NEWSS salmon recovery projects

eDNA research

Submitted by Dr. Brent Murray and Barry Booth

UNBC Ecosystem Science and Management

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This project is a partnership between UNBC and the Nechako Environment and Water Stewardship Society (NEWSS), funded through the BC Salmon Restoration and Innovation Fund. The following report is a summary of the results of the assessment of environmental DNA (eDNA) for the presence of four key salmonid species, Chinook salmon (*Oncorhynchus tshawytscha*), Sockeye/Kokanee salmon (*O. nerka*), Coho salmon (*O. kisutch*) and rainbow trout (*O. mykiss*) in 2024.

Methodology

Hiring summer field crew

We worked with Casey Litton, Nechako Valley Secondary School (NVSS) and Darren Carpenter of School District 91(SD 91) to have our job posting for summer positions posted in late April of 2024. All interviews took place at NVSS. Barry Booth joined the meetings via Teams and Rebecca Morin and Eldon Kochel were present at NVSS. We interviewed 5 students on May 6, 2024. Based on these interviews we selected 3 candidates, one grade 12 and two grade 11 students on May 10, 2024. Rebecca Morin assisted each student in completing all the required employment paperwork.

Our first set of sampling/training took place at NVSS on June 24, with Dr. Brent Murray, Barry Booth (UNBC), and Casey Litton (NVSS). Dr. Murray went over the details of the eDNA project in the lab and we sampled with the Halltech eDNA OSMO sampler in the field with the students. Upon returning from the field, we also went over how to process/store the samples and clean and sterile the filters. From that point on we worked in concert with Casey Litton and David Peterson, NVSS staff to execute field season which included gaining access to SD 91 equipment and lab space.

Further training of the students was effectively 'on the job training' whereby students were continually exposed to new facets of the job (e.g., how to place minnow traps, handle fish, record field data) as the summer progressed. A student report on their summer work experience on the eDNA project is presented in Appendix 1.

Sampling in 2024

In 2024, we took water/eDNA samples from 39 different creeks/water bodies (Table 1). In keeping with our ongoing sampling program, we sampled 7-11 creeks that have been sampled regularly since 2020. Maps of locations are provided in Appendix 2.

Additional features/highlights of our sampling are as follows:

- We continued to work with NEWSS by sampling in conjunction/in proximity to the planned restoration projects. Saul Creek, in Burns Lake, was sampled this season downstream of and above the 2023 restoration. Sampling at the lower site occurred only once, when water levels were suitable
- We continued our riverboat sampling collecting water filter samples from 19 creeks in 2024, adding McPhee Creek to this group of samples. Due to water level restrictions, filter samples were collected at June and August time points.
- We added Watkins Creek on the Endako system.
- We increased the number of samples on the Chilako watershed both in terms of how far up on the Chilako we sampled, as well as increasing the overall number of

creeks sampled within the watershed (including adding an additional sampling location on Dahl Creek).

- We sampled additional upstream sites on both Cutoff and Greer Creeks in the upper Nechako
- We also continued our examination of how salmon are utilizing a developing beaver dam complex on the bottom 1 km section of Murray Creek. This was the fourth year of sampling of this beaver dam complex.

We were very pleased to have the Stellat'en fisheries crew accompany us when we sampled the upper Nechako watershed in August. On this trip we extended out sampling on both Greer and Cutoff Creeks.

Analysis of environmental DNA

As in previous years, environmental DNA (eDNA) was extracted at a dedicated lab at UNBC supervised by Brent Murray. Each site was sampled in duplicate. Each replicate filter was obtained by filtering between 1-2 litres of water per site, depending on the water quality. Filters were placed in a penny envelope and stored in a silica desiccant bead package at 4°C until the extraction of eDNA. Following our established protocol, eDNA was extracted in two 50 μl elutions (see 2023 report). A comparison of signal between elutions allows for an initial assessment of the presence of inhibitors which are generally greater in the first elution. Both elutions were assessed for the presence of the four target species through the established duplexed tagman assays (Chinook/Rainbow and Coho/Sockeye-Kokanee:) using droplet digital PCR (Murray and Booth 2023). The presence of a target species was confirmed though the presence of 4 or more positive ddPCR droplets in all replicates at a site. Samples with 2-3 droplets, below the minimum threshold for acceptance, were reanalysed. If positive droplets were found in the reanalysis, species presence was confirmed. If not, samples were considered not detected for that species.

A relative signal strength was assessed by summing the copy number estimation in both elutions (this represents 1/10 of the eDNA volume recovered) and averaging between the replicates. Results are reported by showing the data on a relative scale: 4-10 copies (Weak signal); 10-20 copies; 20-50 copies (Good signal); 50-100 copies; > 100 copies (Strong signal); and > 1000 copies (Very Strong signal).

Samples that showed evidence of strong ddPCR inhibitors or were negative (not detected) for all fish species were re-examined with an inhibitor control dual assay. This includes an assay for an added Lambda DNA (exogenous control) and for plant material (eplant endogenous control). Both are expected to yield a strong to very strong result, with lower to no signal indicating the presence of ddPCR inhibitors in the eDNA extraction. Samples with inhibitors present in all elutions are being further purified and retested.

Table 1. 2024 eDNA sample locations and dates for post freshet sampling (T1,) midsummer (T2) and late summer/fall (T3). "-" indicates not sampled. "No Water" indicates no surface flow observed at this time point – not sampled.

Location/Area	Site #	T1	T2	T3
Vanderhoof Beaver Dam Survey	BD01 (MU00)	-	-	23-Oct
(Murray Creek)	BD 03	-	-	23-Oct
	BD 04	-	-	23-Oct
	BD 05	-	-	23-Oct
	BD 06	-	-	23-Oct
	BD 07	-	-	23-Oct
	BD 08	-	-	23-Oct
	BD 09	-	-	23-Oct
	BD 11 (MU01)	-	-	23-Oct
	BD 12	-	-	23-Oct
Murray Creek	MU 00	24-Jun	July 15-17	*NS*
	MU 01	24-Jun	July 15-17	12-Aug
	MU 02	24-Jun	July 15-17	12-Aug
	MU 03	25-Jun	July 15-17	12-Aug
	MU 04	25-Jun	July 15-17	12-Aug
	MU 04.1	25-Jun	July 15-17	13-Aug
	MU 05	25-Jun	July 15-17	13-Aug
	MU 06	25-Jun	July 15-17	13-Aug
	MU 07	25-Jun	July 15-17	**No water**
	MU 08	25-Jun	**No water**	**No water**
	MU 09	25-Jun	July 15-17	13-Aug
Knight Creek	KN 01	24-Jun	July 17-18	***No water***
Moss Creek	MS 0.9	24-Jun	22-Jul	19-Aug
	MS 1.0	24-Jun	22-Jul	19-Aug
	MS 1.5	-	22-Jul	19-Aug
Clear Creek	CL 0.9	24-Jun	22-Jul	19-Aug
	CL 01	24-Jun	22-Jul	19-Aug
	CL 03	24-Jun	22-Jul	19-Aug
	CL 04	24-Jun	22-Jul	19-Aug
Eden Creek	EN 01	24-Jun	22-Jul	19-Aug

Table 1 continued. 2024 eDNA sample locations and dates.

