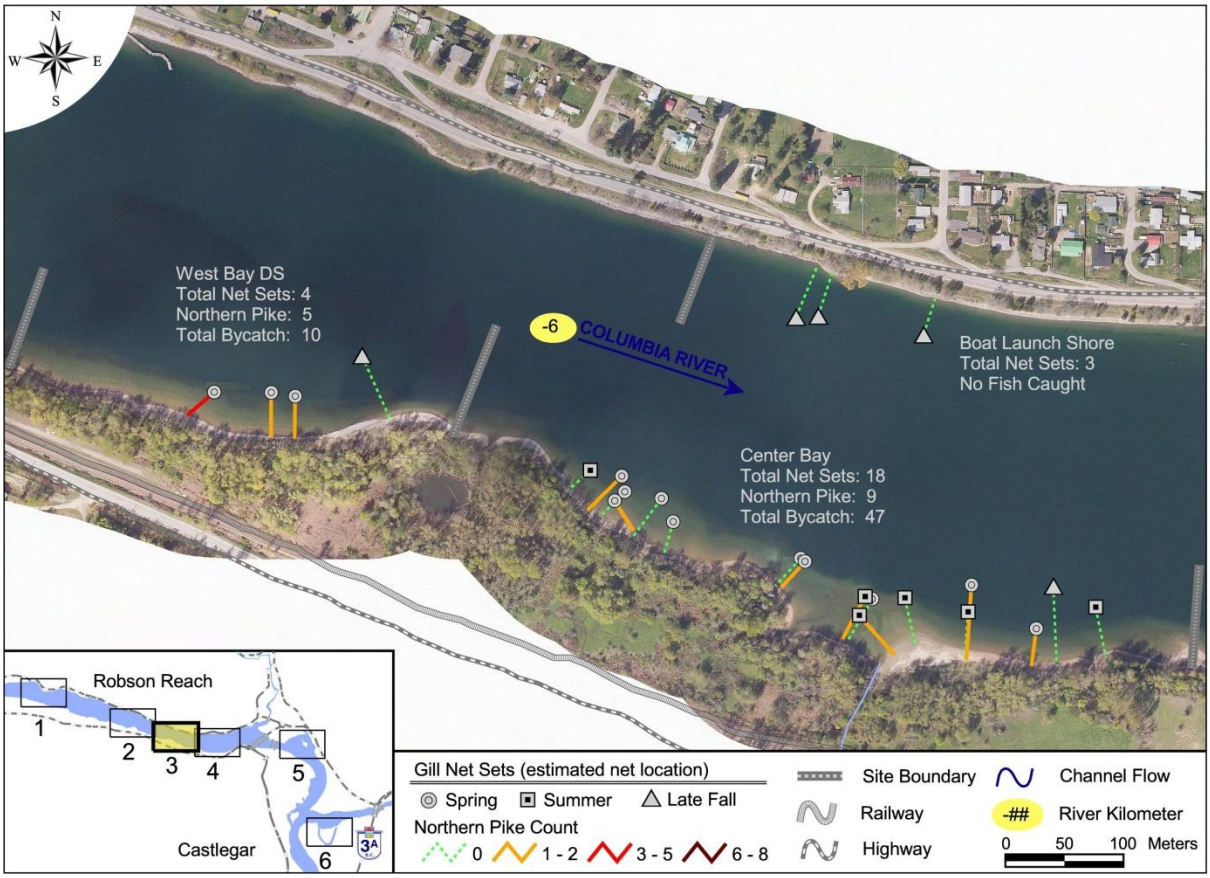


Figure 7. LCR NP gill netting set sites by season and catch per net in the Center Bay Area, 2014.

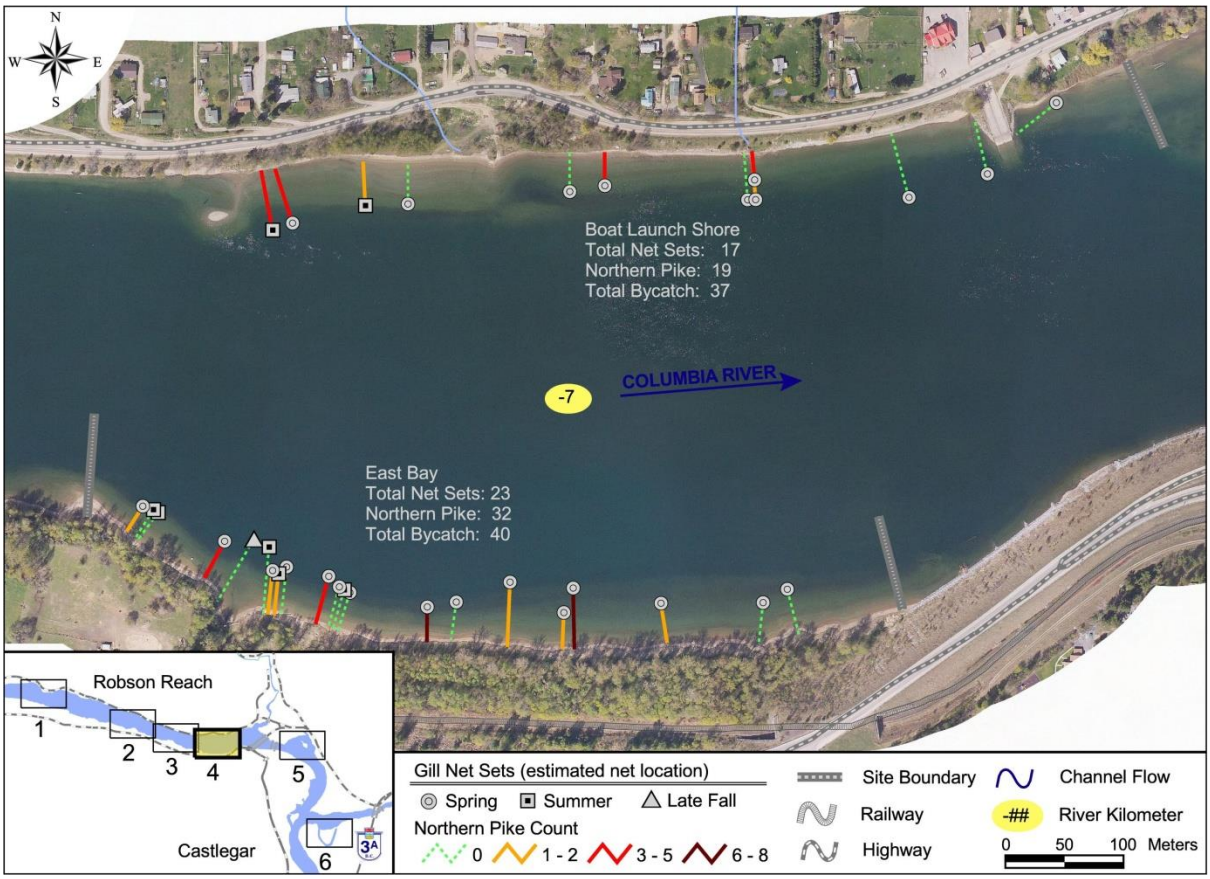


Figure 8. LCR NP gill netting set sites by season and catch per net in the Robson Boat Launch Area, 2014.

