Regional Operational Plan SF.2A.2016.26

Operational Plan: Northern Pike Eradication in the Cottonwood Creek Drainage—Phase 1

by

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and

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March 2017

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

REGIONAL OPERATIONAL PLAN SF.2A.2016.26

OPERATIONAL PLAN: NORTHERN PIKE ERADICATION IN THE COTTONWOOD CREEK DRAINAGE—PHASE 1

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SIGNATURE PAGE

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Approval

Title	Name	Signature	Date
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Project co-leader	Kristine Dunker		10/7/16
Project co-leader	David Rutz		10/7/16
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TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

ABSTRACT

This project will lay the groundwork for the eventual eradication of invasive northern pike from the Cottonwood Creek drainage by conducting biological assessments of 2 lakes known to contain invasive northern pike (Anderson and Kings lakes), surveying Little Niklason and Mud lakes for the presence of northern pike, collecting water quality data and bathymetric data from all drainage lakes, developing a preliminary pike eradication plan, and conducting public scoping to determine the level of support for eradication.

Key words: invasive species, northern pike, *Esox lucius*, Cottonwood Creek drainage, Anderson Lake, Kings Lake, Little Niklason Lake, Mud Lake, water quality, bathymetry

INTRODUCTION

Invasive northern pike (*Esox lucius*) pose a significant threat to salmon habitat in Southcentral Alaska (ADF&G 2007). Northern pike are native throughout much of the state but do not naturally occur south and east of the Alaska Range (Figure 1). They were introduced by anglers to the Yentna River drainage in the late 1950s and subsequently spread throughout the Susitna River basin through flood events and further illegal stockings (Mills 1986).

Northern pike are highly predatory and are responsible for the loss of several fisheries across their invasive range. The Cottonwood Creek drainage is an area of the Matanuska–Susitna Valley that has great potential to be impacted by invasive northern pike because of the optimal pike habitat conditions (i.e., shallow, vegetated waters) found throughout much of the drainage. Two drainage lakes, Anderson and Kings, are already known to harbor established populations of northern pike. For several years, ADF&G has been blocking the outlets of these lakes with fyke nets to contain these northern pike populations. Prior to northern pike establishment, both of these lakes contained robust populations of coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*O. nerka*), and rainbow trout (*O. mykiss*), but today few, if any, of these fish remain in either lake. Even with ongoing attempts to block the outlets, there is potential for northern pike to escape these lakes and colonize the entire Cottonwood Creek drainage. Further, northern pike in these lakes serve as a potential source population for proximate vulnerable drainages such as the Matanuska and Knik River drainages including Jim Creek, Wasilla Creek, and other presently uninvaded waters in the Northern Cook Inlet region.

To prevent northern pike from spreading, Anderson and Kings lakes are high priorities for invasive northern pike eradication in the Northern Cook Inlet Region (ADF&G Strategic Planning Committee[1]). There are 9 connected lakes within the Cottonwood Creek drainage, and some of these lakes provide optimal habitat conditions for northern pike. The native fish assemblage in the drainage as a whole includes Chinook salmon (*O. tshawytscha*), sockeye salmon, pink salmon (*O. gorbuscha*), coho salmon, chum salmon (*O. keta*), rainbow trout, Dolly Varden (*Salvelinus malma*), threespine stickleback (*Gasterosteus cognatus*), slimy sculpin (*Cottus cognatus*), and longnose suckers (*Catostomus catostomus*). The salmon and trout in these lakes contribute substantially to sport fishing activities in the Matanuska Borough (Jennings 2015). To prevent northern pike from spreading and affecting the drainage's native fish populations, efforts to remove northern pike from the Cottonwood Creek drainage will be conducted in 2 phases.

[1] Alaska Department of Fish and Game. unpublished 2010 memorandum. Region II Invasive Northern Pike Priorities. Alaska Department of Fish and Game, Division of Sport Fish. Anchorage.

The first phase of this project will investigate the distribution of northern pike within the Cottonwood Creek drainage. As mentioned, our current understanding is that northern pike in the drainage are restricted to Anderson and Kings lakes. However, if their distribution is more widespread, it is prudent to learn this before subsequent steps are taken in the planning and implementation of northern pike eradication activities. In addition to assessing northern pike distribution in the drainage, we will conduct biotic and abiotic surveys in drainage lakes to prepare for eventual eradication activities. Finally, we'll develop a preliminary treatment plan for the affected areas of the drainage using the piscicide rotenone, the only proven invasive fish eradication method aside from draining a waterbody (Finlayson et al. 2010), and we'll conduct public scoping to gauge the level of public support for northern pike eradication in the drainage.

Phase 2 of this project will eventually complete the permitting processes, fine scale planning, and implementation of the northern pike eradication activities in the drainage. This operational plan focuses on the first phase of this project.

