Fisheries and Aquatic Inventory of The Koyukuk, John, and Wild rivers, 2014

Ambler Mining District Industrial Access Road

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for

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Introduction

In 2009, the state of Alaska began studying the feasibility of a potential road to the Ambler Mining District located in the northwestern region of the state. The Alaska Department of Transportation and Public Facilities (ADOT&PF) was tasked with the preliminary work to identify, design, and potentially construct an access and transportation corridor road that would connect the Dalton Highway to the mining district. When the ADOT&PF evaluated potential routes, there were initially eight corridors being considered; however, only one of those routes, the Brooks East Corridor, was selected for field studies in preparation for the National Environmental Policy Act (NEPA) process. The corridor crossed several rivers including the Koyukuk and Alatna rivers located on the western end of the corridor near Bettles/Evansville. ABR. Inc. - Environmental Research and Services had conducted anadromous fish surveys throughout the corridor; however, there had not been any systematic sampling of fish or aquatic habitat. In 2013, the Alaska Industrial Development and Export Authority (AIDEA) contracted the Alaska Department of Fish and Game (ADF&G), Division of Habitat to conduct fish and fish habitat sampling within the Koyukuk, John, and Wild rivers. This sampling would aid the Division of Habitat in permitting specific portions of road development and would provide extensive data for the NEPA analysis. Fish and aquatic habitat sampling (Figure 1) was conducted by the Division of Habitat from July 1 through 14, 2014 and August 28 through September 7, 2014.

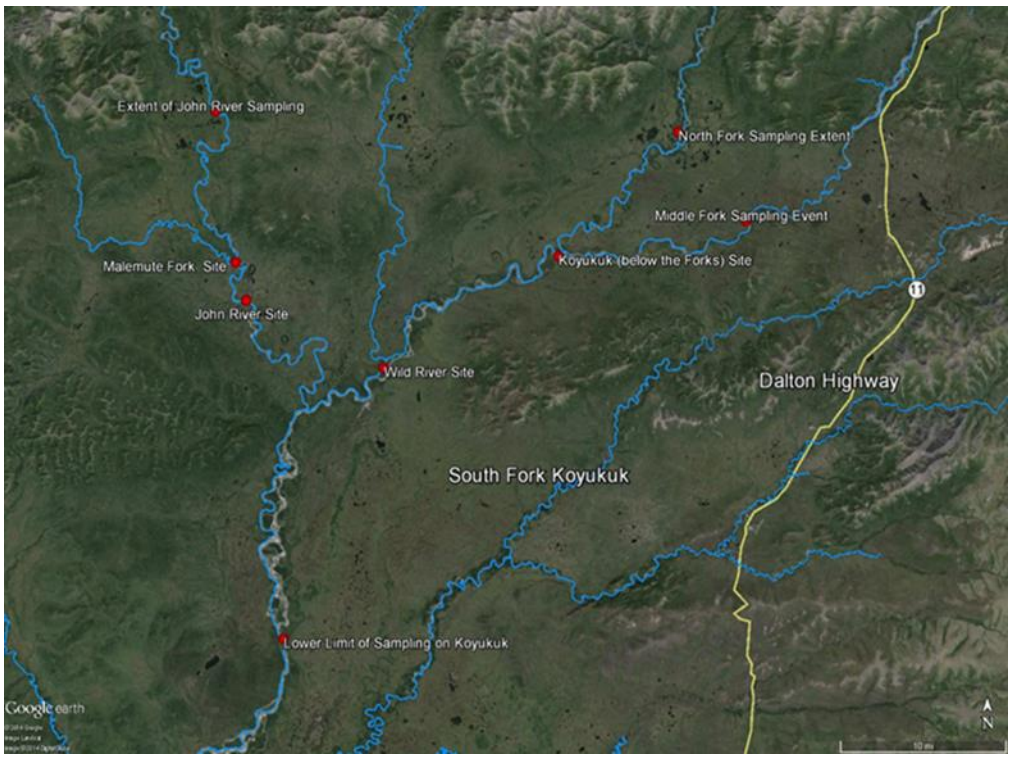

Figure 1. 2014 study area, including aquatic habitat sampling sites, and extent of fish sampling, on the Koyukuk, Wild, and John rivers.

Objectives

- Identify fish species assemblages in water bodies along the corridor.
- Collect fish samples to determine fish population characteristics and life history traits including length/age, age at maturity, diet, and fecundity.
- Measure water chemistry (pH, conductivity, turbidity, temperature).
- Invertebrate sampling to qualitatively and quantitatively identify lower trophic level productivity.

Methods and Results

Fish Sampling

Fish capture gear included gillnets, fyke nets, hoop nets, beach seines, and hook and line sampling. The efficiency of sampling gear was largely influenced by high water events encountered during the sampling periods. Fyke nets in the Wild River and in an unnamed channel located approximately 10 river miles upstream of Bettles had to be pulled and reset frequently which resulted in lower catch rates than anticipated. Additionally, the effectiveness of gillnets was reduced during high water events from debris entanglement. Electrofishing, hoop traps, minnow traps, and beach seines were our most productive capture gear and captured the majority of fish for population characterization work. Capture information for the spring sampling event is in Appendix A, and capture information for the fall event is in Appendix B.

Table 1. 2014 species composition from both summer and fall sampling events.

Fish	#	Minimum (mm)	Maximum (mm)	Mean (+/-SE) (mm)	% of Total Catch
Arctic grayling (*Thymallus arcticus*)	615	28	588	226.70 (**3.64**)	43.25%
Round whitefish (*Prosopium cylindraceum*)	180	25	390	180.43 (**6.55**)	12.66%
Longnose Sucker (*Catostomous catostomus*)	173	33	410	185.11 (**9.96**)	12.17%
Burbot *(Lota lota*)	121	91	930	432.62 (**14.48**)	8.51%
Lake chub (*Couesius plumbeus*)	110	30	133	86.74 (**2.21**)	7.74%
Slimy Sculpin (*Cottus cognatus*)	103	20	110	49.09 (**1.71**)	7.24%
Least cisco (*Coregonus sardinella*)	34	30	113	46.41 (**2.79**)	2.39%
Northern pike (*Esox lucius*)	30	55	705	390.53 (**29.84**)	2.11%
Humpback whitefish (*Coregonus pidschian*)	25	203	465	388.96 (**13.68**)	1.76%
Chinook salmon-juvenile (*Oncorhynchus tshawytscha*)	23	38	70	51.35 (**1.84**)	1.62%
Broad whitefish (*Coregonus nasus*)	3			538.67	0.21%
Sheefish (*Stenodus leucicthyes*)	3			593.67	0.21%
Arctic lamprey (Lethenteron camtschaticum)	2				0.14%

Ninety three fish were euthanized for further analysis (44 during the summer event, and 49 during the fall event). Data/samples collected in the field included fork length or total length depending on species (nearest mm), weight (nearest gram), stage of maturity,

gonadal weight (nearest gram) to determine gonadosomatic indices (GSI= ((weight/gonad weight) x 100), otoliths, and stomach contents. A complete description of dissection data is in Appendix C.

