# Northern Pike Suppression in the Columbia River System

Submitted to:

**Columbia Basin Trust**
Castlegar, British Columbia

**British Columbia Ministry of Forest, Lands and Natural Resource Operations**
Nelson, British Columbia

Submitted by:

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Nelson, British Columbia

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## EXECUTIVE SUMMARY

Northern Pike (*Esox lucius*), a fish endemic to northern regions of Canada, are a recent non-native species invader of the Columbia River system in both Canada and the United States. Northern Pike (NP) are a slow-water, predatory species whose preferred habitat includes shallow lakes, marshes and backwater sloughs with extensive instream cover. NP have the potential to significantly impact sportfish populations and the recovery of species listed under the Species-at-Risk Act (SARA) in the Columbia River through competition, predation and the introduction of disease. In 2014, fisheries managers commenced removal and research programs aimed at suppressing and evaluating the NP population. Various agencies, researchers and stakeholders met in 2016 to share information and discuss efforts underway to control the NP. They identified a need for data synthesis and identification of knowledge gaps to help inform future management and suppression. This report provides a summary of current and proposed suppression and research programs in the Columbia River, data/knowledge gaps and provides recommendations to strengthen NP suppression efforts.

Northern Pike were first detected in the Canadian portion of the Columbia River, downstream of Hugh L. Keenleyside Dam in 2009. Since the initial detection, strategies to inventory and suppress the non-native predator have included changes to angling regulations, an angler incentive/awareness program, adult gill-net suppression, acoustic telemetry, otolith geochemistry, eDNA method development and juvenile detection programs. The adult gill-net suppression program (2014-2017) has removed 288 NP from the river and is estimated to have eliminated approximately 30 to 40% of the NP population annually. In addition to ongoing programs, a NP habitat reduction program will begin in spring 2017.

In the U.S. portion of the Columbia River, downstream of the Canadian reach, Northern Pike were first documented in 2007. Gill-net inventory and suppression began in 2015 and is ongoing. Other strategies to inventory and suppress NP have included boat electrofishing, an angler bounty program, a non-limit fishing regulation, reclassification of NP from game species to prohibited species, otolith geochemistry and eDNA programs. Angling and seine net suppression will also be trialed in 2017. Suppression efforts are also underway in tributaries to the Columbia River in the U.S. including the Pend d'Oreille River and Lake Coeur d'Alene which drains into the Spokane River.

Information needs and data gaps in the Canadian portion of the Columbia River system identified during this review include the identification of juvenile rearing areas, the population status of NP in the Canadian portion of the Pend d'Oreille River and access to references/reports on NP programs in the U.S. portion of the Columbia River. Recommendations to strengthen suppression efforts include the establishment of a NP suppression committee, an annual adult gill-net suppression program, a juvenile boat electrofishing program and assessment of the Pend d'Oreille River NP population using gill-net and boat electrofishing methodology. A meeting was held on June 5, 2017 in Castlegar, BC to discuss the information needs and recommendations within this report. Stakeholders also provided summaries of early 2017 program efforts and preliminary results.

## ACKNOWLEDGEMENTS

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**Canadian Columbia River**

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**United States Columbia River**

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| Jeremy Baxter | Mountain Water Research, Contributing Author |

## TABLE OF CONTENTS

**Page**

## LIST OF FIGURES



## LIST OF TABLES



## LIST OF APPENDICES

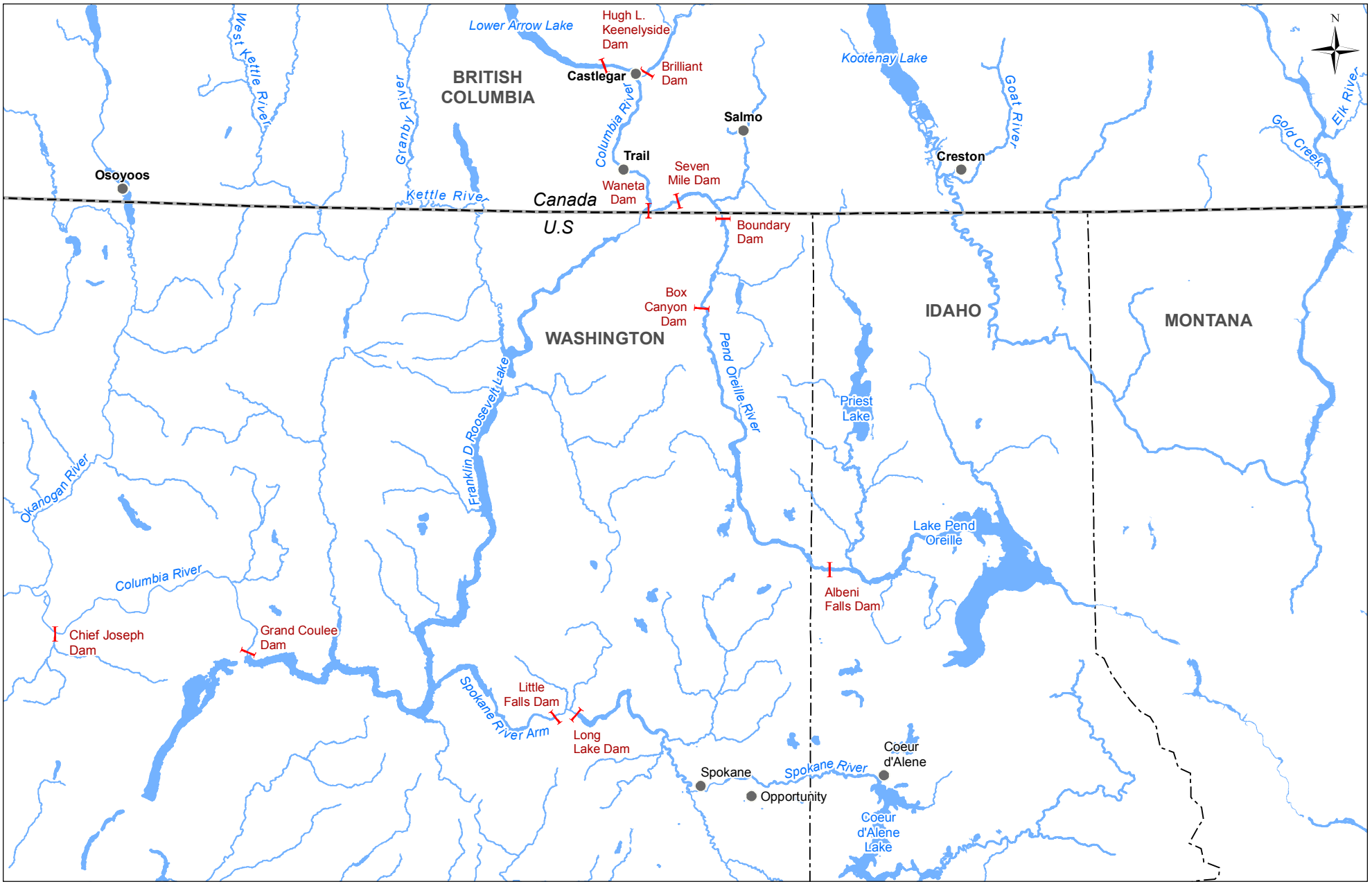
# 1 INTRODUCTION

Northern Pike (*Esox lucius*), a fish endemic to northern regions of Canada, are a recent non-native species invader of the Columbia River system in both Canada and the United States. The presence of Northern Pike (NP) was first observed in the Columbia River in 2009 and documented near Castlegar, BC in 2010 (Golder and Poisson 2013). Anecdotal reports from anglers suggested the population of NP was increasing in the area and the species was captured during subsequent river indexing surveys (Golder and Poisson 2013). At the same time, NP were observed in the Columbia River downstream of the U.S. border near Colville and Kettle Falls, WA (Lee and King 2015). The source of the invasion was likely from the Flathead Lake system in Montana where fisheries managers believe NP were illegally introduced in the 1980s (McMahon and Bennett 1996). The species then traveled via the Clark Fork River into Lake Pend d'Oreille, into the Pend d'Oreille River and downstream into the Columbia River (Bailey 2016). The Pend d'Oreille River enters the Columbia River near Trail, BC just upstream of the international border (Figure 1).

Northern Pike have the potential to significantly impact sportfish populations and the recovery of species listed under the Species-at-Risk Act (SARA) through competition, predation and the introduction of disease (Baxter and Neufeld 2015). Following the discovery of NP in the Columbia River, fisheries managers responded with removal and research programs aimed at suppressing and evaluating the population in Canada since 2014 and the U.S. since 2015 (Baxter and Doutaz 2017, Lee and King 2015). Various agencies, researchers and stakeholders from the Canadian portion of the Columbia River met in July 2016 to share information and discuss efforts underway to control the NP invasion. They identified a need for data synthesis and identification of knowledge gaps to help inform future management and suppression. The Columbia Basin Trust, in collaboration with the Ministry of Forests, Lands and Natural Resource Operations, retained Amec Foster Wheeler to conduct an information review that includes a summary of NP suppression efforts in the Columbia River system and recommended actions that could strengthen current suppression efforts.