		Site #	T1	T2	T3
Burns Lake	Saul Creek	SU 02	09-Jul	**No water**	**No water**
		SU 04	09-Jul	14-Aug	10-Oct
Ft Fraser	Dog Creek	DC 01	10-Jul	07-Aug	19-Sep
	Tats Creek	TC 01	10-Jul	07-Aug	19-Sep
	Nine Mile Creek	9M 01	10-Jul	07-Aug	19-Sep
	Ormond Creek	OR 01	10-Jul	07-Aug	19-Sep
Upper Nechako	Twin Creek	TW 01	26-Jun	23-Jul	20-Aug
		TW 02	-	-	-
	Swanson Creek	SW 01	26-Jun	23-Jul	20-Aug
		SW 02	26-Jun	23-Jul	20-Aug
	Greer Creek	GR 01	26-Jun	23-Jul	20-Aug
		GR 03	26-Jun	23-Jul	20-Aug
		GR 04	26-Jun	23-Jul	20-Aug
		GR 05	-	-	20-Aug
		GR 06	-	-	20-Aug
	Cutoff Creek	CT 02	-	-	20-Aug
		CT 04	-	-	20-Aug
Endako River watershed	Endako from HWY	ED 13	09-Jul	14-Aug	10-Oct
	"	ED 18	09-Jul	14-Aug	10-Oct
	"	ED 22	09-Jul	14-Aug	10-Oct
	"	ED 26	09-Jul	14-Aug	10-Oct
	"	ED 66	09-Jul	14-Aug	10-Oct
	"	ED 66.1	09-Jul	14-Aug	10-Oct
	Tchesinkut Creek	TH 01	09-Jul	14-Aug	10-Oct
	Watkins Creek	WA 01	-	14-Aug	**No water**

Table 1 continued. 2024 eDNA sample locations and dates.

Chilako River watershed

	Site #	T1	T2	T3
Beaverly Creek	BE 01	22-May	01-Aug	11-Oct
"	BE 02	22-May	01-Aug	11-Oct
Butcherflats Creek	BU 01	19-Jun	26-Jul	23-Aug
Dahl Creek	DH01	19-Jun	26-Jul	23-Aug
"	DH 08	19-Jun	26-Jul	23-Aug
Gregg Creek	GG 05	19-Jun	26-Jul	23-Aug
Chilako River	CK 16 @ HWY 16	10-Jul	01-Aug	11-Oct
"	CK 37	19-Jun	26-Jul	23-Aug
"	CK 53	19-Jun	26-Jul	23-Aug
"	CK 102	19-Jun	26-Jul	23-Aug
"	CK 116	19-Jun	26-Jul	23-Aug
Unnamed tributary 1	CK 37 unk 01	19-Jun	26-Jul	23-Aug
Unnamed tributary 2	CK 53 -UNK	19-Jun	26-Jul	23-Aug

Neckako main by river boat

	Site #	Sample 1	Sample 2	Sample 3
Breeze Creek	BZ 00	12-Jun	-	29-Aug
Chilako River	CK 00	12-Jun	-	29-Aug
Cluculz Creek	CZ 00	12-Jun	-	29-Aug
Cutoff Creek	CO 00	13-Jun	-	30-Aug
Engen Creek	EG 00	12-Jun	-	30-Aug
Halsey Creek	HY 00	13-Jun	-	30-Aug
Hullat Creek	HL 00	-	-	-
Hutchinson Creek	HN 00	12-Jun	-	29-Aug
Kluk Creek	KK 00	13-Jun	-	30-Aug
McPhee Creek	MF00	12-Jun	-	29-Aug
Nine Mile Creek	9M 00	13-Jun	-	30-Aug
Sinkut River	SU 00	12-Jun	-	29-Aug
Smith Creek	SM 00	13-Jun	-	30-Aug
Sweden Creek	SN 00	12-Jun	-	29-Aug
Tahultzu Creek	TU 00	13-Jun	-	30-Aug
Targe Creek	TE 00	13-Jun	-	30-Aug
Tatentelichick Creek	TK 00	12-Jun	-	29-Aug
Tatsunai Creek	TC 00	13-Jun	-	30-Aug
Zelkwas Creek	ZK 00	12-Jun	-	29-Aug

Results

eDNA results

The results of the eDNA survey for 2024 are shown as a quantitative estimation of the number of copies of the species-specific eDNA detected in 1/10 of the eDNA extracted (Table 2). Positive detections range from 4 copies to over 1000 copies in the volume tested. Six sites showed evidence of the presence of ddPCR inhibitors, which co-purified with the eDNA extraction. Further sample purification is currently being conducted to assess results at these sites – partial results are shown. At some sites, sampling was not performed due to lack of surface flow or was conducted on isolated pools in the creek bed.

Chinook: Results from 2024 again show the widespread use of the lower sections of streams connecting with the mainstem of the Nechako River by chinook salmon at most time periods. These results are similar to those found in our eDNA surveys since 2020 (Table 3). Chinook were also noted at many locations in the Chilako and Endako system. Our results provide strong evidence for the widespread habitat use of the study area by juvenile chinook salmon. Of interest are the repeated detections of chinook in the southern creeks from Prince George to Vanderhoof. These sites are all located between the CN rail line and the outflow into the Nechako. One area of study in subsequent years could focus on the passage of chinook above the CN rail line culverts in this area.

In 2024, we extended the sampling of the Chilako system (Table 2). This included mainstem locations and tributary creeks. Of note, Chinook were detected at our upper most sampling location, ~116 km from the confluence of the Chilako with the Nechako river. Widespread use of Chilako tributary creeks by chinook salmon was also noted in most creeks tested (Beaverly, Dahl, Butcherfields, and two unnamed) except Cregg creek. Chinook were also not detected in Cregg creek in the more limited sampling (Midsummer time point only) conducted in 2023.

Extended sampling was also conducted in the Endako river and Greer creek. Repeated sampling of sites in the Endako system again confirm the limited surveys in 2023 and show the presence of chinook from approximately 13 km to 66 km upstream of the confluence with the Stellako river, including both pre-spawning (9 July) and post-spawning (10 Oct) time points. The core spawning area for chinook is located at ~54 km upstream of the confluence.

Extended sampling of Greer creek also showed similar results with chinook being detected at site 5 on the Brophy ranch land on the 20th of August. Note that as expected chinook were not detected at site 6 (GR06), located upstream of the falls Chinook were detected at high eDNA copy number level at most sites in the August sampling. This may reflect the supplementation of hatchery-reared fry to the mouth of Greer creek in early June 2024.

Table 2. eDNA results from 2024. Results are shown by quantitative signal (see legend) for three time points June (T1), July (T2) and August (T3). See Table 1 for site codes.