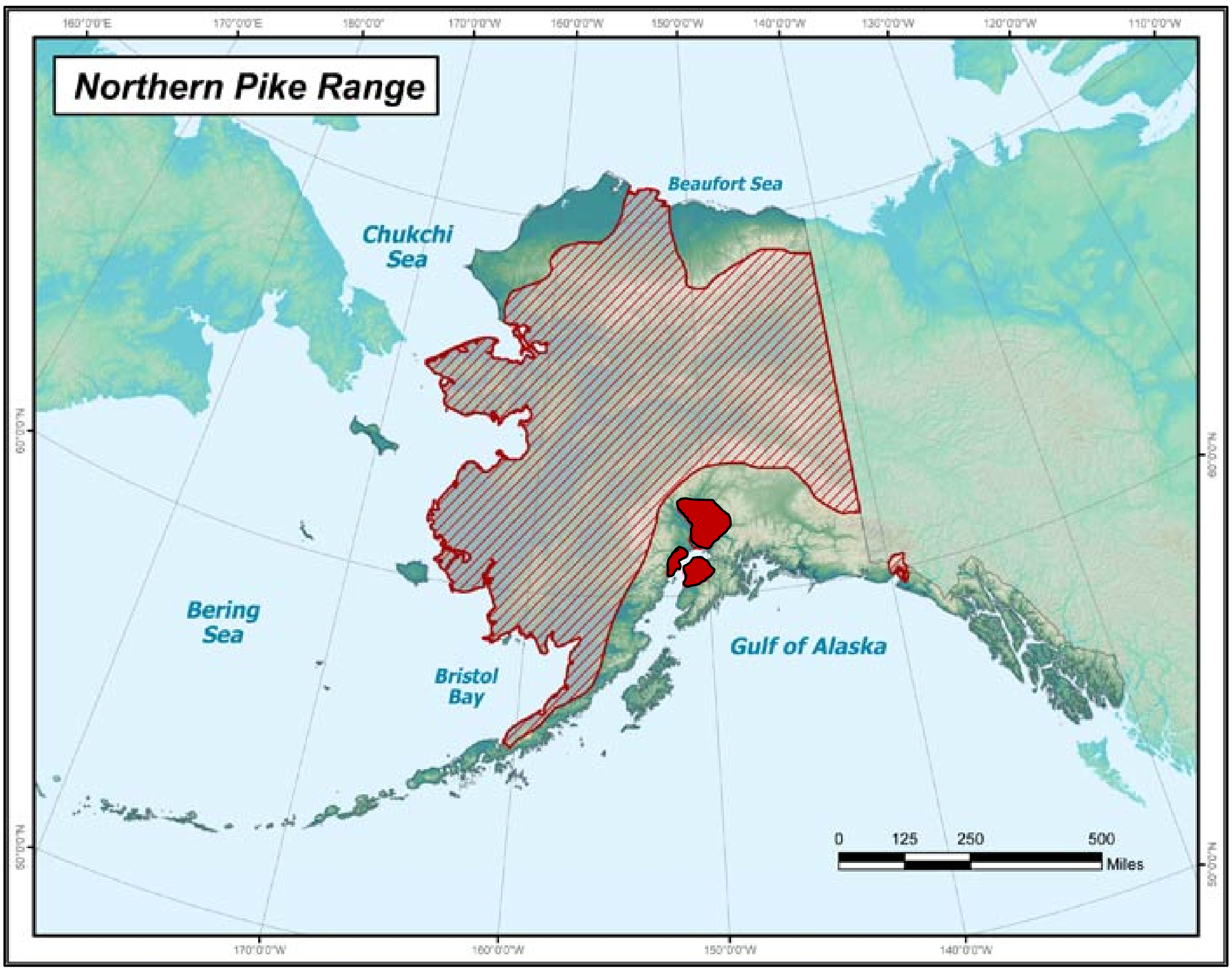

Figure 1.–Native and invasive ranges of northern pike; solid red delineations indicate the invasive range.

OBJECTIVES

This project will lay the groundwork for the eventual eradication of invasive northern pike from the Cottonwood Creek drainage by conducting biological assessments of 2 lakes known to contain invasive northern pike (Anderson and Kings lakes), surveying Little Niklason and Mud lakes for the presence of northern pike, collecting water quality data and bathymetric data from all drainage lakes, developing a preliminary pike eradication plan, and conducting public scoping to determine the level of support for eradication.

PRIMARY OBJECTIVES

1) Detect the presence of northern pike in Little Niklason and Mud lakes during the spring of 2017 such that the probability of detection is 0.99 given the population is at least 4 northern pike.
2) Estimate the mean CPUE of northern pike in Anderson and Kings lakes such that the estimate is within 3.5 fish of the true value 95% of the time in Anderson Lake and within 2.3 fish of the true value 95% of the time in Kings Lake.

SECONDARY OBJECTIVES

1) Collect and analyze eDNA samples for all Cottonwood Creek drainage lakes where northern pike are not captured in gillnets to verify the absence of northern pike in these lakes.
2) Map Anderson, Kings, Mud, and Little Niklason lakes to verify surface acreage and volume.
3) Measure water quality (temperature, dissolved oxygem (DO), pH, specific conductance) monthly from Anderson, Kings, Mud, and Little Niklason lakes.
4) Calculate the mean catch per unit effort (CPUE) of juvenile salmonids and resident fishes in Anderson and Kings lakes.
5) Inventory dominant invertebrate taxa from Anderson and Kings lakes.
6) Document waterfowl usage of Anderson and Kings lakes.
7) Prepare a pike eradication plan and solicit public input.

METHODS

STUDY AREA

The Cottonwood Creek Drainage encompasses 70 mi^2 between Palmer and Wasilla and contains the following interconnected lakes: Kings, Anderson, Dry, Niklason, Little Niklason, Cornelius, Cottonwood, Mud, and Wasilla lakes (Table 1; Figure 2). Of the drainage lakes, only Anderson and Kings are known to have established populations of northern pike. The drainage lakes vary considerably in size and degree of northern pike habitat. Known size and habitat information for the drainage lakes is summarized in Table 1. Bathymetry for Anderson, Kings, Mud, and Little Niklason lakes will be updated during the fall of 2016.

Table 1.–Lakes of Cottonwood Creek drainage.

Lake	Northern pike habitat	Littoral area (acres)	Surface area (acres)	Volume (acre-ft)	Max depth (ft)	Notes
Kings	Good	123	154	1,139	23	East edge has good pike spawning habitat; known pike presence
Anderson	Good	101	135	1,404	28	East edge has good pike spawning habitat; known pike presence
Dry [a]	Good	20	20	120	6	Pike spawning habitat may be limited
Niklason	Marginal	36	72	11,309	57	Poor pike spawning habitat except the west side
Little Niklason [a]	Very good	33	33	198	6	Potential strong-hold; good pike habitat throughout
Cornelius	Poor	29	48	1,088	54	Good rainbow trout habitat
Cottonwood	Poor	131	262	2,835	39	Good rainbow trout habitat
Mud	Unknown	55	55	181	17	Primarily a duck pond
Wasilla	Poor	187	374	6,412	48	Rainbow trout and sockeye salmon fisheries; SWHS records of pike

[a] No previous bathymetric survey exists; sites are estimated from Google Earth[2] but bathymetric surveys will be conducted in August 2016 that will be used to determine netting effort.