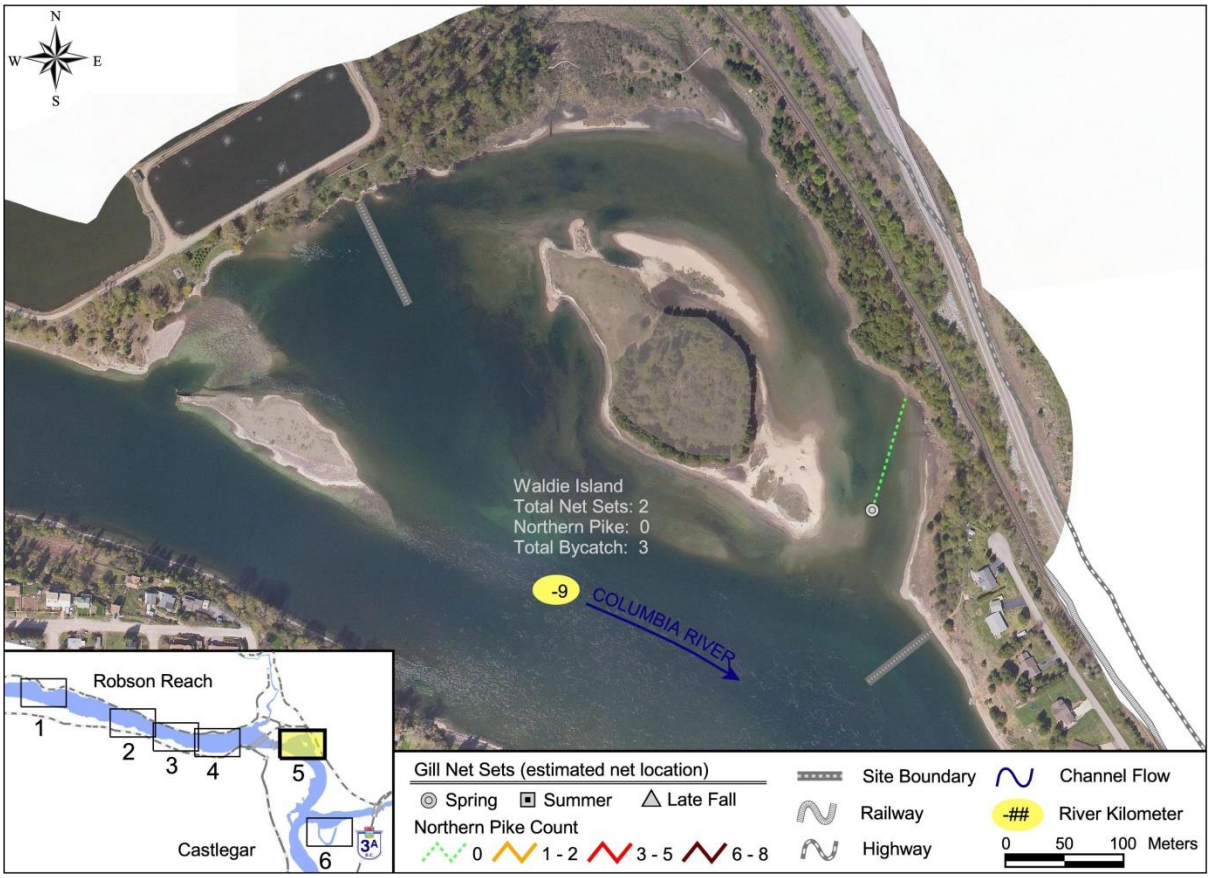


Figure 9. LCR NP gill netting set sites by season and catch per net in the Waldies Island Area, 2014.

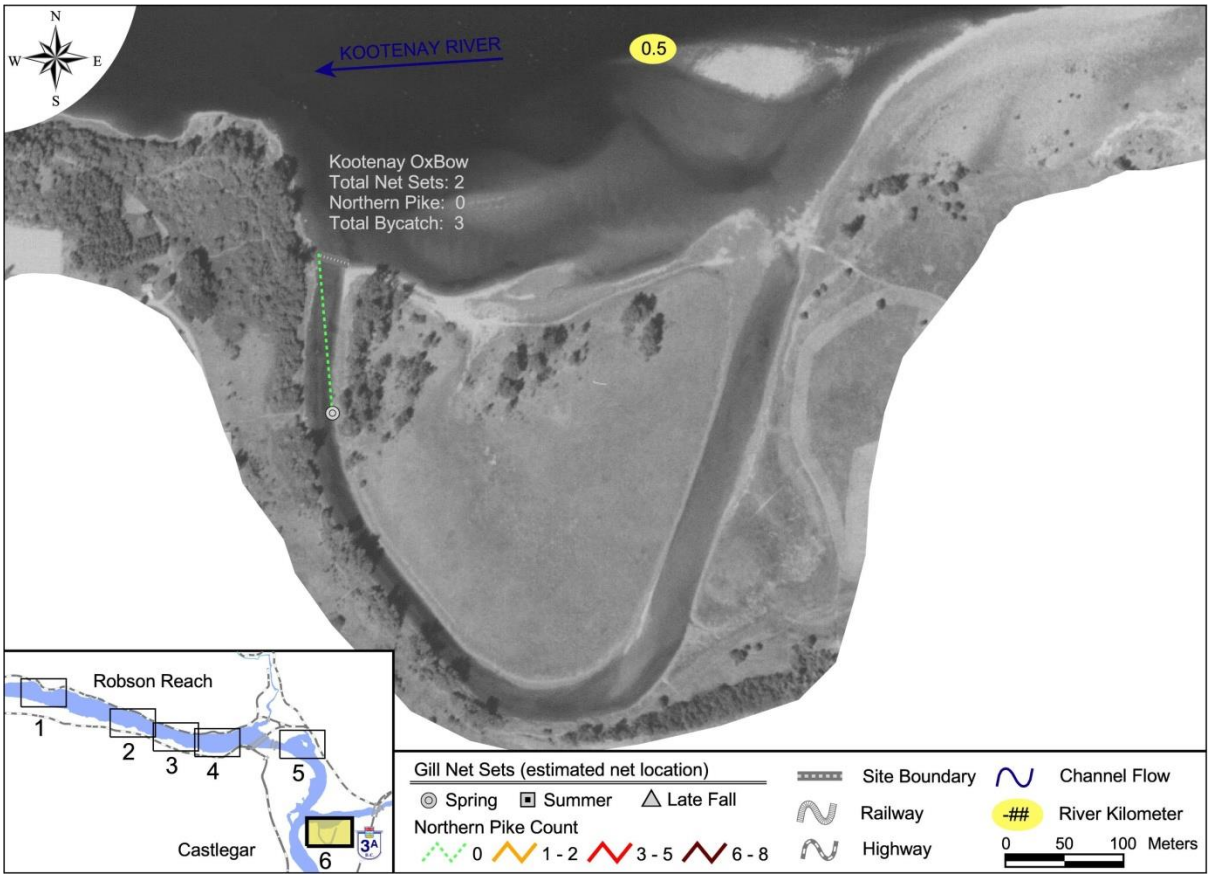


Figure 10. LCR NP gill netting set sites by season and catch per net in the Kootenay Oxbow Area, 2014.