Site	Site code	June/July SD401 Chin	SD401 Rain	SD401 Coho	SD401 Sock	July/Aug SD402 Chin	SD402 Rain	SD402 Coho	SD402 Sock	Aug/Oct SD403 Chin	SD403 Rain	SD403 Coho	SD403 Sock
Chilako													
Chilako Main	CK00			-	-						-	-	-
Beaverly	BE00			-	-			-	-			-	-
	BE01	-		-	-	-		-	-			-	-
	CK16			-	-			-	-			-	-
Dalh	DH01			-	-			-	-			-	-
	DH08			-	-	-		-	-			-	-
	CK37			-	-	-		-	-			-	-
Unktribe 1	CK37-u			-	-			-	-			-	-
Gregg	GG05	-		-	-	-		-	-	-		-	-
	CK53			-	-			-	-			-	
Unktribe 2	CK53-u			-	-			-	-			-	-
Butcherfields	BU01			-	-			-	-			-	-
	CK102			-	-			-	-			-	-
	CK116			-	-			-	-	-		-	
Nechako PG - Vanderhoof													
McPhee	MF00			-								-	-
Sweden	SN00			-	-							-	-
Tatentelichick	TK00	-		-	-							-	-
Breeze	BZ00			-	-							-	-
Zelkwas	ZK00			-	-							-	-
Hutchison	HN00			-	-							-	-
Cluculz	CZ00			-	-							-	
Hullat	HL00												
Sinkut	SU00			-	-					-	-	-	-
Vanderhoof													
Chilco	*CI00*		-	-	-								
Knight	***KN01****			-	-	**	**	-	-				
Murray	MU00			-	-			-					
	MU01	-		-	-	-	-	-	-	-	-	-	-
	MU02			-	-	-	-	-	-	-		-	-
	MU03	-		-	-	-		-	-	-		-	-
West arm	***MU04***	-		-	-	-		-	-	-		-	-
	MU4.1*	-		-	-	-				-		-	-
	MU05	-		-	-	-		-	-	-		-	-
	MU06	-		-	-	-		-	-	-		-	-
East arm	MU07*	-	-	-	-	-	-	-	-				
	MU08*	-											
	MU09*	-	-	-	-	-	-	-	-	-	-	-	-
Clear	CL0.9			-	-			-	-			-	-
	CL01			-	-			-	-			-	-
	CL02												
Eden (CL trib)	EN01*	-	-	C-RT	C-RT	-		C-RT	C-RT	-		C-RT	C-RT
	CL03*	-		C-RT	C-RT	-		C-RT	C-RT	-	-	C-RT	C-RT
	CL04*	-	-	C-RT	C-RT	-		C-RT	C-RT	-		C-RT	C-RT
Moss	MS0.9			-	-			-	-			-	-
	MS01			-	-			-	-			-	-
	MS1.5							-	-			C-RT	C-RT
Vanderhoof - Fort Fraser													
Engen	EG00	-	-	-						-	-	-	-
Halsey	HY00			-	-							-	-
Kluk	KK00			-	-							-	-
Nine Mile	9M00			-	-							-	-
	9M01	-		-	-	-		-	-	-		-	-
Tatsutani	TC00			C-RT	C-RT							C-RT	C-RT
	TC01			-	-			-	-			-	-
Dog	***DC01***			-	-			-	-			-	-
	DC01.1			-	-								
Fraser Lake													
Ormond	***OR1***			-	-			-	-			-	-
Endako													
Endako	ED13			-				-	-			-	-
	ED18			-	-		-	-	-			-	-
	ED22		-	-	-			-	-			-	-
	ED26			-	-	-		-	-				
Tchesinkut (ED trib)	TH01							-	-			-	-
	ED52-5												
Shovel (ED trib)	SH00-01												
Watkins (ED trib)	WA01					-		-	-				
	ED66			-	-	-	-	-	-			-	-
	ED66.1			-	-	-	-	-	-			-	-
Burns Lake - Saul	SU02*	-		-	-								
	SU04*	-		-	-	-		-	-	-		-	-
Upper Nechako													
Smith	SM00		-	-						-	-	-	-
Tahultzu	TU00			-						-	-	-	-
Greer	***8***			-	-			-				-	-
	GR03			-	-			-	-			-	-
	GR04			-	-			-	-			-	-
	GR05					-		-	-			-	-
	GR06									-		-	-
Targe	TE00		-	-	-					-	-	-	-
Swanson	***SW01***			-	-			-	-			-	-
	SW02			-	-			-	-			-	-
Cutoff	CT00			-						-	-	-	-
	CT01 (2)									-		-	-
	CT04									-		C-RT	C-RT
Twin	***TW01***			-	-			-	-				-
	TW02												

	Positive: droplet/copy #	
-	0	Not detected
	4-10	Weak
	10-20	
	20-50	Good
	50-100	
	sup. 100	Strong
	> 1000	Very Strong
	NA	Not Sampled

C-RT	Retesting after further purifcation
	Not sampled due to lack of surface flow
-	No Flow - isolated pool(s) sampled - not detected
**	salvage site

Table 3. Summary of eDNA results from 2020-2024 in the Nechako watershed by creek and relative time point, T1 late-June, T2 late-July, T3 late-August/early-September. Positive detection is noted by C – Chinook, R – Rainbow, H – Coho, and S – Sockeye (S/K – system with Kokanee).

Site	2020 T1	2020 T2	2020 T3	2021 T1	2021 T2	2021 T3	2022 T1	2022 T2	2022 T3	2023 T1	2023 T2	2023 T3	2024 T1	2024 T2	2024 T3
Nechako PG - Vanderhoof															
Chilako Main**										C R - -		- R - -	C R - -		C R - S
McPhee													C R - S		C R - -
Sweden										C R - S		C R H -	C R - -		C R - -
Tatentelichick										C R - -		C R H S	- R - -		C R - -
Breeze										C R - -		C R H -	C R - -		C R - -
Zelkwas										C R - -		C R H -	C R - -		C R - -
Hutchenson										C R - S		C R - S	C R - -		C R - -
Cluculz										C R - S/K		C R - S/K	C R - -		C R - S/K
Hullat												C R H -			
Sinkut										C R - -		C R H -	C R - -		- - - -
Vanderhoof															
Knight	- - -	C R -	C R -	C - - -	C - - -	C - - -	C R - -			C - - -			C R - -	C R - -	
Murray**	C R -	C R -	C R -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - S	C R - S	C R - -	C R H -	C R - -	C R - -	C R - -
Stoney				C R - -	C - - -	C - - -									
Clear**	C R -	C R -	C R -	C R - -	- R - -	C R - -	C R - -	C R - -	C R - S	C R - -	C R - -	C R H -	C R - -	C R - -	C R - -
Moss**					C R - -	C R - -	C R - -	C R - -	C R - -	C R H -	C R - -	C R H -	C R H -	C R - -	C R - -
Vanderhoof - Fort Fraser															
Engen										- - - -			C - - S		- - - -
Halsey												C R H -	C R - -		C R - -
Kluk										C R - S		C R - -	C R - -		C R - -
Nine Mile*				- R - -	C R - -	C R - -	C R - -	- R - -	C R - -	C R - S	- R - -	C R H -	C R - -	C R - -	C R - -
Tatsutani*				- R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -
Dog				C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - S	C R - -	C R - -	C R - -	C R - -	C R - -
Fraser Lake															
Ormond				- R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -	C R - -
Endako															
Endako**										C R - -	C R - -		C R - S	C R - S	C R - -
Burns Lake															
Sauls													- R - -	- R - -	- R - -
Upper Nechako															
Smith										C - - -			C R - S		- - - -
Tahultzu										C - - S		C - - -	C R - S		- - - -
Greer**	- R -	C R -	C R -	- R - -		C R - -	- R - -		C R - S	C R - S	C R - S	C R - S	C R - -	C R - S	C R - -
Targe										C - - -	C R - S/K		C - - -		- - - -
Swanson*	C R -	C R -	C R -	C R - -		C R - -	- R - -		C R - -	C R - S	C R - S	C R - S	C R - -	C R - -	C R - -
Cutoff*	C - -	C R H	C R -						C R - -			C R H -	C R - S		- R - -
Twin*	C R -	C R -	C R -	C R - -		C R - -	C R - -		C R - S	C R - S	C R - S	C R - -	C R - -	C R - -	C R - -
Fort St James															
Sowchea				- R - -		C R - S/K	- R - -	- R - S/K	- R - -						
Nahounli				- R - -	C - - -	- R - -	- R - -	C R - S/K	C R - S/K						
Necoslie river				- - - -	C - - -	- - - -	- R - -	- R - S/K	- R - -						