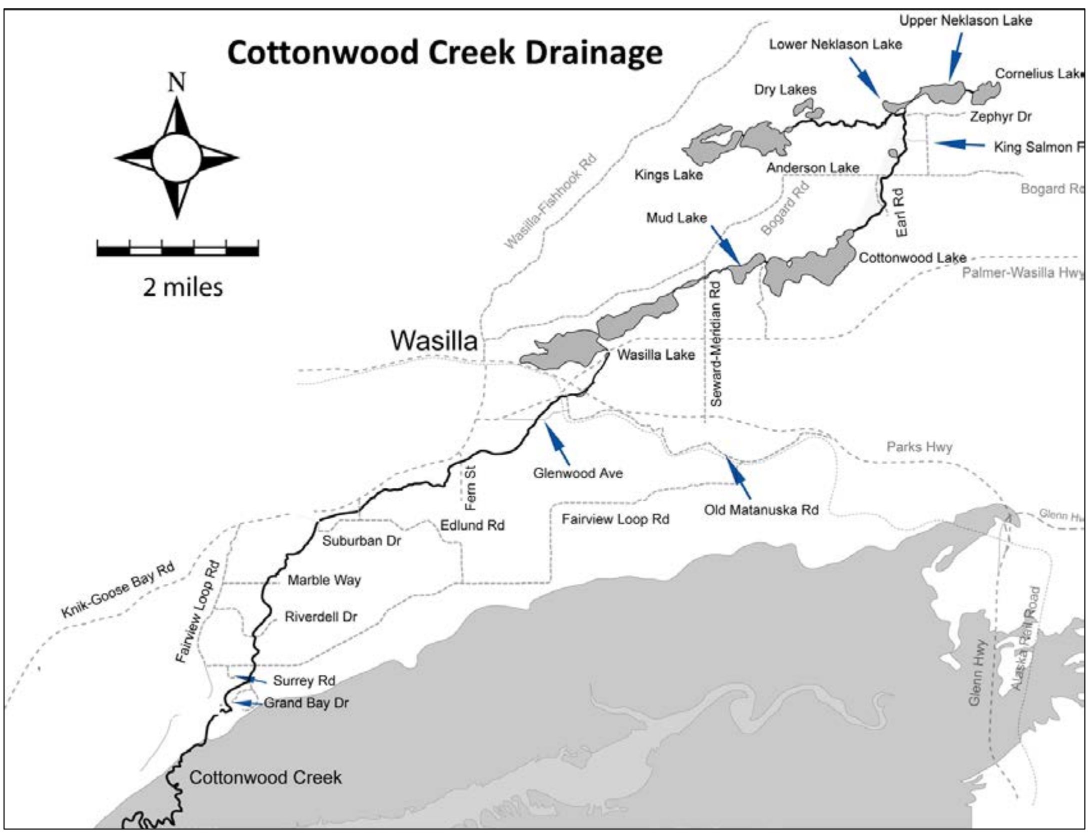

Figure 2.–Cottonwood Creek drainage.

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[2] Product names used in this publication are included for completeness but do not constitute product endorsement.

STUDY DESIGN–PRIMARY OBJECTIVES

Northern Pike Presence in Little Niklason and Mud lakes (Objective 1)

An important step in this project will be to learn if northern pike in the Cottonwood Creek drainage are actually restricted to Kings and Anderson lakes. This will involve intensive sampling of Little Niklason and Mud lakes with gillnets set in the vegetated littoral zone of each lake. Little Niklason Lake is the first lake directly downstream from Anderson Lake and it probably contains some of the best northern pike habitat in the entire Cottonwood Creek drainage. If northern pike are detected in the netting effort on this lake, we will know definitively that northern pike have escaped the Kings–Anderson lakes complex and have spread farther down the Cottonwood Creek system. This would then indicate the need for a broader eradication plan that encompasses more lakes in the system.

Mud Lake is located between the 2 largest lakes in the Cottonwood Creek drainage: Cottonwood Lake and Wasilla Lake. These 2 lakes account for some of the highest native rainbow trout production in the Matanuska–Susitna Valley. Cottonwood and Wasilla lakes are also large rearing lakes for wild sockeye and coho salmon. Mud Lake is the second to the last lake in the Cottonwood Creek system and the final lake to provide any decent northern pike habitat. Intensive netting in Mud Lake will allow us to avoid netting in Cottonwood and Wasilla lakes, which would cause a great deal of unwanted bycatch. Because Mud Lake is located downstream of Cottonwood Lake, it can be concluded that if northern pike are detected in Mud Lake, northern pike are also present in Cottonwood and Wasilla lakes. If northern pike are detected in Mud Lake, and therefore Cottonwood and Wasilla lakes, the northern pike eradication plan for the Cottonwood Creek drainage will probably not be implemented due to the size of the area and the native fish productivity of all of the lakes in the system.

Gillnets are frequently used for the detection and suppression of invasive northern pike in Alaska (Rutz and Dunker *In prep*; Sepulveda 2013). Gillnets are most effective when fished in optimal habitat conditions for northern pike which typically include slow moving streams and sloughs and the shallow bays, embankments, and densely vegetated littoral zones of lakes (Inskip 1982).

Sampling Effort for Meeting Objective 1

To quantify the netting effort necessary to detect a northern pike population of at least 4 fish, we employed a method used following rotenone applications in Southcentral Alaska to evaluate treatment success in removing northern pike populations. In the spring and the fall of 2005, 2006, and 2007, northern pike were removed from Derks and Sevena lakes with gillnets and a subsequent removal estimate of abundance was calculated for each event per lake. The estimated northern pike catch rate for the final 24-hour day of netting (Table 2) provided the basis for assessing our ability to detect a small abundance of northern pike (4 individuals) in other lakes.