## 1.1 Study Area

This synthesis focused on sections of the Columbia River where NP have been observed. This includes the Columbia River between Hugh L. Keenleyside (HLK) Dam near Castlegar, BC downstream to the U.S. border, herein referred to as the Canada Columbia River, and the Columbia River from the U.S. border to Grand Coulee Dam, also known as Lake Roosevelt and herein referred to as the U.S. Columbia River (Figure 1). The study area also included tributaries to the Columbia River where NP have been observed: lower Kootenay River, Kettle River, Pend d'Oreille River, Coeur d'Alene Lake, and Spokane River.




**Legend**

- Populated Place
- Dam Location
- International Boundary
- State Boundary
- Stream
- Waterbody

0 5 10 20

Kilometers

Scale:1:1,350,000

**Reference:**

DataBC Data Distribution Service
Open Government License
(http://www.data.gov.bc.ca/)

Geogratis/Geobase
Open Government License - Canada
(http://data.gc.ca/eng/about-datagcca)

KEY MAP


CLIENT: Columbia Basin trust

PROJECT: Columbia River System Northern Pike Suppression

TITLE: Columbia River Northern Pike Invasion Overview Map

| DATE: | ANALYST: | QA/QC: | |
|---|---|---|---|
| April, 2017 | MY | CL | Figure 1 |

GIS FILE: 01-01-001_Overview

JOB No: VE52635

COORDINATE SYSTEM: NAD 1983 UTM Zone 11N

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## 1.2 Objectives

The main objective of this information review was to gather information from organizations carrying out NP research and suppression activities in the Columbia River system within Canada and the United States. The synthesis of this information includes a summary of the:

- current and planned NP suppression efforts and related research in the Columbia River system;
- information needs (i.e., relative to knowledge gaps) that would better enable suppression efforts; and,
- recommended actions that could strengthen suppression efforts.

# 2 METHODS

Literature searches were conducted using the B.C. Ministry of Environment EcoCat Ecological Reports Catalogue, Google Scholar and other web-based databases. As research related to NP suppression in both Canadian and U.S. sections of the Columbia River system is relatively new, it was recognized that a significant amount of information has likely not been published or reported at this time. Therefore, the following organizations/researchers were contacted to supplement information that was readily available:

- Ministry of Forests, Lands and Natural Resource Operations – Matt Neufeld
- Okanagan Nation Alliance – Amy Duncan and Bronwen Lewis
- Thompson Rivers University – Dan Doutaz and Brian Heise
- Mountain Water Research – Jeremy Baxter
- Salmo River Streamkeepers Society – Gerry Nellestijn
- Central Kootenay Invasive Species Society – Khaylish Fraser
- BC Hydro – Alf Leake and Guy Martel
- Washington Department of Fish and Wildlife – Charles Lee
- Colville Confederated Tribes Fish and Wildlife Department – Holly McLellan
- Spokane Tribes – Elliot Kittel
- Coeur d'Alene Tribes – Jon Firehammer
- Kalispel Tribe Fisheries and Water Resources Division – Nick Bean
- Author/Reporter - Jim Bailey

Information obtained from these sources included details of their research or suppression programs, program timeline, methodology, program partners and/or funding agencies and roadblocks to success or limiting factors identified during the program. A synthesis of this

information is provided in Appendix A. A meeting was held on June 5, 2017 in Castlegar, BC to present the findings of this report and discuss information needs, recommendations and next steps. Stakeholders also provided summaries of early 2017 program efforts and preliminary results. A summary of these updates in provided in Appendix B.

## 3 OVERVIEW OF NORTHERN PIKE BIOLOGY

Northern Pike occur in cool waters throughout the Northern Hemisphere. In British Columbia, the native distribution includes the muskeg lowlands associated with the lower Peace, lower Liard and Hay rivers as well as in the upper Liard and various Yukon River tributaries, all areas in the northern portion of the province (McPhail 2007).

Northern Pike are a slow-water, predatory species found in shallow lakes, marshes and backwater sloughs with extensive instream cover (Roberge et al. 2002; McPhail 2007). Their diet is flexible and includes fish, insects and invertebrates (McPhail 2007). Larval pike begin feeding at a length of about 15 mm, foraging initially on zooplankton but shifting to larger prey including chironomid larvae, macrocrustaceans and eventually fish (McPhail 2007). Adult NP are known as apex predators and they can grow in excess of 1 m length and consume fish up to 75% their body length. These traits enable NP to potentially feed on most native fish in the Columbia River besides adult White Sturgeon. Although most NP stomachs examined in the Columbia River were empty, 51% contained prey items including Rainbow Trout (*Oncorhynchus mykiss*), Kokanee (*Oncorhynchus nerka*) and Mountain Whitefish (*Prosopium williamsoni*) (Baxter and Neufeld 2015). Optimal NP summer forage habitat includes shallow, low velocity or backwater areas with vegetation, mud or detritus or cool, oxygenated refugia (Roberge et al. 2002). Overwintering habitat typically includes deep, low velocity or backwater areas with vegetation, mud or detritus (Roberge et al. 2002). Adults are quite sedentary, except during spawning migrations, and will shift to cooler water when temperatures in shallow areas exceed the thermal optimum for growth (about 20°C, McPhail 2007).

Spawning occurs in the spring, typically in May and June, in sheltered areas with moderate water exchange and extensive aquatic vegetation (Roberge et al. 2002). Water temperatures during the spawning period range between 4°C and 18°C and spawning activity peaks in the afternoon when temperatures are at their highest. Optimal spawning habitat includes shallow (0.1 – 0.7 m), slow velocity or backwater marsh areas with extensive submergent and emergent vegetation (Roberge et al. 2002). Spawning activity typically involves one female broadcasting adhesive eggs that are fertilized by one to three males. Eggs adhere to mats of vegetation or debris; there is no parental care (McPhail 2007). Fecundity is a function of female size and can range between 15,000 and 100,000 eggs or more (McPhail 2007). Egg development rate depends on water temperature with hatching occurring after 5 days at 20°C and after 31 days at 5.8°C (McPhail 2007). Newly hatched larvae are between 6.5 – 8.0 mm in length, lack gills and exchange gas through the skin. The larvae use a sticky secretion from a pair of cement glands on the head to attach themselves to vegetation, where they remain until their yolk sac is absorbed approximately 10 days to 2 weeks after hatching (McPhail 2007). Larvae are approximately 11 – 14 mm

when they detach from the vegetation and 12 – 15 mm when they fill their swimbladder (McPhail 2007).

Young-of-the-year (YOY) grow rapidly reaching sizes up to 150 mm in their first summer (McPhail 2007) and 270 mm by the end of their first year (Harvey 2011). The fish continue to grow rapidly during their second and third growing season, with females growing faster and reaching a larger ultimate size compared to males, but growth begins to slow in later years. Males typically reach sexual maturity at the start of their third growing season, whereas females mature after their fourth or fifth season (McPhail 2007). The largest NP captured during eradication efforts in the Canadian portion of the Columbia River was an 11 kg female with a fork length of 106 cm (Bailey 2016).

Invasive top predators, such as Northern Pike, have been shown to alter aquatic ecosystems by impacting the abundance and species composition of lower trophic levels. NP 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 2008). The range of NP has expanded to waterbodies across North America due to both illegal introductions by anglers and legal stocking by government agencies to establish sport fisheries (Flinders and Bonar 2008). In some cases these introductions have led to the complete collapse of native salmonid populations (Bailey 2016). In addition to potential direct impacts on native salmonid populations, invasive NP can impact the Columbia River ecosystem by introducing a wide variety of parasites and diseases, competing with native species for food resources thus potentially reducing growth and survival, and impacting the recovery of Species at Risk (Baxter and Neufeld 2015).

# 4 COLUMBIA RIVER NORTHERN PIKE RESEARCH AND SUPPRESSION EFFORTS

## 4.1 Canada

Northern Pike were first detected in the Canadian portion of the Columbia River, downstream of HLK Dam in 2009. Since the initial detection, strategies to inventory and suppress the non-native predator have included changes to daily angling quota (unlimited), an angler incentive/awareness program, adult gill-net suppression, acoustic telemetry, otolith geochemistry, eDNA and juvenile detection programs.