Table 2. Sexual maturity scale (Moulton 2010).

stage	maturity
1	immature
2	mature but not spawning this season
3	mature and spawning this season
4	mature and ripe
5	spent (post-spawn)
6	reabsorded eggs (did not spwan)

Arctic grayling

Arctic grayling (AG) are a popular sport and subsistence fish throughout mainland Alaska, inhabiting both rivers and lakes. In rivers they tend to be migratory fish relying on seasonal water conditions to guide their movements towards optimal habitats. They spawn in the spring after break-up and emerge from the gravels in approximately two to three weeks depending on water temperatures. They grow quickly their first few summers until eventually allocating their energy towards sexual maturity. Arctic grayling were abundant throughout the study area; captured fish had a mean fork length (FL) of 227 mm (range= 28–588; Figure 2). Twenty-two Arctic grayling were dissected, and based on stomach contents, chironomids (non-biting midges), mites, black flies, caddis flies, mayflys, stoneflys, copepods, and shrews made up their diet (Figure 3). Five females had eggs present indicating they were already allocating energy towards the 2015 spring spawning event. The mean FL of mature fish was 345.4 mm, and the mean gonadosomatic index (GSI) was 1.79%. Otoliths were aged to conduct length at age analysis and based on linear regression there was a negative correlation which indicates that there is no relationship between length at age, with some older fish displaying a shorter FL than was observed in younger fish. This is likely due to inconsistent food availability, or variability in the productivity of different habitats in which they reside. (Figure 4).

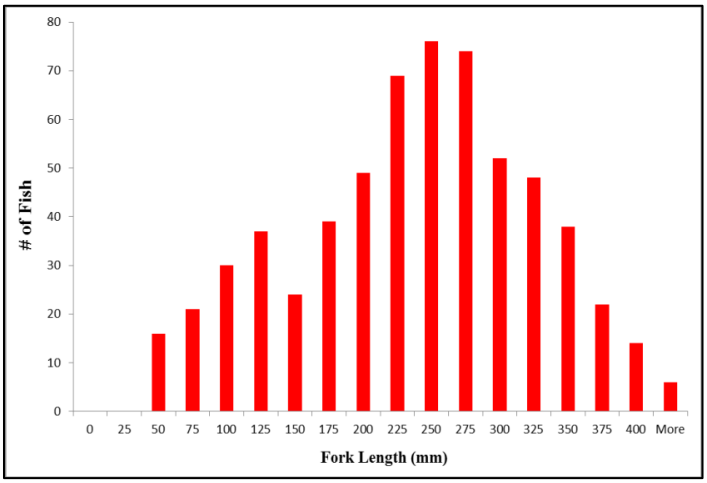

Figure 2. Length frequency for Arctic grayling.

Figure 3. A dissected Arctic grayling, a shrew and digested insect were removed from the stomach.

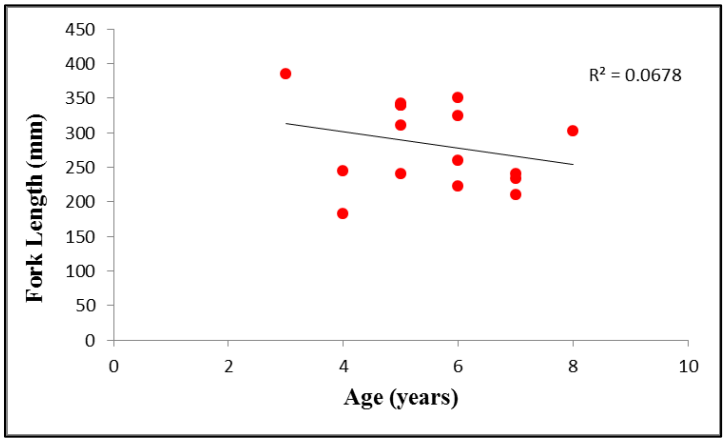

Figure 4. Length at age for dissected Arctic grayling.

Longnose sucker

Longnose suckers (LNS) were the third most abundant species captured (n=173). Captured longnose suckers had a mean FL of 227 mm (range= 28–588; Figure 5). They are distributed throughout Alaska, and are bottom feeders foraging primarily on invertebrates. All of the fish that were dissected (n=5) had empty stomachs. There is great variability in the documented length at maturity; in Western Lake Superior (Bailey 1969) estimated it to be 292 mm. They are spring spawners and three fish were classified as mature; the mean GSI was 3.63%, and the mean FL was 416.67 mm. Otolith analysis of two fish indicated that one fish was seven years old and mature (TL=397 mm), and the other eight years old (TL=290 mm).

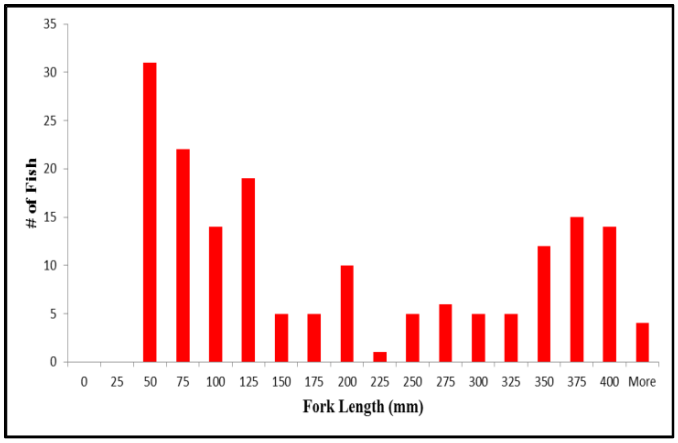

Figure 5. Length frequency for longnose sucker.

Burbot

Burbot (BB) were the fourth most abundant species captured (n=121) largely due to the effectiveness of hoop traps in the high water events that were encountered. Burbot are a voracious predator common throughout the lakes and rivers of Alaska. In the Koyukuk River drainage, they are a subsistence fish harvested under the ice in fish traps (Andersen et al. 2004). They are winter spawners, spawning under the ice in temperatures ranging from 1–4°C (McPhail and Lindsey 1970, Scott and Crossman 1973). Captured burbot had a mean total length (TL) of 443 mm (range= 91–930 mm; Figure 6). Twenty six burbot were dissected and 50% had empty stomachs; the remaining 50% of stomachs contained a wide variety of prey items including burbot, whitefish, slimy sculpins, juvenile salmon, and shrews (Figure 7). Thirteen burbot were classified as likely to spawn that winter; these fish had a mean TL of 537.22 mm (range= 330–842 mm), and mean GSI of 0.91%. One burbot was classified as immature and measured 420 mm. Otoliths were aged to conduct length at age analysis. Based on a linear regression there was a positive correlation between TL and age (Figure 8).

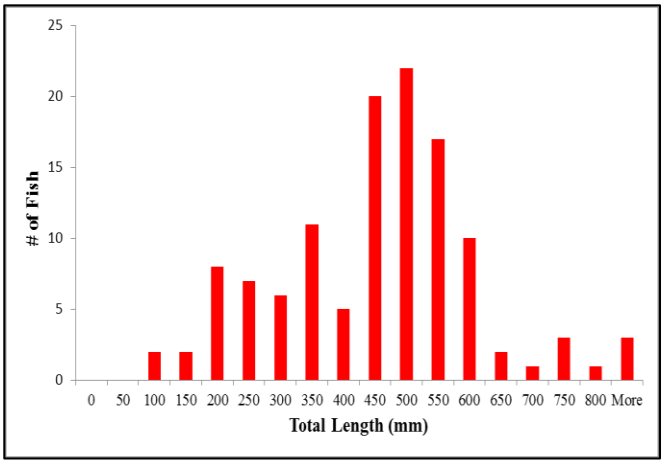

Figure 6. Length frequency for burbot.

Figure 7. A captured burbot with a smaller burbot in its mouth.

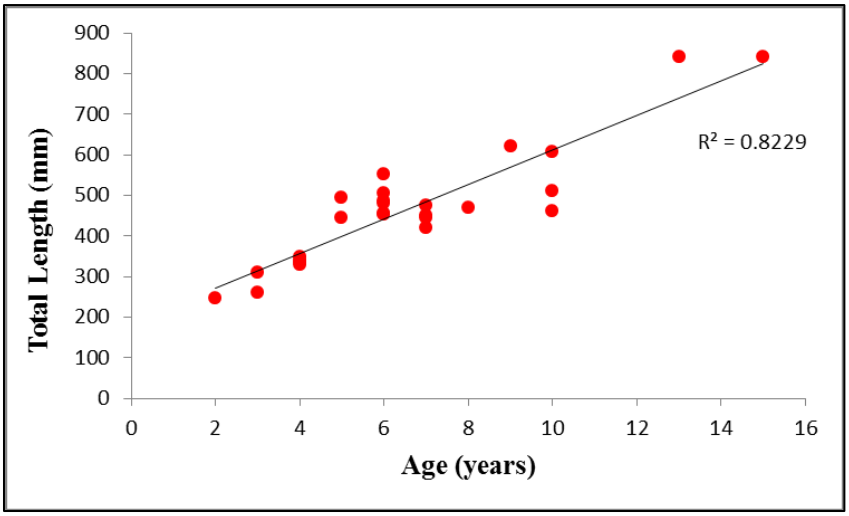

Figure 8. Length at age for dissected burbot.

Lake chub

Lake chubs (chub) were the fifth most abundant species captured (n=110), and were captured primarily in minnow traps and beach seines. In Alaska, lake chubs are known to exist only in the Yukon River and its tributaries (Mecklenberg et al. 2002). Little is known about them other than they spawn in the spring and summer; in British Columbia, Canada, they are thought to mature at age three or four, and do not survive past age 5 (Morrow 1980). Their diet consists primarily of freshwater crustaceans and zooplankton (Morrow 1980). On the Koyukuk River they are likely an important prey species for burbot, northern pike, and sheefish. The mean FL of lake chubs was 87 mm (range = 30–113; Figure 9). Four lake chubs were dissected; their stomachs contained partially digested insect larvae. Unfortunately, we were not able to collect any otoliths; however

we did classify one fish as an immature female (108 mm).

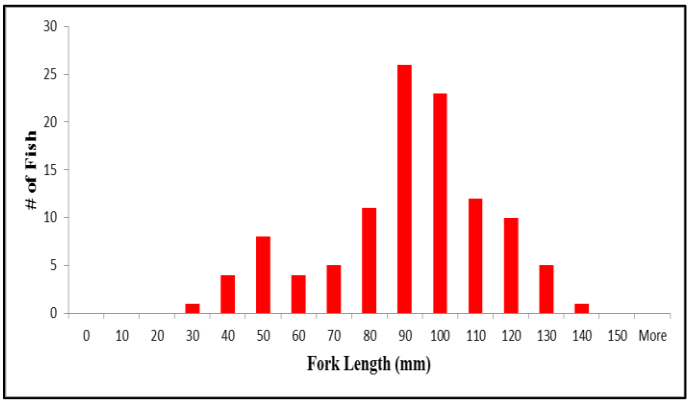

Figure 9. Length frequency for lake chub.

Slimy Sculpin

Slimy sculpin (SS) (n=103) are distributed in large numbers throughout the northern parts of North America, Canada, and Russia (Scott and Crossman 1973). There is little known about this species other than they spawn in the spring following break up, they are relatively sedentary, and typically eat aquatic insect larvae. One hundred three slimy sculpin were captured; the mean TL was 49 mm (range= 20–110 mm; Figure 10). On the Koyukuk River they appear to be an important prey species to burbot and northern pike, often showing up in dissected stomachs of those species.

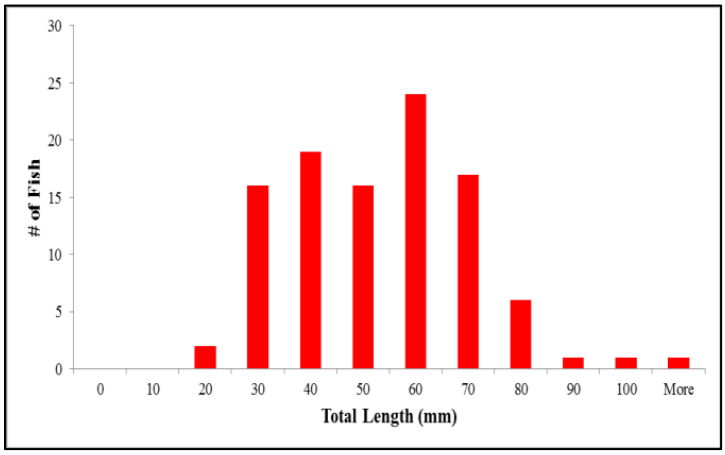

Figure 10. Length frequency for slimy sculpin.

Northern pike

Northern pike (NP) are an important subsistence fish often harvested in the fall along with whitefish (Andersen 2007). They are a voracious predator common to the Yukon River and its tributaries. In general, they are considered a sedentary fish and in the summer they are often found residing in clear, warm, heavily vegetated areas of rivers (Scott and Crossman 1973). Thirty fish were captured and had a mean length of 391 mm

(range = 55–705 mm; Figure 11). Sixteen fish were dissected: of those 31.25% had empty stomachs; the remaining stomachs contained various fish species (whitefish, Arctic grayling, and juvenile northern pike), insects, and shrews (Figure 12). During the fall, two pike were classified as mature and likely to spawn the following spring; their lengths were 655 and 665 mm, and their respective GSIs were 2.86% and 2.12%. Otoliths were aged to conduct length at age analysis, and based on a linear regression there was a positive correlation between TL and age (Figure 13).

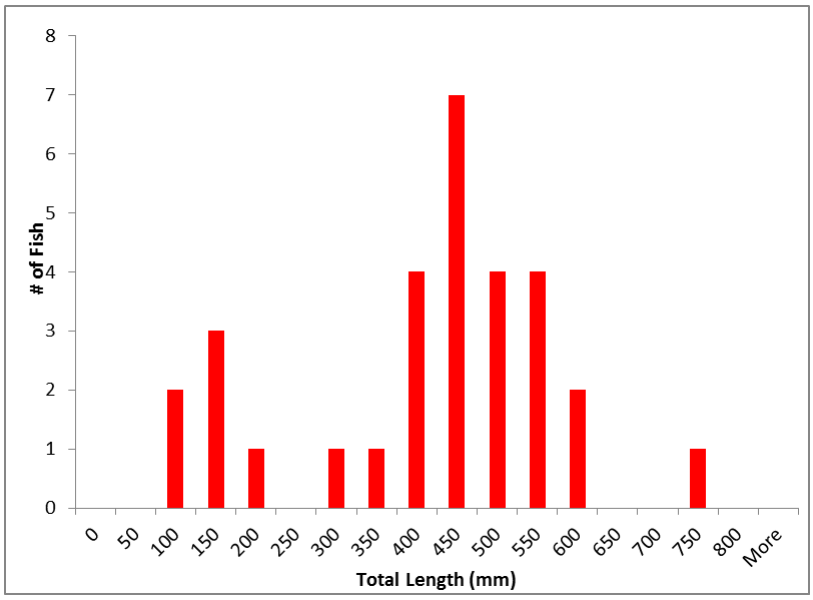

Figure 11. Length frequency for northern pike.

Figure 11. A dissected northern pike with a partially digested round whitefish in its stomach.

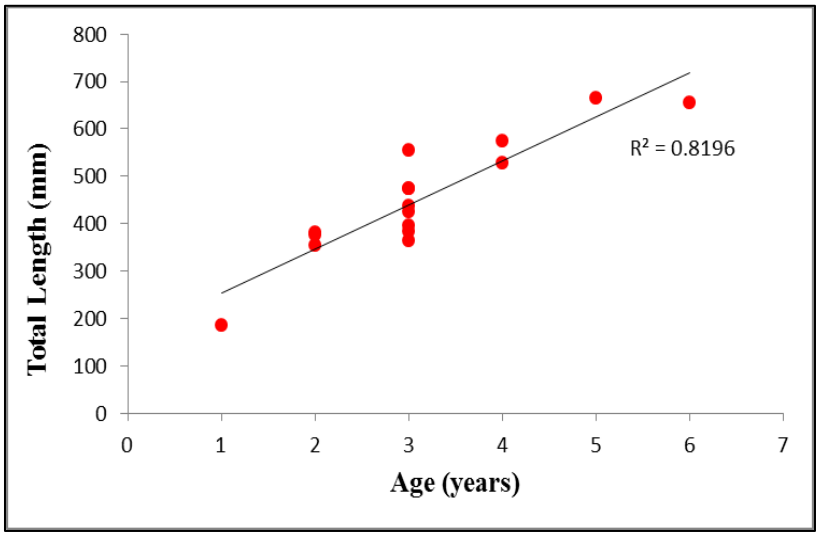

Figure 12. Length at age for dissected northern pike.

Round whitefish

Round whitefish (RWF) were the most abundant whitefish captured and sampled (n= 180), with the majority being juveniles captured in beach seine sets. Round whitefish are found throughout the lakes and rivers of interior Alaska and are a common prey species of northern pike, burbot, and sheefish. Like other species of whitefish they spawn in the fall. The mean FL of sampled round whitefish was 180 mm (range= 25–390 mm; Figure 14). Ten round whitefish were dissected and their stomachs were either empty or contained chironomids and/or vegetation. Given that their mean GSI was 0.90%, we assumed that they were not spawning in fall 2014. Otoliths were aged to conduct length at age analysis, and based on a linear regression there was a positive correlation between FL and age (Figure 15).

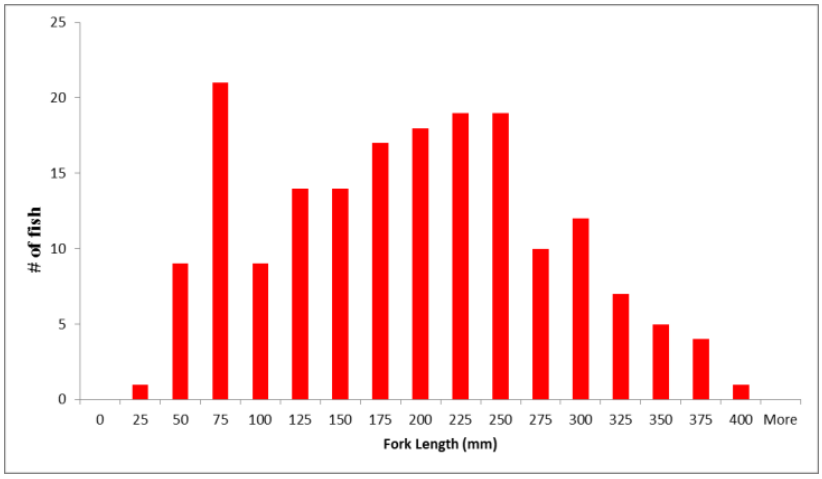

Figure 13. Length at age for dissected round whitefish.

Humpback whitefish, Broad whitefish and Sheefish

Humpback whitefish (HWF), broad whitefish (BWF), and sheefish are important subsistence fishes throughout the Yukon drainage, including both the Koyukuk and Alatna rivers. They (including least cisco) all exist in both freshwater and anadromous forms with the current upper extent of documented anadromy occurring on the Alatna River (Brown et al. 2007, Brown and Burr 2012).

Humpback whitefish (HWF) are bottom feeders, and based on dissections of nine HWF their diet contained snails, beetles, vegetation, and mud. Five fish that were examined were spawning ready (Figure 16) with an average length of 410.2 mm, and an average GSI of 11.87%, which, based on previous work done on the Chatanika River, could produce approximately 20,000 eggs/mature fish (Dupuis and Sutton 2011). One immature female was dissected (length=235 mm). Otoliths were aged to conduct length at age analysis, and based on a linear regression there was a negligible correlation between FL and age (Figure 15).

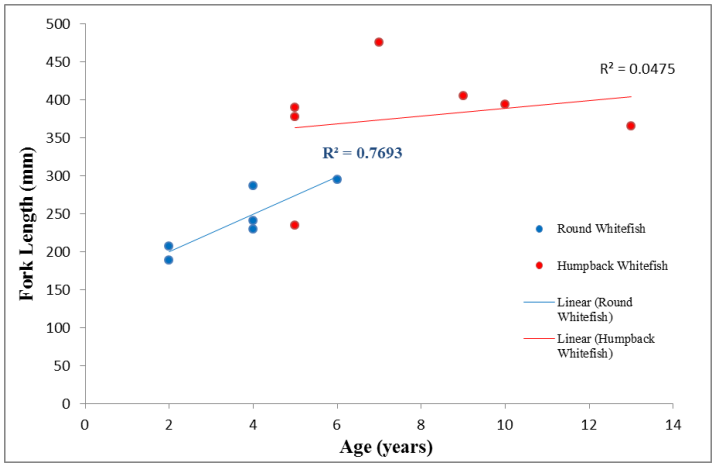

Figure 14. Length at age for dissected round whitefish, and humpback whitefish .

Figure 15. A humpback whitefish being dissected, its eggs are on the scale to determine the GSI.

Only three broad whitefish and three sheefish were captured and all were implanted with radio tags, with the intention of identifying spawning grounds.

Chinook salmon

During the summer event 23 juvenile Chinook salmon (KS) were captured, primarily with beach seines (Figures 17 and 18). The Koyukuk River is a catalogued anadromous water body and although the main stem of the Koyukuk River is not catalogued for KS spawning habitat, it serves as a migration route for spawners using the North Fork, Wild, Alatna, and Jim rivers.

Figure 16. A beach seine being pulled into shore.

Figure 17. A juvenile Chinook salmon captured in a beach seine.

Aquatic Sampling

Water Chemistry

Throughout the study area water, chemistry parameters were measured to assess general fish habitat conditions. Temperature, conductivity, and pH were measured using a HACH HQ40d multi-parameter meter, and a surface grab sample was obtained for turbidity (Figure 19). Water temperature in the spring was warmer that what was observed in the fall. Conductivity was lower in spring than what was observed in the fall, and pH was similar for both sampling events.

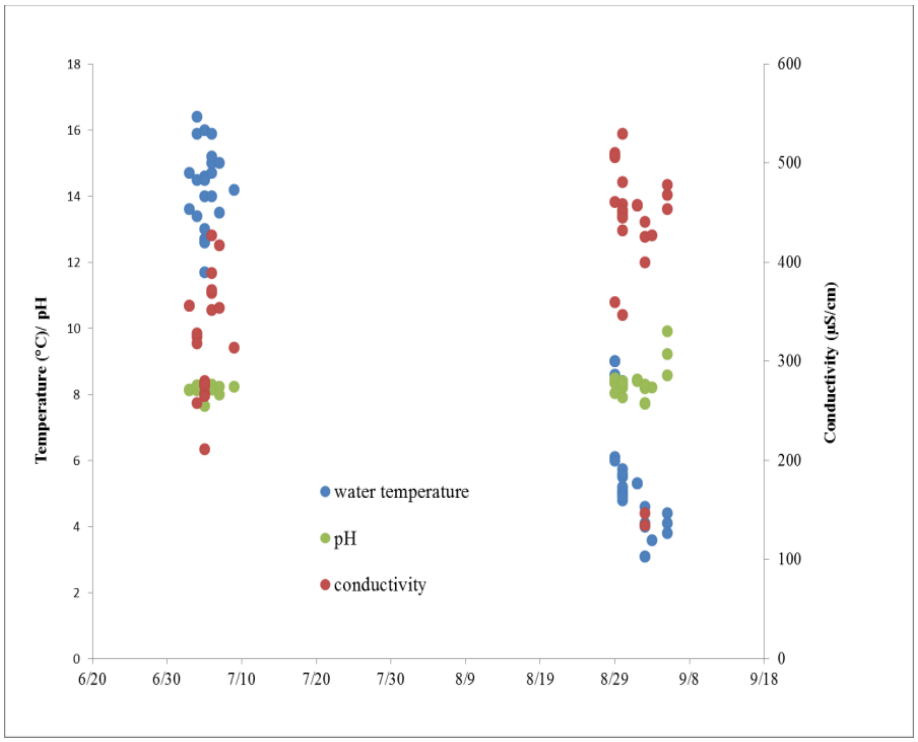

Figure 18. Water chemistry data taken from beach seine sites throughout the study area during both the summer and fall events.

Qualitative and Quantitative Trophic Level Productivity

Four sites were examined for aquatic productivity (Table 3). Aquatic productivity sampling consisted of invertebrate sampling using a D-net, plankton tow, and a petite ponar dredge to collect invertebrates in the substrate. Overall the density and diversity of samples collected was low. This observation was likely influenced by the high water events that were encountered during the spring sampling event. The observed low density of invertebrates may potentially explain the relationship of length at age for Arctic grayling, a species that is primarily an insectivore.

Table 3. Location of sample sites and factors measured.

Sample Site	Temp. (°C)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Invertebrate Taxon	Invertebrate #
Wild River	16.4	258	8.25	4.14	Chironomidae	2
					Limnephila spp.	1
					Acarina	3
Malemute Fork John R.	14.2	314	8.24	8.13	Chironomidae	13
					Acarina	1
					Oligochaeta	1
Mainstem John R.	13.5	354	8	45.4	Chironomidae	11
					Lophognathella spp.	1
					Unk. Ephemeropteran	1
					Unk. Plecopteran	1
					Cyclopoida	1
					Misc. terrestrial	1
					Terrestrial diptera	2
Middle/ N. Fork Confluence of Koyukuk R.	14.5	211.3	8	92.8	Chironomidae	1
					Bosmina spp.	1
					Simulium spp.	1

Summary

Limited sampling due to high water events within the Upper Koyukuk River drainage yielded low catches of several species from the lack of effectiveness of several gear types. Although sampling was limited, the fish assemblage was consistent of those found throughout the Yukon River drainage. Arctic grayling were captured in the mainstem of both the Koyukuk and John rivers, despite the refuge offered by off-channel habitat, which would likely have been more productive; this habitat choice may explain the negative correlation between length and age that was observed. Lake chubs, juvenile whitefish, and juvenile Chinook salmon were using the nearshore areas as would be expected of fish migrating to rearing/over wintering habitat. Northern pike, burbot, and longnose suckers were found in their typical habitats. A few sheefish and broad whitefish, and several humpback whitefish were captured and implanted with radio-tags by the Division of Sport Fish. From fall radio tracking flights, these fish were found congregating near the mouth of the John River, and the confluence of the North Fork and mainstem Koyukuk River (M. Albert, personal communication). Currently, sheefish are the only documented anadromous fish present on the Koyukuk River, and not the John River where three were caught. Future studies should focus on capturing both broad whitefish and humpback whitefish in the fall to use otolith microchemistry to determine anadromy.

Identification of areas used by fish within this project area during this project will allow more thorough and accurate assessments of potential impacts of road siting and construction during the NEPA process. Identification of fish species and their life stages in individual streams will also provide the necessary information to evaluate and design crossing structures such as bridges or culverts. It will also provide information needed to design effective water intake structures needed for water withdrawal during construction and maintenance of the road.

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Appendix A. Capture gear types, dates, locations, and species captured during the July 2014 sampling event.

Set #	Gear	Date Set	Time set	Date pulled	Time pulled	Lat.	Long.	Fish	Size (mm)	Comments
1a (up)	fyke	7/1/2014	1730	7/2/2014	1730			NP	425	Wild R.- flooded out
1b (down)	fyke	7/1/2014	1945	7/2/2014	1730			0		Wild R.- flooded out
2	hoop	7/2/2014	1015	7/3/2014	1720	66°56.959	151°28.848	0		mouth of Wild R.
4	minnow	7/2/2014	1045	7/3/2014	1630	66°57.561	151°26.426	0		clear water slough
5	minnow	7/2/2014	1048	7/3/2014	1630	66°57.544	151°26.501	0		clear water slough
6	minnow	7/2/2014	1209	7/7/2014	1630	66°59.594	151°24.615	0		
7	minnow	7/2/2014	1210	7/7/2014	1630	66°59.601	151°24.587	0		
8	minnow	7/2/2014	1210	7/7/2014	1630	66°59.624	151°24.543	0		
10	Gillnet	7/4/2014	1402	7/4/2014	1800	67°01.589	151°49.127	NP	290	lots of debris floating down
								NP	540	radio tagged
11a (up)	fyke	7/4/2014	1754	7/5/2014	1150	67°02.279	151°49.196	0		
11b(down)	fyke	7/4/2014	1754	7/5/2014	1150	67°02.279	151°49.196	AG	214	
								AG	257	
12	gillnet	7/5/2014	1255	7/5/2014	1430	67°03.742	151°49.984	LNS	390	
								LNS	230	
								LNS	230	
								AG	254	mort
13	beach seine	7/5/2014	1315			67°04.021	151°52.458	chub	75	
								chub	68	
								UNK	25	
14	beach seine	7/5/2014	1416			67°03.651	151°51.172	AG	75	
								AG	75	
								AG	152	mort
15	beach seine	7/5/2014	1457			67°02.202	151°48.536	SS	105	
								AG	82	
16	beach seine	7/5/2014	15:15			67°02.067	151°47.249	chub	82	muddy bar
17	beach seine	7/5/2014	15:50			67°01.478	151°49.527	AG	44	
								AG	84	
18	beach seine	7/6/2014	16:30			67°02.053	151°11.708	0		
19	beach seine	7/6/2014	17:00			67°01.550	151°07.876	BB	260	
20	beach seine	7/6/2014	17:15			67°02.198	151°07.738	chub	87	
								AG	42	
21	beach seine	7/6/2014	17:30			67°03.056	151°06.838	0		
22	beach seine	7/6/2014	18:00			67°02.566	151°05.446	AG	40	
								AG	40	
								AG	240	
								SS	51	
								chub	40	
23	hoop	7/6/2014	19:30	7/7/2014	12:35	67°03.047	151°06.052	0		back eddy
24	minnow	7/6/2014	19:47	7/7/2014	13:13	67°02.984	151°07.097	0		
25	hoop	7/6/2014	19:47	7/7/2014	13:13	67°02.984	151°07.097	0		
26	hoop	7/6/2014	19:55	7/7/2014	13:30	67°02.206	151°07.832	SS	77	
27	minnow	7/6/2014	20:15	7/7/2014	12:30	67°02.236	151°07.808	0		
28	minnow	7/6/2014	20:30	7/7/2014	12:45	67°02.873	151°06.150	chub	89	
29	minnow	7/6/2014		7/7/2014	13:24	67.02655	151.1248	0		
30	minnow	7/6/2014		7/7/2014	13:45	67.02548	151.1431	0		
31	hoop	7/6/2014		7/7/2014	13:45	67.02548	151.1431	NP	370	
32	hoop	7/6/2014		7/7/2014	13:50	67.02465	151.1364	BB	570	radio tagged
								BB	825	radio tagged
33	minnow	7/6/2014		7/7/2014	15:00	67.01967	151.1549	0		
34	minnow	7/6/2014		7/7/2014	15:04	67.02059	151.1552	SS	45	
								SS	52	
								SS	50	
								SS	45	
35	minnow	7/6/2014		7/7/2014	14:59	67.02164	151.164	0		
36	hoop	7/6/2014		7/7/2014	15:21	67.03616	151.1884	0		
37	hoop	7/6/2014		7/7/2014	15:21	67.03616	151.1884	chub	111	
38	minnow	7/6/2014		7/7/2014	15:21	67.03616	151.1884	SS	36	
39	minnow	7/6/2014		7/7/2014	15:33	66.02814	151.1967	0		
40	fyke (down)	7/8/2014	16:20	7/9/2014	11:15	66.94949	151.4809	KS	59	
								AG	244	
								SS	67	
41	fyke (up)	7/8/2104	16:20	7/9/2014	11:25			SS	89	
								SS	74	
								KS	51	
								AG	266	
42	fyke (up)	7/9/2014	11:25	7/10/2014	11:30			KS	50	
43	fyke (down)	7/9/2014	11:15	7/10/2014	11:35			NP	175	

Set #	Gear	Date Set	Time set	Date pulled	Time pulled	Lat.	Long.	Fish	Size (mm)	Comments
								NP	387	
44	fyke (up)	7/10/2014	11:30	7/11/2014	13:15	Wild		0		
45	fyke (down)	7/10/2014	11:35	7/11/2014	13:15			NP		escaped
46	minnow	7/10/2014	12:07	7/11/2014	13:00	66.97939	151.4246	0		
47	minnow	7/11/2014	13:16	7/12/2014	13:00	66.97939	151.4246	0		
48	hoop (small)	7/10/2014	12:09	7/11/2014	13:02	66.97942	151.4231	0		
49	hook & line	7/11/2014				Wild		AG	325	eggs present
50	minnow	7/10/2014	13:44	7/11/2014	11:30	Clear		KS	52	
51	minnow	7/10/2014	13:44	7/11/2014	10:30	Clear		chub	81	
								chub	96	
51	hoop (small)	7/10/2014	13:44	7/11/2014	10:45			0		
52	hoop (large)	7/10/2014	14:07	7/11/2014	10:20			0		
53	hook & line	7/11/2014	11:00					0		
54	beach seine	7/11/2014	15:00					SS	38	
55	beach seine	7/10/2014	15:20					AG	70	
56	hoop	7/10/2014	15:39	7/11/2014	11:32			chub	100	
57	minnow	7/10/2014	15:45	7/11/2014	11:42			SS	40	
								SS	60	
								SS	61	
								SS	72	
58	beach seine	7/10/2014	16:00					0		
59	hoop	7/10/2014	16:10	7/11/2014	11:58			SS	93	
								SS	93	
								chub	91	
								chub	78	
								chub	95	
								KS	50	
60	minnow	7/10/2014	16:15	7/11/2014	11:57			chub	87	
61	seine	7/10/2014	16:45					SS	61	
								SS	51	
								SS	48	
								AG	48	
								KS	43	
								RWF	90	
62	minnow	7/10/2014	17:11	7/11/2014	12:32			chub	82	
								SS	50	
								SS	53	
63	minnow	7/10/2014	17:11	7/11/2014	12:36			chub	76	
								chub	81	
								chub	81	
								chub	51	
								chub	46	
								chub	47	
								chub	46	
								chub	54	
								chub	61	
								SS	52	
								SS	46	
								SS	56	
								SS	57	
								SS	51	
								SS	66	
								SS	51	
								SS	50	
64	fyke (up)	7/11/2014	13:00	7/12/2014	13:15			0		
65	fyke (down)	7/11/2014	13:00	7/12/2014	13:15			SS	55	
								SS	65	
								SS	67	
								SS	44	
								SS	69	
								SS	64	
								SS	44	
								SS	35	
								KS	64	
								KS	55	
								KS	60	
								KS	59	
								KS	61	
								KS	50	
								lamprey	193	
66	beach seine	7/11/2014						0		
67	hoop (large)	7/11/2014	17:15	7/12/2014	12:20			BB	842	
68	hoop (large)	7/11/2014	12:15	7/12/2014	13:33			0		hi grade
69	hoop (large)	7/11/2014	12:40	7/12/2014	13:46			0		hi grade

Set #	Gear	Date Set	Time set	Date pulled	Time pulled	Lat.	Long.	Fish	Size (mm)	Comments
70	hoop (large)	7/11/2014	13:35	7/12/2014	11:30			NP	588	radio tagged
71	hoop (large)	7/11/2014	14:00	7/12/2014	14:00			BB	774	radio tagged
72	hoop (large)	7/11/2014	15:56	7/12/2014	15:56			SS	379	used for bait
73	hoop (large)	7/12/2014	16:09	7/13/2014	12:15	66.93014	151.5998	BB	450	mort
								BB	592	radio tagged
								BB	518	mort
								BB	408	
74	hoop (large)	7/12/2014	16:25	7/13/2014				BB	470	mortality
75	hoop (large)	7/12/2014	16:40	7/13/2014	11:30	66.92708	151.6066	BB	499	radio tagged
76	hoop (large)	7/12/2014	17:05	7/13/2014	11:18			SS	300	
								BB	334	mort
78	hoop (large)	7/12/2014	17:15	7/13/2014	10:45	66.9211	151.622	BB	460	radio tagged
								SS	410	
79	hook & line	7/12/2014	16:09					NP	349	

AG= Arctic grayling, BB= burbot, chub= lake chub, KS= Chinook salmon, LNS= longnose sucker, NP= northern pike, RWF= round whitefish, SS= slimy sculpin, UNK= unknown

Appendix B. Capture gear types, dates, locations, and species captured during the August 2014 sampling event.

Set #	Gear	Date Set	Time set	Date pulled	Time pulled	Lat.	Long.	Fish	Size (mm)	Comments
1a (up)	fyke	7/1/2014	1730	7/2/2014	1730			NP	425	Wild R.- flooded out
1b (down)	fyke	7/1/2014	1945	7/2/2014	1730			0		Wild R.- flooded out
2	hoop	7/2/2014	1015	7/3/2014	1720	66°56.959	151°28.848	0		mouth of Wild R.
4	minnow	7/2/2014	1045	7/3/2014	1630	66°57.561	151°26.426	0		clear water slough
5	minnow	7/2/2014	1048	7/3/2014	1630	66°57.544	151°26.501	0		clear water slough
6	minnow	7/2/2014	1209	7/7/2014	1630	66°59.594	151°24.615	0		
7	minnow	7/2/2014	1210	7/7/2014	1630	66°59.601	151°24.587	0		
8	minnow	7/2/2014	1210	7/7/2014	1630	66°59.624	151°24.543	0		
10	Gillnet	7/4/2014	1402	7/4/2014	1800	67°01.589	151°49.127	NP	290	lots of debris floating down
								NP	540	radio tagged
11a (up)	fyke	7/4/2014	1754	7/5/2014	1150	67°02.279	151°49.196	0		
11b(down)	fyke	7/4/2014	1754	7/5/2014	1150	67°02.279	151°49.196	AG	214	
								AG	257	
12	gillnet	7/5/2014	1255	7/5/2014	1430	67°03.742	151°49.984	LNS	390	
								LNS	230	
								LNS	230	
								AG	254	mort
13	beach seine	7/5/2014	1315			67°04.021	151°52.458	chub	75	
								chub	68	
								UNK	25	
14	beach seine	7/5/2014	1416			67°03.651	151°51.172	AG	75	
								AG	75	
								AG	152	mort
15	beach seine	7/5/2014	1457			67°02.202	151°48.536	SS	105	
								AG	82	
16	beach seine	7/5/2014	15:15			67°02.067	151°47.249	chub	82	muddy bar
17	beach seine	7/5/2014	15:50			67°01.478	151°49.527	AG	44	
								AG	84	
18	beach seine	7/6/2014	16:30			67°02.053	151°11.708	0		
19	beach seine	7/6/2014	17:00			67°01.550	151°07.876	BB	260	
20	beach seine	7/6/2014	17:15			67°02.198	151°07.738	chub	87	
								AG	42	
21	beach seine	7/6/2014	17:30			67°03.056	151°06.838	0		
22	beach seine	7/6/2014	18:00			67°02.566	151°05.446	AG	40	
								AG	40	
								AG	240	
								SS	51	
								chub	40	
23	hoop	7/6/2014	19:30	7/7/2014	12:35	67°03.047	151°06.052	0		back eddy
24	minnow	7/6/2014	19:47	7/7/2014	13:13	67°02.984	151°07.097	0		
25	hoop	7/6/2014	19:47	7/7/2014	13:13	67°02.984	151°07.097	0		
26	hoop	7/6/2014	19:55	7/7/2014	13:30	67°02.206	151°07.832	SS	77	
27	minnow	7/6/2014	20:15	7/7/2014	12:30	67°02.236	151°07.808	0		
28	minnow	7/6/2014	20:30	7/7/2014	12:45	67°02.873	151°06.150	chub	89	
29	minnow	7/6/2014		7/7/2014	13:24	67.02655	151.1248	0		
30	minnow	7/6/2014		7/7/2014	13:45	67.02548	151.1431	0		
31	hoop	7/6/2014		7/7/2014	13:45	67.02548	151.1431	NP	370	
32	hoop	7/6/2014		7/7/2014	13:50	67.02465	151.1364	BB	570	radio tagged
								BB	825	radio tagged
33	minnow	7/6/2014		7/7/2014	15:00	67.01967	151.1549	0		
34	minnow	7/6/2014		7/7/2014	15:04	67.02059	151.1552	SS	45	
								SS	52	
								SS	50	
								SS	45	
35	minnow	7/6/2014		7/7/2014	14:59	67.02164	151.164	0		
36	hoop	7/6/2014		7/7/2014	15:21	67.03616	151.1884	0		
37	hoop	7/6/2014		7/7/2014	15:21	67.03616	151.1884	chub	111	
38	minnow	7/6/2014		7/7/2014	15:21	67.03616	151.1884	SS	36	
39	minnow	7/6/2014		7/7/2014	15:33	66.02814	151.1967	0		
40	fyke (down)	7/8/2014	16:20	7/9/2014	11:15	66.94949	151.4809	KS	59	
								AG	244	
								SS	67	
41	fyke (up)	7/8/2104	16:20	7/9/2014	11:25			SS	89	
								SS	74	
								KS	51	
								AG	266	
42	fyke (up)	7/9/2014	11:25	7/10/2014	11:30			KS	50	
43	fyke (down)	7/9/2014	11:15	7/10/2014	11:35			NP	175	
44	fyke (up)	7/10/2014	11:30	7/11/2014	13:15	Wild		0		
45	fyke (down)	7/10/2014	11:35	7/11/2014	13:15			NP		escaped
46	minnow	7/10/2014	12:07	7/11/2014	13:00	66.97939	151.4246	0		
47	minnow	7/11/2014	13:16	7/12/2014	13:00	66.97939	151.4246	0		

Set #	Gear	Date Set	Time set	Date pulled	Time pulled	Lat.	Long.	Fish	Size (mm)	Comments
48	hoop (small)	7/10/2014	12:09	7/11/2014	13:02	66.97942	151.4231	0		
49	hook & line	7/11/2014				Wild		AG	325	eggs present
50	minnow	7/10/2014	13:44	7/11/2014	11:30	Clear		KS	52	
51	minnow	7/10/2014	13:44	7/11/2014	10:30	Clear		chub	81	
								chub	96	
51	hoop (small)	7/10/2014	13:44	7/11/2014	10:45			0		
52	hoop (large)	7/10/2014	14:07	7/11/2014	10:20			0		
53	hook & line	7/11/2014	11:00					0		
54	beach seine	7/11/2014	15:00					SS	38	
55	beach seine	7/10/2014	15:20					AG	70	
56	hoop	7/10/2014	15:39	7/11/2014	11:32			chub	100	
57	minnow	7/10/2014	15:45	7/11/2014	11:42			SS	40	
								SS	60	
								SS	61	
								SS	72	
58	beach seine	7/10/2014	16:00					0		
59	hoop	7/10/2014	16:10	7/11/2014	11:58			SS	93	
								SS	93	
								chub	91	
								chub	78	
								chub	95	
								KS	50	
60	minnow	7/10/2014	16:15	7/11/2014	11:57			chub	87	
61	seine	7/10/2014	16:45					SS	61	
								SS	51	
								SS	48	
								KS	43	
								RWF	90	
62	minnow	7/10/2014	17:11	7/11/2014	12:32			chub	82	
								SS	50	
								SS	53	
63	minnow	7/10/2014	17:11	7/11/2014	12:36			chub	76	
								chub	81	
								chub	81	
								chub	51	
								chub	46	
								chub	47	
								chub	46	
								chub	54	
								chub	61	
								SS	52	
								SS	46	
								SS	56	
								SS	57	
								SS	51	
								SS	66	
								SS	51	
								SS	50	
64	fyke (up)	7/11/2014	13:00	7/12/2014	13:15			0		
65	fyke (down)	7/11/2014	13:00	7/12/2014	13:15			SS	55	
								SS	65	
								SS	67	
								SS	44	
								SS	69	
								SS	64	
								SS	44	
								SS	44	
								SS	35	
								KS	64	
								KS	55	
								KS	60	
								KS	59	
								KS	61	
								KS	50	
								lamprey	193	
66	beach seine	7/11/2014						0		
67	hoop (large)	7/11/2014	17:15	7/12/2014	12:20			BB	842	
68	hoop (large)	7/11/2014	12:15	7/12/2014	13:33			0		hi grade
69	hoop (large)	7/11/2014	12:40	7/12/2014	13:46			0		hi grade
70	hoop (large)	7/11/2014	13:35	7/12/2014	11:30			NP	588	radio tagged
71	hoop (large)	7/11/2014	14:00	7/12/2014	14:00			BB	774	radio tagged
72	hoop (large)	7/11/2014	15:56	7/12/2014	15:56			SS	379	used for bait
73	hoop (large)	7/12/2014	16:09	7/13/2014	12:15	66.93014	151.5998	BB	450	mort
								BB	592	radio tagged
								BB	518	mort
								BB	408	
74	hoop (large)	7/12/2014	16:25	7/13/2014				BB	470	mortality

Set #	Gear	Date Set	Time set	Date pulled	Time pulled	Lat.	Long.	Fish	Size (mm)	Comments
75	hoop (large)	7/12/2014	16:40	7/13/2014	11:30	66.92708	151.6066	BB	499	radio tagged
76	hoop (large)	7/12/2014	17:05	7/13/2014	11:18			SS	300	
								BB	334	mort
78	hoop (large)	7/12/2014	17:15	7/13/2014	10:45	66.9211	151.622	BB	460	radio tagged
								SS	410	
79	hook & line	7/12/2014	16:09					NP	349	

AG= Arctic grayling, BB= burbot, chub= lake chub, LC= least cisco. LNS= longnose sucker, NP= northern pike, RWF= round whitefish, SS= slimy sculpin

Appendix C. Biological data collected from dissected fish from both the spring and fall sampling events.

								Stomach			
Sample	Species	Fork (mm)	Weight (g)	Sex	Maturity	Gonad Weight (g)	Age	% Full	Contents	GSI	Comments
1	AG	342	480	F	2	10	5	100	ants/flies/beetles/veg	2.08%	
2	BB	462	478	F	3	6	10	0		1.26%	
3	AG	225	114	F	1			25	veg/beetles	0.00%	no oto
4	AG	233	126	F	1		7	25	veg/beetles	0.00%	
5	LNS	446	676	F	3	8		0		1.18%	no oto
6	AG	222	110	F	2		6	75	veg/beetles	0.00%	
7	AG	240	152	F	2			25	veg/beetles	0.00%	no oto
8	AG	240	156	M	2		7	25	veg/beetles	0.00%	
9	AG	182	62	F	1		4	20	veg/beetles/flies	0.00%	
10	NP	355	268	M	2		2	0		0.00%	
11	NP	380	368	F	1		2	0		0.00%	
12	BB	420	464	F	1		7	5	UNK	0.00%	
13	AG	350	372	F	3	6	6	85	veg/beetles/ants	1.61%	
14	AG	340	424	F	3	6	5	80	veg/beetles	1.42%	
15	AG	385	540	F	3	10	3	100	veg/beetles/ants	1.85%	
16	AG	196	68	M	1			65	veg/beetles/ants	0.00%	no oto
17	AG	176	46	U	UNK			80	veg/ants	0.00%	no oto
18	BB	247	78	U	UNK			0		0.00%	no oto
19	RWF	207	80	M	1		2	20	nymphs/UNK	0.00%	
20	RWF	189	48	F	1		2	20	veg	0.00%	
21	NP	555	1060	M	1		3	20	sculpins/bugs	0.00%	
22	NP	436	602	M	1		3	30	dragonfly larvae/nymphs/veg	0.00%	
23	NP	475	730	M	1		3	60	mayflies/sculpins	0.00%	
24	NP	375	340	U	UNK		2	70	small digested fish	0.00%	
25	NP	396	428	M	1		3	10	white insects	0.00%	
26	NP	527	1054	M	1		4	30	insects/UNK	0.00%	roundworms
27	AG	303	312	M	1		8	30	beetles	0.00%	
28	AG	210	102	F	1		7	0		0.00%	
29	NP	384	362	M	1		3	0		0.00%	
30	AG	260	214	M	1		6	50	beetles/digested fish	0.00%	broken oto
31	LNS	407	694	F	4	16		0		2.31%	
32	LNS	397	644	F	4	46	7	0		7.14%	
33	LNS	185	56	M	1			0		0.00%	
34	LNS	290	248	M	2		8	0		0.00%	
35	NP	575	1116	M	3		4	0		0.00%	
36	NP	425	634	M	3		3	0		0.00%	
37	NP	475	620	M	2		3	10	shrew	0.00%	
38	BB	310	156	M	2		3	40	burbot	0.00%	
39	chub	85	6	U	UNK			10	UNK	0.00%	no oto
40	chub	78	4	U	UNK			11	UNK	0.00%	no oto
41	AG	350	264	F	1			10	veg/insects	0.00%	
42	BB	350	152	M	1		4	10	nymphs/digested fish	0.00%	
43	RWF	287	222	F	3	2	4	0		0.90%	
44	chub	108	12	F	2			0		0.00%	no oto
45	NP	363	362	M	2		3	10	UNK	0.00%	
46	NP	185	50	M	2		1	30	digested fish	0.00%	
47	AG	240	156	F	2		5	30	UNK	0.00%	
48	BB	261	102	M	2		3	60	sculpins	0.00%	no oto
49	chub	83	6	U	UNK			75	insect larvae	0.00%	
50	BB	475	515	M	3		7	0		0.00%	
51	AG	245	125	M	2		4	80	yellow jacket, flies, veg	0.00%	broken oto
52	AG	190	56	F	2			30	flies/beetles/veg	0.00%	no oto
53	RWF	116	14	F	2			50	veg/UNK	0.00%	no oto
54	HWF	377	626	M	3		5	40	snails/beetles	0.00%	
55	HWF	412	846	F	3	16		30	UNK	1.89%	
56	BB	842	4442	F	3	28	15	0		0.63%	
57	BB	622	1132	F	3	8	9	0		0.71%	
58	BB	470	634	F	3	6	8	0		0.95%	
59	BB	511	744	F	3	4	10	0		0.54%	
60	BB	455	414	M	2		6	5	juvenile burbot	0.00%	
61	BB	335	196	F	3	2	4	0		1.02%	
62	RWF	231	114	M	1			0		0.00%	
63	RWF	229	94	M	1		4	0		0.00%	
64	RWF	241	114	M	1		4	10	veg/UNK	0.00%	
65	RWF	261	166	M	3			5	veg/UNK	0.00%	
66	RWF	295	186	F	2		6	0		0.00%	

								Stomach			
Sample	Species	Fork (mm)	Weight (g)	Sex	Maturity	Gonad Weight (g)	Age	% Full	Contents	GSI	Comments
67	NP	665	2730	F	3	78	5	85	mature RWF male	2.86%	
68	BB	608	1110	F	3	30	10	0		2.70%	
69	HWF	405	784	F	4	112	9	0		14.29%	
70	AG	325	318	M	3		6	80	shrew/UNK	0.00%	
71	AG	310	300	F	4	6	5	5	veg	2.00%	
72	NP	655	2450	F	3	52	6	90	mature RWF female	2.12%	
73	BB	495	568	M	3		5	0		0.00%	
74	BB	340	210	M	2		4	0		0.00%	
75	HWF	365	462	F	4	84	13	0		18.18%	
76	RWF	330	246	F	3	2		0		0.81%	
77	HWF	235	134	F	2		5	5	UNK	0.00%	
78	BB	452	444	M	1		6	0		0.00%	
79	BB	445	394	F	3	2	7	5	digested fish/UNK	0.51%	
80	BB	450	482	M	3	4	7	8	digested fish/UNK	0.83%	
81	BB	482	574	F	3	2	6	0		0.35%	
82	HWF	475	1340	F	4	168	7	1	water beetle	12.54%	
83	BB	330	172	F	3	2	4	100	4 lake chubs	1.16%	
84	BB	446	490	M	3		5	75	hair/UNK	0.00%	
85	BB	485	604	F	3	2	6	75	shrew/ sculpin	0.33%	
86	AG	340	372	M	2		5	30	cranberry/ nematode/veg	0.00%	
87	HWF	382	724	M	2			5	beetles/UNK	0.00%	
88	HWF	394	818	F	3	102	10	50	mud/snails	12.47%	
89	BWF	540	2478	F	3	498	12	0		20.10%	
90	HWF	390	670	M	2		5	5	worms (?)	0.00%	
91	BB	840	3976	F	3	72	13	95	burbot/shrew	1.81%	
92	BB	552	704	F	3	16	6	25	RWF tails	2.27%	
93	BB	505	700	M	3		6	25	shrew	0.00%	

AG= Arctic grayling, BB= burbot, BWF- broad whitefish, chub= lake chub, HBF= humpback whitefish, LNS= longnose sucker, NP= northern pike, RWF= round whitefish, UNK= unknown
oto= otolith
Maturity: 1 = immature, 2= mature but not spawning this season, 3= mature and spawning this season, 4= mature and ripe, 5= spent (post-spawn), 6= reabsorbed eggs (did not spawn) (Moulton 2010).