The capture rate in Derks Lake during the fall of 2005 (0.085) was one of the lowest observed during 3 years of northern pike removal efforts on the Kenai Peninsula (Table 2) and serves as a conservative surrogate to estimate northern pike detection probabilities in other lakes with small northern pike abundances.

Table 2.–Historical net effort, catch, and removal population estimates for Derks and Sevena lakes during 2005–2007.

	Sevena Lake (33.51 littoral zone surface acres)						Derks Lake (18.89 littoral zone surface acres)					
	2005		2006		2007		2005		2006		2007	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Last day catch	5	27	7	3	2		6	15	1	12	10	32
Total seasonal catch	643	1,403	344	38	10		143	312	74	276	80	469
Population estimate +1SE	680	1,435	359	44	11		153	474	75	394	86	1,444
Nets fished per day	12	12	12	12	24		12	12	12	12	24	24
Number of removal events	16	14	12	4	2		10	15	12	11	4	15
Population estimate at beginning of last sampling day	42	59	22	9	3		16	177	2	130	16	1,007
Capture rate on last day	0.118	0.454	0.318	0.333	0.727		0.377	0.085 [a]	0.500	0.092	0.625	0.032
Percent of available population caught per net on last day	0.010	0.038	0.027	0.028	0.030		0.031	0.007	0.042	0.008	0.026	0.001
Net density (nets/littoral surface acres)	0.358	0.358	0.358	0.358	0.716		0.635	0.635	0.635	0.635	1.271	1.271

[a] Although the catch rate on the last day of netting at Derks Lake during the fall of 2007 was the lowest estimated, it was disregarded because of suspected emigration of northern pike during the removal. The second lowest rate was estimated at Derks Lake in the fall of 2005 and emigration did not appear to be occurring during the removal period. As a result, the capture rate of 0.085 is used to estimate the probability of not detecting a northern pike for other lakes.

The probability of failing to detect any of 4 remaining northern pike (D_p) in a lake of known littoral zone surface acreage with a given amount of netting effort (net density and days of fishing) can be estimated as follows:

$$D_p = \hat{P}_f^{\wedge(T \times R)} \qquad (1)$$

where

$\hat{P}_f$ = the estimated probability that none of 4 remaining fish are captured on the final day of netting at Derks Lake with 0.364 gillnets/surface acre

= 0.605,

T = number of days of gillnetting effort (24-hour day), and

R = relative net density

where

$$R = \frac{N/A}{0.364} \qquad (2)$$

and

N = desired number of nets to set in lake to be evaluated,

A = littoral zone acreage of lake to be evaluated, and

0.364 = nets per littoral-zone-acre used at Derks Lake on last day of netting during the fall of 2005.

The 0.085 capture rate (most conservative from Table 2) can be viewed as the probability of capture per individual fish in a single 24-hour-day of gillnetting effort where gillnet density is equal to 0.364 nets per littoral-surface-acre. Therefore, the probability that an individual fish will not be captured under those conditions is equal to 1 minus 0.085 or 0.915. The probability of not capturing any of 4 fish given that 4 fish remain in a particular lake ($\hat{P}_f$) is 0.915^4 or 0.701. A spreadsheet with these formulas was used to calculate the nondetection probabilities listed in Table 3 and used to calculate the netting effort needed to meet the objective criteria for Little Niklason and Mud lakes.

For this project, 40 nets will be deployed in both Little Niklason and Mud lakes. To obtain a probability of nondetection of less than 0.01, Little Niklason Lake will need to be sampled for 8 days and Mud Lake will need to be sampled for 14 days (Table 3).

Gillnet nets will be deployed in the vegetated littoral zone of both lakes on a Monday morning and fished continuously through their sampling period. Staff will be present at both lakes every day to check the nets, collect and record data, and attempt to free any bycatch. GPS coordinates will be collected at all net locations. Ideally, nets will either remain or be redeployed in the same locations as they were initially set. However, net locations may be altered if bycatch rates are high.

If northern pike are detected in a particular lake, netting will be halted in that lake because northern pike presence will have been established and to prevent further bycatch.

Table 3.–Probabilities of not detecting a small northern pike population (N = 4) in Little Niklason and Mud lakes for 1 to 14 days of netting with 0.364 nets per littoral surface acre.

	Lake	
	Little Niklason	Mud
Days	40 nets	40 nets
1	0.51	0.67
2	0.26	0.45
3	0.13	0.30
4	0.07	0.20
5	0.03	0.13
6	0.02	0.09
7	0.01	0.06
8	0.00	0.04
9	0.00	0.03
10	0.00	0.02
11	0.00	0.01
12	0.00	0.01
13	0.00	0.01
14	0.00	0.00

CPUE of Northern Pike in Anderson and Kings Lakes (Objective 2)

During early fall 2016, field crews will also deploy 18 gillnets and 20 minnow traps in the littoral zone of each lake to estimate the mean CPUE of pike and all other fish combined. All gillnets and minnow traps (baited with salmon roe) will be set for a 24-hour period in each lake. All net and trap locations will be numbered and GPS coordinates will be recorded for each set. All captured northern pike will be removed from the lakes and dissected to identify sex and to enumerate stomach contents to the lowest degree of taxonomic resolution possible. Netting and trapping efforts will be duplicated in the spring of 2017 to eliminate issues arising from any seasonal effects on fish movements.

Number of Sampling Nets for Meeting Objective 2

Because all nets and traps will be set for 24 hours, CPUE will be treated as the mean catch per 24 hours of effort. The number of nets needed to obtain the objective criteria was calculated from

$$n = \left(\frac{Z\alpha/_2\, s}{E}\right)^2 \tag{3}$$

where

$Z\alpha/_2$ = probability from the standard normal distribution

= 1.96

s = estimated standard deviation

where

$$s = \frac{(\max catch\ per\ set - \min catch\ per\ set)}{4} \tag{4}$$

and where "max" and "min" come from the biologists and

E = maximum error of the estimate.

The numbers of nets needed to meet Objective 2are listed in Table 4.