* two sites sampled
** multiple sites (>2)

Not sampled due to lack of surface flow
- - - - no flow - isolated pool(s) sampled

Coho: In contrast to the results of 2023 (Table 3) coho were not detected at any sample locations in 2024. Coho were detected in 2023, primarily from sites in the T3 survey (Table 3). We speculate that the T3 survey captured the fall migration of spawning adults. Although the presence of Coho is known in the system, little is known about the upstream spawning locations. The iMap BC database (accessed Jan 2025) shows only 8 observations from 1976-2018. Curiously, Coho was detected in the upper Nechako site, Cutoff Creek, in both 2020 and 2023, suggesting a possible spawning location.

Sockeye/Kokanee: To compare results among years a table of detection by creek, timepoint, and year was constructed (Table 3). Sockeye are first detected in our surveys of the Nechako system in 2022. Consistent with their detection in the fall of 2022, sockeye were detected at various locations in the late-June time point of 2023. It is not known whether this represents the residual signal from previous adults in the system resulting from the high amounts of straying observed in the Fall of 2022, or if this represents the presence of/outmigration of juveniles. Straying in 2022 has been attributed to stress related 'dropouts' due to the earlier high water temperature during migration (Tracy Cone, DFO, pers. com). The presence of sockeye was confirmed in the 2023 sample, where

numerous detections are noted at the T1, late-June, sample. Sockeye are also detected in the T3, late-August, survey in creeks between Prince Goerge and Vanderhoof as well as in the T2, mid-July, and T3 surveys in the upper Nechako. The persistence of sockeye detection over this time period in Greer, Swanson and Twin Creeks in the upper Nechako is suggestive of rearing. However, the presence of Kokanee in the Targe Creek/Lake system confounds the interpretation. In 2024, Sockeye were detected at fewer sites than 2023 (Table 2 and 3). A cluster of positive sites in the early June site of the Upper Nechako may reflect their continued presence in this zone since the fall of 2023. By the fall of 2024, only two sites show evidence of sockeye/Kokanee, one at the Chilako/Nechako confluence, which may reflect the spawning migration of a number of upstream runs, and one in Cluculz creek, which drains Cluculz lake, known Kokanee habitat.

Restoration sites: As noted in 2023, a number of sites were chosen to coincide with ongoing or planned restoration activities being conducted by NEWSS (Table 2, noted with asterisks). The Clear/Eden creek sites, CL04 and CL03/EN01, are located upstream and downstream, respectively, of previous NEWSS restoration projects. Although rainbow trout were found in some samples, these sites also showed the presence of co-extracting inhibitor. Given their importance for ongoing assessment of the restoration activities these samples are being further purified and will be reassessed with the 2025 samples. If deemed successfully purified they will also be used as core samples for the 2025 metabarcoding study.

The Knight Creek site, KN01, is also just downstream of ongoing NEWSS restoration efforts and upstream of possible culvert improvements. In 2024, the June sampling showed the presence of chinook salmon. Unfortunately, the stream no longer had a surface flow in July and August time periods. In the July sampling, a number of pools were found to contain Chinook and rainbow trout fry. In response to SD 91 (NVSS) students, NVSS teacher Casey Litton and NEWSS staff, with the guidance of DFO biologists, began a fish salvage operation on July 25th that extended into the first week of August. Over this time, the NVSS team captured and moved to lower Knight Creek 713 fish of which 384 were chinook salmon (Isaac Craig, pers.com; Appendix 1).

Murray Creek has multiple sites with planned NEWSS restoration activities. Sites MU07 - MU09 are located on the east arm of Murray creek where multiple beaver dam analogs are planned. Only one of these sites yielded evidence of salmonid presence in the 2024 sampling, MU08 (spring). MU08 and MU07 could not be sampled due to lack of surface water in July and/or August. The presence or absence of salmonids in these Murray Creek sites should be considered baseline data for evaluation of the planned restoration projects.

Saul creek, in Burns Lake, is also targeted for restoration activities. Only one site, SU04 had consistent water flow for testing, showing the presence of rainbow trout at all sampling periods.

Minnow trapping results

Minnow trapping was conducted on a sub-sample of the eDNA survey sites. Results of this component of our project are presented in Appendix 3.

Comparison of eDNA and Minnow trapping results

A comparison of the relative efficiency of species detected was made between the minnow trapping and eDNA surveys conducted from 2021 – 2023 (Table 4). This represents a total of 109 sampling days. On each day, water samples were collected for eDNA prior to the placement of minnow traps, which were generally checked 12-16 hours later. As expected, rainbow trout was the primary salmonid recovered in minnow traps with a detection rate of 33.0%. In contrast, eDNA detection of rainbow trout at sites was approximately 3X higher at 91.7%. While minnow trapping does only catch small rainbow trout, this increased detection rate was also found for chinook (presumably juvenile). Minnow trapping found chinook at 23.9% of sample days while eDNA detected the presence at 54.1% of sample days. For both rainbow trout and chinook, the majority of sites that were positive for minnow trapping were also positive for eDNA. In only 3 cases were species detected by minnow trapping and not eDNA. In each of these cases, previous results had shown the species were present in the creek and these minnow trap only detections may be explained by the movement of fish into upstream sites after the placement of traps.

Table 4: Comparison of eDNA versus minnow trapping detection rates for rainbow trout and chinook by sampling days (the total number of sampling attempts at all sites for which both eDNA analysis and MT was conducted). The number of positive detections in the total sampling days is shown for each year (number in brackets shows the % positive). "New" shows the sampling days with a positive MT detection, but eDNA not detected.

Year	Sampling days	Rainbow eDNA	MT	new	Chinook eDNA	MT	new
2021	43	38 *(88.4)*	13 *(30.2)*	-	24 *(55.8)*	12 *(27.9)*	1
2022	39	35 *(89.7)*	14 *(35.9)*	2	19 *(48.7)*	7 *(18.0)*	-
2023	27	27 *(100)*	9 *(33.3)*	-	16 *(59.3)*	7 *(25.9)*	-
total	109	100 *(91.7)*	36 *(33.0)*	2	59 *(54.1)*	26 *(23.9)*	1

Results of ongoing analysis of the Beaverdam complex on Murray creek.

As in the previous year, the active beaver dam complex on Murray creek (Fig 1) was sampled in October in 2024. Water samples were collected at each pond and analyzed for the four target species (Table 5). Coho were not detected in any survey and have been omitted from the results. In 2021 and 2022, Chinook and rainbow were detected in all ponds with a decreasing signal noted for Chinook as the sampling proceeded upstream. In 2023, Chinook were no longer detected in the uppermost ponds, which are characterised as the deepest ponds and greatest dam height in the complex (data not shown). Similar results are found in 2024, with Chinook being detected in only 3 ponds, ponds 3, 5 and 9. The results indicate that the upper dams of the beaver dam complex are now acting as a barrier to Chinook passage.



Figure 1. Relative locations of beaver dams in lower Murray Creek, October 2022. Beaver dams are noted in red, except for the first location, BD01, which is downstream of the first dam and about 200 m from the Nechako River.

Table 5: Results of the assessment of salmonid use of a Beaverdam complex (Fig 1) on Murray Creek. Surveys were conducted in October of 2021 – 2024.

Site	site code	2021 Chin	2021 Rain	2021 Sock	2022 Chin	2022 Rain	2022 Sock	2023 Chin	2023 Rain	2023 Sock	2024 Chin	2024 Rain	2024 Sock
Pre complex	BD01*			-						-			-
Beaver Dam 1	BD02		4-10	-									
Beaver Dam 2	BD03			-			-			-	4-10		-
Beaver Dam 3	BD04			-			4-10			-	-		-
Beaver Dam 4	BD05			-						-	4-10		-
Beaver Dam 5	BD06	4-10		-					4-10	-	-		-
Beaver Dam 6	BD07							4-10	4-10	-			
Beaver Dam 7	BD08	4-10		-					4-10	-	-	4-10	-
Beaver Dam 8	BD09						4-10			-	4-10	4-10	-
Beaver Dam 9	BD10						4-10				-	4-10	-
Beaver Dam 10	BD11**	4-10		-				-		-	-	4-10	-
Beaver Dam 11	BD12				4-10			-		-	-	4-10	-

* = MU00 (Main Survey)
** = MU01 (Main Survey)

		Positive drop.
-	Not detected	0
	Possible	3
4-10	Weak	4-10
		10-20
	Good	20-50
		50-100
	Strong	sup. 100
		not sampled

Lessons learned

Efficacy of using a river boat for sampling

We capitalized on our success of sampling from a riverboat in 2023. This season we repeated this sampling, adding one additional creek (McPhee Creek). Our coverage of creeks along the Nechako now extends from ~19 km upstream from Prince George to within ~ 20 km of the Kenney Dam.

Drought and its impacts

As in 2023, drought had significant impacts in 2024. As the season progressed, most if not all creeks were 0-30% of their regular flow. Numerous sampling creeks were running subsurface, resulting in the severing of the connection between the confluence and upper sections of the creek. This happened in some of the creeks that we regularly sample (e.g., Swanson, Twin, and Knight Creeks). In some creeks, sections of the creek were running subsurface (e.g., Saul, Murray and Knight Creek). Knight Creek was especially problematic, as we noted a significant fish stranding issue in late July. As noted previously, the field crew, with the guidance of DFO biologists, began a fish salvage operation on July 25th that extended into the first week of August (see Isaac Craig, pers.com; Appendix 1).

Draft sampling plan for 2025-26

Our draft sampling plan will build on results from 2023-24 seasons. In general, sampling will include the following:

- Sampling at NEWSS restoration sites with increased emphasis on areas with beaver dam analogues. This includes:
    - Saul Creek
    - Clear/Eden Creek
    - Murray/McIntosh Creeks (J. Johnson, D. Stephen, A. Marten properties)
    - Knight Creek
- Continue to sample core streams
    - Twin, Greer, Swanson, Ormond, Tatsutani, Nine Mile, Dog/Unnamed, Moss, Clear, Murray, Knight
- Work with CSTC to explore further sampling in the Endako River watershed
- Re-sample beaver dam complex and consider minnow trapping this portion of Murray Creek
- Repeat sampling of creeks from riverboat along the mainstem of the Nechako
- Consider sampling upstream of CN Rail line culverts in creeks between Prince George and Vanderhoof.
- Sample within Chikao watershed.

Appendices

Appendix 1: Report from Isaac Craig, NVSS student, summarizing work on the eDNA project

I was first introduced to the eDNA summer job program by Casey Litton during my Environmental Science 11 class in 2023. I had been working as a lifeguard a year beforehand; however, my interests were in different places and I believe Casey recognized this when he approached me and offered me the job description.

Ever since I have been grateful to have been a part of the eDNA program for two consecutive years, this job offered me an incredible opportunity to spend time outside doing things I had an interest in and allowed me to interact with like-minded people.

Barry Booth was a remarkable mentor throughout both of my summers at the job. The eDNA program was structured in a way that made the work interesting through learning and understanding the impact of the information we collect. The hands-on style of work was very educational and also inspiring once you came to understand it.

In the summer of 2023, we filtered eDNA samples in a lab at NVSS. This was a good experience of working in a lab that required understanding meticulousness and attention to detail to not contaminate samples. In the summer of 2024, we switched to using a backpack filter in the field which required a lot more teamwork and communication. Both of these forms of work were beneficial skills for me as a student to learn and utilize.

Fish trapping was also a big part of this job. I have learned how to accurately identify many types of fish, as well as properly weighing, sizing, and handling them. Being able to identify juvenile chinook and understand their significance in our watershed is also eye-opening.



Juvenile Chinook Salmon



Juvenile Rainbow Trout

I was also lucky enough to do sampling in 2023 on the Endako River and witness the endangered Endako chinook spawning.

This program can easily help foster passion for watersheds in students and it can help push younger people into careers where the health of watersheds and especially vulnerable fish species are cared for.

This program has also been profound because it has helped me understand the importance and functions of the land and watersheds I have lived and grown up on. I have been living on a property with a chinook-bearing creek for fifteen years and I had only learned this in 2023. I believe this shows the need for programs like this that not only engage students but also community members to become invested in our local ecosystems.

This summer we also had a unique opportunity to appear on the eDNA site Knight Creek. Hundreds of juvenile chinook and other species had become stranded in pools along the creek bed due to lowering water levels. Testing showed us the dissolved oxygen levels in these pools

were unsustainable for the amount of fish in the pools and they would likely all die. Through communications with DFO and data that Barry and I collected as well as help from Casey and the two other summer student employees, Bridger Albertson and Trygve Thompson, we were able to move 713 fish, and 384 of them were juvenile chinook. This situation allowed me to learn data collection and report writing as well as understanding hospitable conditions for fish and how to identify their behaviors.



Salvaged Chinook Salmon from Knight Creek

Finally, this program provided me with the opportunity to connect with like-minded individuals with similar passions, the mentorship has been outstanding and I've had the privilege of calling many people involved in this program my friends.

I am currently at The University of Victoria studying Biology and Ecology and this program did a great deal to steer me in this direction. Thank you.

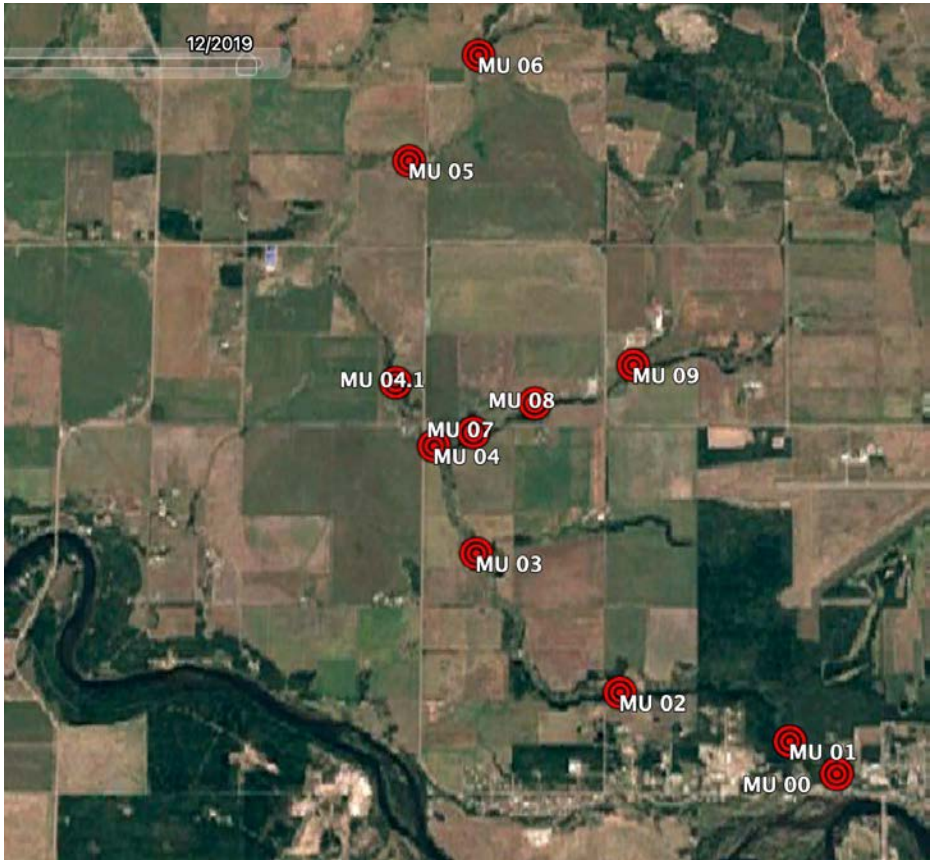


Juvenile Salamander

Appendix 2. Locations of Sites Sampled in 2024

Creeks sampled in 2024

Murray Creek sites



Knight Creek site



Clear Creek sites







Moss Creek sites

Fort Fraser sites



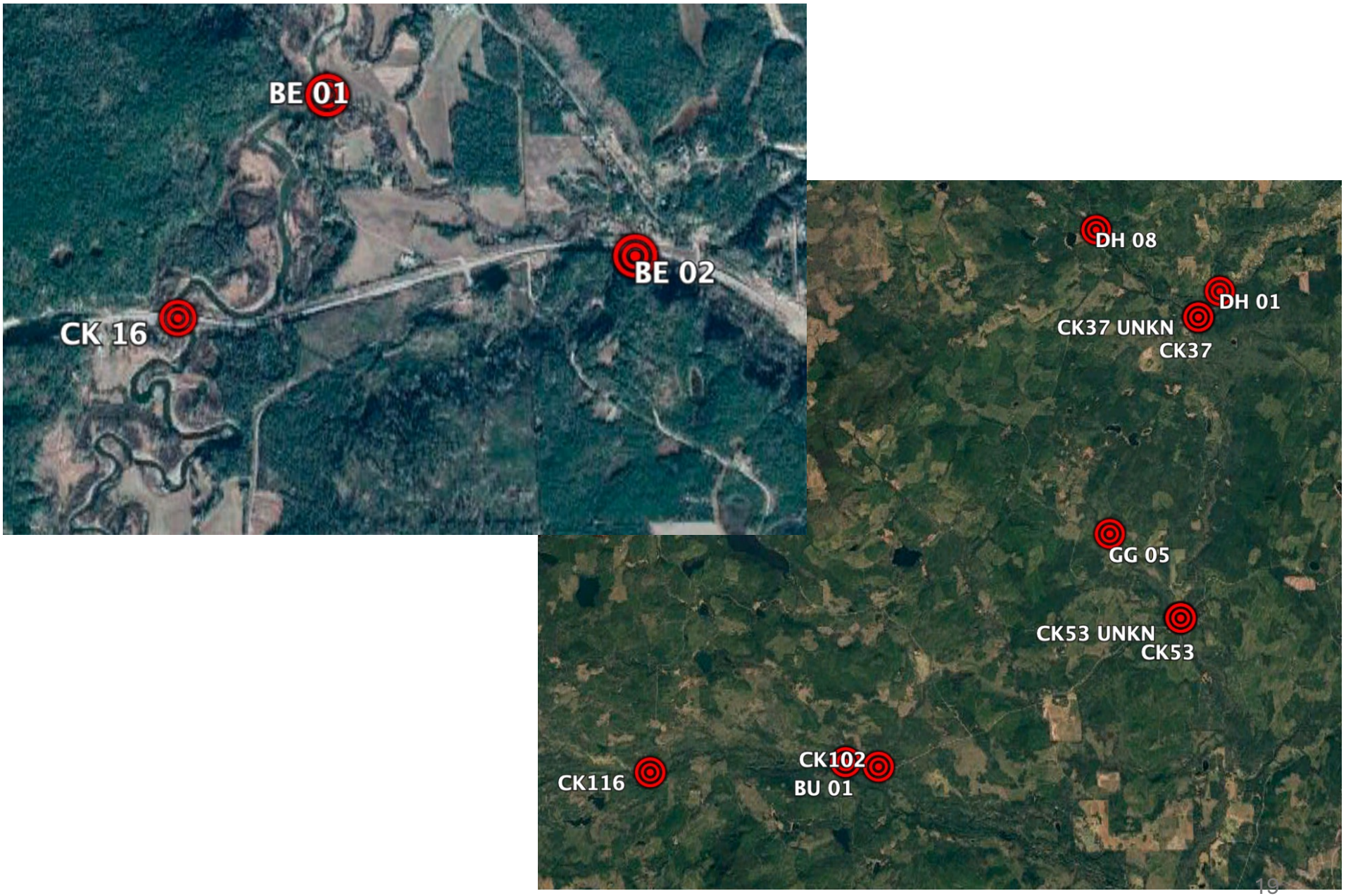
Endako sites



Burns Lake/Sauls Creek sites



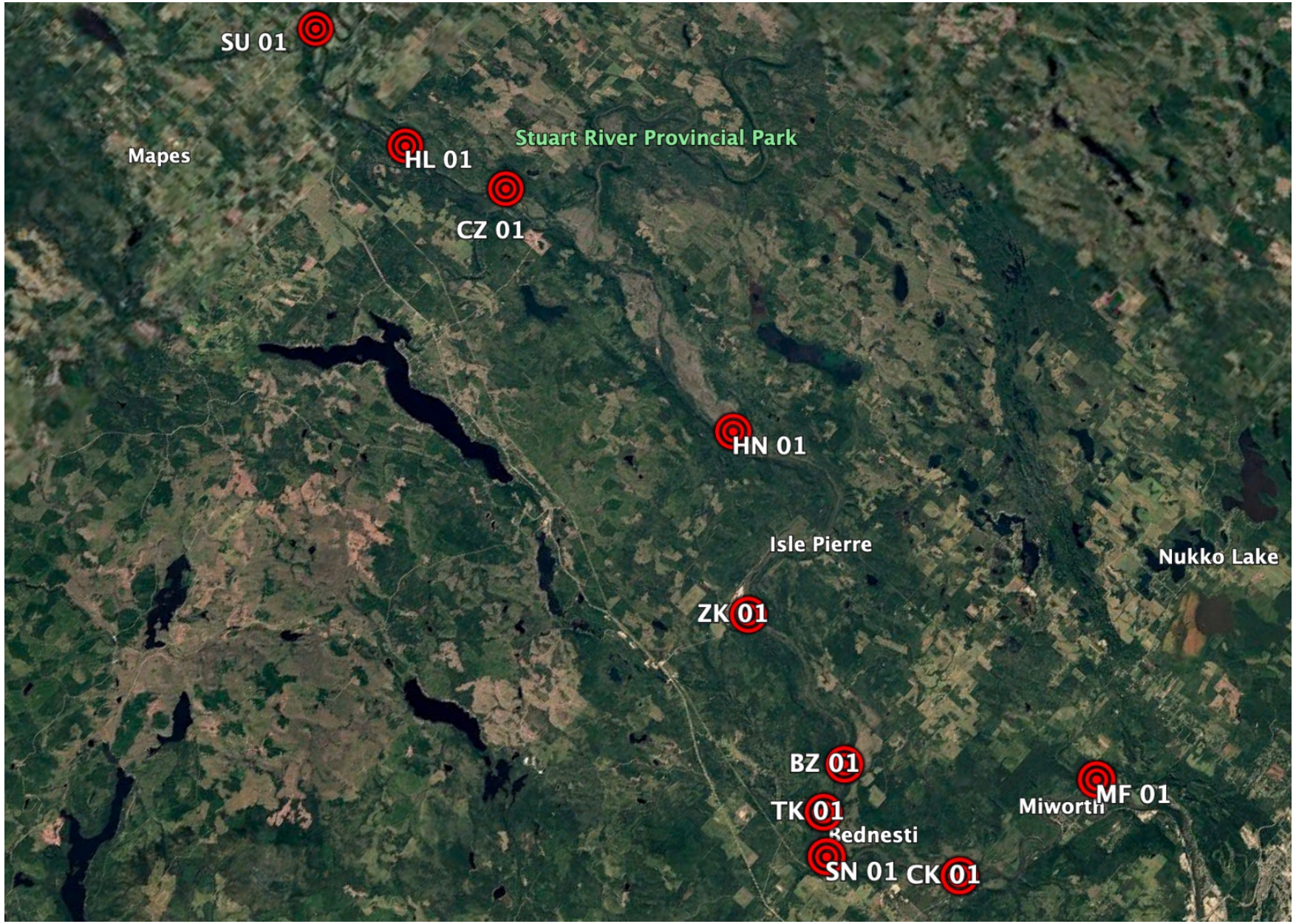
Chilako Sites



Creeks sampled by riverboat – western creeks

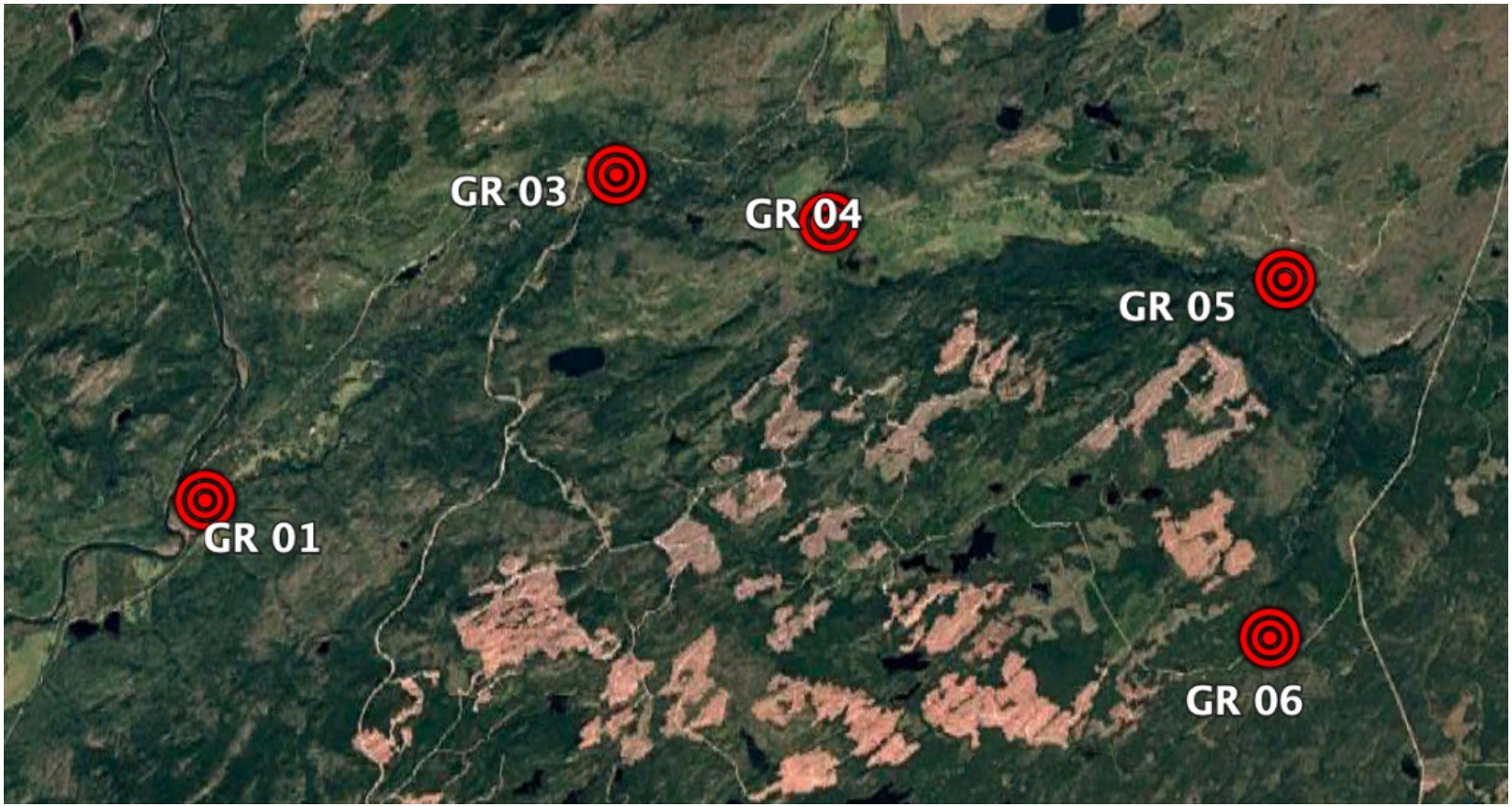


Creeks sampled by riverboat – eastern creeks



Upper Nechako Sites

Greer Creek sites



Upper Nechako Sites

Twin, Swanson and Cutoff sites



Appendix 3. Minnow Trapping Report

Summary of Minnow trapping component of the SD 91/UNBC eDNA project

2024 Season

Submitted by:
Barry Booth
RP Bio
UNBC/SD 91





Nechako Environment & Water Stewardship Society NEWSS
UNBC
vancouver foundation
School District 91 Nechako Lakes
Koh-Learning in our Watersheds
Transforming education by connecting students, communities, and waterways
Fisheries and Oceans Canada
Pêches et Océans Canada

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Photos on cover page, left to right: Bridger Albertson and Isaac Craig filtering water on Eden Creek. Kate Blokker, Brent Murray, Trgve Thompson and Nadia Pagliaro in search of the next beaver dam on Murray Creek.

All photos, B Booth

Project Overview

This report summarizes the results of a minnow trapping project that is being conducted under the auspices of the Koh-learning in Our Watersheds program, an experiential nature- and place-based program of integrative learning taking place throughout School District (SD) 91, Nechako Lakes. The goals of this project are threefold: to support and enhance the outdoor learning outcomes of students in SD 91; to provide baseline information related to juvenile fish in streams in the Nechako River Basin (NRB); and because it is also paired with joint UNBC/SD 91 project that is using environmental DNA (eDNA) to examine the distribution of juvenile salmonids in a selected number of streams in the NRB, the results help corroborate eDNA signals that were detected in selected streams.

Sampling Summary

In 2024 we moved exclusively to obtaining eDNA samples using the Halltech backpack sampler. Using the Halltech sampler requires additional time at each site which has meant that we had limited time to sample minnows during the 2024 season. In 2024 we only sampled fish, using either minnow traps or dip nets, at four creeks and 12 different sampling locations in 2024 (Table 1). Sites were sampled from 16 July 25 through to 23 July. All sampling was completed by Barry Booth and a crew of high school students from School District 91. Dip netting was used in 2024 due to a combination of low water levels of creeks and a significant fish stranding event encountered on Knight Creek.

Table 1. Sites sampled in 2024.

Water Body	Watershed Code	Number of sites	Dates sampled
Murray Creek	180-267500	3	16, 17 July
Knight Creek	180-249800	7	18 July
Moss Creek	180-300500	1	22 July
Twin Creek	180-526600	1	23 July
	Total	12	

We used a combination of minnow traps and dip netting in 2024. Dip netting was used where creek levels were very low (Moss and Twin Creeks) and where fish had been stranded in isolated ponds due to dropping water levels (Knight Creek; Table 2).

Table 2. How sites were sampled in 2024 using minnow trapping and dip netting.

Creek	eDNA site	Minnow trapping	Dip netting
Murray Creek	0.5	X	-
	5	X	-
	6	X	-
Knight Creek	1	X	-
	2	X	X
	3	X	-
	4	X	-
	5	X	X
	6	X	
	7	X	X
Moss Creek	1	-	X
Twin Creek	1	-	X

Results from trapping

Juvenile Chinook - overall

We caught a total of 12 chinook salmon during our trapping efforts. Chinook were caught in all the creeks that were sampled. Chinook caught ranged from 50 to 70 mm in length and weighed between 2.0 and 5.0 grams (Table 3). Individual fish data can be found in Appendix 2.

Table 3. Summary of chinook salmon caught during trapping season (minnow traps and dip netting).

			Length (mm)		Weight (g)	
Creek	Site #'s where chinook were caught	Total # caught	Min	Max	Min	Max
Murray Creek	0.5	1	65	65	5.0	5.0
Knight Creek	1,5,6,7	7	50	70	2.0	3.5
Moss Creek	1	2	55	65	2.5	4
Twin Creek	1	2	45	70	2	5.5

Fish caught in dip nets far exceeded those caught in minnow traps (Table 4). This was due largely because of the large numbers of small rainbow trout that were seen swimming at the surface of one of the ponds on Knight Creek.

Table 4. Numbers of fish caught minnow trapping vs dip netting

Species	#'s caught minnow traps	#'s caught dip nets
Chinook salmon	5	7
Rainbow trout	3	23

Other species caught.

Overall, we caught a total of 39 individuals from seven different species (Table 5).

Table 5. Total number of each species caught in minnow traps/dip nets during trapping season.

Creek	Chinc Salm	Rainbow Trout	Lake Chub	Northern Pikeminnow	Sucker	
Twin Creek	2	0	0	0	0	

Other observations

Reduced flows on creeks were observed throughout the sampling area during the 2024 season. This was especially relevant on Knight Creek. In late-June Knight Creek was flowing at levels such that the creek was clearly connected to the mainstem of the Nechako via the culvert going under Sackner Road. The flows were augmented by headwater storage that had resulted due to beaver activity at the restoration sites that were completed in 2022. During this time, we noted numerous juvenile salmonids in many of the pools in the lower sections of Knight Creek. When we returned on July 18th the water levels had dropped such that pools were cut off from one another. Furthermore, the creek was not flowing through the culvert at Sackner Road. We noted two dead juvenile Chinook salmon on the edges of pools and small rainbow trout swimming in obvious distress (gasping for air at the surface, Photo 1). Water temperatures were not at critical levels at this time (~15-17 °C) but dissolved oxygen levels where low (mean of 66 %). Observations from this day prompted an official fish salvage conducted by NVSS staff (Casey Litton) and the NVSS summer students (Issac Craig, Trgvye Thompson and Bridger Albertson), in conjunction with DFO. Over the course of the week 713 fish were captured and moved to lower Knight Creek and 384 of them were Chinook (Isaac Craig, pers.com).



o 1. One of the isolated pools on Knight
k pools on Knight Creek.



Photo 2. Numerous small rainbow trout swimming at/near the surface the pond in Photo 1

Acknowledgments

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NEWSS
UNBC
School District 91
Nechako Valley Secondary School
Vancouver Foundation
DFO/BC SRIF

Special thanks to all the landowners who allowed us to have access to their property.
Thanks also to the following people who came out and helped us in 2024

Stellat'en fisheries crew
- Taneesh Raymond
- Logan Harris
- Deane Carlson

BC Wildlife Federation
- Nadia Pagliaro
- Katie Blokker

Appendices

Appendix 1. Maps associated with the 2024 sampling season

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Figure 4. Twin Creek 9



Figure 1. Trapping locations on Murray Creek



Figure 2. Trapping locations on Knight Creek



Figure 3. Trapping location on Moss Creek



Figure 4. Trapping location on Twin Creek

Appendix 2. Details of Chinook salmon caught in 2024.

Creek	Reach	Site	Capture technique	Species	Length (mm)	Wt (gms)
Murray Creek	1	0.5	minnow trapping	Chinook Salmon	65	5.0
Murray Creek	5.9	3	minnow trapping	Rainbow Trout	120	n/d
Murray Creek	5.9	3	minnow trapping	Rainbow Trout	110	n/d
Murray Creek	5.9	3	minnow trapping	Rainbow Trout	100	n/d
Knight Creek	2	1	minnow trapping	Chinook Salmon	70	3.0
Knight Creek	2	6	minnow trapping	Chinook Salmon	60	3.0
Knight Creek	2	7	minnow trapping	Chinook Salmon	70	3.0
Knight Creek	2	7	minnow trapping	Chinook Salmon	70	3.5
Knight Creek	2	5	dip netting	Chinook Salmon	65	3.0
Knight Creek	2	7	dip netting	Chinook Salmon	60	3.5
Knight Creek	2	7	dip netting	Chinook Salmon	50	2.0
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
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Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	2	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	5	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	5	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	5	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	5	dip netting	Rainbow Trout	40	n/d
Knight Creek	2	7	dip netting	Rainbow Trout	40	n/d
Moss Creek	3	1	dip netting	Chinook Salmon	65	4.0
Moss Creek	3	1	dip netting	Chinook Salmon	55	2.5
Twin Creek	2	2	dip netting	Chinook Salmon	50	2.0
Twin Creek	2	2	dip netting	Chinook Salmon	60	2.5