Lake Roosevelt Northern Pike Suppression and Monitoring Plan 2018-2022

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Northern Pike Suppression Project Goal

The goal of the Northern Pike Suppression and Monitoring Project is to eradicate Northern Pike in the Lake Roosevelt watershed.

Project Objective

The long-term project objective is to:

- Reduce the abundance of Northern Pike to the point at which they are rarely observed - less than 1 Northern Pike/100 overnight gill net sets in reservoir-wide Northern Pike Monitoring Program gill net catch.

We acknowledge that this is an ambitious target that will take a number of years to achieve, so a series of interim targets were established to adaptively manage the suppression effort (i.e., inform the need to increase fishing effort or evaluate new approaches).

Interim Targets

- By 2020, reduce mean CPUE (number of Northern Pike/set) in the Northern Pike Monitoring Program gillnetting to 75% (25% reduction) of the 2018 baseline. The baseline will be determined from the Northern Pike Monitoring Program gillnetting conducted in 2018.
- By 2022, reduce mean CPUE Northern Pike Monitoring Program gillnetting to 50% (50% reduction) of the 2018 baseline.
- By 2024, reduce mean CPUE Northern Pike Monitoring Program gillnetting to 25% (75% reduction) of the 2018 baseline.
- By 2026, reduce mean CPUE Northern Pike Monitoring Program gillnetting to <1% (>99% reduction) of the 2018 baseline.

Project Strategy

The Northern Pike Suppression and Monitoring Project is designed to be consistent with the Northwest Power and Conservation Councils (NPCC) Fish and Wildlife Program Vision for the Columbia River through the strategies outlined in the Non-native and Invasive Species (NWPCC 2014; pg 46-48) and Predator Management (NWPCC 2014; pg 49-51) sections.

The Vision for the Columbia River "*is a Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife, supported by mitigation across the basin for the adverse effects to fish and wildlife caused by the development and operations of the hydrosystem"* is fully supported by the three co-managers of Lake Roosevelt as demonstrated by the Lake Roosevelt Guiding Document (2009).

The Lake Roosevelt Northern Pike Technical Team (hereafter Technical Team) used the NPCC Non-Native and Invasive Species and Predator Management Principles to develop and prioritize

activities to suppress Northern Pike in Lake Roosevelt. The Principles used to guide the development of the Suppression Strategy included: (1) detect the presence of invasive species early and respond rapidly; (2) educate the public; and (3) prevent, monitor, control, and stop or minimize the spread of non-native and invasive species that pose a threat to native fish (NPCC 2014; page 46 Principle #1).

The Lake Roosevelt Northern Pike Suppression Strategy objectives are to control the spread of Northern Pike within Lake Roosevelt and the Columbia River and educate the public regarding the threat posed by Northern Pike.

To control the spread of Northern Pike, the Technical Team will implement three suppression actions and four monitoring actions, which include: (1) spring gillnetting to remove adults during the pre-spawning and spawning period, (2) capture and remove both adults and juveniles in the summer/fall through gillnetting, fyke netting, seining and/or boat electrofishing, and (3) administer a Northern Pike Reward Program for anglers.

Monitoring actions include (1) a population and distribution status and trend monitoring to measure effectiveness of the suppression program within Lake Roosevelt, (2) microchemistry monitoring to understand spawning locations, distribution patterns, and other source populations that may immigrate to Lake Roosevelt, (3) eDNA monitoring for early detection of changes in distribution within and downstream of Lake Roosevelt, and (4) evaluation of reservoir operations to limit reproductive success or recruitment within Lake Roosevelt.

Public outreach is intended to ensure the public is properly informed of the planned activities and the reasons for those activities.

The suppression activities consume 82% of the budget, followed by the research activities (17%) and the Public Outreach activities (<1%) (Table 1). The 2015-2017 programs were implemented with a variety of funding sources (Table 2).

Table 1. Monthly work plan for research, suppression and public outreach tasks.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Research												
Relative Abundance Survey												
Microchemistry Study												
eDNA Study												
Harvest via Creel												
Suppression												
Adult Gillnetting												
Juvenile Electrofishing												
Reward Program												
Public Outreach												

Table 2. Northern Pike research work plan tasks by Agency.

Task	Year Began	Lead Agency	Who's Paying
Research			
Relative Abundance Survey	2015	WDFW	BPA/ATI/CCT
Microchemistry Study	2015	CCT	BPA
eDNA Study	2017	CCT	CCT/PUD's
Harvest via Creel	2011	STI	BPA
Suppression			
Adult Gillnetting	2017	CCT/STI	BPA/CCT/PUDs/BIA
Juvenile Electrofishing	2016	CCT/STI	CCT/PUD's/STI/BIA
Reward Program	2017	CCT	CCT/PUD's
Public Outreach	2016	CCT/STI/WDFW	All

Project History

The Lake Roosevelt co-managers have used an adaptive management approach to address the Northern Pike colonization of Lake Roosevelt. As Northern Pike observations became more frequent in research activities the co-managers identified the potential impacts of an established Northern Pike population and formed a Northern Pike Technical Team (NPTT) to develop a plan. In 2015, co-managers pooled resources to implement a pilot study to examine Northern Pike abundance and distribution. A request was made to Bonneville Power Administration's Budget Oversight Grout (BOG) under the Spokane Tribe of Indians' BPA Project No. 1994-043-00 to begin evaluation and reduction of the Northern Pike population. Three years of BOG funding was awarded and the co-managers developed a plan for monitoring and removing Northern Pike. Since 2015, co-managers have modified sampling efforts (timing, habitat, effort etc.), and utilized multiple gear types to improve Northern Pike removal efforts. After two years of natural recruitment and distribution more than 75 km downstream, it became apparent that substantially more effort was needed to control Northern Pike.

The co-managers agree that the ultimate goal is to eradicate Northern Pike from Lake Roosevelt. Understanding there is a seed population upstream and the colonizing population in Lake Roosevelt has experienced successful in-reservoir recruitment in recent years, the short-term goal is to reduce Northern Pike abundance and limit downstream distribution. The Kalispel Tribe of Indians and WDFW successfully reduced Northern Pike abundance in Box Canyon Reservoir (Pend Oreille River) with an on-going, aggressive mechanical removal project that began in 2012. Although these suppression efforts were highly successful at reducing Northern Pike abundance, project managers recognize the need for continued suppression to achieve long-term control over the population (Bean 2015). In 2016, the Kalispel Tribe of Indians and WDFW initiated removal efforts downstream in Boundary Reservoir on the Pend Oreille River.

The Northern Pike population in Boundary Reservoir is relatively small; however, it still poses risk to downstream resources via entrainment. In addition to Northern Pike suppression efforts within the US portion of the Upper Columbia Basin, managers in British Columbia, Canada initiated removal efforts in the mainstem Columbia River below Hugh Keenleyside Dam in 2014 (Baxter and Doutaz 2016). Removal efforts have continued annually and researchers have had some success removing Northern Pike; however CPUE has remained consistent across years and natural reproduction is suspected to be occurring within Canadian waters.

In light of the successful establishment of Northern Pike in the US portion of the Upper Columbia Basin, the Lake Roosevelt co-managers have initiated efforts to address the expanding Northern Pike population at an early stage in colonization; however, the size of Lake Roosevelt and complex hydro-operations present substantial challenges. The co-managers understand that controlling, and potentially eradicating, the Northern Pike population will require a rigorous removal effort that is closely monitored to provide adaptive recommendations.

Scope of Work

1.0 Monitoring

1.1 Northern Pike Population Monitoring (WDFW)

Goal: Monitor changes in abundance and distribution to evaluate and inform suppression efforts.

A flow chart has been constructed to illustrate the adaptive management process utilized in the development of the monitoring study design and integration with suppression efforts (Figure 1).

The Lake Roosevelt co-managers examined the utility of the Fall Walleye Index Netting (FWIN) survey for monitoring Northern Pike abundance in Lake Roosevelt. Weist and Weist (2017) examined the 2014 and 2016 Lake Roosevelt FWIN data and suggested a modification to the survey to include more sites that likely contain Northern Pike. Subsequently, the co-managers conducted a post-FWIN sampling effort throughout Lake Roosevelt (rkm 960-1,160). The survey utilized standard FWIN nets [61.0 X 1.8 m; 8 (7.6 m) panels (25, 38, 51, 64, 76, 102, 127 and 152 mm stretch mesh)] and an aerial GRTS design, with modification to the FWIN depth criteria (all nets <15.2 m). An issue with the GRTS draw resulted in a high proportion (43%) of the nets that exceeded the target maximum depth. Increased effort at shallower water depth resulted in higher Northern Pike CPUE than during the FWIN survey; however, Northern Pike CPUE was still relatively low, and they comprised a low proportion of the overall catch (2.9%). An evaluation of depth at capture revealed that the majority of Northern Pike (98.0 %) were captured at depths ≤12.2 m. Conversely, a large proportion of the bycatch was captured at depths >12.2 m (Burbot 63%, native sucker spp. 72%, Mountain Whitefish 66.7%, White Sturgeon 100.0%, and Walleye 45.0%).

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efforts to address the expanding Northern Pike population at an early stage in colonization; however, the size of Lake Roosevelt and complex hydro-operations present substantial challenges. The co-managers understand that controlling, and potentially eradicating, the Northern Pike population will require a rigorous removal effort that is closely monitored to provide adaptive recommendations. A flow chart has been constructed to illustrate the adaptive management process utilized in the development of the monitoring study design and integration with suppression efforts (Figure1).

Abundance estimates derived from mark-recapture abundance studies are useful for gauging the level of removal necessary to achieve population reduction. Mark-recapture abundance estimates were generated for Northern Pike upstream in Box Canyon Reservoir, and in the Robson Reach of the Columbia River in British Columbia, Canada, during early evaluation of Northern Pike populations, prior to initiation of suppression. Conducting a mark-recapture experiment to estimate the Northern Pike population in Lake Roosevelt would require tagging and releasing a substantial number of fish back into the water. Given the need to begin reducing Northern Pike abundance in Lake Roosevelt immediately (to prevent the colonizing population from becoming established throughout the reservoir and to limit downstream movement), release of Northern Pike to produce an abundance estimate would be counter-productive. It is, therefore, assumed that CPUE in monitoring surveys will be representative of Northern Pike abundance in Lake Roosevelt.

Monitoring Plan: A spring and fall survey will be conducted to determine the optimal season for monitoring the Northern Pike population. Metrics for the seasonal comparison include CPUE (fish/net), proportion positive catch (proportion of nets with Northern Pike; PPC), percent species composition, and bycatch mortality. Biological data collected to characterize the Northern Pike population includes total length (TL), weight, sex and maturity. The results of the 2018 seasonal surveys will provide baseline indices of the Northern Pike population for comparison with future monitoring results. Power analysis will be conducted to determine the number of nets necessary to detect a 25% change in CPUE with 80% confidence in the Kettle Falls study area. The analysis will be used to determine the initial effort for Northern Pike population monitoring to be initiated in 2019.

2018 Spring Survey: Conduct a spring Northern Pike survey in The Kettle Falls study area with BPA 1994-043-00 BOG funding. The Spring Pike Index Netting (SPIN) net design [45.7 X 1.8 m; 5 (9.1 m) panels (51, 64, 76, 89 and 102 mm stretch mesh)] will be used and nets will be set perpendicular to flow with the small mesh near shore. The survey will employ a General Random Tessellation Stratified (GRTS) sampling strategy with an equal sample design according to protocols outlined in BOG Request #533, under BPA contract 69860, with slight modification. Previous spring surveys were initiated when the reservoir approached a targeted elevation of 387 m amsl prior to the annual spring drawdown. Additionally, initial netting efforts (2015-2017) utilized daytime net sets (four hour duration) to minimize bycatch mortality, similar to surveys conducted by Baxter (2016). As a result of using elevation as a trigger to initiate spring sampling, the 2017 survey was conducted when water temperatures were ≤2.2°C and Northern Pike CPUE was low. Northern Pike CPUE increased substantially with water temperature during subsequent netting efforts. Although the subsequent netting efforts were targeted (as opposed to random), CPUE was higher at locations that were previously sampled during the random

survey. Netting efforts throughout the year continued to exhibit increased CPUE compared to the early spring survey and previous years, suggesting that low temperature during the spring 2017 survey had an adverse effect on Northern Pike CPUE. Co-managers implemented overnight net sets during some targeted removal efforts in 2017. Northern Pike catch rates were greater in overnight sets during spring targeted surveys compared to daytime sets. Additionally, abundance of bycatch and bycatch mortality was low during the spring in both daytime and overnight net sets. Therefore, the 2018 spring survey will commence when water temperatures are >4°C and gill net soak time will be increased from four hours to overnight sets.

Biological data collected on Northern Pike includes total length, weight, sex, and maturity. CPUE will be calculated as a measure of abundance including standard error (SE) and 80% CI. PPC will also be calculated as a measure of abundance to account for potential bias associated with a disproportional relationship between CPUE and stock abundance (hyperstable or hyperdepletive). Age determination of Northern Pike will be conducted through cleithra analysis. Cleithra will be collected from up to ten samples for each 50 mm TL bin ($n \leq 150$). If additional samples are needed, they will be collected from within the study area during subsequent targeted/suppression efforts within one month of the monitoring survey. Samples will be processed and sent to the WDFW Ageing laboratory for analysis. An age-length key will be constructed to assign ages to unaged fish captured during the monitoring survey. Age-length frequency distribution will be examined to identify changes in age composition and growth over time. Relative weight (Wr) will be calculated as a measure of condition. Gill net mesh size in which Northern Pike are captured will be recorded to aid co-managers with the development of a Northern Pike specific suppression net. Bycatch will be measured for TL, weighed and disposition recorded (alive or dead).

2018 Fall Survey: Conduct a fall Northern Pike survey in the Kettle Falls study area. The survey will follow the established protocols used in the 2018 spring survey.

Monitoring Objectives for 2018:

1. Conduct Spring and Fall survey to determine the best season for monitoring Northern Pike in Lake Roosevelt.
2. Calculate Northern Pike population abundance indices (CPUE, PPC).
3. Collect biological data on Northern Pike to characterize the population including: total length, weight, sex and maturity.
4. Conduct Northern Pike age analysis.
5. Determine amount of effort necessary to detect a 25% change in Northern Pike CPUE with 80% confidence to guide initial 2019 monitoring efforts.
6. Evaluate percent species composition and bycatch mortality.
7. Develop a reservoir wide GRTS survey design to monitor Northern Pike.

2019-2022 Monitoring Surveys: The study area for Northern Pike monitoring surveys (2019-2022) was expanded from initial pilot studies and defined as the area of Lake Roosevelt from

Grand Coulee Dam to Snag Cove (rkm 960 to 1,150) (Figure 2). The study area was divided into two reaches (Upper and Lower) based on abundance and distribution observed in previous surveys. The Upper Reach (rkm 1,080-1,150; including the lower 10 km of the Kettle River) was identified as the core area of colonization, exhibiting higher CPUE with less variability. The Lower Reach (rkm 960-1,080, including the Sanpoil and Spokane arms) has yielded few Northern Pike observations.

The monitoring plan will incorporate a linear GRTS sampling design and utilize the SPIN net design, similar to pilot monitoring efforts. Northern Pike primarily prefer shallow near shore habitat (Diana et al. 1977; Cook and Bergerson 1988; Chapman and Mackay 1984; Banach 1989). Similar to previous investigators, the majority of Northern Pike in Lake Roosevelt have been captured in near shore net sets at depths ≤ 12.2 m. Although Northern Pike have been captured offshore in deeper water, offshore sets typically catch fewer Northern Pike. Only five of 26 Northern Pike captured in the 2017 FWIN survey were captured in offshore net sets >12.2 m deep. The 2017 post-FWIN survey had similar results, with the majority of Northern Pike captured in near shore sites in depths ≤ 12.2 m. Sites will be randomly selected for the study area along a shoreline bathymetric contour according to the following criteria: maximum depth ≤12.2 m, slope ≤23.9°. Depth criteria was derived from the literature and from the results of previous surveys on Lake Roosevelt. The gradient was selected to ensure depth criteria was not exceeded. Sample size (number of net sets) in the Upper Reach will be derived from power analysis conducted on the 2018 sampling conducted during the appropriate season. The sample size in the lower reach will initially be set at half of the sample size in the Upper Reach. Due to the low CPUE of Northern Pike in the Lower Reach, initial surveys will be conducted to detect changes in spatial distribution and PPC. If PPC exceeds 20%, power analysis be conducted to evaluate the level of effort necessary to track changes in CPUE, similar to the Upper Reach. Monitoring in the lower reach will commence upon completion of monitoring efforts in the Upper Reach.

WDFW will consult with a qualified biometrician to develop a tool for site selection and data analysis. Analysis of CPUE and PPC will be conducted separately for the Upper and Lower reaches to reduce variability associated with differences in abundance and distribution. Northern Pike biological data collection will be consistent with the 2018 surveys. In addition to measures of abundance, biological data will be used to examine changes in age/size structure and relative weight (Wr) as a measures of condition and growth.

WDFW will consult with a biometrician to conduct an annual review of the monitoring results. Recommendations will inform the co-managers of the efficacy of monitoring and suppression efforts and provide direction for future actions.

Objectives for Monitoring Surveys (2019-2022):

1. Conduct a reservoir wide survey to evaluate abundance metrics for Northern Pike (CPUE, PPC).
2. Determine if the monitoring effort is sufficient to detect a 25% change in CPUE with 80% confidence.

3. Evaluate CPUE to determine if reduction goals are being met in the Upper and Lower reaches (25% reduction every two years until CPUE < 0.01 NP/net).
4. Evaluate PPC to determine if reduction goals are being met in the Upper and Lower reaches (25% reduction every two years until PPC <0.01).
5. Collect biological data on Northern Pike to characterize the population including: total length, weight, sex and maturity.
6. Conduct Northern Pike age analysis.
7. Provide recommendations to co-managers regarding the level and spatial distribution of suppression effort.