Table 4.–Number of nets needed to estimate the mean CPUE of northern pike within 3.5 fish of the true value 95% of the time in Anderson Lake and within 2.3 fish of the true value 95% of the time in Kings Lake.

Anderson Lake		Kings Lake	
Error (number of fish)	Sample size (number of nets)	Error (number of fish)	Sample size (number of nets)
1	216	1	96
2	54	2	24
3	24	2.3	18
3.5	18	3	11
4	14	4	6
5	9	5	4

STUDY DESIGN–SECONDARY OBJECTIVES

eDNA Assessment of Northern Pike Distribution

Assessment of environmental DNA (eDNA) is a relatively new technique where the presence of an aquatic species can be determined through quantitative polymerase chain reaction (qPCR) amplification of shed DNA material present in water samples. This technique is thought to be more sensitive than traditional fisheries approaches for detecting taxa in low abundance (Ficetola 2008). ADF&G and the United States Fish and Wildlife Service (USFWS) recently partnered to develop and test eDNA markers for northern pike (Olsen et al. 2015), and ADF&G is now using eDNA to survey for northern pike and evaluate the success of current northern pike eradication projects (Dunker et al. 2016). For this project, we have sufficient funding to collect and analyze approximately 150 water samples from lakes in the Cottonwood Creek drainage where northern pike are not presently known to occur. We'll distribute these samples proportional to the surface acreages of each lake (Table 5). Because eDNA is theoretically more sensitive than gillnetting, this assessment is meant to verify the results of the netting surveys. If we find positive eDNA detections in lakes where northern pike are not captured in gillnets, this will indicate the need to collect more eDNA samples and conduct targeted netting in those locations (Dunker et al. 2016). Because Anderson and Kings lakes have confirmed northern pike populations, eDNA samples will not be collected from those two lakes. If gillnet surveys detect northern pike in Little Niklason or Mud lakes, no eDNA samples will be taken and instead, sampling will be allocated elsewhere in the drainage. Latent sources of northern pike eDNA (i.e., sources not from living fish but rather from sediment release, upstream sources, etc.) are potential sources of error when using this technique (Dunker et al. 2016). For this reason, we will conduct gillnet surveys prior to collecting eDNA samples. If collected in reverse, it would be difficult to discern whether eDNA detections were from proximate live fish or from sources upstream. Some ambiguity in eDNA results may remain, but if there are any positive eDNA results in lakes where gillnets do not capture northern pike, then either follow-up netting, additional eDNA sampling, or both will be needed to definitively prove the presence or absence of northern pike in those lakes.

Table 5.–Number of eDNA samples that will be collected in proportion to total surface area of lakes in the Cottonwood Creek drainage given there are 150 samples..

Lake	Approximate surface acreage of lake	Proportion of total surface acreage (%)	Number of eDNA samples to collect
Dry	20	2	3
Niklason	72	8	13
Little Niklason	33	4	6
Cornelius	48	6	8
Cottonwood	262	30	45
Mud	55	6	10
Wasilla	374	43	65
Total surface acres	864	100	150

Sample site locations in each lake will be determined after new bathymetric maps are generated. Samples will not be distributed randomly through each lake. Instead, because we have a limited number of samples we can collect, we will target favorable northern pike habitat. After the new lake maps are generated (see Lake Mapping section), we will identify the best areas to sample within each lake and will partition samples as evenly as possible within the littoral zones of those areas. Site selection will be finalized during the winter of 2017.

Each eDNA sample will consist of a 1-liter composite sample collected using a Nasco Swing Sampler[3]. The swing sampler has a long handle that can extend to 12 ft (3.7 m). At one end is a clamping device that can hold the sample bottle. The clamping device can be rotated between zero and 90 degrees in relation to the handle axis. Fixing the sample bottle at an angle to the handle axis facilitates holding the sampling bottle upside down (open end facing downwards) as it enters the lake and forms an airlock. To fill the bottle at a desired depth, the handle is rotated to break the airlock and the sample bottle fills. When collecting each composite sample, we will grab water from 3 different depth strata: 1) within 1 foot of the lake surface, 2) the midwater column, and 3) within 1 foot of the lake bottom. Each discrete depth stratum sample will contribute approximately one-third of the (1 L) composite sample volume.

While at each lake, we will collect a field blank (of the same volume used for the lake sampling) using deionized water. The field blanks will be handled and transported using the same protocols as the study samples. For each sampling period, we will also prepare a single travel blank that will accompany us while collecting field samples. The travel blank will be prepared in the lab using deionized water and will be transported to and from the field in the coolers used to transport the study samples. This will help determine whether we are getting false positive detections from handling or transport and shipping. Before taking a sample at each sampling site, the collector will wear new nitrile gloves and the swing sampler will be disinfected with a 10% bleach solution and triple rinsed with deionized water to reduce the chance of cross-contamination of samples between lakes or sample sites. All samples collected in the field will be chilled by packing them in ice inside an insulated cooler.

Within 2 days of sample collection, all samples will be filtered at the Fort Richardson Hatchery Facility using a GeoTech series II peristaltic pump and 0.45 µm nitrocellulose membrane filters. After filtering, all membrane filters from unique samples will be stored in separate vials and placed into cold storage. If multiple filters are required to filter a single sample, all can be

[3] Product names used in this publication are included for completeness but do not constitute product endorsement.

combined in a single vial. Each day samples are filtered, a 1-liter control sample filled with deionized water (a "lab blank") will be filtered to detect contamination during the filtering process. All field water sampling, equipment decontamination, sample filtering, and storage are designed to follow established eDNA protocols (Wolt 2015). After samples are collected, filtered, and placed in cold storage, they will be transferred to the USFWS Conservation Genetics Lab in Anchorage for qPCR analysis. The USFWS will then inform us of all detection results.