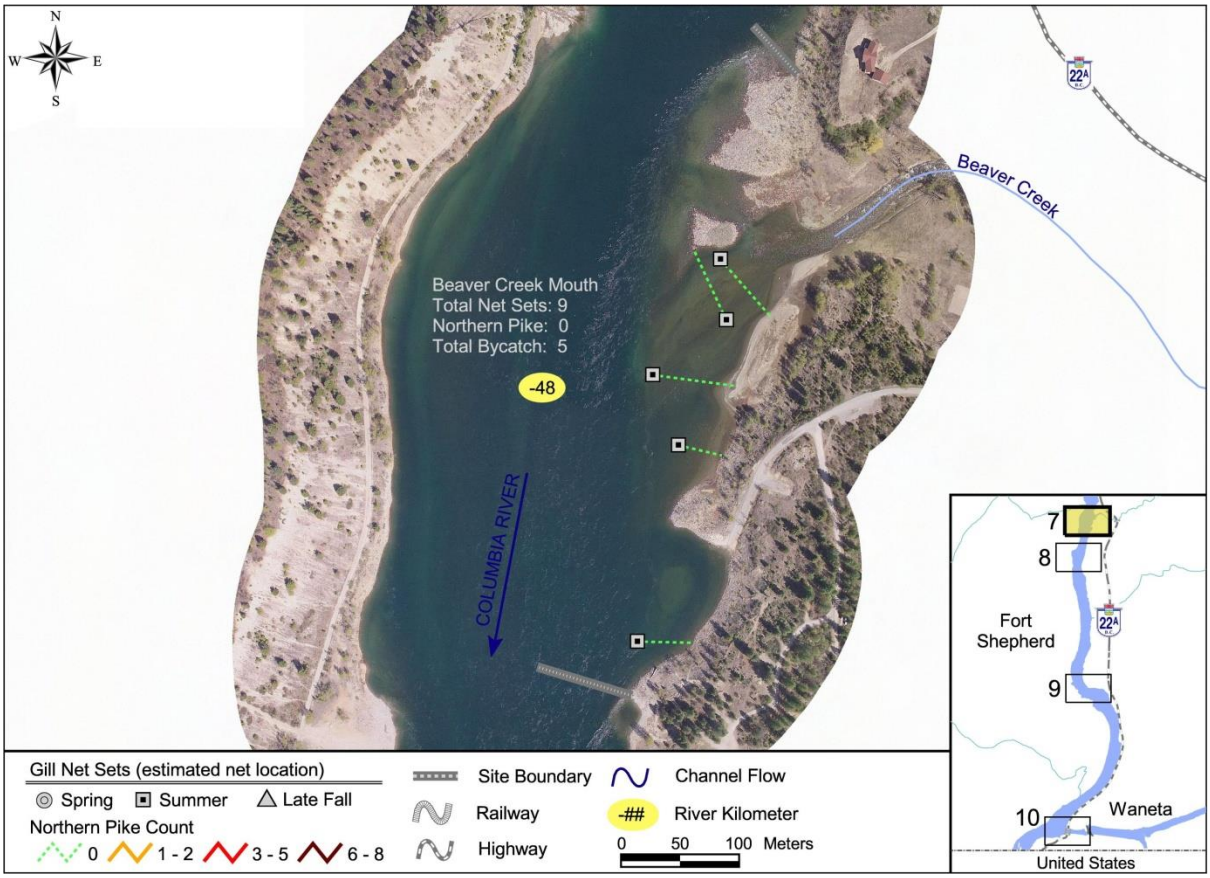


Figure 11. LCR NP gill netting set sites by season and catch per net in the Beaver Creek Area, 2014.

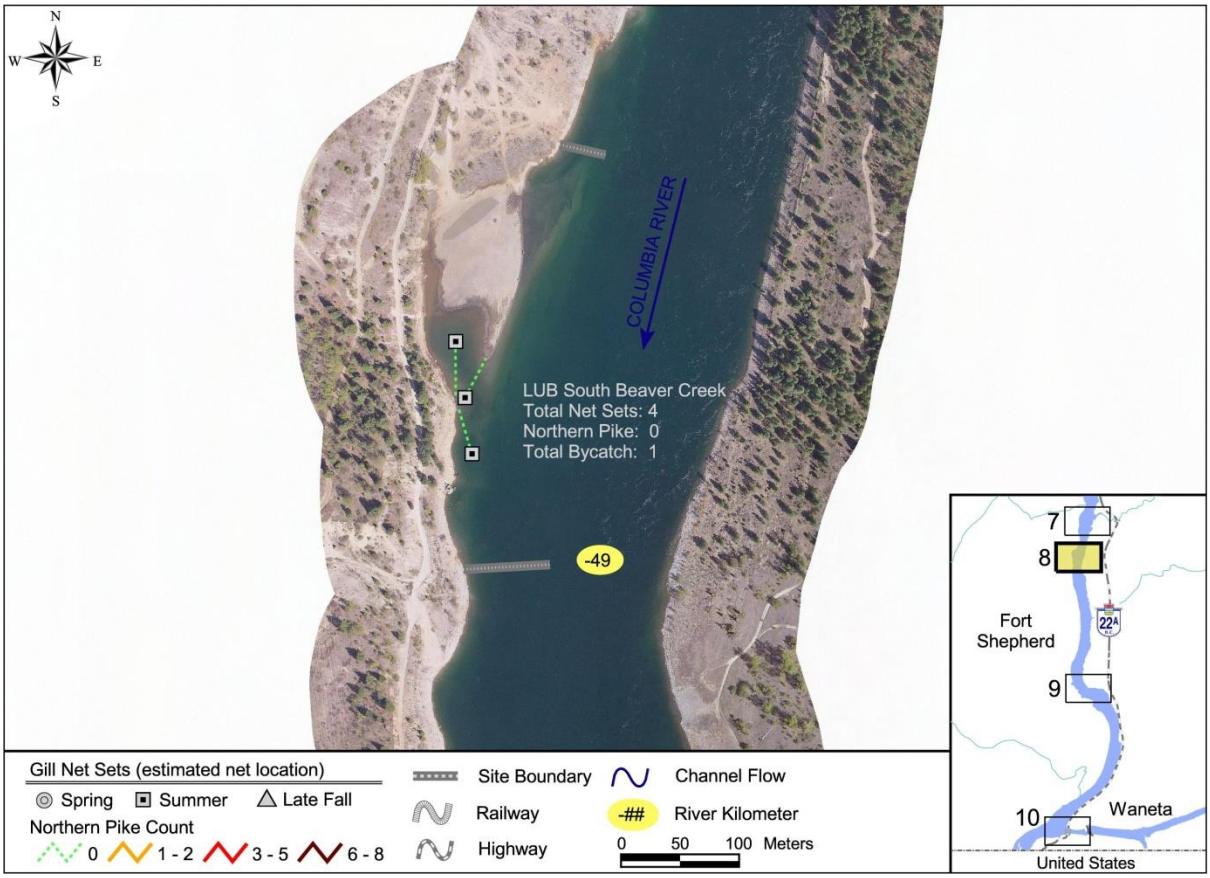


Figure 12. LCR NP gill netting set sites by season and catch per net in the Beaver Creek South Area, 2014.