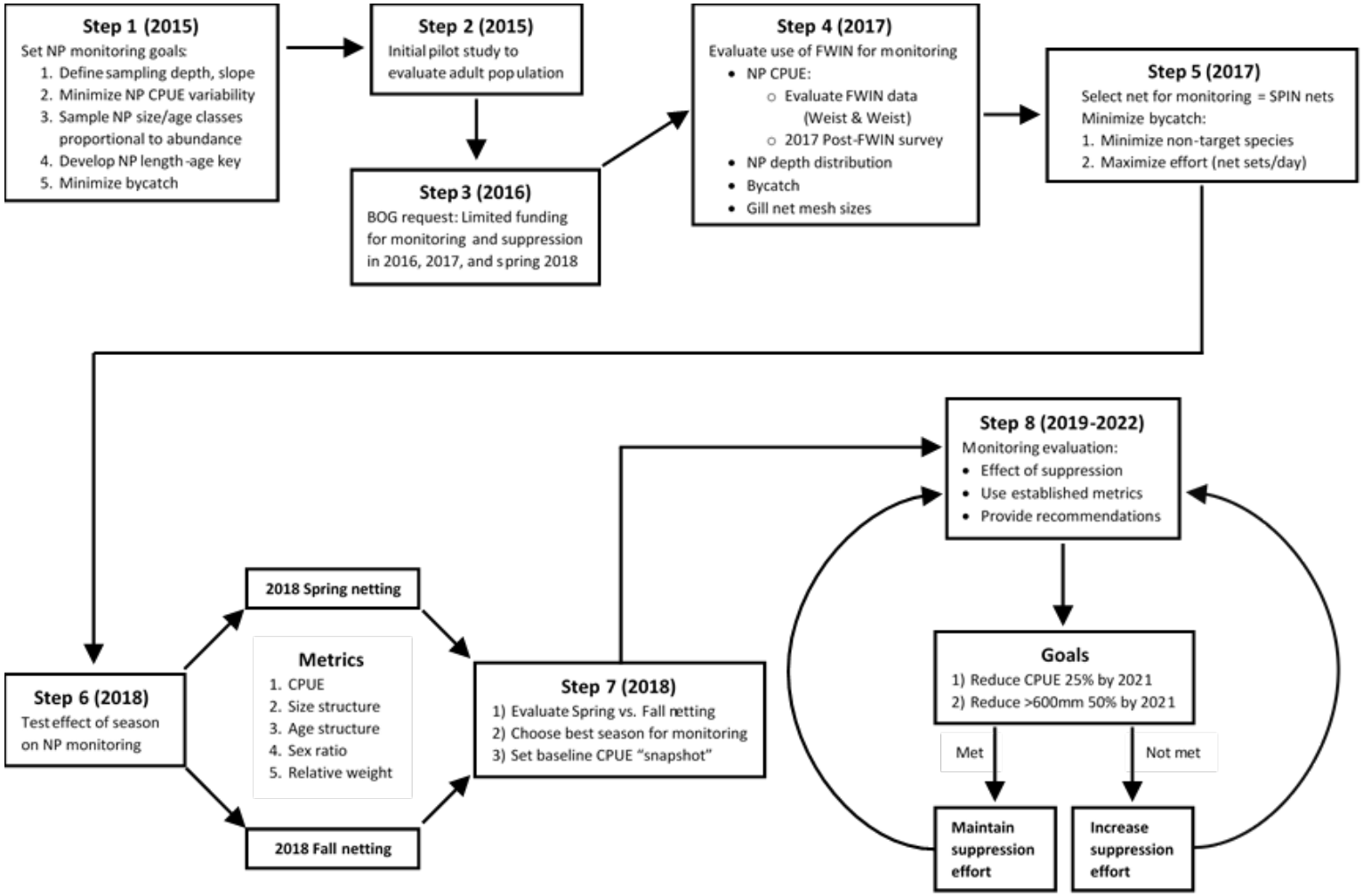


Figure 1. Adaptive management steps for Northern Pike Monitoring in Lake Roosevelt.

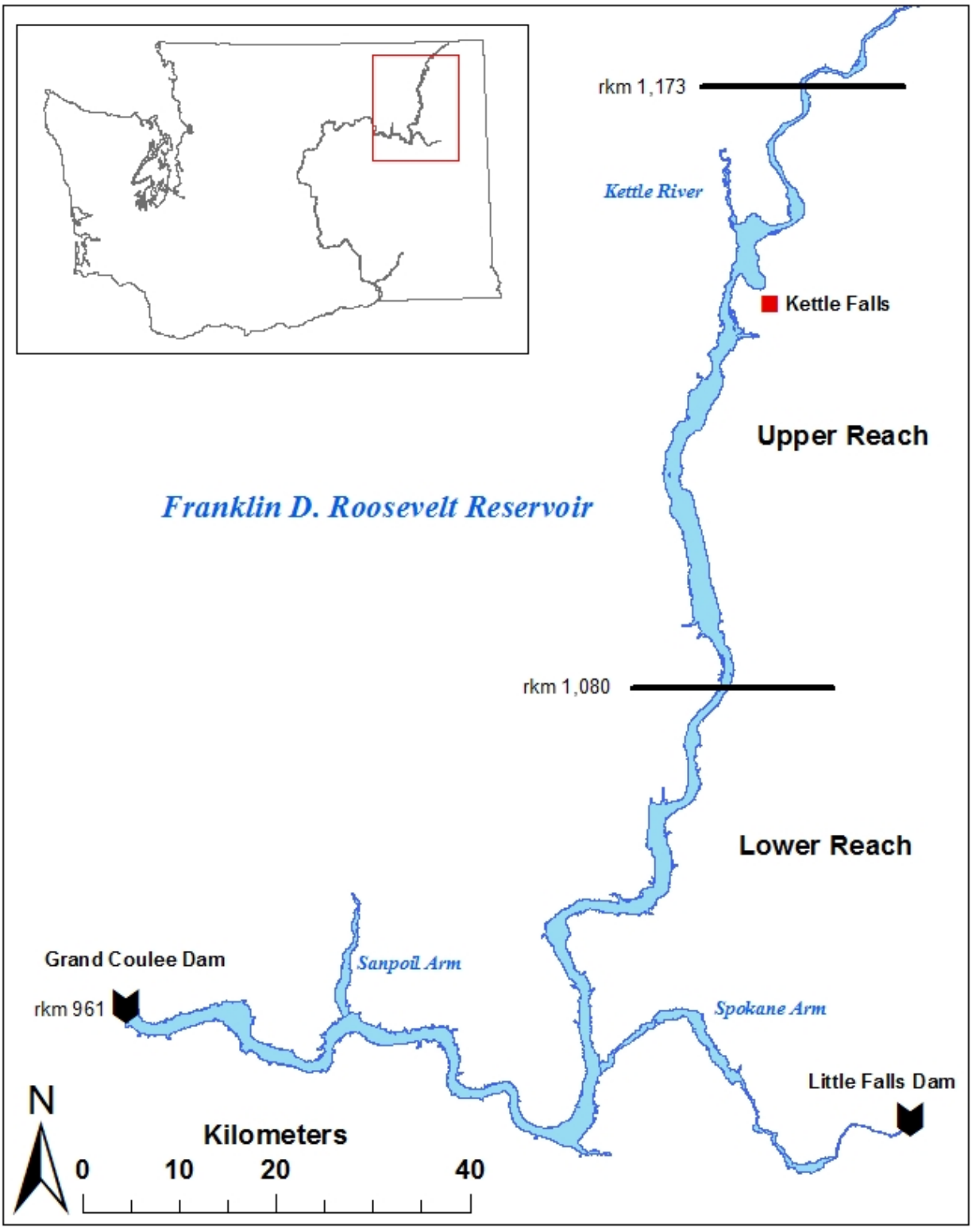


Figure 2. Map of Franklin D. Roosevelt Reservoir Northern Pike study area (2018).

1.2 Northern Pike Natal Origin Monitoring (CCT Lead)

Goal: Use otolith microchemistry techniques to determine if new invasions are occurring from upstream waters and to identify spawning locations to assist with adapting the suppression project should the Northern Pike population continue to expand.

The origin of the first Northern Pike to invade Lake Roosevelt and the upper Columbia River (British Columbia) is unknown, although it is hypothesized that they entrained from upstream source populations in the Pend Oreille River, principally Box Canyon Reservoir. Support for this hypothesis is the previous establishment of a Northern Pike population in Box Canyon Reservoir which joins to Columbia River upstream of Lake Roosevelt. A Northern Pike population also occurs in Lake Spokane, a Spokane River reservoir located upstream of Lake Roosevelt; however, it seems unlikely that the Lake Spokane population was the source population due to historically low catch of Northern Pike in the Spokane Arm of Lake Roosevelt and the distance between the Spokane Arm and Kettle Falls - the high density Northern Pike area in Lake Roosevelt. As the abundance of Northern Pike increased in Lake Roosevelt, as evidenced by increased catch in routine research sampling and the recreational fishery, fish managers began to question the source. Specifically, managers were interested in determining if Northern Pike were coming from upstream source populations in the Pend Oreille River, the newly established population in the upper Columbia River in British Columbia, or from fish that were spawning within Lake Roosevelt or its tributaries.

In 2016 -2017, CCT contracted with Pacific Northwest Laboratories (PNNL) to investigate Northern Pike stream origin using microchemistry techniques to determine if Northern Pike were populating Lake Roosevelt from upstream waters, or if they were naturally reproducing in Lake Roosevelt or one of its tributary rivers. To identify natal origin, the geochemical composition of 80 otoliths (40 adult and 40 juveniles) from Northern Pike captured in the reservoir and adjoining tributaries (Kettle and Colville rivers) were compared to chemical analyses of seasonal water samples collected from 45 sites throughout the basin from 2014-2016 (Wolvert et al. 2017) (Figure 2.). This research demonstrated wide variation in the elemental (e.g. Sr/Ca, Ba/Ca and isotopic $^{87}Sr/^{86}Sr$) signatures of water in the reservoir and adjoining tributaries (Linley et al. 2016; 2017; 2018 *in draft*), which were taken up in the otoliths of Northern Pike providing a map of their spatial life history, natal origins, and rearing habitat(s).

For example, the mean $^{87}Sr/^{86}Sr$ values from the six major tributaries (Kettle River, Colville River, Sanpoil River, Pend Oreille, Coeur d Alene Lake, Spokane River) vary widely (Figure 3). These rivers drain geologic formations of widely differing age and composition (Cascade and Rocky Mountains, respectively), which resulted in a general pattern of lower $^{87}Sr/^{86}Sr$ in watersheds west of Lake Roosevelt and higher $^{87}Sr/^{86}Sr$ in watersheds to the east (Figure 3).

The results from otolith $^{87}Sr/^{86}Sr$ analysis indicated five distinct life history patterns based on adult and juvenile samples collected in Lake Roosevelt (Figure 2). The majority of adult Northern Pike captured at Singers Bay, Evans, and Marcus sites (mainstem Columbia River near the Kettle River) fell into one group. These fish had otolith core and early life history $^{87}Sr/^{86}Sr$

values indicative of the Kettle River, but moved into higher $^{87}Sr/^{86}Sr$ water later in life, suggesting movement into Lake Roosevelt.

The juvenile Northern Pike collected in the Kettle River all had otolith core values suggestive of Kettle River origin. However, juveniles captured in Lake Roosevelt had otolith core values indicative of a natal origin that approximated the $^{87}Sr/^{86}Sr$ of the Columbia River (0.71448) (Figure 4; graph #5). It is unclear if the mainstem spawning fish originated in the Columbia River, upstream of Lake Roosevelt (Canada), or from spawning locations within Lake Roosevelt.

The 2016-17 analysis was limited to a small geographic area and did not include samples from the upper reaches of Lake Roosevelt (upstream of China Bend), or from areas where Northern Pike have subsequently been captured downstream of the Kettle Falls area including the Spokane Arm. With the exception of the small area near Kettle Falls, the relative contributions of Northern Pike from spawning areas within Lake Roosevelt and its tributaries including the upper Columbia River in British Columbia are unknown. Knowledge of the contribution by source spawning area will allow for strategic implementation of suppression effort. For example, if contributions from upstream source populations are relatively small, then suppression effort should be maximized in spawning and natal rearing locations.

In order to ensure the suppression program is implemented appropriately, it is necessary to have a clear understanding of entrainment from upstream waters (Pend Oreille River, the Columbia River in Canada, and the Spokane River) and awareness of spawning locations within Lake Roosevelt.

Management Question

What are the relative contributions of Northern Pike from spawning areas within Lake Roosevelt and its tributaries, including the upper Columbia River in British Columbia?

Research Hypotheses

Hypothesis #1: Northern Pike are not contributing to the Lake Roosevelt population from upstream waters, including the Pend Oreille River, Columbia River in Canada, and the Spokane River.

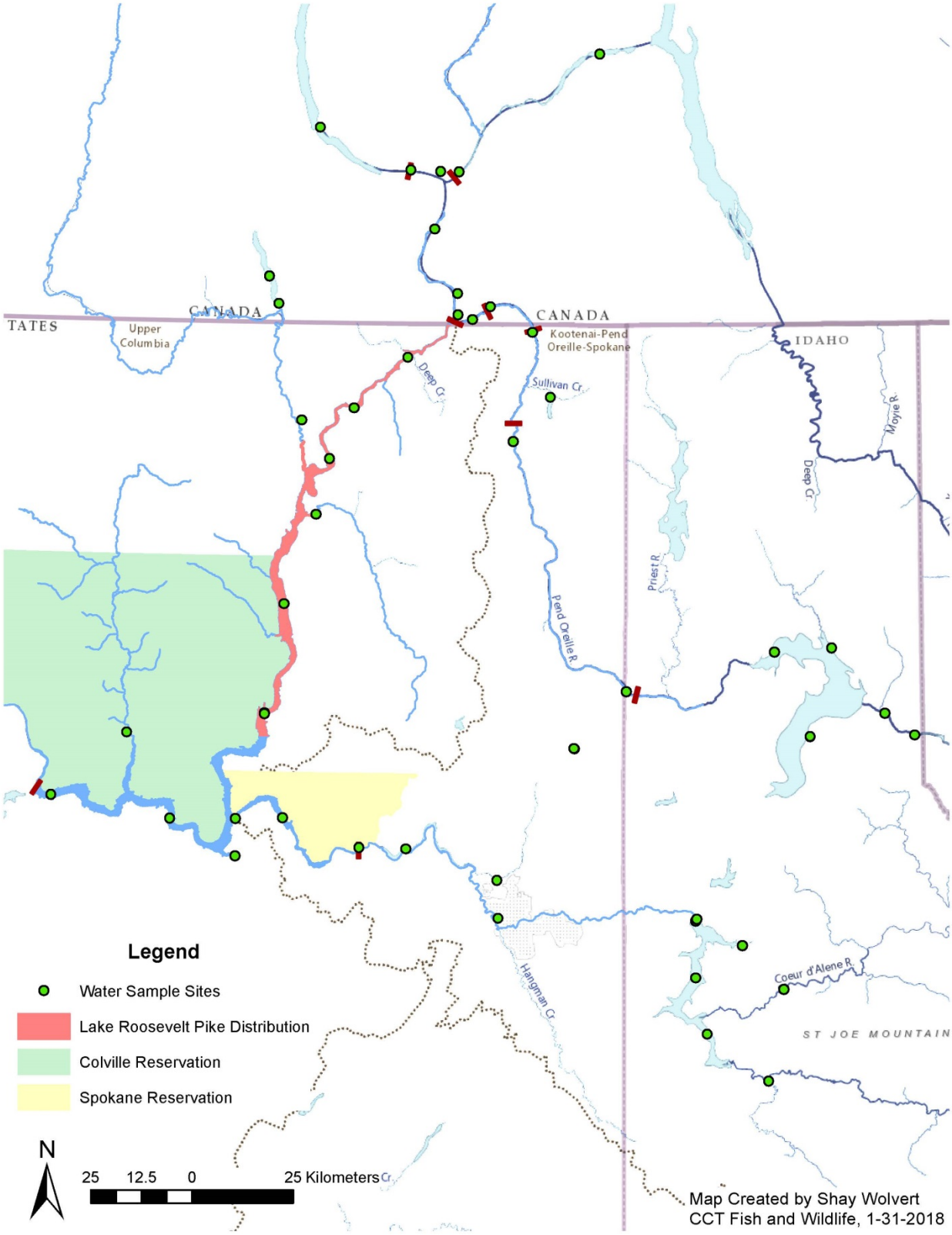


Figure 3. Water chemistry samples (n = 45) sites used for the Northern Pike microchemistry study.

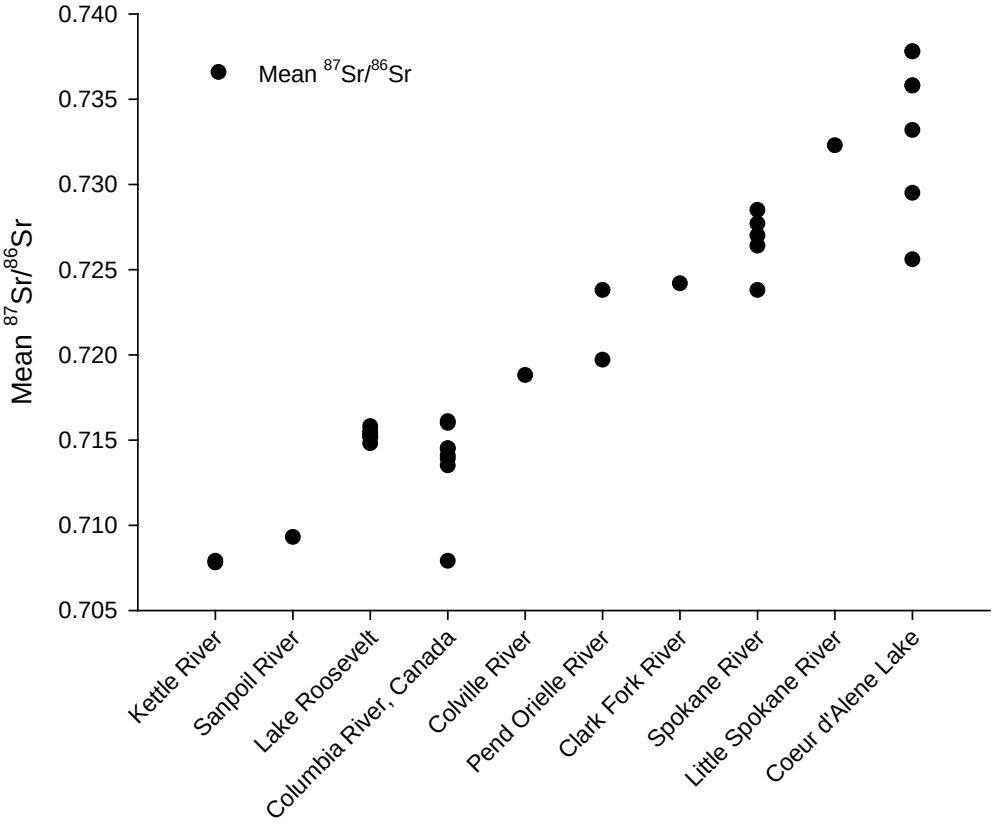


Figure 4. Mean 87Sr/86 Sr water chemistry values for tributaries that drain into Lake Roosevelt from the west (Kettle River and Sanpoil rivers), Lake Roosevelt, tributaries that drain from the east (Colville River, Spokane River, Little Spokane, Coeur d'Alene Lake), and rivers that enter from the north (Columbia River in Canada, Pend Oreille and Clark Fork rivers).