Lake Mapping

Before rotenone treatments can be conducted in any of the drainage lakes where northern pike are confirmed, there is substantial field monitoring necessary for project planning and permitting. To begin, volume estimates must be verified for all drainage lakes, and updated bathymetric maps need to be generated. We will use a boat-mounted Lowrance HDS 7 survey unit and transducer to record depth and bottom structure by driving a boat in concentric circles around each lake from the shoreline inward to the center. Transects will be spaced approximately 40 meters apart, and this can be gauged by watching the GPS track on the Lowrance unit's monitor. After concluding each survey, the depth and bottom structure data will be downloaded to a computer and submitted to ciBiobase Inc., a mapping company that will run algorithms on the data and generate volume estimates and detailed bathymetric maps of each lake (Appendix A1).

Water Quality Monitoring

Water quality parameters including temperature, pH, turbidity, and dissolved oxygen will be collected monthly for 1 year in King, Anderson, Little Niklason, and Mud lakes in 1-meter increments from the deepest areas of each lake. GPS coordinates of all locations will be collected for repeatability. The water quality parameters will be collected using a portable YSI 556 unit, and a secchi disk will be used to measure turbidity. Samples will be collected from a boat during open water and by drilling through the ice during the winter. These seasonal data are important for eventual rotenone treatment planning and permitting.

Stream discharge information is also needed for estimating the necessary amounts of rotenone and potassium permanganate (used to neutralize rotenone) and for calculating the appropriate application rates of those chemicals. Stream discharge measurements will be collected from the outlets of Anderson and Kings lakes during water quality sampling in May 2017. Measuring techniques will comply with United States Geological Survey (USGS) specifications as described in Nolan and Shields (2000).

Biological Assessments of Kings and Anderson Lakes (CPUE of Salmonids, Invertebrate Taxa, and Waterfowl Usage)

Pretreatment biological assessments of Anderson and Kings lakes, the 2 lakes within the Cottonwood Creek drainage known to have northern pike, will also be conducted. Macroinvertebrate and plankton surveys will be collected in both Anderson and Kings lakes to document the dominant taxa and their relative abundance. In each lake, zooplankton evaluations will be made at 2 sites by replicate vertical tows using a 0.5 meter diameter Wisconsin net with 153 µm mesh at different locations near maximum lake depth. The Wisconsin net will be lowered to just above the lake bottom near maximum depth and then retrieved at a rate of 1 meter every 2 seconds. Zooplankton samples will be analyzed to a reasonable degree of taxonomic resolution and relative abundance. An Ekman dredge will be used to collect bottom sediment from 2 sites at both lakes; sediments will be screened to extract any invertebrates for later identification. Kick nets will be used to collect invertebrates along vegetated shorelines in 3 locations from both lakes. At both lakes, attempts will be made to visually locate and collect freshwater mussels and snails. All sample locations will be recorded with a GPS to ensure repeatability of site selections. All invertebrate specimens from all collection efforts will be preserved in 90% ethanol, labeled with the date, collector initials, and site location, and archived for later evaluation.

In addition, all waterfowl, amphibians, and mammals observed during these sampling events will be noted.

Eradication Planning and Scoping

After conducting the biological and physical assessments of Anderson and Kings lakes and surveying the remainder of the drainage with eDNA samples and gillnets (in Little Niklason and Mud lakes), a northern pike eradication plan will be written. This plan will provide the details necessary to conduct rotenone treatments in these lakes and will serve as the basis for the public scoping process to determine the level of interest and support for removing northern pike from the affected lakes in the drainage.

This public scoping process will compose the final component of this project phase. A planning firm will be hired to facilitate public scoping with ADF&G on proposed northern pike eradication plans, conduct stakeholder interviews, and administer and evaluate public surveys on the topic. The results of the scoping process will be submitted to ADF&G in a report for determination on whether or not to proceed with the eradication activities. It is anticipated that there will be public support for this project. If that is the case, our next step will be to begin soliciting funds for the permitting, fine-scale planning, and eradication activities in the drainage.

DATA COLLECTION

Northern Pike Presence in Little Niklason and Mud lakes

All fish captured in gillnets will be counted and identified to species. Catch of all species other than northern pike will be recorded on the “Bycatch Form” (Appendix B1), and all fish other than northern pike will be released immediately. The fork lengths (FL; tip of nose to fork of tail) of all captured northern pike will be measured and recorded to the nearest millimeter. We will dispatch all captured pike on-site and will record their sex, maturity, and stomach contents (Appendix B2). Guidelines for completing the catch and sampling forms are found in Appendix B3.

CPUE of Northern Pike in Anderson and Kings Lakes

For each net or trap set, all captured animals will be enumerated by species. The date, net or trap number, GPS location, net or trap set time, and net or trap pull time will also be recorded. All salmonid individuals and resident fish will be released alive, if possible. Data for each day’s catch will be recorded in the bycatch and northern pike forms in Appendices B1 and B2.

eDNA Assessment of Northern Pike Distribution

Prior to collecting eDNA samples, approximate sample locations will be numbered and identified on a bathymetric map of each lake. Sample bottles will be labeled with the name of the lake, date, sampler initials, and sample number. An Excel spreadsheet of this information will be prepared prior to field sampling and printed to bring in the field. During sampling, the time each sample was collected will be recorded as well as notes on the day's weather conditions. These times will be entered in the Excel spreadsheet. During sample filtering, the time and date each sample was processed will also be recorded. Finally, while sampling in the field, GPS coordinates of all sample sites will be collected, and GIS maps will later be generated to illustrate sample locations in each lake.

Lake Mapping

All lake mapping data will be collected and stored digitally on a Lowrance HDS 7 GPS unit and stored on an SD card until it can be downloaded and submitted to ciBiobase. ciBiobase will then generate and supply bathymetric maps and volume estimates similar to that illustrated in Appendix A1.

Water Quality Monitoring

Monthly water quality data (temperature, dissolved oxygen, pH, and specific conductance) will be collected using a YSI 556 unit. All measurements will be recorded on data sheets in the field (Appendix B4) and entered into an Excel file to graph seasonal patterns.

Biological Assessments of Kings and Anderson Lakes (CPUE of Salmonids, Invertebrate Taxa and Waterfowl Usage)

All observed waterfowl taxa will be noted in a field notebook. During invertebrate surveys, invertebrates will be collected in the field and later identified down to the lowest known taxonomic level and entered into an Excel file in the lab.