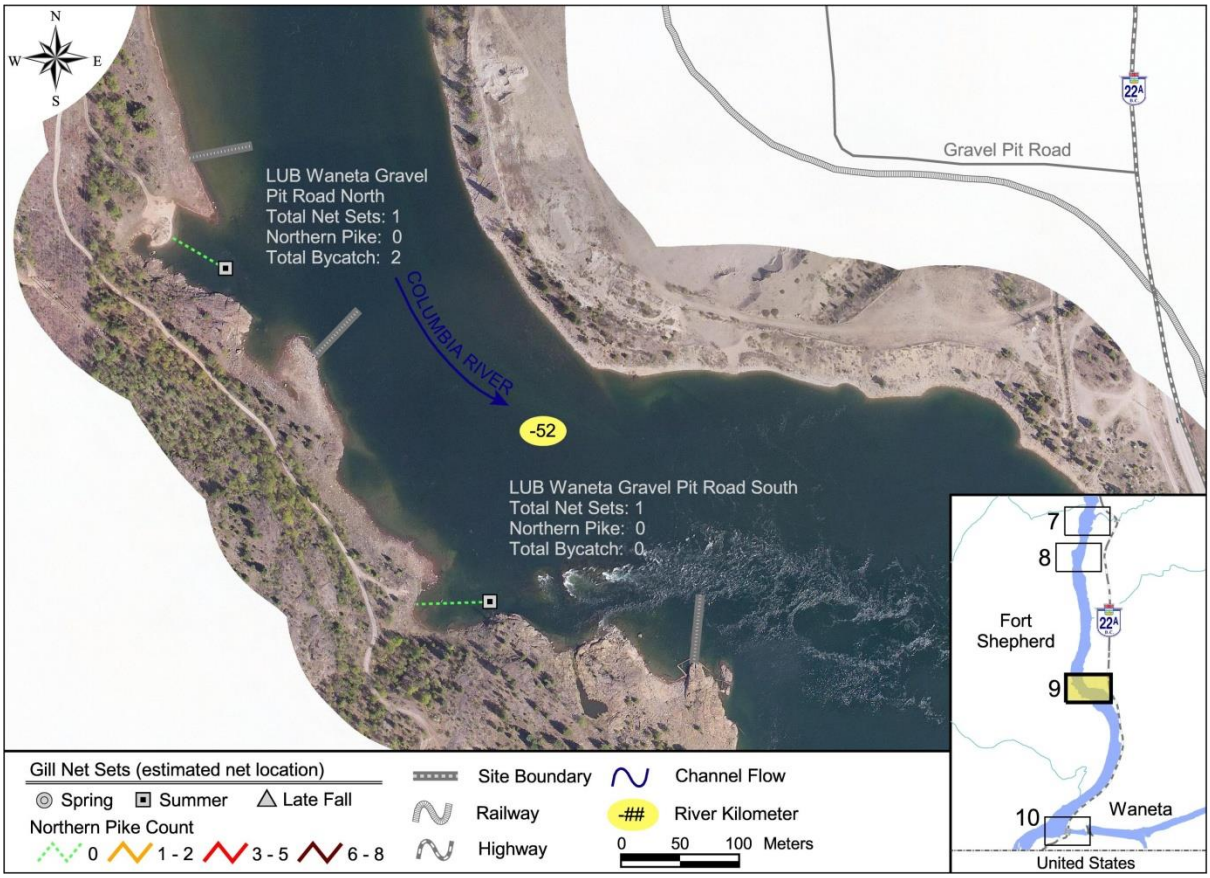


Figure 13. LCR NP gill netting set sites by season and catch per net in the Gravel Pit Road Area, 2014.

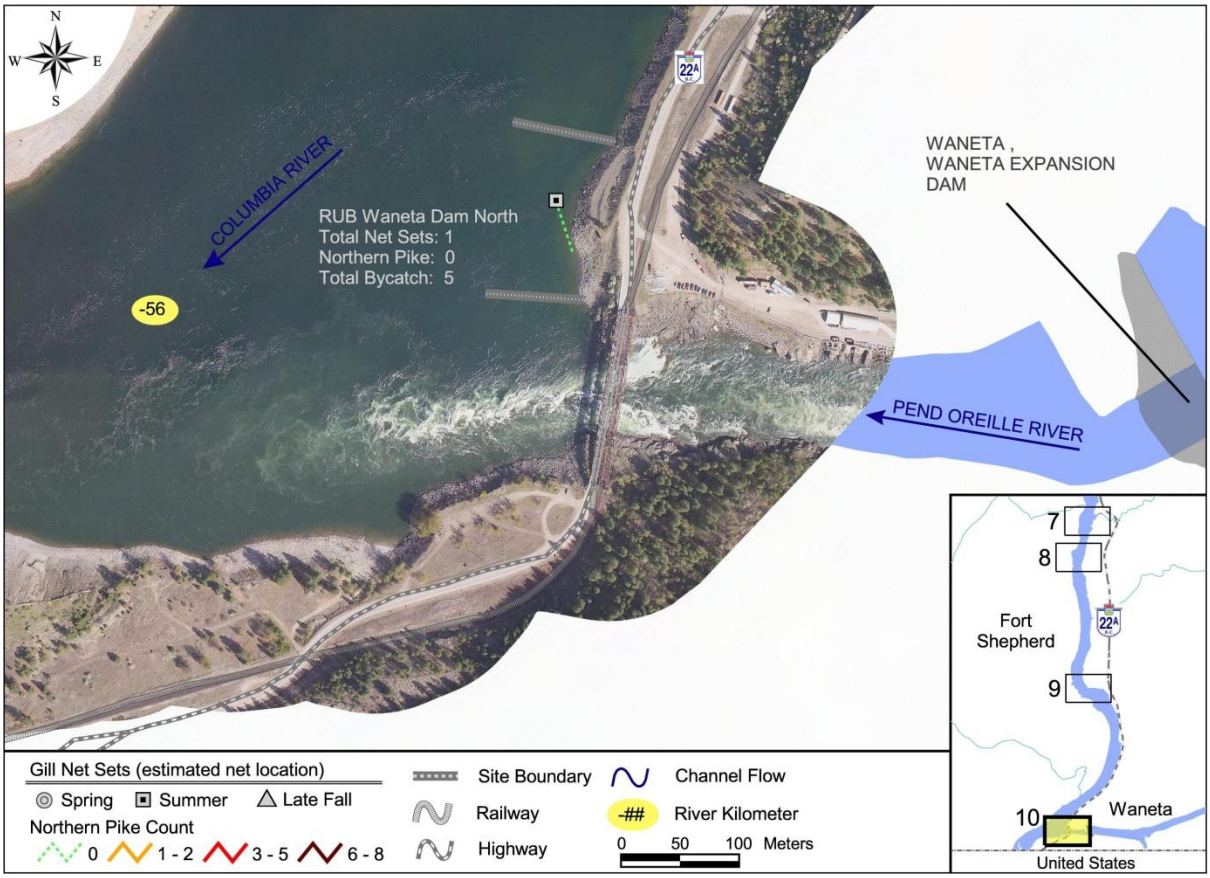


Figure 14. LCR NP gill netting set sites by season and catch per net in the Waneta Dam Area, 2014.