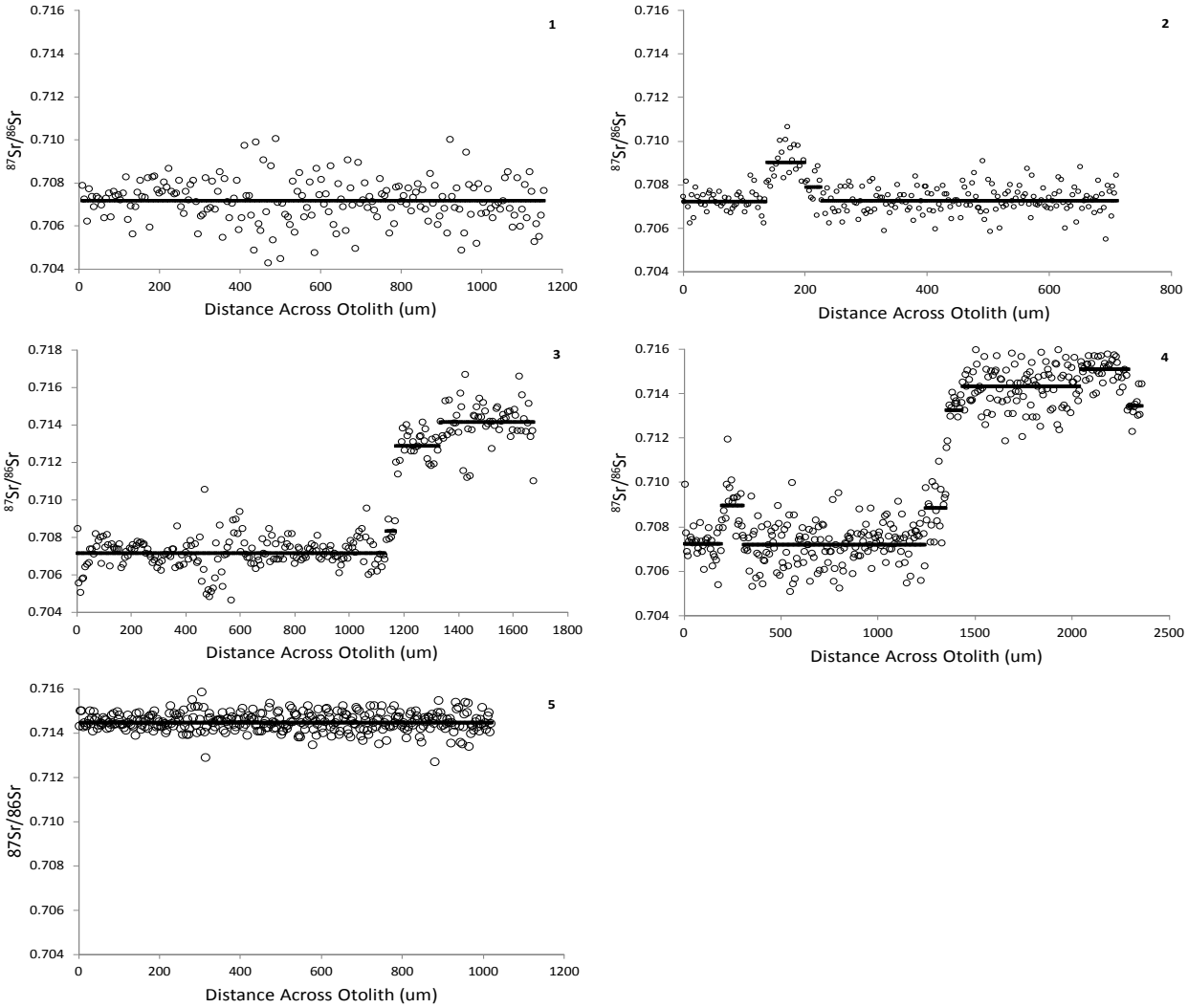


Figure 5. Representative life history patterns among adult and juvenile Northern Pike captured in Lake Roosevelt and the Kettle River. Patterns described in the text are numbered in upper right corner: (1) adult, (2) juvenile, (3) adult, (4) adult, and (5) juvenile Northern Pike. X-axes scaled to otolith width.

Experimental Design,

Otolith and Cleithra Analysis: It is currently unclear if Northern Pike are entering Lake Roosevelt from upstream waters (i.e Pend Oreille River, the Columbia River in Canada and Spokane River). To address this question, up to 50 Northern Pike a year collected in collected in areas of potential entrainment or from new locations outside the core area will be analyzed for origin and general movement patterns using microchemistry techniques (Figure 5). These include Northern Pike collected upstream of China Bend, downstream of Hunters, the Spokane Arm of Lake Roosevelt, and the Sanpoil Arm of Lake Roosevelt.

All age classes will be sampled. The samples will be analyzed for $^{87}Sr/86^{Sr}$ and various element/Ca ratios including Sr/Ca and Ba/Ca. Northern Pike collected upstream of China Bend that are found not to be from the Pend Oreille will have further analysis conducted on the cleithra for heavy metals such as Zn, Cd and Cr that are products of the discharge from Teck Cominco near Trail, B.C. Cleithra will be analyzed for the industrial metals as metals are more readily taken up in bone than in otoliths.

Northern Pike that originated in the Columbia River downstream of the smelter should have heavy metal signatures near the natal rearing portion of the cleithra. Northern Pike that originated in the Columbia River upstream of the smelter should not have heavy metal signatures near the center of the cleithra.

Northern Pike collected in tributaries of Lake Roosevelt will be tested for origin and general movement patterns. This information will assist researchers with determining if the downstream distribution is resulting from reproduction in the primary known spawning location (Kettle River) or from other locations. This information will be used to prioritize suppression netting.

Water Samples: The water chemistry anomaly detected in the Northern Pike life history 2 and 4 (Figure 2), that indicated a slight bump in $^{87}Sr/86^{Sr}$ is not clearly understood, but most likely a result of the reservoir refilling during the spring. The general mixing zones from the major rivers is currently not represented in the water chemistry database. The project would benefit from adding two sites to each of the major river influence areas (Kettle River, Colville River, Spokane River, Sanpoil River), as well as a dedicated site in the Kettle River bay (suspected spawning location). These 10 sites would be sampled twice a year (20 total samples).

Methods

Cleaned otoliths and cleithra will be sent to the PNNL laboratory in Richland, WA by August 31 of each year. Otoliths will be prepared for inductively coupled plasma mass spectrometry (ICP-MS) using established methods (similar to Secor et al. 1992). Briefly, otoliths will be attached sulcus side up to glass slides with thermoplastic glue (Crystal Bond 509) and polished with successively finer grit silicon carbide paper to reveal the otolith core. Laser ablation for otolith $^{87}Sr/^{86}Sr$ will be performed using an Nd:YAG 213 nm wavelength laser (Electro Scientific Industries) coupled to a NuPlasma II multi-collector IPC-MS. Prior to data collection, a cleaning pass across the area of interest in the otolith will be conducted by ablating with a low power setting (10% power) and a wide beam (100µm). All otoliths will be quantified for $^{87}Sr/^{86}Sr$ by ablating a 30 µm wide laser beam at a rate of 6 µm per second (100% power, repetition rate of

10 Hz) across the growth axis from a point immediately ventral to the core to the dorsal edge. The ablated material will be introduced with a gas mixture of ultra-high purity helium (0.5 L/min) and argon (0.4 L/min). Cleithra will be sectioned with a Buehler Isomet 1000 saw, then cleaned and polished in a manner similar to the procedures for otoliths for analysis by ICP-MS.

The $^{87}Sr/^{86}Sr$ ratio will be determined following standard procedures to remove potential interferences from krypton (Kr) and rubidium (Rb). Logarithmic correction of the measured $^{86}Sr/^{88}Sr$ to 0.1194 will be applied to account for instrument mass fractionation. An in-house marine coral standard will be analyzed after every 10-15 samples to check for instrument drift and determine if the accepted value of 0.70918 of $^{87}Sr/^{86}Sr$ for modern seawater will be obtained within 2 standard errors.

Element/Ca ratios for otoliths and cleithra will be analyzed similarly by laser ablation except the laser was coupled to a Thermo Fisher X-Series ICP-MS. These otoliths will be re analyzed for Sr, Ba and Ca concentrations and the results will be expressed on a molar basis relative to Ca as an internal standard in mmol/mol. Cleithra will be similarly analyzed for Sr, Ba, and Ca, but also for Zn, Cd, U, and Cr.

Water samples will be prepared for $^{87}Sr/^{86}Sr$ analysis following the procedures described in Linley et al. (2016). Water samples will be collected in 120 mL plastic sampling bottles lined with Teflon. The bottles must be sterilized with Optima nitric acid and Milli-Q water (under a class 100 hood). The collection jar is filled with water 6-12 inches below the surface. The sample is preserved with two drops of 15M nitric acid within 24 hours of collection. The preserved samples are shipped to PNNL after the full array has been collected.

The samples will be filtered through PFA (1-2 µm) membranes, dried over low heat, and treated with alternating treatments of ultra-high purity 15M nitric acid and 30% hydrogen peroxide to dissolve organic matter. After re-suspension in 2 M HCl, the samples will be loaded onto Biorad 50W-x8 cation exchange columns and eluted with 6 M HCL to capture the available Sr. All sample preparation and column chemistry will be performed in a class 1000 clean lab, under a class 100 laminar flow hood, and analyzed by a multi-collector ICP-MS (Nu Plasma II, Nu Instruments).). All water samples will be analyzed for $^{87}Sr/^{86}Sr$, Sr, Mg, Ca, Ba, Mg, Zn, Cd, U, and Cr and expressed relative to Ca in mmol/mol.

Data Analysis

The mean natal zone (otolith core), early and late rearing (otolith edge) signatures for $^{87}Sr/^{86}Sr$, and element/Ca ratios will be determined by regression tree analysis. Details are described in Linley et al. (2016). Briefly, each otolith will be first fit with a regression tree model to identify distinct shifts in $^{87}Sr/^{86}Sr$ (Python 3.6.1) indicative of movement between habitats (i.e. reservoir and tributary). Autocorrelations within each series will be identified prior to model fitting and ameliorated using auto-regressive (AR), moving average (MA), and combination ARMA models with the greatest Akaike Information Criterion (AIC) weight. The model-predicted values of $^{87}Sr/^{86}Sr$ will be partitioned into mutually exclusive groups that were homogeneous as possible with the response ($^{87}Sr/^{86}Sr$) and predictor (distance from the otolith core) values. The predictor variable (i.e., distance) for each group will be separately split by maximizing the LogWorth significance value (i.e., the negative log of the adjusted *P* value) for each split

candidate (Sall 2002). The minimum homogenous group size will be set to *N*=5 and the adjusted *P* =0.01 will be selected to partition the $^{87}Sr/^{86}Sr$ ratios into homogeneous partition groups without overfitting. Plots of otolith $^{87}Sr/^{86}Sr$ will be visually inspected to identify splits that most closely approximated shifts between life stages. The values within these splits will be used to derive the mean $^{87}Sr/^{86}Sr$ for the otolith core, early, and adolescent or adult rearing periods in the reservoir.

Strontium isotope ratios for otolith samples will be tested for normality and transformed (log 10) if needed to meet this assumption. Differences among basins or sites within basins for surrounding watersheds will be compared using analysis of variance (ANOVA) and Tukey-Kramer (HSD) or ANOVA by ranks (e.g., Kruskal-Wallis).

Water samples collected during the Linley et al. (2016) study and Northern Pike otoliths will be used to calculate partition coefficients [D = (element/$Ca_{otolith}$) / (element/Ca_{water})] for Sr and Ba to determine if the Northern Pike captured in Lake Roosevelt may have originated from Norn's Creek (near Castlegar, British Columbia), which has water $^{87}Sr/^{86}Sr$ approximating that of the Kettle River. The coefficients will be calculated from the otolith core and water Sr/Ca and Ba/Ca averaged across each of the various basins sampled for Northern Pike.

Reporting: An annual report will be provided to CCT by February 1 of each year to be included as an Appendix in the co-managers annual report.

Adaptive Management Framework

This information will be provided to regional managers to support Northern Pike suppression efforts. Specifically, to determine if suppression activities need to expand to include upstream areas from China Bend to the Canadian border, the Spokane Arm of Lake Roosevelt and/or any other new location, including new spawning locations. This information will be provided to regional managers if it is discovered that Northern Pike are entraining into Lake Roosevelt from upstream waters bodies including the Columbia River in Canada, Pend Oreille, Spokane River, or Coeur d'Alene Lake.

Budget:

- 50 otoliths/per year analyzed for $^{87}Sr/^{86}Sr$ and elements. $230/otolith x 50 = $11,500
- 10 otoliths and 10 cleithra analyzed for heavy metals. $200/structure x 10 structures = $2,000
- 24 water samples x $ 325/water sample = $7,800
- Analysis and report: $10,000

Total estimated budget: $31,300

Monitoring Methods Protocol:
https://www.monitoringresources.org/Document/Protocol/Details/3282

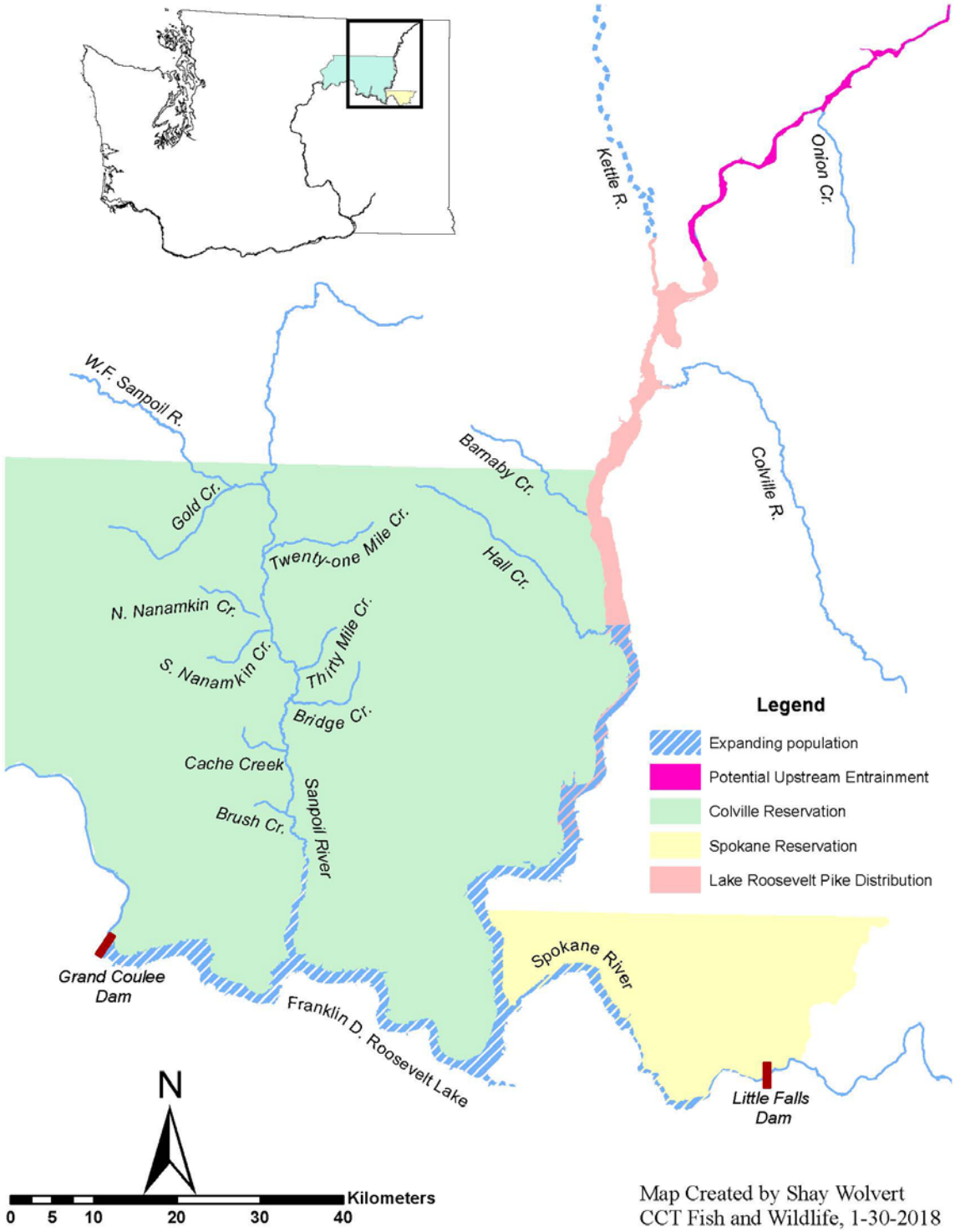


Figure 6. Map of Lake Roosevelt with areas of concern for entrainment potentail and further expansion.

1.3 Northern Pike Early Detection Monitoring - eDNA (CCT Lead)

Goal: Use eDNA as an early detection tool for monitoring the distribution of Northern Pike in the Upper Columbia River watershed.

Environmental DNA (eDNA) is DNA that have been released by an organism into its environment and can be detected in the air, water, or soil. In aquatic systems eDNA has been shown to provide a sampling approach that is sensitive enough to detect species presence or absence and can be performed rapidly and efficiently (Laramie et al. 2015; Carmin et al 2016).

Environmental DNA has recently emerged as a powerful tool for detecting aquatic animals in low abundance (Dunker et al. 2016). The National Genomics Center for Wildlife and Fish Conservation (NGC) has developed taxon specific eDNA assays for a number of native fish species including Bull Trout *Salvelinus confluentus* , Westslope Cutthroat Trout *Oncorhynchus clarkii*, and Chinook Salmon *Oncorhynchus tshawytscha* as well as non-native species such as the Northern Pike *Esox Lucius* (Laramie et al. 2015; Carmin et al 2016).

Invasive Northern Pike are suspected to have migrated from the Clark Fork river system in Montana, downstream to the Pend Oreille River, and now into the upper reaches the Columbia River in the United States. Northern Pike were first captured in standardized fishery surveys in Lake Roosevelt in 2007 when a single fish was captured in a gill net at Alder Creek (rkm 1058.5) (Lee et al. 2010). Subsequently, Northern Pike have been captured in increasing numbers during various fisheries surveys (King and Lee 2016; Seibert et al. 2015; Blake et al. 2015) in the upper reaches of Lake Roosevelt, near Kettle Falls, Washington.

In 2017, the distribution of Northern Pike in Lake Roosevelt increased and are now found consistently from Hunters, Washington (rkm 1071.7) upstream to the Canadian border (rkm 1205.4), including the lower 14.7 km of the Kettle River, to Napoleon Bridge and the lower 0.5 km of the Colville River (Figure 6).

Currently, it is unknown how far up the Kettle River Northern Pike are distributed. Anecdotal information from anglers indicates Northern Pike have disturbed upstream to the Canadian border with one angler reporting to have observed a Northern Pike in Christina Lake, British Columbia (drains into the Kettle River). The Kettle River upstream of the Napoleon Bridge is riverine and shallow and not conducive to motorized boats, making it difficult to. Before investing in gear that can be used to capture Northern Pike effectively in the upper Kettle River and expending additional sampling effort, it is more cost-effective to investigate distribution using relatively inexpensive eDNA techniques.

Similar to the Kettle River, Northern Pike distribution within the Colville River is unknown and is difficult to sample with available gear. The Colville River is another location where a confirmation of Northern Pike presence would be preferable before investing in new gear and expending additional sampling effort.

The current suppression effort is only focused in the current distribution area (form Hunters upstream to the Canadian border). The monitoring program will be conducted reservoir-wide, but the probability to detect Northern Pike in low densities is unknown. The combined approach of monitoring with gill nets (including other standardized surveys, such as FWIN) and

eDNA is assumed to increase the chances of detecting a range expansion. In addition, they provide validation for each other. When Northern Pike increase their distribution the suppression effort will have to be adapted to include new areas.

The expansion of Northern Pike downstream of the current locations and possibly into new water bodies with ESA listed salmonids is of extreme concern to fisheries managers. Expansion into Banks Lake, which feeds the Columbia River Basin Reclamation Area, would have monumental consequences to the current fisheries and will likely lead to more rapid expansion to other areas of the Columbia River Basin. The habitat throughout the Columbia Basin Reclamation Project is conducive to supporting Northern Pike populations. If Northern Pike establish a foothold, it would nearly impossible to eradicate them. As such, eDNA may provide a low cost method for early detection of Northern Pike in waterbodies of concern downstream of Lake Roosevelt. Early detection will be key to addressing Northern Pike expansion before they have the ability to establish strong populations.

Research Objectives (Question):

- Question #1: What is the distribution of Northern Pike within the Kettle River upstream of Barstow Bridge?
- Question #2: What is the distribution of Northern Pike within the Colville River upstream of the Highway 25 Bridge.
- Question #3: Are Northern Pike present in the Columbia River drainage downstream of the current known distribution (Hunters, Washington)?

Research Hypothesis:

- Hypothesis #1: Northern Pike are not present in the Kettle River upstream of Barstow Bridge.
- Hypothesis #2: Northern Pike are not present in the Colville River upstream of the Highway 25 Bridge
- Hypothesis #3: Northern Pike are not present in the Columbia River downstream of the current known distribution (Hunters, Washington).

Experimental Design:

In consultation with the National Genomics Center for Wildlife and Fish Conservation (NGC; Missoula, Montana), a total of 50 sites were selected for monitoring that will be sampled twice a year (May and September). May was selected because this is the peak spawning period when Northern Pike will be concentered in shallow water increasing the probability of detection. September was selected because it is considered a low flow month and Stephen et al. (2015) found the highest rate of DNA detection during low flow periods.

Of the 50 sample sites, 10 are within the current known distribution and 40 are outside of the current known distribution (hereafter unknown sites). The unknown sites are within the Kettle, Colville, Spokane, and Sanpoil rivers, as well as within Lake Roosevelt downstream of Hunters (know distribution), Banks Lake, Rufus Woods Reservoir, and the Okanogan River (Table 3;

Figure 6). Specific sample locations have habitat conditions characteristic of typical Northern Pike spawning (May) and rearing (September) habitat based on literature descriptions. The characteristics of Norther Pike habitat are relatively shallow depths, relatively low velocities, and aquatic vegetation.

DNA is not permanent in the environment. Microbes and the ultraviolet light from the sun break down eDNA in a matter of hours to days, depending on conditions. Dunker et al. (2016) found Northern Pike eDNA to break down rapidly and only being detected at 10.8% 40 m downstream of a known carcass. To ensure downstream sites would not be contaminated from known upstream Northern Pike populations, all "unknown sites" were at least 10 km from a known population.

The 10 monitoring sites within the current known Northern Pike distribution allows for method validation, as well as provides an opportunity investigate relationships between Northern Pike density and density of eDNA. If a relationship exists, eDNA could become an inexpensive method by which we could to monitor the effectiveness of the suppression program.

Methods:

Field Sampling: Sampling methods follow the Carim et al. (2016) field protocol. The NGC lab provides a sampling kit for each location (N=50; plus controls). The kit includes sterilized gloves, forceps, bag with silica beads, filter cup, and filter. A hydrostatic pump is used to pump 5 L of water through the filter per site. After the appropriate amount of water has been filtered, the filter is carefully removed and placed in the bag with silica beads, labeled, and stored in a dark cool place.

If a boat is required to sample a location, special care is taken to ensure the sampling cup never touches the boat. The sampling cup is placed in a clamp attached to a pole. The boat is orientated facing upstream and the cup is lowered into the water upstream of the boat. Only areas of flowing water will be sampled. Locations with eddies or backwater are avoided.

Lab Analysis: Samples are shipped overnight weekly to the NCG during the sampling period. Samples were stored at -20 C at the NCG until DNA extraction occurred. Environmental DNA will be extracted from one half of each filter using a QIAGEN DNeasy Blood and Tissue Kit and QIAshredder using a modified protocol with a final elution volume of 100 µl. The second half of each filter will be archived at -20°C for future analysis. If more than one filter is used to collect the sample, DNA from one half of each filter is combined after initial lysis incubation in the extraction process. All DNA extracted from environmental samples is stored at -20°C until qPCR analysis occurred.

The qPCR analysis will occur in 15-µl reaction volumes containing 7.5 µl Environmental Mastermix 2.0 (Life Technologies), 0.75 µl of 20X assay, 4 µl of DNA extracted from tissue, 1.5 µl 10X IPC Mix, 0.3 µl 50X IPC DNA, and 0.95 µl water using the same cycling conditions as for primer optimization above. Each PCR plate also includes a triplicate negative control to screen for contamination in PCR reagents.

Data Analysis:

DNA is quantified for all samples using the Northern Pike marker with the standard curve analysis. The average of reactions will be computed and associated with each sample and then multiplied by 16.67 to estimate quantities per L of sampled water (DNA is extracted from half of the filter producing a 100 µl elution volume, each reaction uses 4 µl of the elution, and a total of 5 L will be filtered). The long version of this calculation is as follows: multiply the average DNA quantity in the triplicate reaction by 25 to estimate the DNA quantity in 100 µl volume of extracted DNA, then multiply this number by 2 to estimate all DNA on one entire filter, and finally divided this number by 3, the total number of liters sampled to reach the estimated number of DNA copies per liter.

Reporting: A summary report developed by NGC Lab will be provided to the CCT by February of each year and included in the co-managers annual report, due March 15th.

If Northern Pike range expansion is detected outside of the Lake Roosevelt area, the appropriate agencies/Tribes will be notified. The early detection protocol will allow the appropriate agencies/Tribes to implement rapid response measures before Northern Pike establish a foothold in the new area.

Notification Process – (see flow chart below)

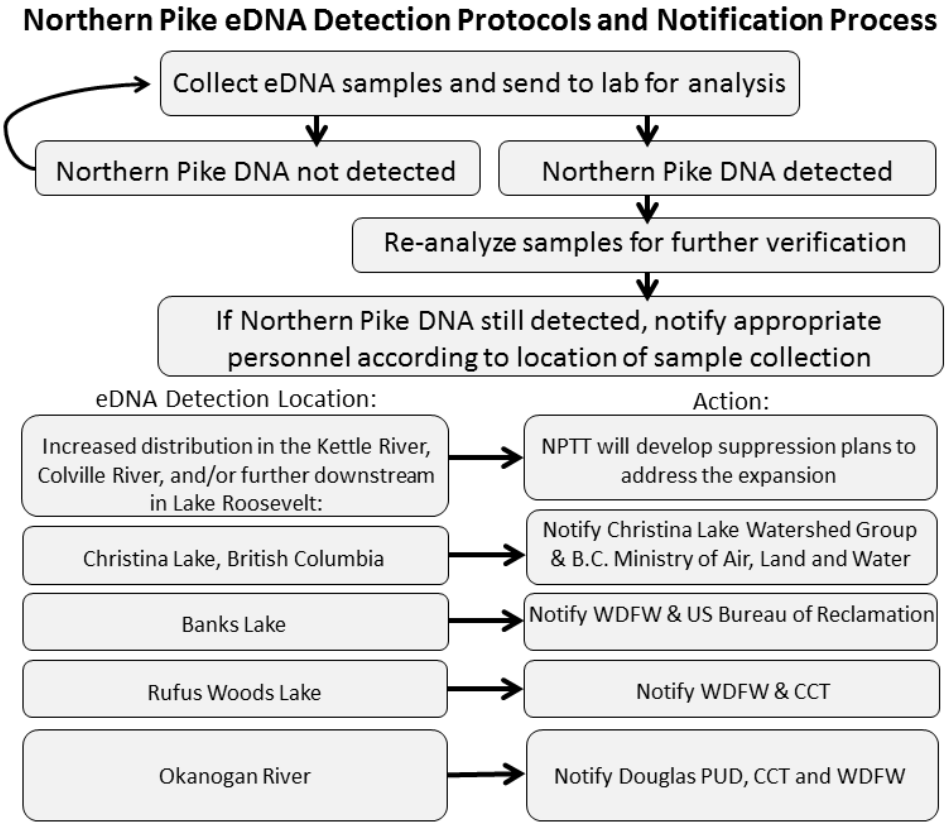
IF Northern Pike eDNA is detected in an area outside of the current known distribution, the NGC will be asked to re-analyze the samples to verify the original result.

IF a negative result is obtained during verification, the site will be re-sampled.

IF a positive result is obtained during verification, then the appropriate agencies/Tribes will be notified.

Agencies to be notified of Northern Pike eDNA detection specific to the sampling locations are as follows:

- Kettle River, Colville River, Lake Roosevelt – Lake Roosevelt Co-Managers.
- Christina Lake, British Columbia - Christina Lake Watershed Group and BC Ministry of Air, Land, and Water.
- Banks Lake - WDFW and US Bureau of Reclamation.
- Rufus Woods Reservoir - WDFW and CCT.
- Okanogan River – WDFW, CCT, and Douglas Public Utility District.



Adaptive Management

The downstream spread of Northern Pike is of concern to regional fisheries managers because Northern Pike pose a serious threat to the conservation and persistence of native fish species. The use of eDNA monitoring may assist with monitoring Northern Pike distribution and early detection of downstream expansion. Early detection will provide resource managers with time to implement suppression programs for specific water bodies.

The distribution information will be used to monitor the expansion of Northern Pike into currently unknown areas and adaptively manage the suppression program. The data will be used to continuously improve the precision of the suppression program.

Estimated Budget: $80/sample + 15% overhead = $92/sample. 107 samples x $92 = $9,844.

Monitoring Methods Protocol:
https://www.monitoringresources.org/Document/Protocol/FieldAndOfficeMethods/3353

Table 3. Environmental DNA monitoring locations in the Upper Columbia River watershed.

Site #	Water body	Sampling Site	Boat / Hike	Latitude	Longitude	Pike Presence
1	Columbia River _ Lake Roosevelt	China Bend (1) East	Boat	48.81043	-117.95110	Present
2	Columbia River _ Lake Roosevelt	China Bend (2) West	Boat	48.81437	-117.95627	Present
3	Columbia River _ Lake Roosevelt	Kettle Falls (1) East	Boat	48.59910	-118.12363	Present
4	Columbia River _ Lake Roosevelt	Kettle Falls (2) West	Boat	48.60056	-118.13537	Present
5	Columbia River _ Lake Roosevelt	Barnaby (upstream of culvert)	Hike	48.43373	-118.22216	Unknown
6	Columbia River _ Lake Roosevelt	Hunters East Bank	Boat	48.12965	-118.22550	Present
7	Columbia River _ Lake Roosevelt	Hunters West Bank	Boat	48.13918	-118.23920	Present
8	Columbia River _ Lake Roosevelt	Spokane Arm: Blue Creek	Boat	47.88840	-118.14596	Unknown
9	Columbia River _ Lake Roosevelt	Spokane Arm Laughbons Landing	Boat	47.87834	-118.15200	Unknown
10	Columbia River _ Lake Roosevelt	Spokane Arm: Mill Canyon South	Boat	47.79265	-118.06241	Unknown
11	Columbia River _ Lake Roosevelt	Spokane Arm: Mill Canyon North	Boat	47.79938	-118.05416	Unknown
12	Columbia River _ Lake Roosevelt	Spring Canyon West Bank	Boat	47.94581	-118.92802	Unknown
13	Columbia River _ Lake Roosevelt	Spring Canyon East Bank	Boat	47.93590	-118.93760	Unknown
14	Columbia River _ Lake Roosevelt	Hawk Creek	Hike	47.81494	-118.33202	Unknown
15	Columbia River_Lake Roosevelt	Whitestone	Boat	47.87782	-118.52958	Unknown
16	Columbia River_Lake Roosevelt	Keller Ferry	Boat	47.93190	-118.70123	Unknown
17	Columbia River_Lake Roosevelt	Sanpoil Arm West Shore	Boat	47.95705	-118.69339	Unknown
18	Columbia River_Lake Roosevelt	Sanpoil Arm East Shore	Boat	47.94961	-118.66828	Unknown
19	Colville River	Site 1: 1 mile upstream	Hike	48.57798	-118.06380	Unknown
20	Colville River	Site 2: Below waterfall	Hike	48.59442	-118.06094	Unknown
21	Kettle River	Kamloops East Bank	Boat	48.67927	-118.11103	Present
22	Kettle River	Kettle River Campground West Bank	Boat	48.71560	-118.12112	Present
23	Kettle River	Napoleon Bridge East Bank	Boat	48.73464	-118.11662	Present
24	Kettle River	Napoleon Bridge West Bank	Boat	48.73517	-118.11762	Present
25	Kettle River	Barstow Bridge East Bank	Boat	48.78329	-118.12447	Unknown
26	Kettle River	Barstow Bridge West Bank	Boat	48.78215	-118.12415	Unknown
27	Kettle River	Orient Bridge East Bank	Hike	48.86708	-118.19827	Unknown
28	Kettle River	Orient Bridge West Bank	Hike	48.86723	-118.19907	Unknown
29	Kettle River	Rock Cut Bridge East Bank	Hike	48.91502	-118.20146	Unknown
30	Kettle River	Rock Cut Campground West Bank	Hike	48.91955	-118.20724	Unknown
31	Kettle River	Laurier North Bank	Hike	48.99541	-118.20457	Unknown
32	Kettle River	Laurier South Bank	Hike	48.99411	-118.20273	Unknown
33	Kettle River	Cascade Falls North Bank	Hike	49.02085	-118.21479	Unknown

34	Kettle River	Cascade Falls South Bank	Hike	49.02093	-118.21455	Unknown
35	Kettle River	Christina Lake	Dock	49.04193	-118.20779	Unknown
36	Kettle River	Christina Lake	Beaver Dam	49.04400	-118.20913	Unknown
37	Sanpoil River	Sanpoil River South Bank	Hike	48.06387	-118.67003	Unknown
38	Sanpoil River	Sanpoil River North Bank	Hike	48.06408	-118.67018	Unknown
39	Columbia River _ Rufus Woods	Near Nespelem River North Bank	Boat	48.13003	-119.04355	Unknown
40	Columbia River _ Rufus Woods	Near Nespelem River South Bank	Boat	48.12393	-119.04322	Unknown
41	Columbia River _ Rufus Woods	Chief Joseph Dam boat launch South Bank	Boat	47.99495	-119.61595	Unknown
42	Columbia River _ Rufus Woods	Chief Joseph Dam boat launch North Bank	Boat	48.01315	-119.60755	Unknown
43	Banks Lake	Banks Lake South	Boat	47.92373	-119.06030	Unknown
44	Banks Lake	Banks Lake North	Boat	47.94540	-119.05373	Unknown
45	Banks Lake	Banks Lake Outlet (North Bank)	Hike	47.61822	-119.17548	Unknown
46	Banks Lake	Banks Lake Outlet (South Bank)	Hike	47.62749	-119.32828	Unknown
47	Okanogan River	Mosquito Park (Hwy 97 Bridge) East Bank	Hike	48.10238	-119.70908	Unknown
48	Okanogan River	Mosquito Park (Hwy 97 Bridge) West Bank	Hike	48.10287	-119.71003	Unknown
49	Okanogan River	Malott Bridge East Bank	Hike	48.28018	-119.70467	Unknown
50	Okanogan River	Malott Bridge West Bank	Hike	48.28085	-119.70482	Unknown
51	Control Site	Wilmont Creek (above waterfall)	Hike	48.07577	-118.32538	Control
52-55	Control Sites	TBA				

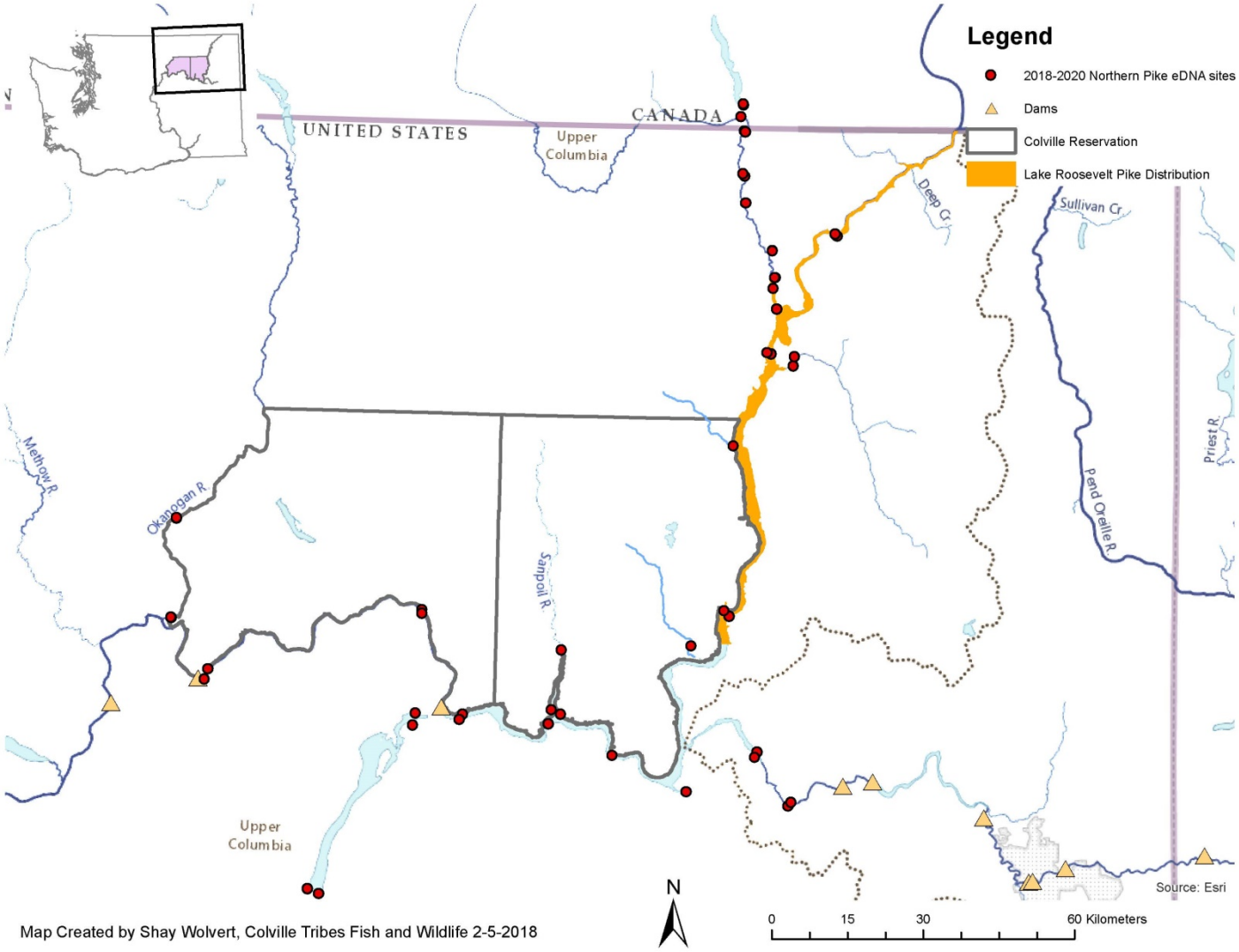


Figure 7. Map of eDNA monitoring locations in the Upper Columbia River watershed.

1.4 Reservoir Operations Study (CCT Lead)

Goal: Use reservoir operations to dewater key spawning locations as a tool to reduce Northern Pike spawning success.

Northern Pike can be particularly sensitive to water level changes due to their specific habitat needs during the spawning period. Typically, Northern Pike spawn in sheltered, shallow (0.5 – 1.5 m) water over inundated vegetation of wetlands or shorelines (Casselman and Lewis 1996; Mingelbier and Brodeur 2008). Water temperatures during spawning usually range between 8-12 °C. Northern Pike eggs are deposited where they can stick to vegetation, which suspends them off of the sediment until they hatch in approximately 2 weeks (Casselman and Lewis 1996; Craig 1996; Pierce 2012).

In Lake Roosevelt, based on measurements at the US/Canada Border, the water temperatures generally reach 8 °C in late April and do not exceed 12 ^{o}C until early June. Thus, temperatures are not likely a limiting factor for Northern Pike spawning. Lake Roosevelt is drawn down approximately 15.5 meters (50 ft) every spring to accommodate the spring freshet. Peak drawdown typically occurs around May 1st. During the drawdown the shoreline is dewatered and terrestrial vegetation begins to grow (Figure 7). The reservoir begins to refill in early May, inundating the new vegetation just as the water temperatures are reaching 8 ^{o}C, likely creating suitable Northern Pike spawning habitat. Otoliths removed from age-0 Northern Pike collected in 2016 indicate that Northern Pike are spawning in Lake Roosevelt in May (Figure 8) (CCT/STI/WDFW unpublished data).

Sudden dewatering in the spring has been shown to result in high mortality of fish embryos and larvae (Holland 1987). Mingelbier and Brodeur (2008) developed a spatially explicit model for a largescale river system to predict spawning habitat surfaces available for Northern Pike egg deposition and the potential mortality by dewatering during the embryonic-larval stages. These studies suggest that reservoir operations may be used to reduce Northern Pike reproductive success by desiccating embryos and potentially larvae. Investigating the use of reservoir operations to dewater Northern Pike embryos requires further investigation, beginning with a comprehensive literature review and development of a detailed study plan. The literature review and study plan will identify data gaps and describe approaches for filling them. The study plan will also describe the analytical approach for determining if and how reservoir operations could be used to reduce Northern Pike production. Initial thoughts include using existing 2-dimensional hydrodynamic models for Lake Roosevelt (from White Sturgeon research) and information about embryo survival when desiccated on aquatic vegetation to evaluate the potential for operational approaches to kill Northern Pike embryos.

Project Plan:

2018-2019: Develop a study plan for a reservoir operations study.

- Solicit a subcontractor to assist with study design.

2020-2022

- Fill data gaps identified in the study design.
- Implement prescribed analysis, if feasible.

Figure 8. May 10th, 2016, Colville River mouth during spring drawdown. Terrestrial vegetation begins to grow in the drawdown zone.

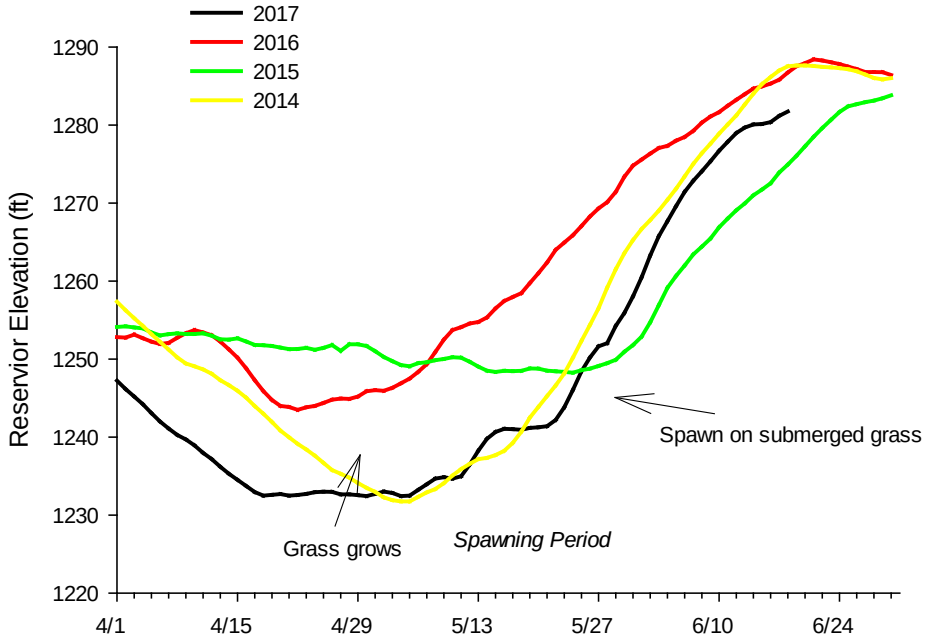


Figure 9. Reservoir elevation during the spring of 2014-2017 in Lake Roosevelt.

2.0 Suppression 2016-17

2.1 Mechanical Removal (CCT and STI Leads)

Goal: Use mechanical removal techniques to reduce the mean Northern Pike CPUE (NP/hr) of to ≤ 0.00 NP/hr by 2025.

- 2018-2019 Goal: Reduce mean annual Northern Pike CPUE (NP/hr) Goal = ≤ 2.0 NP/hr
- 2020-2022 Goal: Reduce mean annual Northern Pike CPUE (NP/hr) Goal = ≤ 1.0 NP/hr
- 2023-2025 Goal: Reduce mean annual Northern Pike CPUE (NP/hr) Goal = ≤ 0.0 NP/hr

Gill Net Suppression:

(a) Gear Description

Agencies participating in the Northern Pike gill net suppression will select from the six nets listed in (Table 4):

(1) Fall Walleye Index Net (FWIN): An experimental monofilament sinking net with eight panels comprised of different mesh sizes. This is the standard net for state-wide FWIN surveys conducted annually. In Lake Roosevelt, the spatial extent of the FWIN survey is reservoir-wide. All three co-managers possess an inventory of these nets.

(2) Spring Pike Index Net (SPIN): An experimental monofilament sinking net with five panels. This is the standard net used for Pend Oreille River Northern Pike suppression and is the proposed gear for monitoring the efficacy of Lake Roosevelt Northern Pike suppression. The STI and WDFW possess and inventory of these nets.

(3) CCT Predator Net: An experimental monofilament sinking net with six panels. This net is currently used by CCT to suppress Walleye and Smallmouth Bass in the Sanpoil Arm of Lake Roosevelt. The CCT possesses an inventory of these nets.

(4) Multi-filament (1): A multi-filament (twisted nylon) sinking net that consists of a single mesh size. This net is similar (half as deep) to the standard net used for White Sturgeon recruitment monitoring. The STI and CCT possess an inventory of these nets.

(5) Multi-filament (2): An experimental multi-filament (twisted nylon) sinking net that consists of five panels, identical to SPIN net panels. The STI possesses an inventory of these nets.

(6) CCT Kokanee Net: A monofilament sinking net that consists of a single mesh size. The CCT possesses an inventory of these nets.

The gill nets used for Northern Pike suppression have not been consistent within and amongst the three co-management entities. Reasons for the inconsistency included: 1) a lack of data demonstrating one configuration is better than another for Northern Pike catch or avoiding bycatch; 2) limited resources preventing purchase of new nets (i.e., had to use what was available); and 3) limited resources preventing statistically rigorous comparisons of each net type.

The plan moving forward (2018):

- CCT: use CCT gillnets during suppression activities. During May and September set equal numbers of CCT gillnets and multi-filament (1) nets. Compare catch results per net per season.
- STI: use SPIN nets during suppression activities. During May and September set equal numbers of SPIN nets and multi-filament (2) nets. Compare catch results per net and season.
- WDFW: use SPIN nets during monitoring and suppression surveys.

The results of catch and bycatch will be discussed with the NPTT and a consistent net use plan will be implemented for future years.

(b) Deployment Methods

To suppress Northern Pike, CCT and STI each plan to deploy 2,430 (1,215 ea) overnight gill nets a year. Each crew will deploy 45 nets per week (Table 5). The proposed netting effort approximately triples the effort expended by the co-managers in 2017 which removed 2,500 Northern Pike. This is the maximum amount of nets crews can currently set with the proposed staff time.

Gill net deployment will follow standard deployment methodologies described in Monitoring Resources Protocol No. 3354 and in Hubert (1996). The CCT and STI will each provide a specialized gillnetting vessel and crew. This includes 26-28 foot landing craft boats outfitted with gill net drums and pot haulers.

Gill nets will be fished overnight (approximately 23 hrs). According to data collected in 2016 and 2017, overnight sets had higher catch rates of Northern Pike than 4-hr daytime sets and careful adaptive site selection effectively minimizes bycatch. During 2017 suppression gillnetting, Northern Pike comprised 54.5% of all fish caught in overnight net sets (when combining all net types).

Gillnet Suppression: https://www.monitoringresources.org/Document/Protocol/Details/3354

(c) Location Selection

Northern Pike are currently distributed from the Canadian border downstream 112 km (70 mi) to the Hunters area(Figure 9), including the lower sections of the Kettle and Colville rivers. The Kettle Falls area (highlighted in red) is identified as the *high priority* or core area because it has the highest densities of Northern Pike and encompasses known spawning locations.

Each week, suppression will be conducted in areas where catch is anticipated to be the greatest. Sites will be selected using gill net results from monitoring, within season suppression, and the previous year's suppression efforts (Figure 10). Specific net deployment locations within the fishing areas will be at the discretion of the sampling crew, with the intention of using all available information to maximize catch of Northern Pike.

Suppression gillnetting will initially be focused in the *high priority* area including the Colville River, Kettle River, Singers Bay, Marcus Flats and Evans. Gillnetting will be conducted in these areas until mean weekly CPUE (pike/net) drops below 1.0 or until June 15th.

Crews will expand below or above the priority area after June 15th. This includes upstream to China Bend and downstream to Hunters. After June 15th, the Northern Pike spawning period has ended and the reservoir typically approaches full pool. At this point additional bays and flat areas are inundated and become conducive for Northern Pike juvenile rearing.

If a bycatch threshold is reached prior to June 15th in a *high priority* area, the crews will move to another *high priority* area for the remainder of the week. If a bycatch threshold is reached after June 15th, the crew will move either upstream or downstream of their current location. Gillnetting will not be suspended but moved to other areas during suppression sampling.

(d) Spatial and Temporal Selection

The suppression gillnetting effort incorporates three seasonal phases, the pre-spawn and spawning period (Feb-May), the post-spawning period (June- August), and juvenile rearing (Sept – November). The *high priority* area will be targeted during all seasonal phases, with the other areas targeted during the summer and fall sampling periods.

Suppression conducted from February to May (hereafter spring suppression) will target adult Northern Pike staging to spawn in water less than 9 m (30 ft). Data collected in 2016 and 2017 indicated Northern Pike in Lake Roosevelt become active and formed pre-spawn aggregations when water temperatures approach 4.4 °C, which typically occurs in March. Other suppression projects have demonstrated that removing gravid females during the pre-spawn period accelerates population collapse. Suppression netting will continue in primary locations until Northern Pike catch rates decrease (< 1.0 Northern Pike/set). If the reservoir drops below 1234 ft the Kettle Falls boat launch will not be accessible and suppression will be suspended until the reservoir refills back to this level. This event typically occurs once every three years and lasts about two weeks.

The post spawn period (June – August) will focus on capturing age-0 Northern Pike. Gillnetting between June and August will be reduced to focus on collecting age-0 Northern Pike with fyke nets and seines. Data collected in 2016 and 2017 indicated age-0 Northern Pike began recruiting to 5.1 cm (2.0 in) stretch mesh by late August. Fyke and seine nets will be used in the Kettle River Bay and Singers Bay to collected age-0 Norther Pike. Gill nets will be set along vegetated flats in the area between the Kettle River and Wilmont Creek (including Barnaby Flats) to target Northern Pike entering newly submerged vegetation (water depths ≤ 15 m) as well as upstream of Evans Campground in backwater sloughs.

(e) Field Data

All live bycatch will be counted and released immediately to maximize survival. Bycatch mortalities will be counted and measured for total length. Data and samples collected from Northern Pike will include total length (mm), weight (g), sex (male or female), and maturity (immature [gonads undeveloped], mature [gonads developed], ripe [flowing eggs or milt],

spawned out [spent gonads], unknown). Data will be kept on fish capture per gill net mesh size to inform development of the suppression gillnetting protocol.

Otoliths and cleithra will be collected from all Northern Pike captured upstream of China Bend and downstream of Hunters for the microchemistry study. If an adequate number of cliethra were not collected during the monitoring survey, the appropriate length bins will be filled during suppression surveys. This effort will be coordinated by WDFW.

A subset (n = 100) of Northern Pike will be measured between jaw points to establish a regression equation that can be used to estimate total length from a Northern Pike head turned for the Reward Program. Nilsson and Bronmark (2000) published a paper that established a relationship between Northern Pike gape and total length (gape = 0.098 TL -0.339, r2 = 0987, P < 0.001, n= 49). In 2018, CCT staff will field test this equation by measuring 100 Northern Pike for total length (mm) and gap width (mm). The Northern Pike will be divided into 4 length bins with 25 fish from each (Bin #1 = ≤ 249 mm TL; Bin #2 = 250 – 499 mm TL; Bin #3 500 – 750 mm; and Bib #4 ≥750 mm TL). If the equation agrees with field tested measurements, the equation will be used to estimate total lengths. If it does not, the sampling with be doubled and a Lake Roosevelt specific equation will be developed.

(f) Field Data Management

Field data will be recorded on a standardized paper (waterproof) data sheet (see Appendix A; datasheets). All data will be entered into a standardized Excel spreadsheet by each agency. Each agency will be responsible for quality control of their dataset. Quality control consists of double checking all entered data with the paper data prior to sharing with the group. Data from each agency will be sent to CCT who will combine the files and re-distribute. Data will be received by December 15 of each year and re-distributed no later than January 15.

The otolith samples and matching data will be provided to CCT on a monthly basis for inclusion in the microchemistry study.

The cleithra samples will be provided to WDFW on a monthly basis for aging analysis.

(g) Descriptive statistics

Descriptive statistics to be produced include annual and monthly mean, variance, range, and sample size by sex and stage of maturity for CPUE (Northern Pike/set), total length (mm), weight (g), condition (relative weight), and length-at-age. In addition, relative representation in the catch, length and age frequency distributions, age frequency distribution, sex ratio, and proportion by stage of maturity will be evaluated.

Net Selection Analysis: The difference in the mean number of Northern Pike and priority native fish captured per mesh size, per net type by season will be compared using one-way ANOVA. Priority native fish include Redband Trout, Kokanee Salmon, Burbot, and White Sturgeon. The assumptions made while conducting an ANOVA are: the sample groups had equal variances, the data for each group was distributed on a normal curve (central limit theorem), and each group was drawn independently of each other. If the ANOVA describes a statistical difference between one mesh to another a Tukey-Kramer studentized range multiple comparison test will be used to identify pairwise differences.

Table 4. Gill net options for suppression surveys. Color indicates marks on the net float line to simplify mesh size identification during net retrieval.

Panel Mesh Size in. (mm)	**1.0 (25)**	**1.5 (38)**	**2.0 (51)**	**2.5 (64)**	**3.0 (76)**	**3.5 (89)**	**4.0 (102)**	**5.0 (127)**	**6.0 (152)**
Panel Color	**Yellow**	**Pink**	**White**	**Green**	**Blue**	**Purple**	**Red**	**Black**	**Tan**
	Panel Number								
FWIN (60.96 x 1.82); mesh panels equal in length	1	2	3	4	5		6	7	8
SPIN (45.72 x 1.82); mesh panels equal in length			1	2	3	4	5		
CCT Predator (60.96 x 1.82); 64 mm panel = 22.86 m long; all other panels 7.62 m long.			1	2	3		4	5	6
CCT Kokanee (45.72 x 1.82); all one mesh size			1						
Multi-filament (1) (60.96 x 1.82); all one mesh size			1						
Multi-filament (2) (60.96 x 1.82); mesh panels equal in length			1	2	3	4	5		

Table 5. Summary of planned monthly net sets for CCT and STI.

Monthly	Nets per week		# of weeks sample	Net sets per month
	CCT	STI		
February	45	45	2	180
March	45	45	3	270
April	45	45	4	360
May	45	45	4	270
June	45	45	3	180
July	45	45	2	270
August	45	45	3	180
September	45	45	2	180
October	45	45	2	180
November	45	45	2	180
Total	450	450	27	2,430

Table 6. Weekly bycatch thresholds agreed upon by the co-managers.

Fish Species	Weekly Threshold
White Sturgeon (wild)	1
White Sturgeon (hatchery; wild larvae origin 2010-2016)	10
Redband Trout	10
Wild Kokanee	10
Mountain Whitefish	15
Burbot	50
Sucker species	50
Hatchery Rainbow Trout	50
Walleye	100
Smallmouth Bass	100
White Sturgeon (hatchery; direct gamete take 2001-2009)	No limit
All other non-native fish species	No limit

Boat Electrofishing:

Goal: Reduce Northern Pike CPUE (NP/hr) to < 0.01 NP/hr by 2025.

- 2018-2019 Goal: Reduce mean annual Northern Pike CPUE (NP/hr) Goal = ≤ 15.0 NP/hr
- 2020-2022 Goal: Reduce mean annual Northern Pike CPUE (NP/hr) Goal = ≤ 10.0 NP/hr
- 2023-2025 Goal: Reduce mean annual Northern Pike CPUE (NP/hr) Goal = ≤ 0.01 NP/hr

(a) Gear Description

An aluminum motorized Smith-Root electrofishing boat equipped with a 5.0 Generator Powered Pulsator (GPP) will be used for Northern Pike suppression.

(b) Deployment Methods

Boat electrofishing will follow standard methodologies described in Monitoring Resources Protocol No. 3355 and in Reynolds and Lawrence (2012). Electrofishing settings will be standardized to 340 volts DC current, 40% duty cycle, 120 pulse/sec; 3-7.5 amps and adjusted to maximize catch of Northern Pike). During sampling, the boats will travel at a rate of 6-9 km/hr. A standard survey will consist of 10-30 minutes of electrofisher "on" time. Boat electrofishing surveys will occur during the day between 08:00 and 19:00. Catch rates were approximately equal during day and night boat electrofishing surveys during 2017 (STI, unpublished data). Therefore, day events were selected.

Juvenile Suppression https://www.monitoringresources.org/Document/Protocol/Details/3355

(c) Location Selection

Boat electrofishing will occur in known juvenile rearing areas within the high priority area (Figure 9). The locations are Singers Bay, the Colville River Arm, the Kettle River bay, Marcus Flats, and Evans Campground.

(d) Spatial and Temporal Selection

Electrofishing for Northern Pike suppression will be conducted from August until November. Previous surveys indicate age-0 Northern Pike begin recruiting to boat electrofishing when they reach 150 mm TL and the water temperatures are above 16 °C, which typically occurs at the beginning of July. The STI and CCT will expend at least 108 hrs each (216 total hrs) of boat electrofishing. This level of effort is the maximum amount possible under proposed staffing levels.

Shorelines and areas with submerged vegetation with depths < 3 m (10 ft) will be electrofished.

(e) Field Data

Only Northern Pike will be picked up during boat electrofishing surveys. Data and samples collected from Northern Pike will include total length (mm), weight (g), sex, and maturity.

(f) Field Data Management

Field data will be recorded on standardized paper (waterproof) data sheets (see Appendix A; datasheets). All data will be entered into a standardized Excel spreadsheet by each agency.

Each agency will be responsible for quality control of their dataset. Quality control consists of double checking all entered data with the paper data sheet prior to sharing with the group. Data from each agency will be sent to CCT who will combine the files and re-distribute. Data will be received by December 15 of each year and re-distributed no later than January 15.

(g) Descriptive Statistics

Descriptive statistics to be produced will include annual and monthly mean, variance, range, and sample size by sex and stage of maturity for CPUE (Northern Pike/hr), total length (mm), weight (g), condition (relative weight), length at age. In addition, relative proportion relative representation in the catch, length and age frequency distributions, age frequency distribution, sex ratio, and proportion by stage of maturity.

Table 7. Monthly boat electrofishing plan.

Monthly	# of 10 min transects/wk		# of weeks sampled	# of 10 min transects per month	Effort (hr)
	CCT	STI			
February					
March					
April					
May					
June					
July					
August	72	72	2	288	48
September	72	72	3	432	72
October	72	72	2	288	48
November	72	72	2	288	48
Total	288	288	9	1,296	216

Fyke Nets

Goal: Reduce Northern Pike/fyke net to < 0.01 Pike/fyke net by 2025.

- 2018-2019 Goal: Reduce mean annual Northern Pike CPUE (NP/fyke net) Goal = ≤ 50.0 NP/fyke
- 2020-2022 Goal: Reduce mean annual Northern Pike CPUE (NP/fyke) Goal = ≤ 30.0 NP/fyke
- 2023-2025 Goal: Reduce mean annual Northern Pike CPUE (NP/fyke) Goal = ≤ 0.01 NP/fyke

(a) Gear Description

Two fyke nets will be utilized. The fyke nets will be identical, but with different lead lengths. Both fyke nets are constructed with 6.4 mm [0.25 in (#44)] knotless nylon netting coated with black UV treatment. The nets are configured with two 1.2 m long x 1.8 m wide (4.0 ft x 6.0 ft) rectangular frames constructed of 1.9 cm (0.75 in) diameter welded conduit, followed by five 1.1 m (44.00 in) diameter tapered steel hoops. Vertical trapping panels extend from the first to second boxes 7.2 cm (3.00 in) off-center. Apertures reducing to 12.7 cm (5.00 in) openings are attached to the first and third hoops. A 15.2 m long x 1.2 m deep (50.0 ft x 4.0 ft) lead is attached to the center bar of the first rectangular frame. The lead has a 22.3 kg (50 lb) lead core bottom line and a 7.9 mm [0.31 in(5/16)] polypropylene float line with SB-2 floats spaced every (48.00 in).

(b) Deployment Methods,

Fyke nets will be deployed following the standard methods described in Monitoring Resources Protocol No. 3355 and in Hubert (1996). Areas within bays that have depths of < 2 m will be targeted. (https://www.monitoringresources.org/Document/Protocol/Details/3355).

(c) Location Selection,

Fyke nets will be set in two high priority juvenile rearing locations; Singers Bay and the Kettle River Bay (Kamloops Campground).

(d) Spatial and Temporal Selection,

Each agency will set up to 72 fyke nets during the summer/fall months; the maximum estimated under the current staffing level. (Table 1).

(e) Field Data

All live bycatch will be counted and released immediately to maximize survival. Bycatch mortalities will be counted. Data and samples collected from Northern Pike will include total length (mm).

(f) Field Data Management

Field data will be recorded on standardized paper (waterproof) data sheets (see Appendix A; datasheets). All data will be entered into a standardized Excel spreadsheet by each agency. Each agency will be responsible for quality control of their dataset. Quality control consists of double checking all entered data with the paer data prior to sharing with the group. Data from each agency will be sent to CCT who will combine the files and re-distribute. Data will be received by December 15 of each year and re-distributed no later than January 15.

(g) Descriptive Statistics

Mean annual and monthly CPUE (fish/fyke net), relative abundance, annual length frequency distribution will be calculated using methods described in Zale et al (2012; Fisheries' Techniques).

Table 8. Fyke net sampling schedule.

Monthly	# Fyke nets/ wk	# of weeks/ mo	Fyke Net sets per month
February			
March			
April			
May			
June			
July			
August	12	2	24
September	12	2	24
October	12	2	24
November			
Total	36	6	72

Seine Surveys

Goal: Reduce Northern Pike CPUE (NP/seine) to < 0.01 NP/seine by 2025.

- 2018-2019 Goal: Reduce mean annual Northern Pike CPUE (NP/seine) Goal = ≤ 100.0 NP/seine
- 2020-2022 Goal: Reduce mean annual Northern Pike CPUE (NP/seine) Goal = ≤ 50.0 NP/seine
- 2023-2025 Goal: Reduce mean annual Northern Pike CPUE (NP/seine) Goal = ≤ 0.01 NP/seine

(a) Gear Description,

Two seine nets will be used depending on the habitat selected for the survey. Seine #1 will be used in large bays (≥ 183 m wide) and seine #2 will be used in smaller bays (≤ 183 m).

1). 91.4 m x 1.83 (300 ft long: x 6 ft deep): ½ inch square #126 knotless nylon netting, top rope 3/8 inch braided ploy with SB-6 floats every 24 inches. Bottom rope: 3/8 inch braided poly with #10 leads every 12 inches. Breast line: 1/8 inch solid braid nylon. Hung using #15 Twine.

2). 45.7 m x 1.83 (150 ft x 6 ft tall seine): ¼ inch square #44 knotless nylon netting. Top rope: 3/8 braided poly with SB-6 floats every 24 inches. Bottom rope: 3/8 braided poly with #10 leads every 12 inches. Breast line: 1/8 inch solid braid nylon, hung using #15 twine.

(b) Deployment Methods,

Beach seines will be deployed following the standard methods described in Monitoring Resources Protocol No. 3355 and in Hayes et al. (1996). Beach seines are difficult to pull through thick aquatic vegetation, limiting their utility in ideal Northern Pike natal habitat. However, the benefits of the beach seine include low cost, the ability to capture numbers of Northern Pike simultaneously, and minimal harm to bycatch.

(c) Location Selection

Seine surveys will be conducted in two high priority juvenile rearing locations; Singers Bay and the Kettle River Bay (Kamloops Campground).

(d) Spatial and Temporal Selection

Each agency will conduct 20 total seine surveys in August and September (Table 9).

(e) Field Data

All live bycatch will be counted and released immediately to maximize survival. Bycatch mortalities will be counted and measured (total length). Data and samples collected from Northern Pike will include total length (mm).

(f) Field Data Management

Field data will be collected on standardizes data sheets (see Appendix A; datasheets) and entered into a standardized Excel spreadsheet by each agency. Each agency will be responsible for quality control of their dataset. Data from each agency will be sent to CCT who will combine the files and re-distribute. Data will be received by December 15 of each year and re-distributed no later than January 15th.

(g) Descriptive Statistics

Mean annual and monthly CPUE (fish/seine survey), relative abundance, annual length frequency distribution will be calculated using methods described in Zale et al (2012; Fisheries' Techniques).

Table 9. Seine Survey schedule.

Monthly	# Seine surveys/wk		# of weeks sample	Net sets per month
	CCT	STI		
February				
March				
April				
May				
June				
July				
August	5	5	2	22
September	5	5	2	20
October				
November				
Total	10	10	4	40

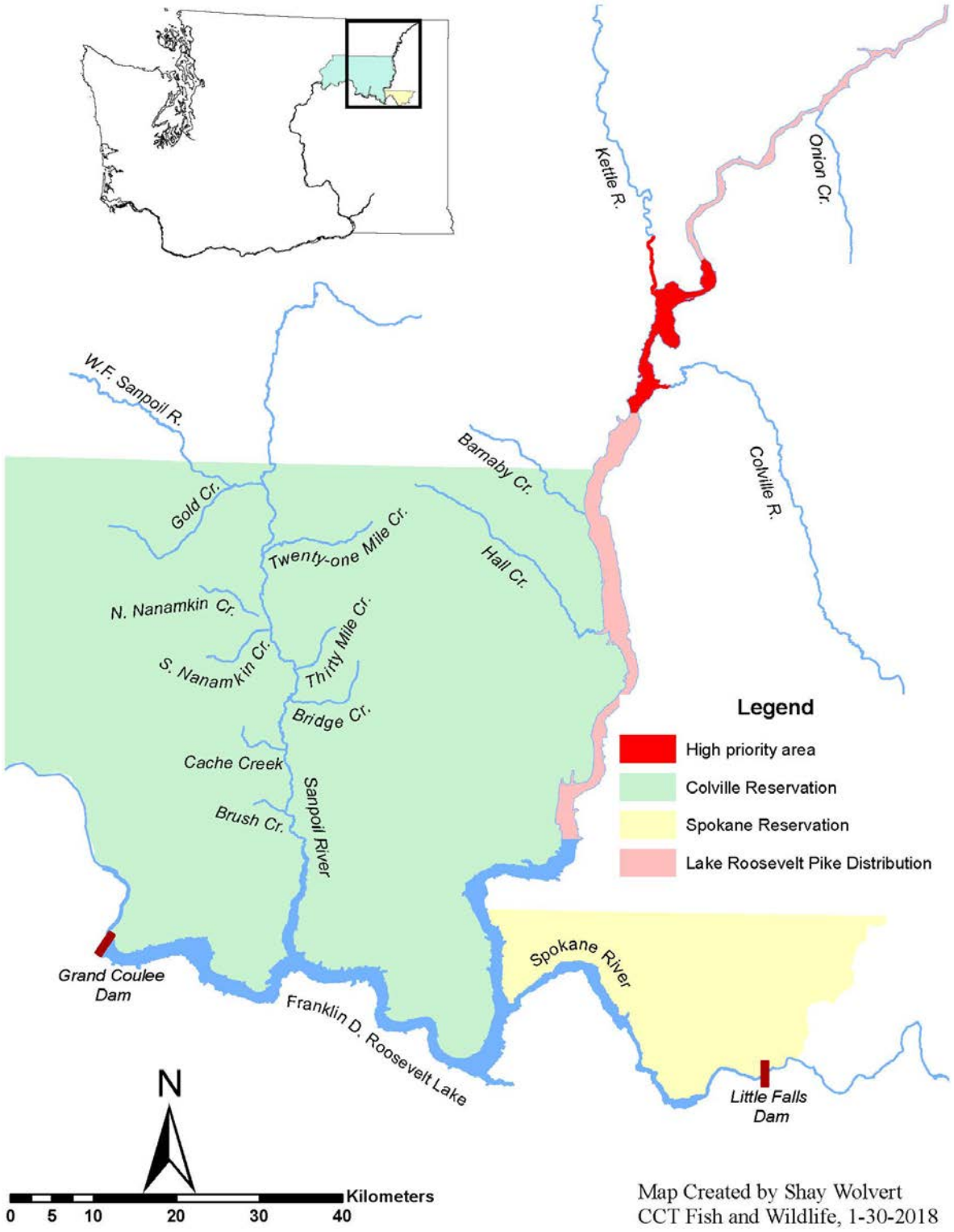


Figure 10. Map of Lake Roosevelt with current Northern Pike distribution (pink) and high priority removal areas (red).

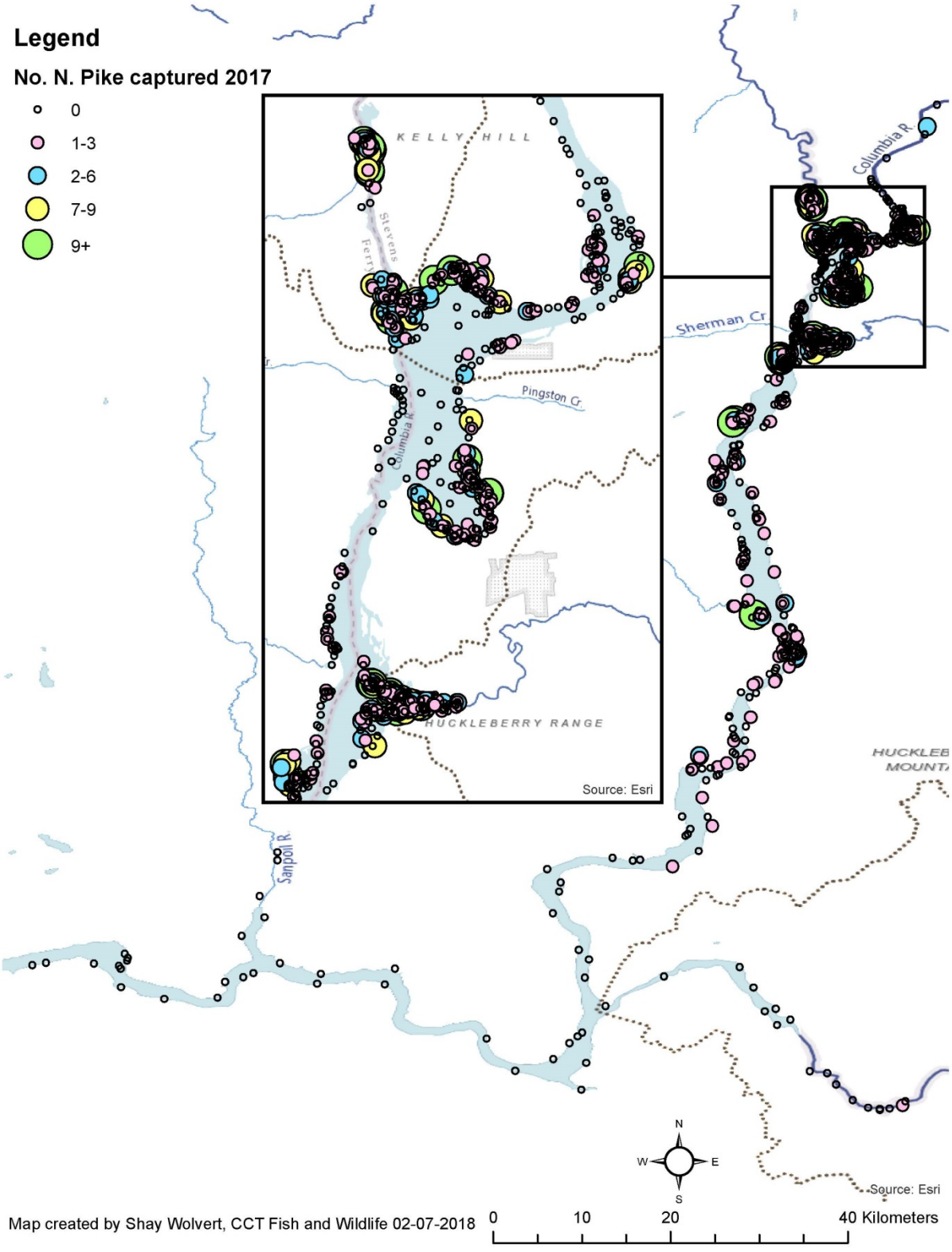


Figure 11. Map of Lake Roosevelt with gill net locations and a summary of Northern Pike captured at each location.

2.2 Northern Pike Reward Program (CCT Lead)

Goal: Incentive for anglers to remove Northern Pike from Lake Roosevelt.

The spread of Northern Pike throughout the Columbia River Basin is a significant concern for resource managers. If the Northern Pike population is allowed to grow it can have profound impacts to local fisheries and native fish recovery efforts. Programs that encourage incentivized harvest may be an effective management tool if implemented properly.

The Lake Roosevelts Northern Pike Reward Program was implemented as one part of the Comprehensive Lake Roosevelt Northern Pike Removal Strategy. This strategy was developed with the eight key points listed by Pasko and Goldberg (2014); 1) define management plans and objectives, 2) manage costs, 3) understand the target species population dynamics, 4) evaluate potential ecological outcomes, 5) monitor for unintended outcomes, 6) prevent re-introduction, 7) incorporate adaptive management, and 8) conduct public outreach.

The Colville Tribe secured three years of funding ($15,000 a year) from Chelan PUD, Grant PUD, and CCT internal funds to support the program through 2019.

Management Plans and Objectives:

Objective 1: Encourage anglers to kill Northern Pike and not to release them alive back into the water.

Objective 2. Remove at least 1,500 Northern Pike a year via the Northern Pike angler reward program.

Implementation Plan

- Pike Reward Program rules can be found on the Colville Tribe's website: https://www.cct-fnw.com/news/.
- The CCT developed the Northern Pike Reward Program Rules (see below) with input from the co-managers and the National Park Service. These set of rules ensured the program would stay on budget, anglers would abide by current fishing regulations, established payout limits, and specific steps for anglers to follow.
- A limit of $590 per angler/year was established to reduce administrative costs associated with sending 1099 tax forms to anglers that receive $600 a year or more https://www.irs.gov/pub/irs-pdf/i1099msc.pdf
- Protocols for anglers were established and posted at the drop off locations (see forms below)
- Fliers and a tri-fold handout were developed and provided to local business to encourage anglers to participate. See below.
- Drop off locations were established in cooperation with local businesses and the National Park Service (see map below).
- Protocols were developed for CCT staff collection, processing and administrative payout to the anglers

- The Colville Tribe Business passes a Resolution to support the Northern Pike Reward Program (Resolution 2017-176).
- The Reward Program will be conducted annually through 2019. The program will continue if new funding is secured.

Manage Costs:

The Colville Tribe secured $15,000 a year for three years (2017; 2018; 2019) for the Northern Pike angler reward program. To ensure the program would not go over budget a variety of controls were set in place.

- Limit the reward payout per angler to $590 per angler per year. This addresses the tax 1099 issue, administrative burden and to discourage illegal movement of Northern Pike into new waters.
- Ensure the Colville Tribe can suspend the Northern Pike Program if the program has the potential to go over budget or if the program is not meeting the removal objectives.

Understand the Targeted Species Population Dynamics

- Northern Pike are a new invasive species in Lake Roosevelt. Their current distribution primarily occurs in the upper one third of the reservoir with the spawning population in the Kettle Falls area. This area was selected as the target for the reward program with drop stations near popular angler locations (Kettle Falls boat launch fish cleaning station and the Noisy Water gas station) (Figure 11). If the Northern Pike population expands downstream, CCT will collaborate with the National Park Service to place drop off freezers at popular boat launches (Hunters, Porcupine Bay, Fort Spokane, Keller Ferry and Spring Canyon). CCT will also work with local business (gas stations) that are frequently visited by anglers to post signs and potentially add new drop off locations if the program continues to receive positive feedback.

Evaluate Potential Ecological Outcomes

- Northern Pike are a new invasive species to Lake Roosevelt. Their presence has negative consequences for the mitigation fishery and ecological stability of Lake Roosevelt, and has the potential to undermine numerous recovery efforts within Lake Roosevelt (Redband Trout, White Sturgeon, Kokanee Salmon) as well as downstream in ESA listed waters.

Monitor for Unintended Outcomes

- New programs, especially ones with few other regional examples, must be approached carefully and designed to reduce risk. A potential unintended consequence is the deliberate introduction of Northern Pike into private or other regional water bodies as a

way to ensure a constant income to a person via the reward program. One of the reasons the annual payout was set low ($590/year) was to address this risk.

- The $590 annual payout can be raised if the CCT administration was willing to take on the financial 1099 burden. However, the total annual payout will stay below a living wage to reduce the risk of illegal introductions to serve as host populations.

Prevent re-introduction

- It is currently illegal to transport live Northern Pike.
- The co-managers will continue public outreach to ensure the angling public is aware of the dangers Northern Pike pose to local ecosystems. This includes handouts, pamphlets, social media communication, newspaper articles, and radio interviews with local stations. See Public Outreach Section.

Incorporate Adaptive Management

- The program will be evaluated each year to determine if it is meeting the removal goal of 1,500 Pike a year.
    - If the program meets the annual goal, CCT will continue to look to increase funds or increase the angler payout amount.
    - If the program does not meet the annual goal, CCT will evaluate the program and look for improvements that can be made to increase awareness and participation in the program.
    - If the program does not meet the annual goal consistently, the CCT reserves the right to suspend the program.

Conduct Public Outreach

- Public outreach is a key component to the Northern Pike Reward Program. The CCT website has link to the program https://www.cct-fnw.com/news/, fliers, and handouts have been developed for the program.
- The CCT has worked closely with the National Park Service to ensure the angling community is aware of the program.
- The CCT has coordinated with local vendors (gas stations and convenience stores) to ensure the local communities are aware of the program.
- The program will expand downstream to new vendors and new boat launches at the Lake Roosevelt National Park if Northern Pike expand their range.

2017 Review: The Northern Pike Reward Program launched in May, 2017. During the program's first 8 months, anglers turned in 1,097 Northern Pike heads (pay out $10,097). The majority of the heads were turned in during September (n=591).

Budget: $15,000 a year through 2019 (Chelan, Grant, and CCT funds).

Requesting additional $30,000 a year from BPA.

2017 Northern Pike Reward Program Rules

Anglers participating in the Northern Pike Reward Program must adhere to the following rules:

1. Adhere to all applicable state/tribal fishing regulations for the area in which you fish. Contact your local state or tribal fishery agency for license requirements and current fishing regulations.
2. Provide true and accurate information to authorized program representatives regarding the taking, possession, delivery, transportation, or any other use of fish caught while participating in the Northern Pike Reward Program.
3. Comply with the directions of authorized program personnel related to the collection of sampling data and angler participation in the Northern Pike Reward Program.
4. Anglers must completely fill out the Pike Head tag information at the designated drop off area. Fish heads must be placed in a freezer bag, with the head label and dropped into the freezer. **Or brought to a CCT Fish and Wildlife Office.**
5. Fish must have been caught in the main stem Columbia River from **Wells Dam** upstream to the Canadian border, the Spokane River upstream to Little Falls, the Kettle River, or the **Okanogan River**. A random number of heads will be selected for microchemistry analysis to confirm the fish's origin.
6. There are no size restrictions on Northern Pike that are eligible for the reward.
7. Participants may receive $10 for every Northern Pike head deposited into the designated **location**, up to an individual maximum of $590 per calendar year.
8. All participants must be 17 years or older to receive the reward.
9. All fish to be redeemed for the reward must have been personally caught solely by the angler submitting them for the reward.
10. Fish head must be in good condition and clearly identifiable. Unidentifiable heads will not be accepted or awarded.
11. Violations of any of the above rules may result in participant disqualification from the Northern Pike Reward Program.
12. The Northern Pike Reward Program can be suspended or terminated at any time at the discretion of the Colville Tribes Fish and Wildlife program.

October 16, 2017 V.3

Directions to properly process Northern Pike to qualify for the reward program

1. Heads must be cut off at the location indicated by the red line in the picture below (behind the gills).

2. Place the head in a provided Ziploc bag. More than one head can be placed in the same bag as long as each fish was caught by the same angler.

3. Fill out all the information on the provided form and place it in the Ziploc bag. Fill out all of the information on the form to insure your reward will be sent to the right location in a timely manner.
4. Drop the bag with the head(s) into the freezer. A Colville Tribe employee will collect heads weekly. Please allow 4 to 5 weeks to receive your reward.

Thank you for participating in the Northern Pike Reward Program

Please fill out the information below and place IN the plastic bag with your fish heads. Seal the bag and drop into the freezer.

Today's Date:
Name:
Address:
Driver's License # (individual ID):
Birthday (must be over 17):
Phone Number:
Email:
Fish Information
Date of Capture:
General Location:
of Pike heads in the bag:
Other Information:

WANTED

Northern Pike Heads- $10 Reward

Attention Anglers:

Help protect the Columbia River from Invasive Northern Pike!

Northern Pike pose significant threats to the Columbia River fisheries including predation on native and important game fish species, introductions of parasites and disease, and competition with other species for food resources.

Drop off locations located at the Noisy Water Gas Station and near the Park Service Kettle Falls fish cleaning station, or any CCT Fish and Wildlife Office

Fill out the label with: drivers license, birthday, name, address, phone number, email, date of capture, and general location of capture

(Pike from Lake Roosevelt and the Kettle River only)

Place the head and the label in the bag and deposit into the freezer

[1]A $10 Reward will be mailed to you

Questions:
Holly McLellan
Colville Confederated Tribes
(509) 209-2415

[1]Allow 4-5 weeks for processing
$590 limit per person/year

Funding provided by the Colville Confederated Tribes

Reward Program Rules

ANGLERS PARTICIPATING IN THE NORTHERN PIKE REWARD PROGRAM MUST ADHERE TO THE FOLLOWING RULES:

Adhere to all applicable state/tribal fishing regulations for the area in which you fish. Contact your local state/tribal fishery agency for license requirements and current fishing regulations.

Provide true and accurate information to authorized program representatives regarding the taking, possession, delivery, transportation, or any other use of fish caught while participating in the Northern Pike Reward Program.

Comply with the directions of authorized program personnel related to the collection of sampling data and angler participation in the Reward Program.

Anglers must completely fill out the Pike Head tag information at the designation drop off area. Fish heads should be placed in a freezer bag, with the head label and dropped into the freezer.

Fish much have been caught in the mainstem Columbia River from Grand Coulee Dam upstream to the Canadian border, the Spokane River upstream to Little Falls, or the Kettle River. A random number of heads will be selected for microchemistry analysis to confirm the fishes origin.

There is no size restrictions on Northern Pike that are eligible for the reward.

Participants will receive $10 for every Northern Pike head deposited into the designated freezers.

A maximum of $590 will be awarded to any one individual during one calendar year.

All participant must be 17 years or older to receive the cash reward.

A maximum of $10,000 will be awarded per year.

All fish to be redeemed for the reward must have been personally caught solely by the angler submitting them for the reward.

Violations of any of the above rules may result in disqualification from the Northern Pike Reward Program. The Program can be suspended or terminated at any time at the discretion of the Colville Tribes Fish and Wildlife program.

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Funding Provided by:
Colville Confederated Tribes

Please feel free to contact us with questions or concerns.

Northern Pike Reward Program $10 a head

CHELAN COUNTY P.U.D.

Colville Confederated Tribes

Spokane Tribe of Indians

Washington Department of Fish and Wildlife

Lake Roosevelt National Park Recreational Area

Chelan PUD

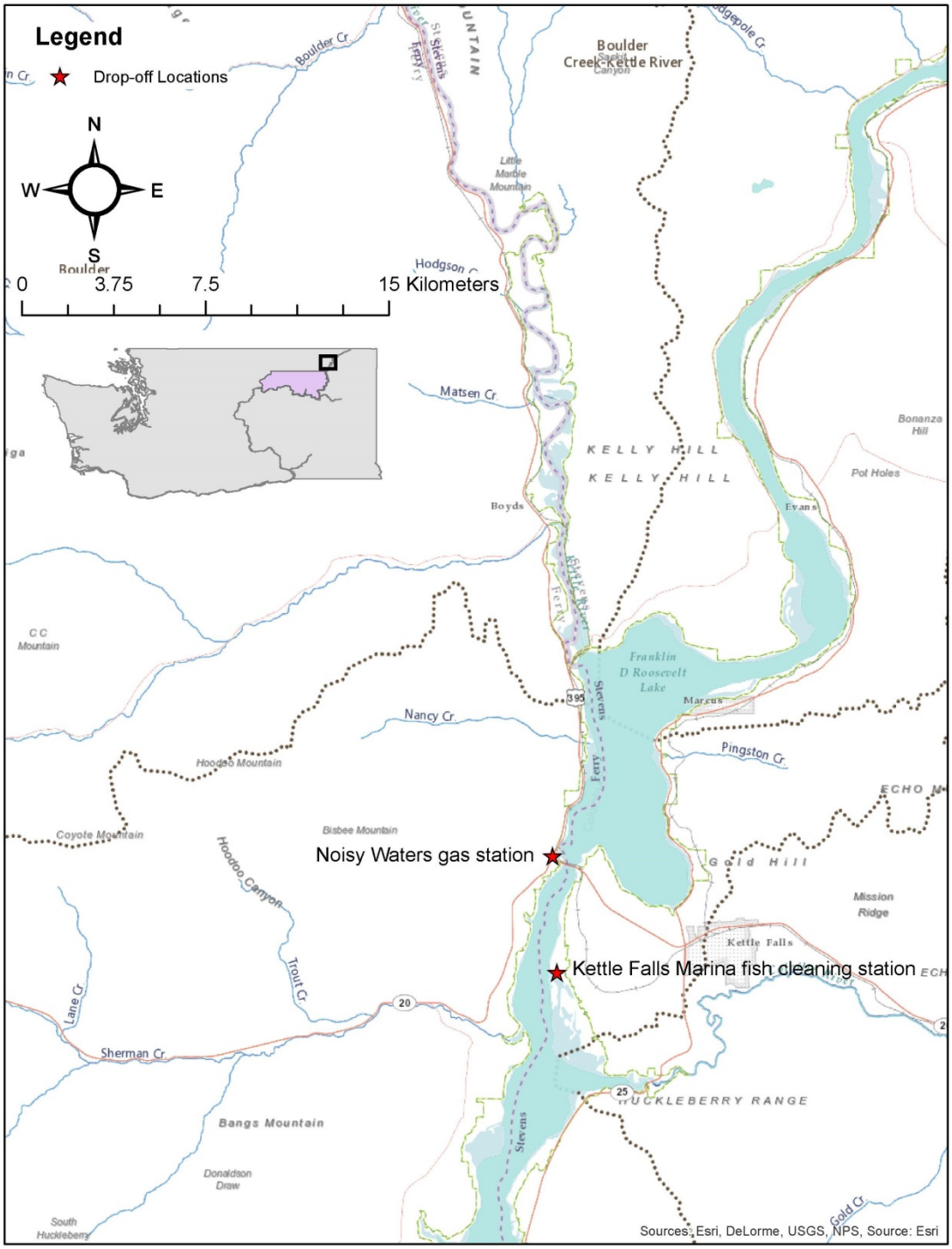


Figure 12. Map indicated current Northern Pike head drop off stations.

3.0 Public Outreach Plan

Goal: Ensure the public is educated on the adverse effects Northern Pike pose to local watersheds and economies and are also informed of management actions.

The co-managers of Lake Roosevelt have collaborated with regional stake holders to educate the public on the adverse effects Northern Pike introductions can have on an ecosystem and regional economies.

The co-managers have collaborated with the National Park Service to post Northern Pike Warning signs at every boat launch on the reservoir. The CCT and STI have also posted these signs at boat launches at inland lakes on the Reservations.

In 2017, the proponents and regional stakeholders collaborated to install Invasive Northern Pike Signs at 27 National Park Boat Launch sites, 2 Spokane Tribal boat launch sites and 6 Colville Tribal boat launch/fishing locations (Figure 12).

In 2017, the co-managers have presented the Northern Pike Suppression and Monitoring plan at Walleye Club meetings, Trout Unlimited meetings, and provided information to local newspapers and regional news radio stations.

2018-2022 annual actions include

- Upkeep of the current 35 signage locations around Lake Roosevelt.
- Expansion of the current signage to Rufus Woods (3 locations) and Banks Lake (3 locations).
- Present results and plans to the local communities through fishing clubs (1 presentation), radio stations (2 interviews), and newspaper articles (2 articles), as well as presenting at regional fisheries conferences (1 conference). These presentations and press releases will remind the public of the prohibited status of Northern Pike in Washington State, of threats posed to the entirety of the Columbia River system, and promote the $10 reward program.
- The proponents and regional stakeholders will collaborate to develop an informational Northern Pike brochure and will print 1,000 copies annually. The brochure will describe the prohibited status and threats posed by Northern Pike to Washington State and downstream waters. The brochure will be made available to the public at the CCT Northern Pike reward drop off locations, at specific high-use angler access sites, and will be distributed by the Lake Roosevelt angler creel survey clerks.
  Implement a Public Awareness Survey to determine if angler awareness changes overtime. The proponents developed a short post card sized questionnaire that will be distributed to 50 anglers per season per three creel survey areas (Figure 13). The questionnaire will ask four yes or no questions. The response to the questions will be summarized by STI and results reported annually in the Lake Roosevelt Northern Pike Annual Report. The information will be used to establish a baseline regarding angler awareness of Northern Pike.

- The proponents will coordinate with the National Park Service to include an informational page on the Lake Roosevelt website which will provide information on the threats of Northern Pike and other aquatic invasive species. There will also be links to the co-managers websites that provide additional information.

List of Public Outreach Articles competed in 2017.

April 2nd, 2017. "Gillnetting ramps up to curb northern pike in Columbia River" by Rich Landers. The Spokesman Review. < http://www.spokesman.com/stories/2017/apr/02/gillnetting-ramps-up-to-curb-northern-pike-in-colu/#/0>

April 14th, 2017. "Tribe to offer anglers $10 reward for northern pike heads from Lake Roosevelt" by Rich Landers. The Spokesman Review. < http://www.spokesman.com/blogs/outdoors/2017/apr/14/tribe-offers-anglers-10-reward-northern-pike-heads-lake-roosevelt/>

April, 15th, 2017. "Field Reports: $10 bounty offered for Roosevelt pike" by Rich Landers. The Spokesman Review. < http://www.spokesman.com/blogs/outdoors/2017/aug/18/northern-pike-documented-farther-down-lake-roosevelt-hunters/>

April 21st, 2017. "Tribe offers bounty on pike". The Omak-Okanogan County Chronicle. < http://www.omakchronicle.com/news/2017/apr/21/tribe-offers-bounty-pike/>

August, 18th, 2017. "Northern pike documented farther down Lake Roosevelt at Hunters" by Rich Landers. The Spokesman Review. < http://www.spokesman.com/stories/2017/apr/15/field-reports-10-bounty-offered-for-roosevelt-pike/>

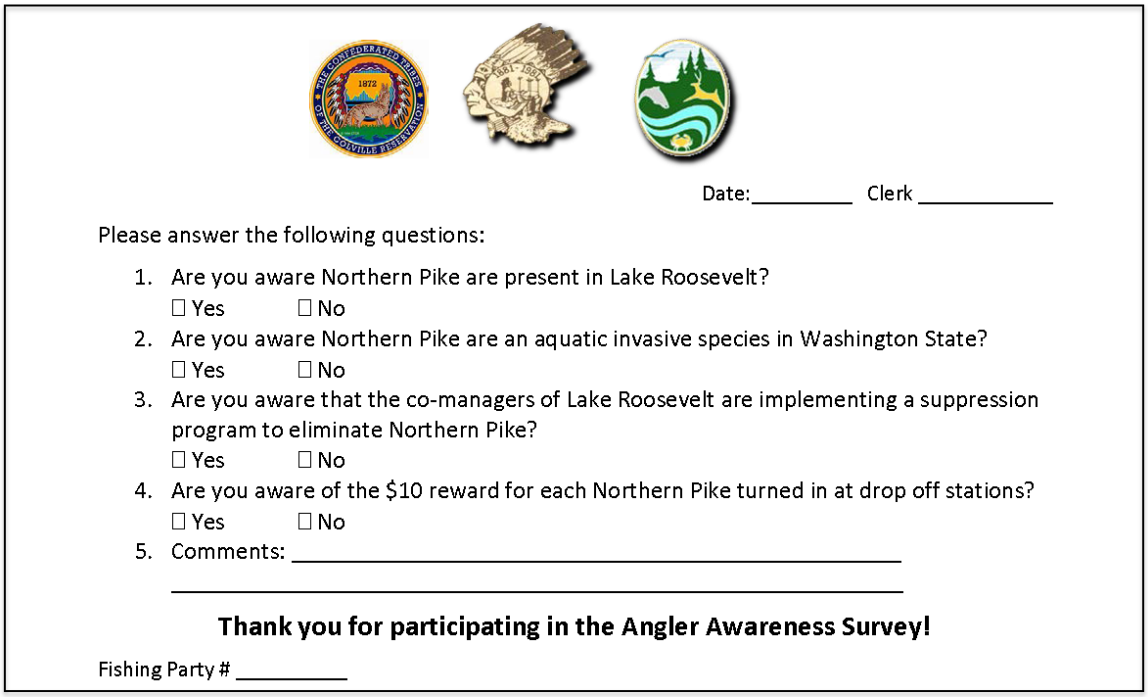
October 2nd, 2017. "The Redband Rally Continues: Indians' Staff Spends Day with Spokane Tribal Fisheries" The Spokane Indians Baseball Club. < https://www.milb.com/spokane-indians/news/print/the-redband-rally-continues-indians-staff-spends-day-with-spokane-tribal-fisheries/c-257232090>

December 14, 2017. "Power Council Says Northern Pike Spreading in Lake Roosevelt". Best States News. < https://www.usnews.com/news/best-states/washington/articles/2017-12-14/power-council-says-northern-pike-spreading-in-lake-roosevelt>

December 15th, 2017. "Colville tribal Northern Pike Rewards Program Continues On". Tribal Tribune. < http://www.tribaltribune.com/news/article_29059c30-e1c1-11e7-b820-1ba6072b4595.html>

December 22nd, 2017. "Invasive 'Devil Fish' Make It To Washington's Lake Roosevelt" by Courtney Flatt. OPB.org. < https://www.opb.org/news/article/invasive-devil-fish-make-it-to-washingtons-lake-roosevelt/>

Figure 13. Invasive Northern Pike sign posted at boat launches and fishing locations through Lake Roosevelt.



Date:_____ Clerk _____

Please answer the following questions:

1. Are you aware Northern Pike are present in Lake Roosevelt?
   ☐ Yes ☐ No
2. Are you aware Northern Pike are an aquatic invasive species in Washington State?
   ☐ Yes ☐ No
3. Are you aware that the co-managers of Lake Roosevelt are implementing a suppression program to eliminate Northern Pike?
   ☐ Yes ☐ No
4. Are you aware of the $10 reward for each Northern Pike turned in at drop off stations?
   ☐ Yes ☐ No
5. Comments: _____
   _____

Thank you for participating in the Angler Awareness Survey!

Fishing Party # _____

Date:_____ Clerk _____

Please answer the following questions:

1. Are you aware Northern Pike are present in Lake Roosevelt?
   ☐ Yes ☐ No
2. Are you aware Northern Pike are an aquatic invasive species in Washington State?
   ☐ Yes ☐ No
3. Are you aware that the co-managers of Lake Roosevelt are implementing a suppression program to eliminate Northern Pike?
   ☐ Yes ☐ No
4. Are you aware of the $10 reward for each Northern Pike turned in at drop off stations?
   ☐ Yes ☐ No
5. Comments: _____
   _____

Thank you for participating in the Angler Awareness Survey!

Fishing Party # _____

Figure 14. Northern Pike in Lake Roosevelt Angler Awareness Questionnaire.

4.0 Data and Reports

Each agency will be responsible for data entry and quality control of their data sets. Each agency will enter their data in a pre-designed Excel worksheet. Data will be sent to the Colville Tribe in December, who will combine all of the data and redistribute the data sets to the co-managers by early January.

The co-managers will combine datasets and summarize suppression and monitoring results into one annual report, due March 15 after each project year. The report will be uploaded into the new Pike Suppression and Monitoring Project (BPA # 2017-004-00).

Budget Breakdown

Deliverable Title	Starting FY	Ending FY	Estimated Budget				
				CCT	STI	WDFW	Total
Suppression: Adult Northern Pike Removal (DELV-1)	2018	2022	$2,770,422	$1,166,194	$1,143,149	$461,079	$2,770,422
Suppression: Juvenile Northern Pike Removal (DELV-2)	2018	2022	$761,448	$388,731	$372,717	$0	$761,448
Suppression: Northern Pike Angler Reward Program (DELV-3)	2018	2022	$150,000	$150,000	$0	$0	$150,000
Monitoring: Northern Pike eDNA (DELV-4)	2018	2022	$60,000	$60,000	$0	$0	$60,000
Monitoring: Northern Pike Status and Trend (DELV-5)	2018	2022	$488,572	$0	$0	$488,572	$488,572
Monitoring: Northern Pike Microchemistry (DELV-6)	2018	2022	$150,000	$150,000	$0	$0	$150,000
Monitoring: Reservoir Operations Study (DELV-7)	2018	2022	$100,000	$100,000	$0	$0	$100,000
Public Outreach (DELV-8)	2018	2022	$25,000	$8,334	$8,333	$8,333	$25,000
	2018	2022	$4,505,441	$2,023,259	$1,524,198	$957,984	$4,505,441

All Agencies	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Personnel	$386,525	$436,885	$449,512	$462,506	$475,878
Travel	$78,456	$88,465	$91,023	$93,655	$96,363
Prof. Meetings & Training	$1,725	$1,777	$1,830	$1,885	$1,942
Vehicles	$36,173	$40,762	$41,939	$43,151	$44,398
Facilities/Equipment	$108,854	$104,999	$106,231	$109,353	$112,566
Rent/Utilities	$2,460	$2,534	$2,610	$2,688	$2,769
Capital Equipment	0	0	0	0	0
Overhead/Indirect	$123,951	$133,432	$137,154	$140,983	$147,841
Other	$92,000	$69,860	$71,776	$73,749	$84,782
Total	$830,144	$878,713	$902,075	$927,970	$966,539

CCT	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Totals
Personnel	$163,799	$168,713	$173,774	$178,987	$184,357	
Travel	$23,430	$24,133	$24,857	$25,603	$26,371	
Prof. Meetings & Training	$975	$1,004	$1,034	$1,065	$1,097	
Vehicles	$18,120	$18,664	$19,224	$19,800	$20,394	
Facilities/Equipment	$62,920	$64,808	$66,752	$68,754	$70,817	
Rent/Utilities	$1,740	$1,792	$1,846	$1,901	$1,958	
Capital Equipment	$0	$0	$0	$0	$0	
Overhead/Indirect	$48,106	$49,550	$51,036	$52,567	$54,144	
Other	$62,000	$63,860	$65,776	$67,749	$69,782	
Total	$381,090	$392,523	$404,299	$416,427	$428,920	$2,023,259

STI	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Totals
Personnel	$167,339	$172,360	$177,530	$182,856	$188,342	
Travel	$43,740	$45,052	$46,404	$47,796	$49,230	
Prof. Meetings & Training	$750	$773	$796	$820	$844	
Vehicles	$12,660	$13,040	$13,431	$13,834	$14,249	
Facilities/Equipment	$26,450	$27,396	$26,363	$27,154	$27,969	
Rent/Utilities	$720	$742	$764	$787	$810	
Capital Equipment	$0	$0	$0	$0	$0	
Overhead/Indirect	$36,390	$37,482	$38,606	$39,764	$40,957	
Other	$0	$0	$0	$0	$0	
Total	$288,049	$296,843	$303,894	$313,011	$322,401	$1,524,198

WDFW	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	Totals
Personnel	$55,387	$95,812	$98,208	$100,663	$103,179	
Travel	$11,286	$19,280	$19,762	$20,256	$20,763	
Prof. Meetings & Training	$0	$0	$0	$0	$0	
Vehicles	$5,393	$9,058	$9,285	$9,517	$9,755	
Facilities/Equipment	$19,484	$12,796	$13,116	$13,444	$13,780	
Rent/Utilities	$0	$0	$0	$0	$0	
Capital Equipment	$0	$0	$0	$0	$0	
Overhead/Indirect	$39,455	$46,401	$47,512	$48,651	$52,740	
Other	$30,000	$6,000	$6,000	$6,000	$15,000	
Total	$161,004	$189,348	$193,883	$198,531	$215,217	$957,984

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Appendix A. Data sheets

2018 Northern Pike Program: Suppression or Monitoring (circle one)

Data Sheet Page_____ of _____

Waterbody _____ General Location _____ Site # _____ Gear Type Gill Net Personnel _____ Agency _____

GPS WGS84 (ddd.ddddd)		Set					Pull		Net Type: ☐ FWIN ☐ SPIN ☐CCT Predator. ☐ Multi-filament (1) ☐ Multi-filament (2) ☐ Other_____
Latitude	Longitude	Date	Time	Depth (m)		Temp (°C)	Date	Time	
				Min	Max				
(s)									Net Orientation (Parallel/Perpendicular)
(e)									

Fish Number	Mesh Size (mm) or Panel #	Species	FL (mm)	TL (mm)	Fish Wt (g)	Fin Clip	Sex (M/F/U)	Maturity (I/M/SO/U)	Cleithra Number	Scale Number	Otolith Number	Genetic Number	Mark/Recap (M/R)	PIT TAG NUMBER (or other tag number)	Disposition Alive = A Dead = D	Notes
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Fish Number	Mesh Size (mm) or Panel #	Species	FL (mm)	TL (mm)	Fish Wt (g)	Fin Clip	Sex (M/F/U)	Maturity (I/M/SO/U)	Cleithra Number	Scale Number	Otolith Number	Genetic Number	Mark/Recap (M/R)	PIT TAG NUMBER (or other tag number)	Disposition Alive = A Dead = D	Notes
26																
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Code Key																Fin Clip	Maturity
BBH	Brown Bullhead	BUR	Burbot	CT	Cutthroat Trout	LND	Longnose Dace	WF	Mt. Whitefish	RB	Rainbow trout- Unknown	TT	Tiger Trout	LV/RV = left OR right ventral	I = Immature
BC	Black Crappie	CK	Chinook	EB	E Brook Trout	LNS	Longnose Sucker	NPM	N. Pikeminnow	RS	Redside Shiner	WAL	Walleye	LP/RP = left or right pectoral	M=Mature
BLC	Bull Trout	CMO	Chiselmouth	GS	Green Sunfish	LRS	Largescale Sucker	NP	N. Pike	SMB	Smallmouth Bass	YP	Yellow Perch	AD = Adipose clipped	R= Ripe
BRS	Bridgelip Sucker	COT	Sculpin spp.	K	Kokanee	LT	Lake Trout	PMO	Peamouth	SPD	Speckled dace			CP = Caudal punch	SO= Spawned Out
BT	Brown Trout	CP	Carp	LMB	Largemouth Bass	LW	Lake Whitefish	PS	Pumpkinseed	TNC	Tench			DP=dorsal punch	U = Unknown

Panel Mesh Size in. (mm)	1.0 (25)	1.5 (38)	2.0 (51)	2.5 (64)	3.0 (76)	3.5 (89)	4.0 (102)	5.0 (127)	6.0 (152)
Panel Color	Yellow	Pink	White	Green	Blue	Purple	Red	Black	Tan
	Panel Number								
FWIN (200ft)	1	2	3	4	5		6	7	8
SPIN (150ft)			1	2	3	4	5		
CCT Predator Net (200ft)			1	2	3		4	5	6

Panel Mesh Size in. (mm)	1.0 (25)	1.5 (38)	2.0 (51)	2.5 (64)	3.0 (76)	3.5 (89)	4.0 (102)	5.0 (127)	6.0 (152)
Panel Color	Yellow	Pink	White	Green	Blue	Purple	Red	Black	Tan
	Panel Number								
CCT KOK Net			1						
Multi-filament #1 (200 ft)			1						
Multi-filament #2 (150 ft)			1	2	3	4	5		

2018 Northern Pike Program: Suppression or Monitoring (circle one)

Data Sheet Page_____ of _____

Waterbody _____ General Location _____ Site # _____ Gear Type Boat e-fish Personnel _____ Agency _____

Latitude (ddd.ddddd)	Longitude (ddd.ddddd)	Date	Start Time	Temp (°C)	Effort (sec)
(s)					
(e)					

Fish Number	Mesh Size (mm) or Panel #	Species	FL (mm)	TL (mm)	Fish Wt (g)	Fin Clip	Sex (M/F/U)	Maturity (I/M/SO/U)	Cleithra Number	Scale Number	Otolith Number	Genetic Number	Mark/Recap (M/R)	PIT TAG NUMBER (or other tag number)	Disposition Alive = A Dead =D	Notes
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