DATA REDUCTION

Paper data forms completed by field crews for the gillnetting, water quality monitoring, and biological assessments of Anderson and Kings lakes will be entered into Microsoft Excel data files.

DATA ANALYSIS

Northern Pike Presence in Little Niklason and Mud lakes

If northern pike are detected, we will know that northern pike presence has been established.

If northern pike are not detected given the sample size determined above, we will conclude that either no northern pike are in the lake or that there is a population of less than 4 northern pike in the lake (probability of nondetection error <0.01).

CPUE of Northern Pike in Anderson and Kings Lakes

Mean catch per 8-hour set will be calculated for each gear type and species following standard procedures for arithmetic mean and variance.

eDNA Assessment of Northern Pike Distribution

The United States Fish and Wildlife Service Conservation Genetics lab in Anchorage will perform all laboratory analyses of collected water samples and will provide either positive or negative results of eDNA detections for all samples.

Water Quality Monitoring

Water quality data for all drainage lakes will be summarized and presented in graphs to show seasonal patterns in each lake.

Lake Mapping

The mapping company ciBiobase will generate bathymetric maps and apply algorithms to our data to estimate lake size and volume. Bathymetric maps and data output files will be provided by ciBiobase to ADF&G within 2 weeks of data submission.

Biological Assessments of Kings and Anderson Lakes (CPUE of Salmonids, Invertebrate taxa, and Waterfowl usage)

Invertebrate taxa will be ranked based on catch.

Counts of all waterfowl species observed during field excursions will be entered into our Excel data files.

SCHEDULE AND DELIVERABLES

Year	Dates	Activity
2016		
	March	Begin monthly water quality monitoring in Cottonwood Creek drainage lakes
	April	Monthly water quality monitoring
	May	Monthly water quality monitoring
	June	Monthly water quality monitoring; subscribe to ciBiobase for lake mapping.
	July	Monthly water quality monitoring
	August	Monthly water quality monitoring; purchase gillnets; begin mapping drainage lakes
	29 August–2 September	CPUE surveys in Anderson and Kings lakes; biological assessments of Anderson and Kings lakes
	September	Monthly water quality monitoring; continue mapping drainage lakes; gillnet Little Niklason and Mud lakes to survey northern pike
	October	Monthly water quality monitoring; continue mapping drainage lakes
	November	Monthly water quality monitoring
	December	Monthly water quality monitoring
2017		
	January	Monthly water quality monitoring
	February	Monthly water quality monitoring
	March	Monthly water quality monitoring
	15 March–30 March	Gillnet Dry lake under the ice to survey for northern pike
	April–May	eDNA survey of drainage lakes
	May–June	Process eDNA samples
	June	Biological assessment of Anderson and Kings lakes; hire planner for public scoping
	July–September	Draft treatment plan for northern pike eradication in the drainage
	October	Public scoping
2018		
		Solicit funding and begin permitting for Phase 2

RESPONSIBILITIES

Cody Jacobson, Fishery Biologist I, Primary Project Biologist

Duties: Coordinate all field logistics, purchasing, and project implementation, enter and manage data, prepare project reporting and presentations to public.

Kristine Dunker, Fishery Biologist III

Duties: Provide oversight and make recommendations on study designs and project plans, assist with data analysis and project reporting, coordinate and assist with the completion of project deliverables.

Pat Hansen, Biometrician IV

Duties: Provide guidance on study design, review project operational plans and reports.

Dave Rutz, Fishery Biologist II

Duties: Assist project biologist with logistical planning and sampling, and provide input on study design.

Chris Ryzink, Fish and Wildlife Technician II

Duties: Assist with field work and data collection.

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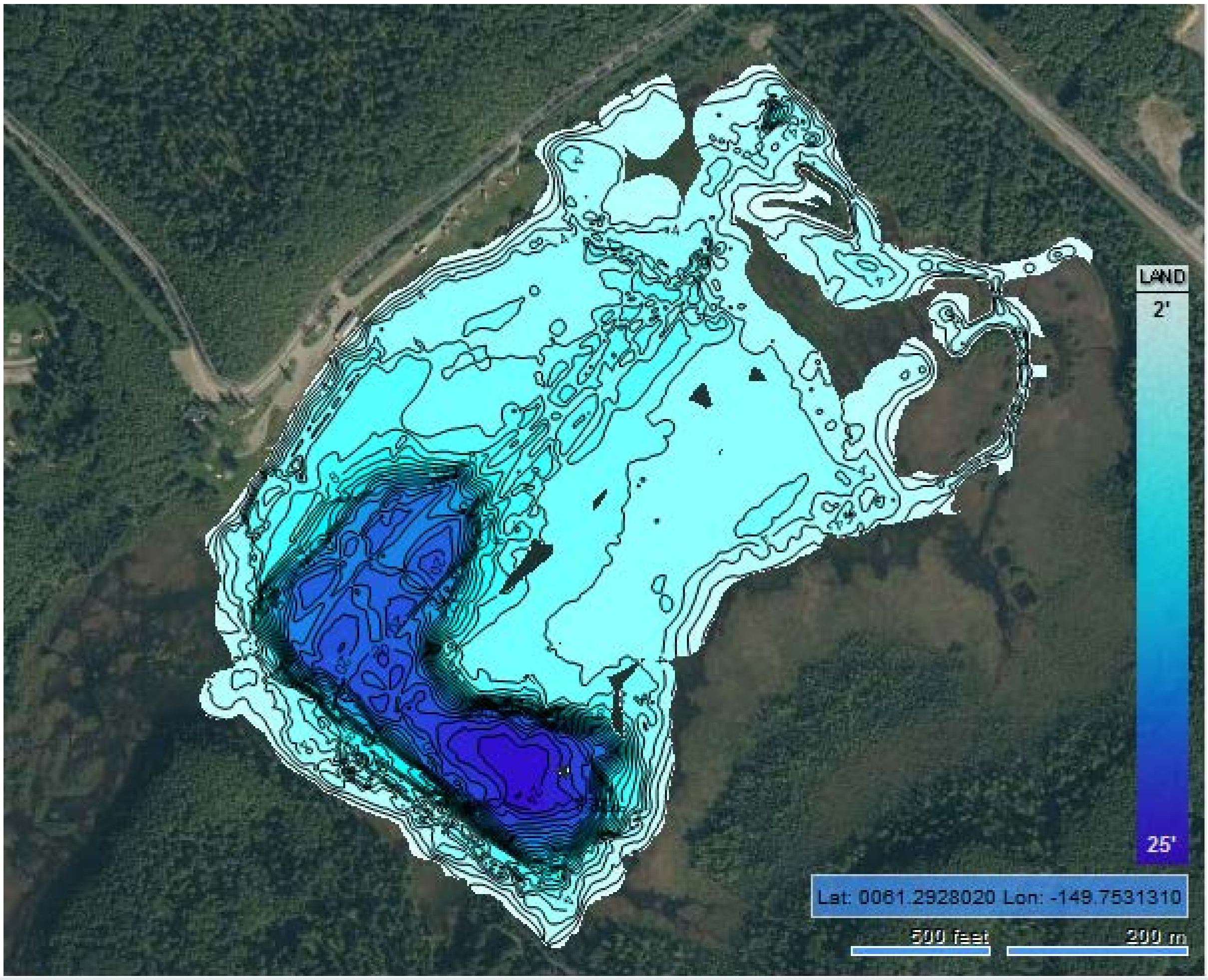
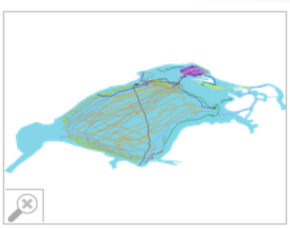
APPENDIX A: EXAMPLE OF BATHYMETRIC MAP