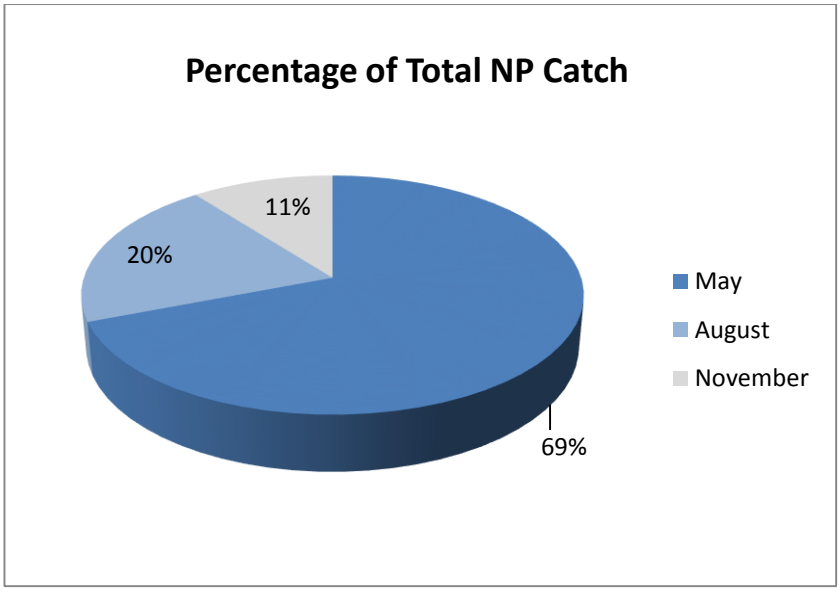


Figure 15. Percentage of NP gill-net catch by month, 2014

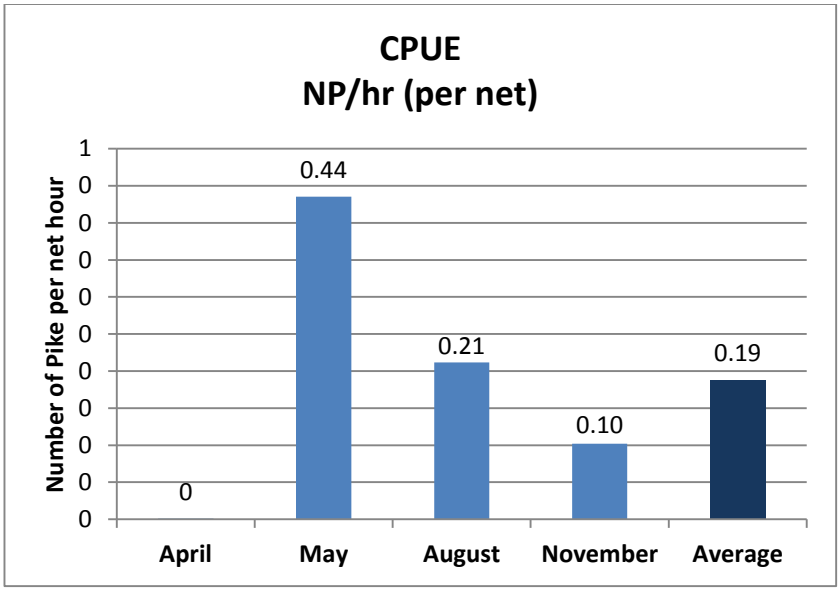


Figure 16. CPUE (NP/hr) per net by month in 2014.

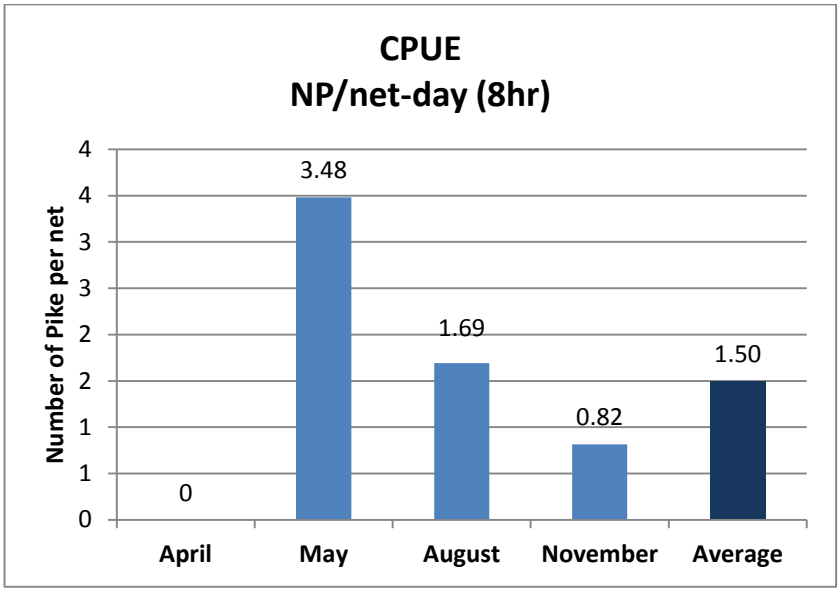


Figure 17. CPUE (NP/net-day) per net by month in 2014.

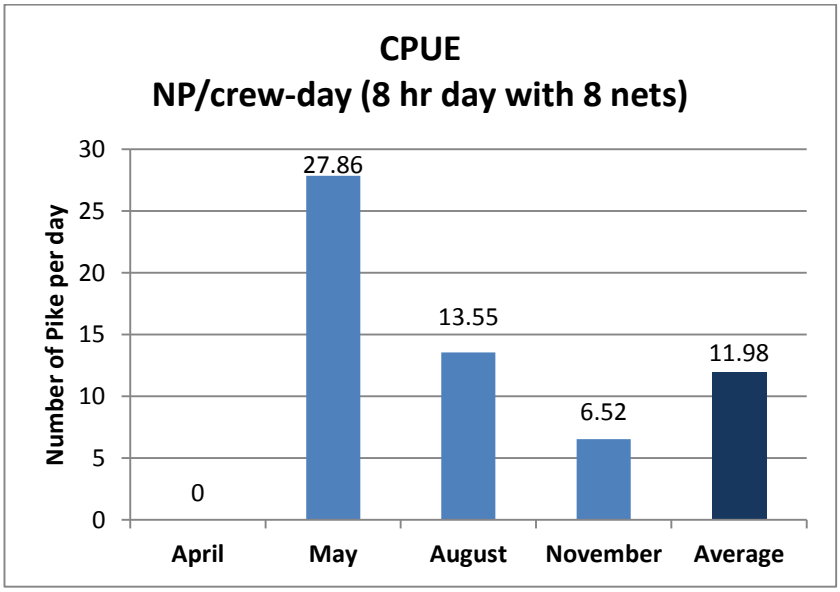


Figure 18. CPUE (NP/crew-day) by month in 2014. Based on a crew of two deploying 8 nets a day for 8 hours.

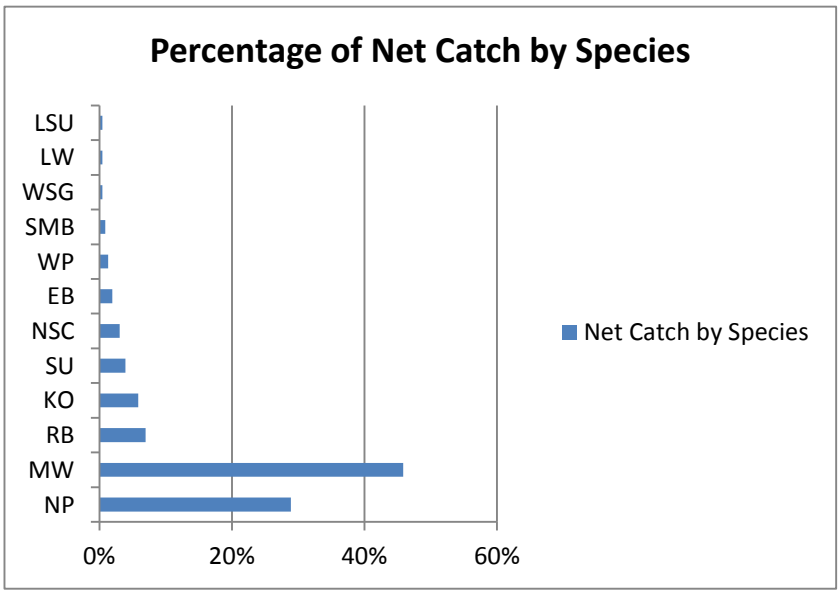


Figure 19. Percentage of gill-net catch by species in 2014.

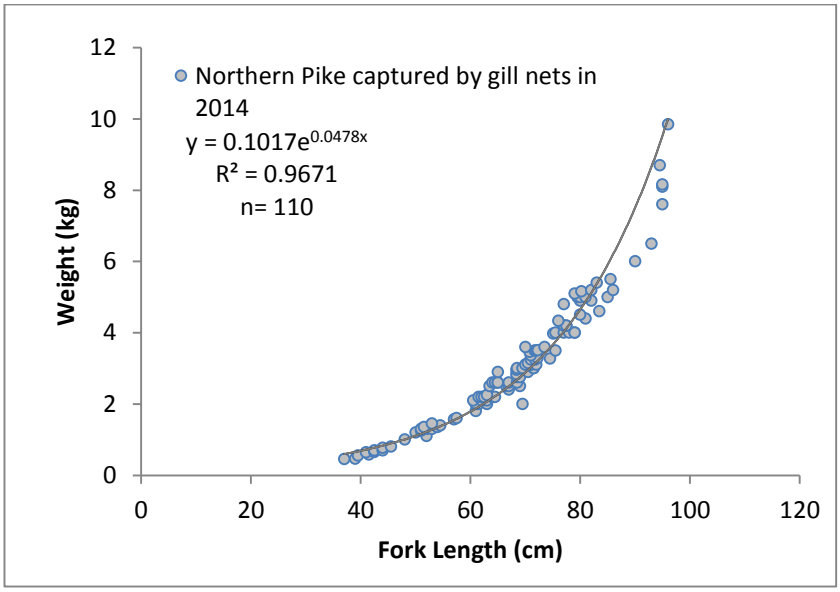


Figure 20. Length-weight regression of Northern Pike captured by gill-nets in the LCR in 2014.

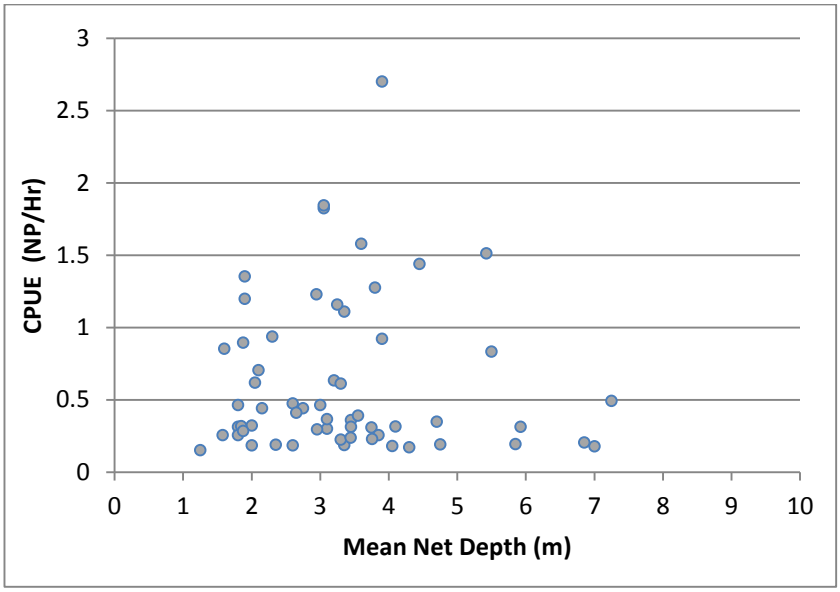


Figure 21. Northern Pike gill-net catch rates by mean site depth in 2014.

Population Estimate and Growth Rates

A simple Lincoln-Petersen mark and recapture estimate was conducted using the PIT tag recaptures and all of the known caught Northern Pike in 2014. 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 in the first session: 30.
n_2 = total number captured in the second session: 163 (includes gill-nets (133), angler returns (24), and Indexing (9).
m_2 = number found marked in the second session: 6 (all from gill nets).

The population of NP in the LCR is estimated to be 725 with a lower 95% CI of 478 and an upper 95% CI of 2,759 (Figure 22).

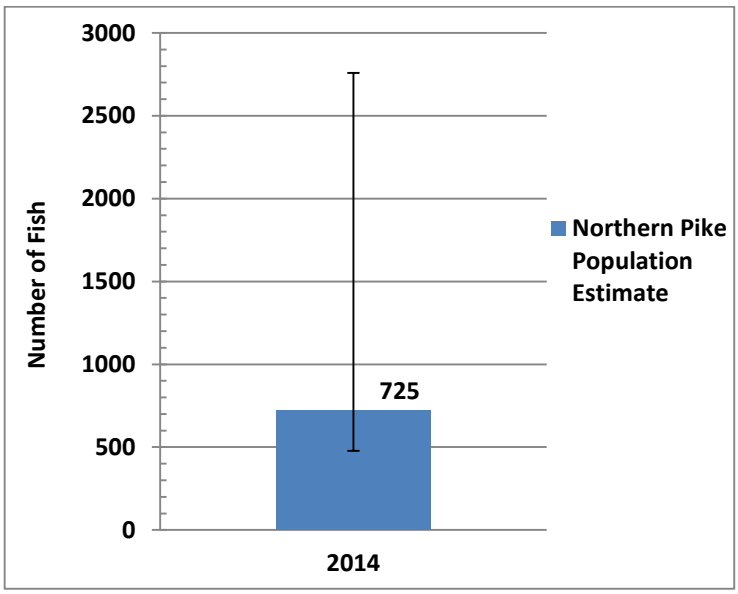


Figure 22. LCR NP population estimate based on a Lincoln-Petersen mark and recapture. The error bars represent the upper and lower 95% CI.

The lengths and weights of three PIT tagged NP (all females) were recorded during both the marking and recapture and their growth rates averaged 7.20 cm/year and 1.42 kg/year (Figure 23 and 24).

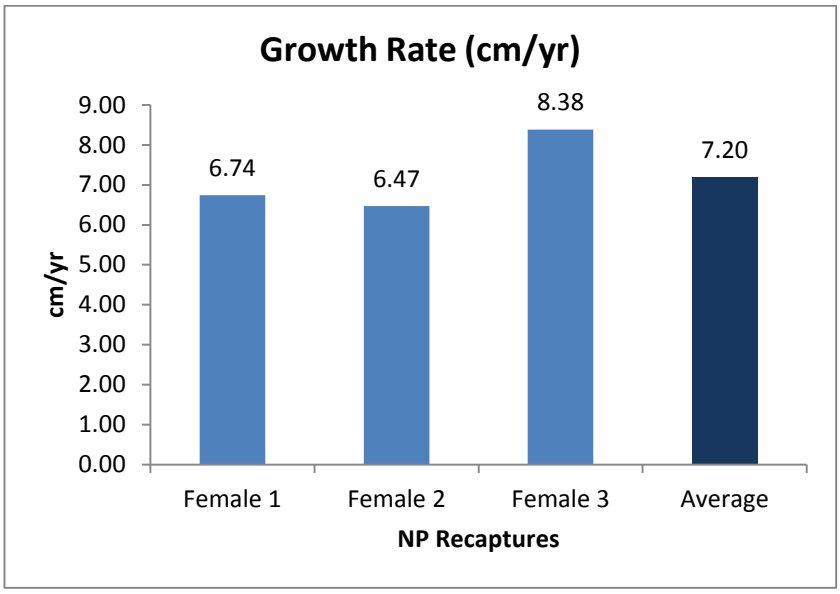


Figure 23. LCR NP length growth rates per year of three recaptured females in 2014.

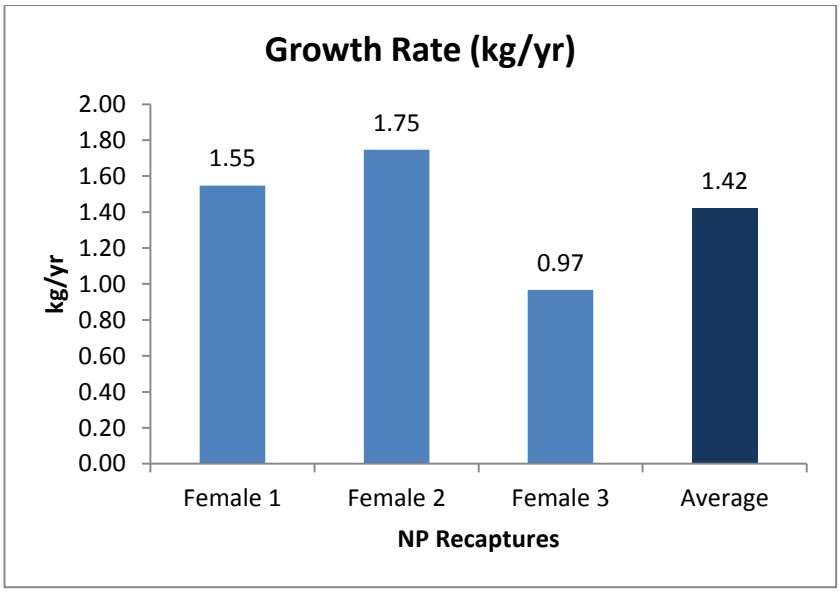


Figure 24. LCR NP weight growth rates per year of three recaptured females in 2014.

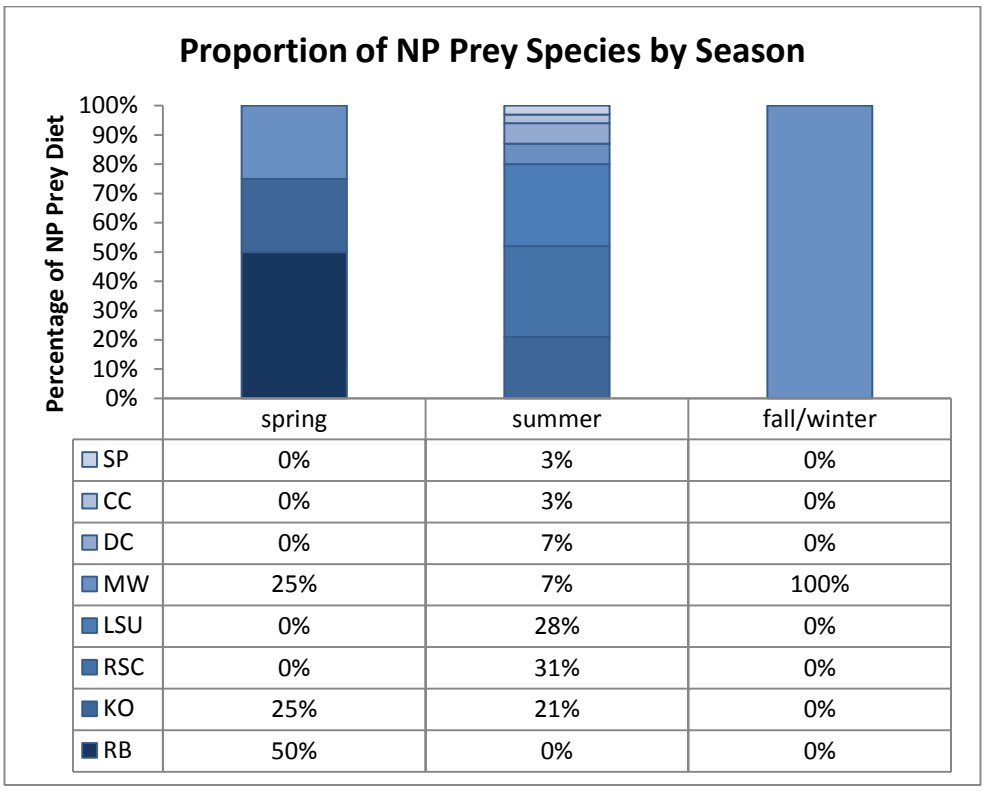
Northern Pike Stomach Analysis

The stomach contents of all NP captured by gill-nets were examined in the field and prey was identified to species. Only 25% (n=33) of all the NP examined (n=133) 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 vast majority of stomachs were completely empty. No aquatic invertebrates or aquatic vegetation was present in any of the stomachs sampled and the majority (76%) of NP diet consisted of native salmonids

(Rainbow Trout, Kokanee and Mountain Whitefish; Figures 26-27). Prey preference changed based on the time of year (Figure 25) and NP appeared to be consuming whole native species up to 38 cm in length, which were vulnerable and grouped during spawning (i.e., Rainbow Trout in the spring, Kokanee in the late summer, and Mountain Whitefish during the fall and winter). The size range (length) of NP prey species was 6 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), and one unidentified species (SP). The proportion of prey by species and their lengths can be found in Figure 25 below. Prey for individual Northern Pike can be found in Table 4.

Table 4. LCR NP prey species for individual fish, 2014.

Date Captured	Predator	Predator Length (mm)	Predator Weight (kg)	Prey	Prey Length (mm)	Comment
19-May	NP	950	7.6	RB	380	
21-May	NP	860	5.2	KO, RB	260, 150	
23-May	NP	900	6	MW	300	
22-Aug	NP	390	unknown	LSU	90	
22-Aug	NP	830	unknown	KO	250	spawner
22-Aug	NP	850	unknown	KO	230	spawner
22-Aug	NP	840	unknown	KO	250	
22-Aug	NP	700	unknown	MW, RSC	230, 90	
22-Aug	NP	470	unknown	SP	0	no ID
22-Aug	NP	765	unknown	KO	210	
22-Aug	NP	680	unknown	MW	180	
24-Aug	NP	950	8.16	KO	245	
24-Aug	NP	440	0.7	LSU, LSU, RSC	95, 110, 65	3 fish
24-Aug	NP	370	0.45	DC, SU, LSU	65, 85, 70	3 fish
24-Aug	NP	855	5.5	KO	250	spawner
25-Aug	NP	390	0.46	CC, RSC	75, 60	
25-Aug	NP	390	0.46	RSC	60	
25-Aug	NP	440	0.77	SP	0	bones
25-Aug	NP	395	0.55	RSC, RSC	75, 80	
25-Aug	NP	425	0.65	RSC, RSC	60, 70	
25-Aug	NP	455	0.8	LSU, RSC	85, 50	
25-Aug	NP	410	0.64	LSU, LSU, RSC	55, 95, 65	3 small fish
17-Nov	NP	575	1.6	MW	240	
17-Nov	NP	960	9.85	MW	265	spawner
17-Nov	NP	480	1	MW	150	
17-Nov	NP	510	1.3	MW	110	
17-Nov	NP	530	1.45	MW	165	
17-Nov	NP	545	1.4	MW	95	
18-Nov	NP	520	1.3	MW	195	
18-Nov	NP	530	1.3	MW	140	
19-Nov	NP	945	8.7	SP	0	vertebrae
20-Nov	NP	520	1.1	SP	0	empty, bones
20-Nov	NP	515	1.35	MW	185	worms



	spring	summer	fall/winter
SP	0%	3%	0%
CC	0%	3%	0%
DC	0%	7%	0%
MW	25%	7%	100%
LSU	0%	28%	0%
RSC	0%	31%	0%
KO	25%	21%	0%
RB	50%	0%	0%

Figure 25. LCR NP proportion of prey species by season, 2014. SP = unidentified species, CC = Sculpin sp., DC = Dace sp., MW = Mountain Whitefish, LSU = Longnose Sucker, RSC = Redside Shiner, KO = Kokanee, and RB = Rainbow Trout.

Figure 26. 38 cm Rainbow Trout found in the stomach of a 95 cm, 7.6 kg Northern Pike on May 19, 2014.

Figure 27. 24.5 cm Kokanee found in the stomach of a 95 cm, 8.16 kg Northern Pike on August 24, 2014.

Pathology Sampling

Standard fish pathology tests on a total of nine pike were completed in November 2014 (FFSBC case# 2014-1104), and did not identify any significant fish health concerns. Pike viral tests were negative for IHNv, IPNv and VHSv. Long, thin, Gram negative rods were found in the gills of 1/9 fish and on the skin of 1/9 fish. Kidneys inoculated onto Tryptic Soy Agar (TSA) and Sheih's (HS) media showed no pathogenic bacteria. Smears were made from scrapings of the inside of the intestinal wall to check for *Ceratomyxa shasta*, and subsequently no spores were detected. Upper intestinal tract were checked for parasites. Intestinal worms were only discovered in 1/9 fish. These were preserved in 10% buffered formalin and examined under microscope. The preserved worms were determined to be cestodes (tapeworms) from the genus *Eubothrium* or *Proteocepahlus.*

DISCUSSION

It is estimated that 725 Northern Pike were present in the Lower Columbia River downstream of the HLK dam in 2014. Based on mark and recapture data, the NP population could be as low as 478 and as high as 2,759. Assuming the population is 725, the gill-netting suppression program in 2014 removed approximately 18% of the NP. When combined with the angler returns and Large River Indexing program the total NP removal for 2014 is approximately 20% of the estimated population.

In 2014 the gill-netting suppression program was distributed over all seasons (spring, summer, and fall/winter). The highest CPUE/net-day (3.48) occurred in the spring and 69% (n=92) of the NP were removed in the month of May. In the Box Canyon Reservoir 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 spring (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). The nets were also set overnight in the Box Canyon Reservoir (fishing for at least 8 hours) while the nets during this program were only set for 4 hours each and then re-deployed to limit bycatch. It is estimated that a crew of two deploying

eight nets a day for eight hours could remove approximately 27 NP a day in the spring time (May NP spawning period) in the LCR downstream of the HLK dam. To have a substantial suppression of the NP population like the success in the Box Canyon Reservoir (90% removal) a crew of two deploying eight nets a day would need to work 24 days in the spring to remove approximately 650 NP if catch rates did not decline through time.

Stomach analysis revealed that 75% of Northern Pike had empty stomachs, which is typical for a highly piscivorous fish (Frost, 1954; Diana 1979; Chapman et al 1989). Native fish species (particularly salmonids) are the primary prey in the LCR. White Sturgeon were not found in any of the NP stomachs in 2014. Invasive Northern Pike growth rates are high in the LCR, averaging 1.42 kg/yr. At the time of this report the cleithrum samples were yet to be aged. However, Northern Pike can reach >35 cm by age-1 (Flinders and Bonar, 2004), suggesting that the smaller NP (20-35 cm) captured during this program and the Large River Indexing (Golder and Associates, 2014) may be recruited from a successful spawning population in the LCR, however we could not rule out potential for juvenile recruitment from upstream sources. General observations of parasitic worms were observed in approximately 10% of the NP sampled; consistent with FFSBC fish pathology results. Fish pathology testing showed parasitic worms in 1/9 samples and no pathogenic bacteria or viruses were detected; suggesting the risk to native species from disease and parasites from this recent introduction are low. The tapeworms were determined to be from the genus *Eubothrium* or *Proteocepahlus*.

The potential impact of invasive Northern Pike to native salmonids in the Lower Columbia River is significant. Approximately 76% of the prey is made up of salmonids (44% MW, 17% RB, and 15% KO). 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. Further investigation and mitigation may be required to better understand the source of the invasive Northern Pike in the Lower Columbia River. Anecdotal reports from 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. Gill-netting suppression efforts in 2015 should continue on the LCR and include sampling in both the ALR and Pend D'Oreille to determine how far the invasion has spread and whether or not successful spawning is taking place. Future programs should continue to remove pike, and focus on identifying the feasibility of control. In addition, larval fish sampling should be completed near Norns Creek downstream of known spawner congregations to identify if the pike population in this reach is spawning successfully, or if the current population results from populations outside the Columbia mainstem.

Going forward, more information about growth rate both inter-annually and within the year, as well as additional information about abundance, distribution and condition would be beneficial in understanding the significance of invasive NP in the LCR and how they are impacting native fish populations. To do this, a more detailed mark-recapture program would be required to get growth and abundance while still controlling the population through gill-netting suppression techniques.

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