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. Teck Metals Ltd. has also provided funding for the adult gill-netting suppression program (2014-2017) to assist the Ministry's suppression efforts that is currently estimated to have eliminated approximately 30 to 40% of the NP population annually.

Other research programs have also collected information on NP population trends and life history. Northern Pike have consistently been captured during BC Hydro's Lower Columbia River Fish Indexing Program since 2010. Thompson Rivers University began to use telemetry, otolith geochemical analysis and eDNA in 2015 to assess location of recruitment

and the risk of NP invasion of the Arrow Lakes upstream of HLK Dam. The Castlegar and District Wildlife Association and the Okanagan Nation Alliance (ONA) received funding from CBT and attempted to detect juvenile NP in 2015 and 2016, respectively, to confirm if successful recruitment to the Columbia population is occurring. One juvenile NP was captured in 2016 confirming that NP are reproducing in the Canadian Columbia River. Further details on these Canadian activities are provided below.

### 4.1.1 *Columbia River Fish Indexing Program*

The Lower Columbia River Fish Population Indexing Survey (CLBMON-45) is a program conducted by BC Hydro that was initiated in 2001 and scheduled for completion in 2020 (Golder 2008; BC Hydro 2007). It was the first program to document NP in the Columbia River in 2010 and has captured NP annually (Golder and Poisson 2013; Golder et al. 2016). The number of NP observed and captured during the program is summarized in Table 1. The program is scheduled for completion in 2020 (BC Hydro 2007).

**Table 1: Northern Pike observed and captured during BC Hydro's Lower Columbia River Fish Indexing Program (CLBMON-45), 2010-2016.**

| Year | Number Observed | Number Captured | Total |
|---|---|---|---|
| Before 2010 | 0 | 0 | 0 |
| 2010 | 3 | 4 | 7 |
| 2011 | 1 | 8 | 9 |
| 2012 | 10 | 1 | 11 |
| 2013 | 90 | 45 | 135 |
| 2014 | 16 | 9 | 25 |
| 2015 | 6 | 3 | 9 |
| 2016 | 0 | 4 | 4 |

Notes: Data from 2010 to 2015 was presented by Golder et al. (2016) and 2016 data was provided by Amy Duncan (Fisheries Biologist, Okanagan Nation Alliance, pers. comm., 2017).

### 4.1.2 *Angling Regulations, Angler Incentive Program and Education*

Since 2011, there has been no quota on the number of NP anglers can remove from the Canadian Columbia River (MFLNRO 2017). Anglers are encouraged to kill all captured NP. An angler incentive program was conducted by MFLNRO in 2013-2014 and 2015-2016. In 2013, this program offered a $500 reward for the return of any NP heads containing PIT tags that were applied to fish in 2013 (Baxter and Neufeld 2015), while the program in 2015 allowed each returned head as a lottery entry towards a draw for $2,000 in prizes. Anglers were encouraged to return all NP heads the FrontCounter BC office in Castlegar, BC. The objective of the program was to remove NP, and allow an interface with NP anglers to provide education around the risk of invasive species introductions such as non-native NP.

Twelve anglers returned heads during the 2013-2014 program and 22 anglers returned heads during the 2015-2016 program with most anglers returning only one head and a few returning more than one. MFLNRO considers the program to have had limited effectiveness because they did not receive a significant number of angler returns (Matt Neufeld, MFLNRO, pers. comm. 2017).

Education and outreach are critical components of the work done the by Central Kootenay Invasive Species Society (CKISS) and preventing the introduction of invasive species is one of their primary goals. Education programs such as Clean, Drain, Dry and Don't Let it Loose provide information on all aspects of aquatic invasive species and NP information is disseminated through these programs where possible (Khaylish Fraser, Aquatic Species Program Coordinator, CKISS, pers. comm. 2017).

### 4.1.3 *Gill-Net Suppression Program*

Gill-nets were initially used by MFLNRO in the spring of 2013 to investigate the presence of NP in the Canadian Columbia River. The MFLNRO obtained input from the Kalisbel Tribe of Indians, who had been effectively suppressing the population of NP in the Box Canyon Reservoir of the Pend d'Oreille River (Section 4.3.1). Through site visits and associated meetings, information obtained included NP habitat preferences and a cursory evaluation of suitable habitat areas in a large river system and monofilament gill-net specifications (mesh sizes, length and depth) found to be highly effective at removing pike. Suitable NP habitat was identified in the Robson Reach, which is downstream of HLK Dam and upstream of Castlegar, and adult NP were subsequently captured both in these locations by gill-nets and by angling (Baxter and Neufeld 2015; Matt Neufeld, Fish, Wildlife & Habitat Management Branch – Kootenay Boundary Region, MFLNRO, pers. comm. 2017). Overnight gill-net sets were trialed, however, the bycatch rate was high and issues with SARA-listed White Sturgeon were identified. In addition the catch rate of NP was similar to that during shorter sets therefore the program moved to short term sets (approximately 4 hours), twice per day. Early spring surveys (i.e. early April) were less effective than later spring surveys, likely due to low water temperature and limited growth of instream vegetation (Matt Neufeld, pers. comm. 2017).

Following the initial sampling success in 2013, an adult gill-net suppression program with the objective of suppressing adult NP from the Canadian Columbia River has been conducted by Mountain Water Research with funding primarily provided by Teck Metals Ltd. from 2014 to 2017 and supplemental funding provided by MFLNRO and the Columbia Basin Trust (CBT). Stomach content analysis was included in 2014 as part of the Upper Columbia River White Sturgeon Recovery Initiative and Teck's Waneta Dam Upgrade compensation commitments by investigating prey found in stomachs of fish collected during gill-net surveys. Since 2014, a total of 288 NP have been successfully removed during the gill-netting suppression. For all study years (2014-2016) approximately 51% (n=147) of all the NP examined (n=288) contained food in their stomachs and in most cases included whole fish. The NP diet consisted primarily of native salmonids including Rainbow Trout, Kokanee and Mountain Whitefish. Other native fish prey species included Suckers (*Catostomus* sp.), Sculpins (*Cottus* sp.), Northern Pikeminnow (*Ptychocheilus oregonensis*) and Dace (*Rhinichthys* sp.). Cannibalism was also recorded in NP stomach samples (Section 4.1.5). Fish listed under SARA were not observed in any of the NP stomach samples.

Annual NP catch rates have consistently averaged 0.19 NP/hr (Baxter and Doutaz 2017) and the catch rates were higher in the spring (0.44 NP/hr) when compared to the summer (0.21 NP/hr) and fall (0.10 NP/hr) sampling (Baxter and Neufeld 2015). The average weight

of captured NP was 3.15 kg in 2014, 2.04 kg in 2015, and 2.38 kg in 2016. The gender distribution, determined by dissection, of NP for all three years was 123 males (45%), 118 females (44%) and 30 of unknown sex (11%). A total of 1,030 fish were caught as bycatch in gill-nets in the three years of the suppression program, 820 of which were released alive (79.6%).

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 the Waneta Dam as well as in the lower Kootenay River and suppression sessions have occurred in the spring, summer and fall (Baxter and Neufeld 2015). Initially NP were only captured in the Robson Reach and catch rates were highest in the spring (Baxter and Neufeld 2015). Based on these results, gill net suppression has primarily been conducted in the Robson Reach in the spring with additional locations and seasons added where time and budget allows. In 2016, NP were also captured near Zuckerberg Island and in the Kootenay River oxbow near Castlegar, BC (Baxter and Doutaz 2017). The program is conducted by a 2-person crew for two 5-day sessions deploying 8 nets twice a day in late May and June with additional sessions added when funding is available (Baxter and Doutaz 2016). In 2017, an additional 5 days of sampling will be conducted with funding from CBT.

A population estimate has been generated during each year of the suppression program (Table 2), 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). This estimate now incorporates an additional 15 NP that were affixed with internal sonic tags in early spring 2016 (Baxter and Doutaz 2017; Section 4.1.4). Currently, there is no funding for the gill-netting program beyond 2017.

**Table 2: Annual population estimate of Northern Pike in the Canadian Columbia River, including 95% confidence intervals, and number of Northern Pike captured during the gill-net suppression program, 2014-2016.**

| Year | Population Estimate | Confidence Intervals | | Gill-Net Suppression |
|---|---|---|---|---|
| | | Lower 95% | Upper 95% | |
| 2014 | 725 | 478 | 2759 | 133 |
| 2015 | 410 | 151 | 670 | 116 |
| 2016 | 107 | 59 | 155 | 49 |

**Notes**: Population estimates for 2014 and 2015 are based on number of NP captured during the gill-net suppression/angler incentive program and BC Hydro's Lower Columbia River Fish Indexing Program (CLBMON-45) while the estimate for 2016 only includes number captured during the gill-net suppression program.

### 4.1.4 *Thompson Rivers University Research Program*

Thompson Rivers University (TRU) initiated the Columbia River Northern Pike Removal – Risk and Feasibility of Control project in 2015. The objectives of the program are to:

- determine the risk of colonization of the Arrow Lakes by NP through HLK Dam navigational lock;

- determine the geographical life history of NP captured in the Columbia River through microchemical analysis of otoliths;
- use acoustic telemetry to locate crucial spawning habitat and evaluate movements of NP in the Columbia River; and,
- determine the feasibility of using eDNA to detect presence and spread of NP in the Columbia, Arrow Lakes and other tributaries.

The TRU work is primarily being conducted as part of a 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 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 (Section 4.1.3). Recent microchemistry analysis of 50 otolith samples collected from NP captured during the 2014 gill-net suppression program (Baxter and Neufeld 2015) indicated that the origin of 49 NP fish was from the Columbia River and 1 NP originated from the Pend d'Oreille River (Dan Doutaz, TRU, pers. comm. 2017). This may indicate that NP are successfully recruiting in the Columbia River.

### 4.1.5 *Juvenile Detection Programs*

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, the West Kootenay Fly Fishing Association and the 10$^{th}$ 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 of 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 (*Richardsonius balteatus*).

### 4.1.6 *Northern Pike Habitat Reduction*

The ONA in collaboration with Golder Associates Ltd. and the Central Kootenay Invasive Species Society (CKISS) will be conducting the Eurasian Water Milfoil Suppression Project in the Robson Reach in spring and summer 2017. The objectives of the program are to: 1) Remove or limit the growth of invasive Eurasian Milfoil (*Myriophyllum spicatum*) in the Robson Reach; and, 2) Limit aquatic macrophyte production in areas where NP adults and juveniles have been captured to remove spawning and rearing habitat. Methods will include the use of black geotextile barriers (frames) set on milfoil beds in the spring and summer to inhibit production and growth. The barriers will be left in place for eight weeks then moved to another location for the same amount of time with the goal of covering one quarter hectare over the study period. SCUBA will also be used to hand-remove plants using methodology similar to an ongoing project of invasive aquatic plant removal in Christina Lake (Amy Duncan, ONA, pers. comm. 2017).

## 4.2 United States

Efforts to assess and control the NP population in Lake Roosevelt (i.e. the U.S. Columbia River) began in 2015. Northern Pike were first documented in Lake Roosevelt in 2007 and observations during Fall Walleye Index Netting and White Sturgeon surveys showed a notable increase in 2013 and years following. Northern Pike have been observed in the northern reach of Lake Roosevelt, primarily in embayments near the Kettle and Colville River confluences and there is a high level of concern the invasion will expand downstream to the Spokane and Sanpoil rivers where native Rainbow Trout populations are already impacted by non-native Walleye (*Sander vitreus)* and Smallmouth Bass (*Micropterus dolomieui)* predation. The Washington Department of Fish and Wildlife (WDFW), Colville Confederated Tribes (CCT) and Spokane Tribe of Indians (STOI) implemented a standardized NP gill-net survey in the Kettle Falls area of Lake Roosevelt in June 2015. In 2016 gill-net suppression and boat electrofishing were used to inventory and suppress both adult and juvenile NP in Lake Roosevelt. The objectives of ongoing suppression efforts are to limit the expansion of the NP population in Lake Roosevelt and prevent the invasion from extending downstream below Grand Coulee Dam where NP would pose a substantial risk to anadromous salmonid populations. The Columbia River downstream of Grand Coulee Dam and important tributaries such as the Okanagan River, include extensive sections of low gradient habitat with aquatic macrophytes that could likely support robust NP populations.

The majority of funding for NP evaluation and suppression in Lake Roosevelt comes from the Bonneville Power Administration (BPA) with funding directed by the Northwest Power & Conservation Council (NPCC) Fish and Wildlife Program. All proposed projects are evaluated by the Independent Scientific Review Panel (ISRP) prior to receiving funding. The “Lake Roosevelt Northern Pike Suppression Plan” was initiated in 2016 under the ongoing Lake Roosevelt Fisheries Evaluation Program (Data Collection) project (#1994-043-00) and the ISRP reviewed the proposal in early 2016 (Nichols and Kittel 2016; Schroder 2016). Appendix A provides additional funding details for NP suppression projects in Lake Roosevelt.

### 4.2.1 *Gill-net Suppression*

Suppression began during a 5-day pilot program in upper Lake Roosevelt and the lower Kettle River in June 2015 (Lee and King 2015). The objectives of the pilot program were to investigate localized abundance, diet, age structure and biological metrics of the NP population in upper Lake Roosevelt. NP were captured in shallow, nearshore backwater or embayment habitats in both drainages and age-1 (n=11) and age-2 (n=10) age classes were identified. Contents were observed in 19 of 22 NP stomachs with the most frequent prey items being Salmonidae (trout and whitefish) and Catostomidae (suckers) which were found in 58% and 42% of stomach samples, respectively, while Cottidae (sculpins) were only observed in one stomach (Lee and King 2015). Lee and King (2015) also observed that Lake Roosevelt NP had higher growth rates than in nearby Pend d'Oreille and Coeur d'Alene populations and attributed this to the newness of the invasion resulting in low NP densities, thus providing them with a substantial prey base to exploit. Catch rates, which had been 0.08 NP/hr in June 2015, increased to 0.38 NP/hr in February 2016 then decreased to 0.12 NP/hr in June 2016 (Lee and King 2015; C. Lee, Fisheries Biologist, WDFW, pers. comm. 2017). Suppression programs conducted early in the season have had higher NP catch per unit effort (CPUE) and lower bycatch CPUE than later in the season. Catch and release mortality also increased later in the season when water temperatures were higher (Lee and King 2015).

An expanded program was initiated in 2016 with funding expected to continue through 2018 as a co-ordinated effort of the WDFW, CCT and STOI. The NP abundance assessment is led by the WDFW and occurs in February and June. During each 4-day survey, two boat crews deployed a minimum of four gill nets twice per day (n=16 nets total a day) as per standard NP indexing assessments (Nichols and Kittel 2016; McLellan 2016b). In addition to the abundance surveys, three 2-day targeted gill-net suppression surveys occur in the spring and summer in areas of high NP abundance, as identified during the abundance surveys, to remove as many NP as possible (BPA 2017). Additional effort is added when extra funds are available.

### 4.2.2 *Boat Electrofishing Suppression*

Juvenile NP (n=100) were captured in shallow bays of the Kettle River during periodic boat electrofishing surveys in August 2016 at a capture rate of 12.3 NP/hr (Holly McLellan, Principle Fish Biologist, CCT, pers. comm. 2017). Juveniles were also documented during targeted boat electrofishing surveys conducted by the STOI (n=797; 48.3 NP/hr) with an additional 152 captured during juvenile White Sturgeon sampling in October 2016 (STOI unpublished data). The CCT found maneuvering the electrofishing boat slowly into shallow, weedy bays with electrofisher power off until the boat reached shallow (< 50 cm) river margins before turning the power on at a high voltage was the most effective way of capturing juvenile NP using the boat shocker (Holly McLellan, CCT, pers. comm. 2017). The STOI found running the electrofisher with power on while moving through the shallows to be more effective and remaining in one location for a few seconds was required before the NP would rise to the surface (Elliott Kittel, STOI, pers. comm. 2017). In addition, the STOI found that daytime boat electrofishing surveys had higher NP capture rates and lower bycatch capture rates than nighttime surveys.

A juvenile suppression program is proposed for fall 2017 using boat electrofishing as well as gillnets in Lake Roosevelt (Holly McLellan, CCT, pers. comm. 2017). The program will be conducted as a co-ordinated effort between the STOI and CCT.

#### 4.2.3 *Angler Bounty Program and Angling Regulations*

In 2011, the WDFW Fish and Wildlife Commission voted to reclassify NP from a "game species" to a "prohibited species" and the state presents NP as an invasive problem fish, not an angling opportunity (Lee and King 2015). There is no daily limit, no minimum size and no possession limit, however, fish must be dead before being removed from the vicinity of capture (WDFW 2016).

The CCT have implemented a Northern Pike Bounty Program which will pay anglers $10 per NP head returned (Holly McLellan, CCT, pers. comm. 2017). Details on the bounty program were not located, however, the proposed program is likely similar to that ongoing in Coeur d'Alene Lake (Section 4.3.2).

#### 4.2.4 *Angling, Fyke Net and Seine Net Suppression*

The Colville Confederated Tribes have proposed a targeted angling, fyke net and seine net survey program for 2017 to suppress adult NP (Holly McLellan, CCT, pers. comm. 2017). This methodology has not been trialed or used previously in the U.S. Columbia River as a means of suppression.

#### 4.2.5 *Otolith Geochemistry*

The geochemical composition of otoliths extracted from NP during 2016 gill-net suppression efforts is being evaluated to determine the natal origin of the fish by comparing geochemical signatures in the environment with those expressed in the chronological history of the otolith (BPA 2017; McLellan 2016b). This work is being co-ordinated with similar analyses in the Canadian Columbia River (Section 4.1.4). Preliminary results of microchemistry conducted on NP otoliths collected during gill netting surveys targeting Walleye in Lake Roosevelt suggested the NP captured were spawned in the Kettle River and possibly elsewhere in Lake Roosevelt (Lee and King 2015).

#### 4.2.6 *Environmental DNA*

The CCT will be conducting a basin-wide eDNA assessment to investigate the presence of NP in other tributaries to the Columbia River and areas downstream of the known invasion. The anticipated extent of the eDNA evaluation will be from the Canada/U.S. border to Rock Island Dam in central Washington (Holly McLellan, CCT, pers. comm. 2017).

### 4.3 Columbia River Tributaries

The following sections briefly summarize suppression programs in the two tributaries to the Columbia River where NP populations have become established: the Pend d'Oreille River and Coeur d'Alene Lake/Spokane River.

#### 4.3.1 *Pend d'Oreille River*

The Pend d'Oreille River NP population has been identified as the source of the Columbia River invasion. Illegal introductions into the Flathead Lake system in Montana in the 1980's were followed by downstream dispersal and establishment of NP populations in areas with

suitable habitat in the Pend d'Oreille River. One such area is the Box Canyon Reservoir, a 90 km long reservoir bounded by Albeni Falls Dam upstream and Box Canyon Dam downstream. Box Canyon Dam is located 20 km upstream of the next impoundment, Boundary Dam, which is immediately upstream of the Canada/US border. The NP population in Box Canyon Dam rose from approximately 300 in 2004 to >10,000 in 2011 (Schroder 2016). The rapid explosion of the population of the voracious piscivore posed a significant risk to the recovery of native fish populations in the reservoir. In response, The Kalispel Tribe of Indians Natural Resource Department, in conjunction with the WDFW, initiated a gill-net suppression program that has been ongoing since 2012. The gill-net suppression program occurs in the early spring, followed by a Spring Pike Index Netting (SPIN) survey where the catch-rate and number of NP captured determines if suppression will be continued in the following months or discontinued until the following spring. Catch rates have been reduced from a high of 12.2 NP/net night in 2012 to 0.18 NP/net night in 2015 and over 16,000 NP were removed between 2012 and 2015 (Harvey and Bean 2016). The program has successfully reduced the population of NP by approximately 90% since 2012 thus meeting the program's objective of reducing NP abundance by 87% by 2014 (Schroder 2016).

The Kalispel Tribe anticipate continuing the program in Box Canyon though the program will begin to scale back now that the population has been significantly suppressed. The tribe has also extended their mechanical suppression efforts, in coordination with Seattle City Light and WDFW, to the Boundary Reservoir upstream of Boundary Dam with the objectives of limiting the NP population in the reservoir and reducing the movement of more NP to downstream areas (i.e. to the Canadian section of the Pend d'Oreille and Columbia River further downstream).

At this time, there are no suppression programs in the Canadian Pend d'Oreille River system. AMEC (2015) summarized the limited records of NP captures in Seven Mile Reservoir (n=3) and identified areas of suitable NP habitat. Research is being conducted in this section of the river including telemetry to evaluate the distribution and movement of NP in Waneta Reservoir. Four NP, captured by gill-nets and angling, were acoustic tagged and fixed-station tracking is being used to assess downstream migration via entrainment through Waneta Dam to the confluence with the Columbia River (Dan Doutaz, TRU, pers. comm. 2017).

A collaborative partnership between the Salmo River Streamkeepers, Ktunaxa, ONA and Kalispel Tribe has proposed to conduct gill-net suppression in the Seven Mile Reservoir section of the Canadian Pend d'Oreille River and the downstream reach of the Salmo River (Gerry Nellestijn, Salmo River Streamkeepers, pers. comm. 2017). A non-sportfish migration barrier constructed of large boulders is located approximately 1.5 km upstream of the reservoir on the Salmo River. A recent review of the barrier and NP swimming and jumping capabilities conducted by MFLNRO and the Freshwater Fisheries Society of BC (FFSBC) suggested NP may be able to breach the barrier under favorable conditions and the current design of the barrier provides protection from fast currents that may allow NP passage. Doutaz and Heise (2016) suggested modifications to the barrier are necessary to ensure exclusion of NP from the Salmo River though any design changes should consider the impacts on native migratory salmonids.

### 4.3.2 *Coeur d'Alene Lake and Spokane River*

Northern Pike were illegally introduced into Coeur d'Alene Lake in the mid-1970's and spread to several lowland lakes in northern Idaho as well as downstream into the Spokane River (McMahon and Bennett 1996). The Spokane River drains into the lower reach of Lake Roosevelt creating an additional potential point of invasion to the Columbia River watershed. Anglers have reported NP encounters in Lake Spokane, an impoundment of the Spokane River upstream of Long Lake Dam, have increased in recent years though a standardized survey conducted by WDFW in 2015 yielded only 2 NP (Lee and King 2015). At this time there are no active suppression programs in the Spokane River.

The Idaho Department of Fish and Game (IDFG) treats NP as a game fish and has liberal angling regulations (no limit and no minimum size) in hopes of encouraging angler harvest (Jeff Dillon, Fisheries State Manager, IDFG, pers. comm. 2016). The Coeur d'Alene Tribe considers NP an invasive species and has undertaken localized suppression efforts where Cutthroat Trout (*Oncorhynchus clarkii*) conservation is a concern. The Coeur d'Alene Tribe, in collaboration with IDFG, has an ongoing suppression program (2015-2017) in Windy Bay of Lake Coeur d'Alene where overnight gill-nets are set in the spring to remove NP from an important Cutthroat Trout spawning migration corridor and limit predation of the native species. Because NP are considered a game fish in Idaho, NP captured during the gill-net suppression program are tagged and relocated to Cougar Bay by IDFG where they are accessible to the popular sport fishery in the area. Preliminary results of the 2015 program suggested of the 234 relocated NP, 30% of tagged fish were returned by anglers close to where they were released in Cougar Bay while 2 NP were recaptured back in Windy Bay only three weeks after being relocated (Firehammer 2016).

The Tribe has run an angler reward program since 2015 in the southern third of Lake Coeur d'Alene where NP abundances are believed to be higher than other regions of the lake. The reward program offers prizes of either $50 or $500 for tagged NP returned with details of capture location; the program runs from October through May. In 2015, 28 anglers returned 155 NP (Firehammer 2016).

## 5 INFORMATION NEEDS AND DATA GAPS

The following were identified as information needs and/or data gaps related to NP suppression and research in the Columbia River Basin. The focus is related to programs or research in Canada.

- Identification of YOY/Juvenile Rearing - Observations of YOY and juveniles are limited; juveniles (n=4) were identified in NP stomachs in 2015 and one juvenile was captured in the Robson Reach in July 2016. Identifying juvenile rearing areas and life history requirements may help suppression efforts, especially if juveniles can be removed before they can feed on larger sized fish.
- Obtain US References - Information from programs in the U.S. portion of the watershed has been difficult to obtain and an updated reference list may help coordinate efforts and encourage data sharing.

- Population Status in the Pend d'Oreille River - The status of NP in the Canadian portion of the Pend d'Oreille River between Boundary Dam and the confluence with the Columbia River is unknown. Baxter and Neufeld (2015) and ONA (2016) suggested effort should be expended in the Pend d'Oreille River to better understand the abundance, distribution and life history of NP in the Canadian portion of the river identified as the most likely source of the NP invasion of the Columbia. Currently, the only research ongoing in the Pend d'Oreille River is telemetry tracking of four tagged NP. Habitat in the Pend d'Oreille differs from the Columbia in that a significant portion of the reservoir consists of steep sided shorelines the shallow, slack, vegetated habitat preferred by NP is very limited (Dan Doutaz, TRU, pers comm. 2017). It is unknown at this time if NP are recruiting in the Canadian Pend d'Oreille or if they are migrants entrained through Boundary Dam from upstream feeder populations in Boundary and Box Canyon reservoirs. Additional links from potential recruitment in the Pend d'Oreille River to supply of juveniles to the Columbia River population are also not clear because of the lack of upstream data noted here.

## 6 RECOMMENDED ACTIONS TO STRENGTHEN SUPPRESSION EFFORTS

The following recommended actions to strengthen suppression efforts are based on this information review.

1) **Establish a Northern Pike Suppression Committee**. As summarized in this review, various stakeholders are contributing to research and suppression of NP in the Canadian Columbia River. An initial effort was made in July 2016 to bring these stakeholders together and it is recommended this group transform into a more formalized committee. The committee will need a dedicated coordinator, whether separately funded (see 1b) or led by an establishment. The committee requires representatives from government agencies, First Nations, industry, technical experts and other stakeholder groups. A transboundary committee should include stakeholders from both sides of the border with open communications specific to NP suppression activities throughout the Columbia basin. The following is a suggested list of objectives for the Northern Pike suppression committee:

    a) **Share Information and Identify Data Needs.** The primary purpose of the committee would be to maintain open communication between various stakeholders. The group would work together to prioritize suppression activities based on recent research and survey information from suppression programs in both Canada and the U.S.

    b) **Identify Long-Term Funding Sources.** The committee could identify and seek out long-term funding sources for NP suppression programs. Support from a diversity of funding sources may provide a funding base that is more sustainable than relying on a single agency.

    c) **Provide Input on Proposals for Priority Activities.** The committee could either help funding agencies by providing input on NP research and suppression proposals or the committee could directly submit proposals to these funding agencies for priority activities.

d) **Provide Advice on Immediate Responses to NP Invasions of New Waterways.** Time was identified as the critical factor in limiting the abundance, distribution and impacts to native fish populations following invasion by NP. The Kalispell Tribe identified the high level of effort expended in the initial 2-years of NP suppression in Box Canyon Reservoir as the key to the successful control of the rapidly growing population (Notes from NP Meeting, Coeur D'Alene, ID, November 16, 2016). Research including eDNA and telemetry studies as well as angler reports can be useful tools to monitor the distribution of NP in the Columbia Basin. Currently the highest risk of invasion is upstream of HLK Dam to the Arrow Lakes. Committee members with knowledge and expertise can provide advice on an effective response to new invasions, if and when they occur.

e) **Maintain Connection with U.S. Columbia River NP Fisheries Managers**. There is a common interest that would be served by continued efforts to either include U.S. fisheries managers in this group or request participation in U.S. groups already functioning. Collaborating as a transboundary committee would provide an opportunity to discuss the status and successes of ongoing programs.

2) **Conduct the Following Northern Pike Suppression Activities:**

a) **Annual Columbia River Adult Gill Net Suppression**. The gill-net suppression program initiated in 2014 has reduced the NP population by 30-40% annually. NP are established in the Canadian Columbia River and complete removal of the population is unlikely, however, continued suppression can limit NP abundance, distribution and impact on native fish species. Based on the success of the 2014-2017 program, it is suggested that a suppression program using a similar level of effort (at least two 5-day sessions) and continue for the long-term. Currently the program occurs during the spawning period in May and June when NP are staging or in nearshore spawning habitat and catch rates have been higher than during other seasons. Studies in the U.S. found catch rates were higher when NP were staging in the shallows prior to spawning in February and March, which may be a time period to target if additional funding is available, however, gill net sampling was trialed by MFLNRO in April 2013 with very little success. The program should continue to target the high-use Robson Reach and assess other locations when time and budget allows, use short (~4 hr) gill-net sets to limit exposure of SARA-listed bycatch and increase effort following high water years.

b) **Investigate other potential control actions using other programs success as a guide.** For example, investigating boat electrofishing as a juvenile NP control method in the Canadian Columbia River**.** Two programs over two years have attempted to identify juvenile NP in the Robson Reach of the Canadian Columbia River resulting in the capture of one juvenile NP. Information from juvenile NP programs in the U.S. suggest daytime boat electrofishing in the late summer and/or fall may be a more effective method of identifying juvenile NP rearing areas. Concentrations of juveniles were observed in shallow, slack water embayments with aquatic vegetation in the Kettle River and Lake Roosevelt in 2016 and fisheries managers in the U.S. will be using boat electrofishing as a juvenile suppression

method in fall 2017. Previous programs have identified embayment areas in Robson Reach as the most likely NP spawning habitat and initial juvenile boat electrofishing surveys should target this area followed by similar habitat areas near Waldie's Island, Zuckerberg Island and the Kootenay Oxbow. Boat electrofishing could be conducted as a one season trial to identify juvenile rearing areas and if proves feasible as a suppression method it could be conducted in future years.

c) **Pend d'Oreille River Gill Net and Boat Electrofishing Survey.** It is unknown at this time if NP are recruiting in the Canadian Pend d'Oreille River or if they are migrants entrained through Boundary Dam from upstream feeder populations in Boundary and Box Canyon reservoirs. See Section 5 for additional background.

## 7 CLOSING

Northern Pike have become established in the Canadian Columbia River. The Canadian response to the initial invasion is heralded by fisheries managers in the U.S. because it was fast and effective. Though NP will likely never be eradicated completely from the system, a long-term suppression program can likely limit the severity and extent of the invasion. Moving forward, a coordinated effort to suppress NP, prevent extension of the current NP distribution and respond quickly to new invasions will protect the natural ecology and native species of the Columbia River system.

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# Appendix A
# Columbia River Northern Pike Suppression and Research Summary Spreadsheet

| Organization | Contact Person (s) | Program Name | Program Location (s) | Program Partner (s) | Program Timeline (Start/ End Dates) | Completed, Current or Proposed | Program Objectives | Program Summary including Methodology | Program Successes | Information Needs Identified Over the Duration of Project | Factors Limiting the Success of the Project | Recommendations/ Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO)** | Matt Neufeld | Angler Incentive Program | Canada - Columbia River | FWCP - Arrow program; HCTF; Freshwater Fisheries Society; MWR; ONA | 2013-2014; 2015-2016 | Completed | Public information and angler awareness (objective was not as a significant control method) | Tagged summer 2013 and returns ended March 2014 - gills nets set during spring 2013, NP pit tagged and released, rewards through the year. 12 anglers returned in 2013-2014, some returned more than one head. Late Spring 2015 through March 2016 - 22 anglers returned heads (some returned multiple heads but <30 fish). | Not very effective. Didn't get a significant number of returns. Thought it was a good way to interact with anglers. Public information piece. | American data was difficult to obtained - updated list of published data. | Number of anglers - angler interest? By 2015 Pike were hard to catch limiting the use of this project. | Long-term suppression program |
| **BC Ministry of Forests, Lands and Natural Resource Operations (MFLNRO)** | Matt Neufeld | Lower Salmo River Fish Barrier Assessment | Canada - Pend d'Oreille River | Freshwater Fisheries Society of BC; TRU | 2015-2016 | Completed | Assess the risk of NP passage from the Pend d'Oreille River to the Salmo Watershed | Literature review and site insection of the coarse fish barrier. | Completed evaluation | Population structure of NP in Seven Mile Reservoir | None identified | Barrier may prevent upstream access during low discharge period but during high discharge shelter from fast currents behind boulders may allow passage. Suggested modification to right upstream bank to eliminate protected areas. Native salmonid passage must be considered if alterations occur. |
| **Okanagan Nation Alliance (ONA)** | Amy Duncan | Lower Columbia River Juvenile Northern Pike (*Esox lucius* ) Assessment | Canada - Columbia River, Robson Reach | Columbia Basin Trust | April 17-22 and 24-29, July 25-29 and Aug 29-Sept 2, 2016 | Completed | 1) Determine if NP are successfully recruiting in the LCR by sampling for juveniles (1+); 2) If juvenile NP are found, identify critical habitat features and dietary preferences of juvenile NP in the system. | Fyke nets set to determine presence and distribution of juvenile NP in the Robson Reach of the LCR. 35 fyke net sets, each for 4-5 days, average of 22.5 hrs between checks. One young-of-the-year NP (12.5 cm fork length, 11.8 g) was captured in a fyke net on July 27, 2016. Three opportunisty beach seines were also conducted. Habitat features where juvenile NP was captured was documented and stomach content analysis showed one partially digested small fish suspected to be a Redside Shiner. | Objectives of the program were met. Determined that NP are successfully recruiting in the Robson Reach based on the capture of one juvenile. | None identified. | Currently no funding for 2017, however, ONA may fund some surveys internally. | Continued suppression efforts in the Lower Columbia River targeting all life stages of Northern Pike; Further research in identifying spawning locations in an effort to decrease / suppress Northern Pike spawning habitat in the Lower Columbia River (e.g., removal of weeds, spawning substrates, etc.); Investigate the Canadian Pend Oreille Reservoir for YOY and juvenile Northern Pike; Suppression efforts in the Canadian Pend Oreille Reservoir for all life stages of Northern Pike. |
| **Okanagan Nation Alliance (ONA)** | Amy Duncan | Eurasian Water Milfoil Suppression Project | Canada - Columbia River, Robson Reach | Golder and Central Kootenay Invasive Species Society | Spring/Summer 2017 | Current | 1) Remove or limit the growth of invasive Eurasian Milfoil in the Robson Reach; 2) Limit aquatic macrophyte production in areas where Northern Pike adults and juveniles have been captured to remove spawning and rearing habitat. | Methods including using black geotextile barriers (frames) set on milfoil beds in the spring and summer to inhibit production/growth. Leave for 8 weeks then move to another location. Goal is to cover 1/4 ha over the project. Also will use SCUBA for hand-removal of plants, similar to methods used in Christina Lake. | N/A | N/A | Method has been used in lakes, unknown if it will work in riverine habitat. Pilot project at this time. | N/A |

| Organization | Contact Person (s) | Program Name | Program Location (s) | Program Partner (s) | Program Timeline (Start/ End Dates) | Completed, Current or Proposed | Program Objectives | Program Summary including Methodology | Program Successes | Information Needs Identified Over the Duration of Project | Factors Limiting the Success of the Project | Recommendations/ Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Golder Associates Ltd.** | Bronwen Lewis (now Indigo River Consulting); Dana Schmidt | Larval survey for invasive Northern Pike in the Robson Reach, Columbia River | Canada - Columbia River, Robson Reach | Columbia Basin Trust, Castlegar and District Wildlife Association, West Kootenay Fly Fishing Association | June to July 2015 | Completed | 1) Capture larval Northern Pike to determine if a breeding population is present; and 2) Confirm the most effective Northern Pike larval sampling technique for a large river like the Columbia. | Golder (2015) attempted to collect larval NP in June and July 2015 in the Robson Reach area of the Canadian Columbia River. Various methods were used during both the day and night including backpack electrofishing, dip netting, beach seining plankton towing, minnow trapping and light trapping (Golder 2015). No NP were captured during 2015 juvenile sampling conducted by Golder though a spent female NP was captured during the adult gill-net suppression program confirming that spawning did occur. However, it is possible that recruitment did not occur or that it occurred only in small areas or areas not sampled (Golder 2015). | Captured fish species other than Northern Pike; methods may be useful for future sampling. | Further investigation | Spawning was confirmed during the project but no larvae were captured; time and resources for an effective sampling program. | Suppression |
| **Thompson Rivers University (TRU)** | Dan Doutaz, Brian Heise | Columbia River Northern Pike Removal - Risk and Feasibility of Control | Canada - Columbia River, Kootenay River, and Pend d' Oreille River | HCTF, MFLNRO, TRU | 2015-2018 | Current | Determine risk of colonization of Arrow Lakes through Hugh L. Keenleyside Dam navigation lock. Determine geographical life history of Northern Pike captured in the Columbia through microchemical analysis of otoliths. Locate crucial spawning habitat and movements of Northern Pike in Columbia through acoustic telemetry. Determine the feasibility of using environmental DNA (eDNA) testing to detect the presence and spread of Northern Pike in the Columbia and its tributaries. | Still in prep. | Still in prep. | See Objectives | Funding sources limited. Currently out of funds for 2017. | N/A |
| **Mountain Water Research (MWR)** | Jeremy Baxter | Lower Columbia River Northern Pike Suppression | Canada - Columbia & Kootenay Rivers | Teck, CBT, MFLNRO | 2014-2017 | Current | Remove and control invasive NP in the LCR. Determine threats NP have to native species. | See word document - MWR NP Project Summary. | Yes. The program has been successful at removing approximately 25-30% of the NP population each year. Collaboration with MFLNRO, CBT and Teck has been extremely successful. | Pike are attempting to spawn in shallow water areas of the Robson Reach. Spawning areas have been identified. Pike are consuming native salmonids and other native species. Currently SARA listed species are not being consumed by pike. Gill-netting has been successful at controlling pike. | Funding sources after 2017 not determined. Northern Pike long term management plan for the LCR has not been discussed. Bycatch mortality is low but does concern native fish species. Upstream source (Pend d'Oreille) and NP recruits from Lake Roosevelt may continue to enter the LCR. No plan to control invasive species in Pend d'Oreille in Canada. | Continue to suppress and control NP in the LCR in BC. Develop long term management plan. Keep communication with efforts in the USA. |
| **Salmo Streamkeepers** | Gerry Nellestijn | None at this time | Canada - Pend d'Oreille River | Kalispel Tribe of Indians, ONA, Ktunaxa | N/A | Proposed | Gill-netting program to remove adult Northern Pike from the Pend d'Oreille River between Boundary Dam and Seven Mile Dam. | Gill-net supression with training by Kalisbell; eDNA work done in partnership with TRU; some investigation in downstream reach of Salmo River below the coarse fish barrier. Building a partnership/community-based approach to Northern Pike suppression in the Pend d'Oreille. | N/A | N/A | Pending funding | N/A |

| Organization | Contact Person (s) | Program Name | Program Location (s) | Program Partner (s) | Program Timeline (Start/ End Dates) | Completed, Current or Proposed | Program Objectives | Program Summary including Methodology | Program Successes | Information Needs Identified Over the Duration of Project | Factors Limiting the Success of the Project | Recommendations/ Outcome |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BC Hydro** | Alf Leake | Seven Mile Reservoir – Habitat Suitability and Non-Native Species Control | Canada - Pend d'Oreille River | Amec Foster Wheeler, Hagen and Associates Ltd. | 2015 | Completed | Evaluate habitat in Seven Mile Reservoir in terms of suitability for adult NP; assess impacts of co-occurance of non-native species on native species in the reservoir | Summarized the limited records of NP captures in Seven Mile Reservoir (n=3) and identified areas of suitable NP habitat | Desktop evaluation of suitable NP habitat areas | Ground truthing to confirm results of habitat evaluation | No field evaluation; based on existing habitat data | Field assessments to confirm habitat assessment; trial gill-net suppression in the reservoir. |
| **Local Author** | Jim Bailey | News Articles | Columbia River | N/A | 2015-2017 | Current | Inform the public | Prepared various newspaper articles on NP in the Columbia River. Also an article in American Angler in December 2016. | Public awareness | N/A | N/A | N/A |
| **Central Kootenay Invasive Species Society (CKISS)** | Khaylish Fraser, Dave DeRosa | Clean, Drain and Dry; and, Don't Let it Loose | Canada, Central Kootenay | Various | Ongoing | Current | Education and outreach programs to foster behavioural changes. Primary purpose of Clean, Drain, Dry is to identify dreissenid mussels at inspection stations - also check for live fish being transported (including Northern Pike). | Opportunistic checks for live NP being transported at inspection stations. Information about NP provided on CKISS website. Partner with other organizations - for example on ONA Eurasion watermilfoil project. | Public outreach and education | N/A | N/A | Provide a copy of this information review to stakeholders involved in research and suppression of NP. |
| **Washington Department of Fish and Wildlife (WDFW)** | Charles Lee | Lake Roosevelt Fisheries Evaluation Program - Northern Pike Suppression Plan | Washington, USA - Columbia River - Lake Roosevelt & Lower Kettle River | Bonneville Power Administration (BPA), WDFW and Colville Tribe. | 2015-2018 | Current | To investigate Northern Pike distribution and relative abundance, and to evaluate the feasibility of targeted removal efforts. | The Lake Roosevelt Northern Pike Suppression Plan is a co-ordinated effort of the WDFW, Colvile and Spokane tribes primarily funded by the BPA and managed by the Spokane Tribe. Includes NP adult abundance surveys and suppression, a Northern Pike Bounty Program ($10/head), targeted juvenile suppression surveys in the fall using boat electrofishing, pilot angling and seine surveys to suppress adult Northern Pike, microchemistry study on Northern Pike otoliths to determine natal origin and basin wide eDNA (Columbia River from Rock Island to Canadian border). | The program has established gill-netting and boat shocking techniques to control adult and juvenile (young of the year) pike. Program continues to be a successful collaborative effort. | See Interstate NP meeting notes document from November 16, 2016. | Took a year to receive funding. In 2016 saw age-0 NP recruit to catch nets; over 1000 zero-age fish since August; therefore an increasing problem. In Lake Roosevelt, gill nets can cause by-catch of walleye, and Canadian SARA-listed sturgeon that reside in Lake Roosevelt, so must be used with care. | Continue to control pike and understand their impacts to native fish species and their origin. |
| **Colville Confederated Tribes (CCT)** | Holly McLellan | Lake Roosevelt Fisheries Evaluation Program. Colville Confederated Tribes - Non-Native Predator Removal. | Washington, USA - Columbia River - Lake Roosevelt & Lower Kettle River | Bonneville Power Administration (BPA), WDFW, Spokane Tribe, and Chelan County Public Utility District. | Proposed for 2017 | Current | The overall objectives of ongoing suppression efforts are to limit the expansion of the NP population in Lake Roosevelt and prevent the invasion from extending downstream below Grand Coulee Dam where NP would pose a substantial risk to anadromous salmonid populations. | | | See Colville Tribe Abstract Proposal. | In Lake Roosevelt, gill nets can cause by-catch of walleye, and Canadian SARA-listed sturgeon that reside in Lake Roosevelt, so must be used with care. | Continue to control pike and understand their impacts to native fish species and their origin. |
| **Spokane Tribe of Indians (STOI)** | Elliott Kittel | Lake Roosevelt Fisheries Evaluation Program - Northern Pike Suppression Plan | Washington, USA - Columbia River - Lake Roosevelt & Lower Kettle River | Bonneville Power Administration (BPA), WDFW and Colville Tribe. | 2015-2018 | Current | 1) Develop and implement NP relative abundance surveys to evaluate CPUE trends, collect biological data, assess bycatch and inform targeted gillnetting efforts; 2) Implement targeted NP gillnetting efforts to reduce NP numbers in the Kettle Falls area of Lake Roosevelt; 3) Determine natal origin of NP captured during 2016 survey efforts conducted on Lake Roosevelt; and, 4) Develop an outreach plan and materials for anglers and recreational users addressing the presence of NP in Lake Roosevelt. | | | See Interstate NP meeting notes document from November 16, 2016. | Took a year to receive funding. In 2016 saw age-0 NP recruit to catch nets; over 1000 zero-age fish since August; therefore an increasing problem. In Lake Roosevelt, gill nets can cause by-catch of walleye, and Canadian SARA-listed sturgeon that reside in Lake Roosevelt, so must be used with care. | Continue to control pike and understand their impacts to native fish species and their origin. |

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| **Kalispel Tribe of Indians** | Nick Bean | Pend Oreille Non-Native Fish Suppression | Washington, USA - Pend'Oreille River - Box Canyon Reservoir & Boundary Reservoir | Bonneville Power Administration, Avista Utilities & WDFW | 2010-2018 | Current | Remove and control invasive NP. | See Interstate NP meeting notes document from November 16, 2016. | Yes. The program has been successful at removing approximately 90% of the NP population. Collaboration with WDFW has been good with an estimated $20k USD additional support and effort from WDFW during Spring Pike Index Netting sessions. | See Interstate NP meeting notes document from November 16, 2016. | Some angler and public resistance as the warm water fishery is desirable and some want pike fishery to continue. A large capital investment for annual suppression efforts of NP is directed by the KT; would prefer that the $100,000 spent annually on suppression could be spent instead on bull trout and cutthroat trout recovery efforts. | Continue to control pike. |
| **Coeur d' Alene Tribe of Indians** | Jon Firehammer | Coeur d' Alene Lake Northern Pike Suppression | Idaho, USA - Coeur d' Alene Lake | IDFG | 2015-2017 | Current | Remove and control invasive NP; protect native at-risk species such as Cutthroat Trout | The Tribe has run an angler reward program since 2015 in the southern third of Lake Coeur d'Alene. In collaboration with IDFG ongoing suppression program (2015-2017) in Windy Bay of Lake Coeur d'Alene where overnight gill-nets are set in the spring to remove NP from an important Cutthroat Trout spawning migration corridor and limit predation of the native species; NP are relocated to a different area of the lake and release to provide angler opportunity. | NP in Idaho have an angler following, which helps to control and put pressure on NP populations. | N/A | Release of NP to other locations in the lake. 2 NP returned to original suppression location. | |

# Appendix B
## Stakeholder Meeting June 5, 2017 – Spring 2017 Project Updates

## Northern Pike Meeting – Spring 2017 Project Updates

Monday June 5, 2017
Columbia Basin Trust office
Castlegar, BC

Attendees:
1. Adam Brooks (Teck)
2. Brent Nichols (Spokane Tribe of Indians)
3. Bret Nine (Colville Confederated Tribes)
4. Brian Heise (Thompson Rivers University)
5. Bronwen Lewis (Independent)
6. Chris King (Golder Associates)
7. Charles Lee (Washington Department of Fish & Wildlife)
8. Crystal Lawrence (AMEC Foster Wheeler)
9. Dan Doutaz (Thompson Rivers University)
10. Dustin Ford (Golder Associates)
11. Elliot Kittel (Spokane Tribe of Indians)
12. Emily Nilsen (Columbia Basin Trust)
13. Gerry Nellestijn (Salmo Streamkeepers)
14. Guy Martel (BC Hydro)
15. Holly McLellan (Colville Confederated Tribes)
16. Jason Olsen (Kalispel Tribe of Indians)
17. Jim Bailey (author and reporter)
18. Khaylish Fraser (Central Kootenay Invasive Species Society)
19. Krista Watts (Columbia Power Corporation)
20. Luis Cancela (Castlegar & District Wildlife Ass.)
21. Louise Porto (AMEC Foster Wheeler)
22. Matt Neufeld (Ministry of Forest Lands and Natural Resource Operations)
23. Michael Hounjet (Columbia Power Corporation)
24. Nick Bean (Kalispel Tribe of Indians)
25. Rena Vandenbos (Selkirk College)
26. Rachael Roussin (Meeting coordination - consultant)

**Thompson Rivers University:**

- Otolith geochemistry conducted on 50 fish from Columbia River suggested 49 were from the Columbia River while 1 was from the Pend d'Oreille.

*Columbia River update:*

- 9 acoustic tagged fish still accounted for in Columbia River; remain in Robson Reach area.
- No tagged fish have moved upstream into Arrow Lakes
- Apparent spawning-related migrations in the Robson Reach, specifically to the area around Celgar. Included a pike moving from the Kootenay Oxbow to Celgar then back to the Oxbow after one day.

*Pend d'Oreille River update:*

- 4 tags in Waneta Dam reservoir – all remain in the reservoir at this time (no entrainment downstream into the Columbia River)

- Only method used in Seven Mile Reservoir has been angling. Was on the water during a large release from Boundary Dam upstream – large debris loads moving downstream. Something to consider for any inventory, suppression programs in the reservoir.

**Okanagan Nation Alliance:**

- 16 mats out in the Robson Reach for Milfoil Suppression project.
- Divers completed first round of hand-pulling; focused on 3 areas where milfoil was identified.

**Mountain Water Research/Teck Metals:**

- Suppression program removed 17 pike this year; two of TRU's tagged fish were captured and 1 was released alive. Juveniles were captured (n=4 or 5).
- Cold water temperatures, especially during second session, reduced sampling effectiveness.

**B.C. Ministry of Forests, Lands and Natural Resource Operations:**

- Trialed overnight sets in 2013 but high level of bycatch and not much difference in catch rates of pike compared to 4 hour sets.
- Earlier surveys were less effective because of water temperature.
- Ideally would set nets deeper earlier in the year but too many issues with bycatch of White Sturgeon.

**Kalispell Tribe**

- Box Canyon suppression program has removed about 17,500 pike between 2012 and 2017. Very successful. Annual catch is now in double digits.
- Reduced effort as population has been significantly reduced. Previously set about ~1000 nets/year, now ~300 nets/year.
- Suppression occurs between February and April when water temperature is between 4 and 12°C, spawning typically done by May 1.
- Boat electrofishing was not an effective method for catching juveniles in the Pend d'Oreille.

**Colville Confederated Tribes**

- Gill netting since February this year. 950 pike removed. 44 days of sampling, 400 nets. Found overnight sets using 2-2.5" mesh the most effective.
    - Trialing use of parallel gill net sets but only in certain habitats.
- Sampling in Kettle Falls area
- This summer they will be using fyke nets, seine nets and high pressure angling (i.e. 16 rods out on one boat).
- Late summer boat electrofishing for juveniles.
- Bounty program ongoing - $10 per head return. Created a modified freezer for direct drop-off by anglers.
- Otolith geochemistry – all pike from the Kettle River
- eDNA being used to look at downstream distribution and introduction to new tributaries.
- Angler report of one pike observed downstream of Grand Coulee dam but unconfirmed.

**Spokane Tribe**

- Spokane River – previous indexing resulted in the capture of only 2 pike from Long Lake Reservoir; however, recent sampling for carp captured 162 pike in same areas.
- Most effective method for boat electrofishing was to run the boat through shallows (5-25 cm) with continuous power on, high voltage. Only successful during the day. Also bycatch rates are lower during the day.

**Washington Department of Fish and Wildlife**

- Cold early season water temperatures in 2017 resulted in reduced capture rates.
- Telemetry work ongoing – 10 tags out.
- Parallel gill-net sets might work for certain habitats.