Otter Lake, Anchorage Municipality Alaska Generated: 9/4/2015 7:41:09 PM (UTC)

Waterbody Size: 60.14 ha *(148.60 acres)* report link



Data Collector
Jay Baumer

Data Collection Date
8/13/2015 12:16:33 AM (UTC)

Average Water Temperature
18.29° C (64.92° F)

Location
Start: 61.2854805, -149.73587036
End: 61.28646088, -149.73434448

Survey Size
Area: 48.02 ha (118.65 acres)
Percent: 79.84% of waterbody
Volume: 1,089,284.80 cu. m (883.10 acre ft)

Est. Waterbody Volume ?
1,364,443.10 cu. m
(1,106.17 acre ft)

Settings

Track Buffer:	25 m
Grid Cell Size:	5 m
Min. BV Detect:	5%
Min. Veg Depth Detect:	0.73152 m

Quality Control
Reviewer: Valley, Ray
Comments: See watervolume with new shapefile. Look at the thumbnail to see the new shapefile boundary. This should hopefully get you closer to the true volume

Survey Summary

	Type ?	PAC ?	Avg BVp ?	SD BVp ?	Avg BVw ?	SD BVw ?	Depth Range	Avg Depth	Distance	No. Points
Full Survey	Point	82.6%	29.9%	±23.4%	24.7%	±24.1%	0.5-7.59 m	2.06 m	34.72 km	11,620
	Grid	87.1%	29.4%	±22.6%	25.6%	±23.3%	0-7.63 m	2.26 m	-	15,556

Appendix A1.–Example of Bathymetric Map produced by ciBiobase.

Note: All Cottonwood Creek drainage lakes listed in Table 1 will be remapped in this format.

APPENDIX B: SAMPLING FORMS

Appendix B1.–Bycatch form.

Lake	Gillnet #	Date	Time	Intial Set (Y or N)	Northern Pike	Arctic Grayling	Whitefish	Longnose Sucker	Rainbow trout	Burbot	Chinook Salmon	Coho Salmon	Sockeye Salmon	Dolly Varden	Pink Salmon	Chum Salmon	Muskrat	Beaver	Vole	Bird Bycatch	GPS Coordinates

Appendix B2.–Northern pike sampling form.

Date: ________ **Lake:** ________________ **Gillnet #:** ________________

Pike #	Fork Length (mm)	Reproductive Product (M, E, or A)	Maturity (M,I,or U)	Ses (M or F)	Stomach Contents	Comments

Appendix B3.–Definition of terms for catch and sampling forms (Appendices B1 and B2).

Gillnet #: Assign each net a number in numerical order as they are set

GPS loc: Shoreline start of net

Species: Record everything caught, even birds and mammals

Mort: "X" for mortality of bycatch only. Pike assumed to be killed.

Reproductive Products: Before dissection of fish, squeeze to observe release of sex product

M= milt

E= eggs

A= absent

Maturity: Dissect fish.

M = mature (Gonads enlarged)

I = immature (Gonads not developed)

U = unknown

Sex: Mark only if absolutely known after dissection of fish.

M = male

F = female

U = unknown

Stomach Contents: common abbreviations for species.

KS=king salmon; SS=silver salmon; RS=red salmon; CS=chum salmon; PS=pink salmon; WF=white fish; LS=long nose sucker; SB=stickleback; RT=rainbow; GR=grayling; NP=northern pike; BB=burbot; DV=dolly varden; SC=sculpin; PL=pacific lamprey.

Other catch could be: macro invertebrates, rodents, other mammals, birds, leeches, frogs…

Appendix B4.–Water quality data sheet.

Lake: ____________________ **Sampler:** ____________________

Date: ____________________ **Time:** ____________________

	Temperature ºC	**Specific Conductance S/cm**	**Dissolved Oxygen mg/L**	**Dissolved Oxygen %**	**pH**
1 M					
2 M					
3 M					
4 M					
5 M					
6 M					
7 M					
8 M					
9 M					
10 M					
11 M					
12 M					
13 M					
14 M					
15 M					
16 M					
17 M					
18 M					

Visibility (m): ____________________

Ice Thickness (In): ____________________

Comments: