Meadow Creek Spawning Channel
(COL-F24-F-3985-DCA)
2023-2024 (F24) Activity Report
1 April 2023 to 31 March 2024

Meadow Creel Kokanee 2023; G. Sanders

Prepared for: Fish & Wildlife Compensation Program (FWCP)

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Acknowledgements

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Executive Summary

The Meadow Creek Spawning Channel (MCSC) is managed and delivered through the Ministry of Water, Land and Resource Stewardship with financial support from the Fish & Wildlife Compensation Program. BC Hydro built the MCSC in 1967 to compensate for lost natural kokanee habitat due to the construction of Duncan Dam. The channel provides spawning for a large proportion of Kootenay Lake kokanee, which are the primary prey species for both bull trout and Gerrard rainbow trout.

Operations and maintenance activities for the MCSC in the 2023 (F24 fiscal year) included kokanee fry counts in the spring, settling pond and gravel cleaning in the summer, adult kokanee counts and sampling, and egg plants in the fall. After summer scarification was complete, the channel dried out to reduce the presence of the Infectious hematopoietic Necrosis (IHN) virus. As part of efforts to recover kokanee stocks, electric fencing was installed in the fall to protect kokanee redds in the channel from disturbance from bears and protect spawning fish from bear predation. Road improvements and vegetation removal were also completed. Water monitoring and control to reduce sediment and optimize incubation conditions continued throughout the year.

Kokanee fry outmigration from naturally spawned eggs was estimated at 4.84 million, however there is uncertainty in this estimate given it results in an egg to fry survival estimate of >100%. Eyed egg plants occurred in the upper section of the spawning channel in the fall of 2022 as part of Kootenay Lake kokanee recovery efforts which produced an additional 692,709 fry. Fry emigration peaked on May 15th, 2023.

A total of 71,423 kokanee spawners returned to Meadow Creek in the fall of 2023, which was the highest return in the past decade. Average fork length for females and males was 31.2 cm and 32.8 cm respectively. Average female weight was 361 g and males averaged 456 g. Fecundity was estimated at 548 eggs/female. Size and fecundity numbers were lower than in previous years of the kokanee collapse period.

Approximately 2.5 million eggs from Hill Creek and the Columbia River near Fairmont were reared to the eyed egg stage by the Freshwater Fishery Society of BC and then planted in MCSC in the fall of 2023 as an action for kokanee recovery. The estimated egg deposition in Meadow Creek, including the spawning channel, below the channel, and planted eyed eggs was 22.4 million eggs. As in previous years, spawners tested positive for IHN virus. Spawners at MCSC in 2023 appeared to be approximately 40% age 2 and 60% age 3 based on preliminary analysis.

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Introduction

Spawning habitat for kokanee was inundated following the construction of Duncan Dam and the Meadow Creek Spawning Channel (MCSC) was built to provide alternate spawning habitat. MCSC has been operated by the Province since, and operational tasks associated with the spawning channel are funded by BC Hydro through the Fish and Wildlife Compensation Program (FWCP). Facility maintenance such as gravel scarification and settling pond cleaning are required annually.

The spawning channel plays an important role in sustaining Kootenay Lake kokanee, especially since the severe population decline in 2013. Kokanee are the primary prey species for both bull trout and Gerrard rainbow trout, and also supported a recreational fishery when numbers were higher. Kokanee carcass decomposition benefits natural nutrient levels in the creeks and lake, in addition to providing seasonal forage for other aquatic, terrestrial and avian predators. MCSC is recognized for its wildlife viewing opportunities and has also operated as a provincial source of kokanee eggs for the Freshwater Fish Society of BC (FFSBC).

This project implements and maintains ongoing operations at MCSC to support kokanee fry production for Kootenay Lake. Operations include spring fry enumeration, scarification of the channel during July and August and fall adult spawner enumeration. Water control occurs year-round to minimize sediment inputs and ensure adequate flows are managed for the various life stages of egg to fry. Facility maintenance is an important aspect of this project, and includes vegetation and road management, bridge refurbishing, rip rap replacement, hazardous tree removal and flood protection improvements. An on-site cabin is maintained as an office and accommodation for Ministry staff.

Major maintenance and upgrades are required periodically and can include building maintenance; channel modifications; gravel, weir, bridge refurbishing; rip rap replenishment; hazardous tree removal and flood protection improvements. Additionally, due to low kokanee returns electric fencing was installed on a portion of the channel to protect egg redds from disturbance from bears. Seasonal installation and maintenance of this electric fence is anticipated to be a part of annual MCSC activities until kokanee spawner numbers improve.

Work activities and timelines completed in 2023/2024 (F24):

- Fry enumeration – April to June
- Scarification of the gravel in the spawning channel – July 15 - August 15
- Monitoring of Meadow Creek diversion upstream of Channel
- Channel dry out – August
- Installation of electric fencing – August-October
- Kokanee spawner enumeration – August and September
- Bear safety and management – August - November
- Water flow maintenance – year round
- Maintenance of grounds and facility – year round

Linkage to Fish and Wildlife Compensation Program Action Plans

The MCSC project is focused on producing kokanee fry that supplements fry production from the Lardeau River and smaller tributaries to maintain the abundance of kokanee in Kootenay Lake. Kokanee are the primary forage species for bull trout and piscivorous rainbow trout. The project falls within the Habitat Based Action Type as a Priority 1 in the Reservoirs and Large Lakes Action Plan (FWCP, 2019); COLRLL.ECO.HB.09.01 Operation of Meadow Creek and Hill Creek Spawning Channels-P1 (Figure 1) with the intended outcome of "Improved kokanee productivity to support a healthy and resilient reservoir ecosystem".

Reservoir & Large Lake Ecosystem Actions

RESERVOIRS AND LARGE LAKES ACTION TABLE - ECOSYSTEMS (AQUATIC PRODUCTIVITY)							Version:AUG2019	
Action #	Action Type	Priority Action Short Description	Priority	Priority Area	Target Species	Priority Action	Intended Outcome	Delivery Approach
9	Habitat-based	**COLRLL.ECO.HB.09.01 Operation of Meadow Creek and Hill Creek spawning channels-P1**	**1**	Kootenay Lake Arrow Lakes	Fish	Support the maintenance and operation of the Meadow Creek and Hill Creek spawning channels to ensure sufficient kokanee production in Kootenay Lake and Arrow Lakes Reservoir.	Improved Kokanee productivity to support a healthy and resilient reservoir ecosystem.	Directed

- **Habitat-based Actions** – These actions will conserve, restore, and enhance reservoir and large lake habitats. Examples include habitat creation, restoration, and enhancement; enhancing habitat connectivity; nutrient restoration; and invasive species prevention.

Figure 1. Spawning Channel components of the Reservoirs and Large Lakes Action Table – Ecosystems (Aquatic Productivity) in the Columbia Region Reservoirs and Large Lakes Action Plan (FWCP, 2019).

Study Area

Meadow Creek Spawning channel is located at the north end of Kootenay Lake (Figure 2)

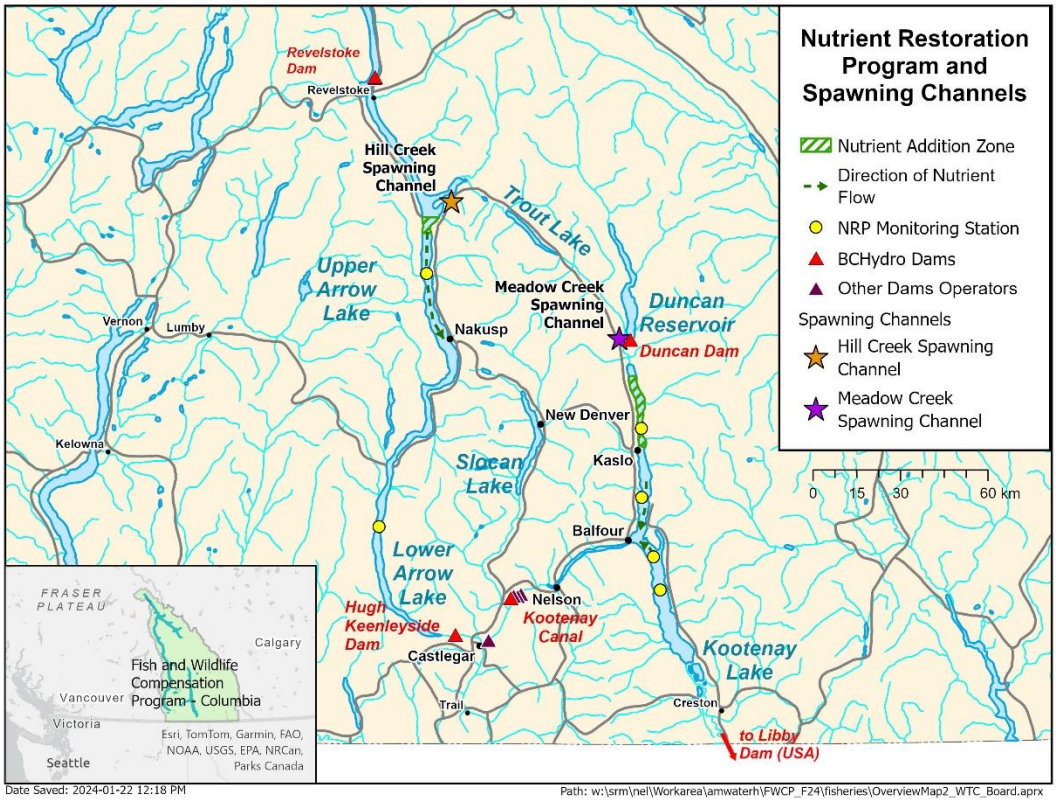

Figure 2. Map of location of Meadow Creek Spawning Channel in the Columbia region.

Methods

Kokanee Fry Outmigration

Spring fry outmigration was monitored at the enumeration fence on 40 nights between April 11 and June 18 in 2023. Eyed egg plants in fall 2022 occurred in the upper section of the channel, where natural spawners were restricted to below by a barrier. As a result, there were two fry enumeration fences to separate the planted vs. wild fry counts.

Fry sampling began on the night of April 11th and was intermittent before occurring nightly between May 4th and May 28th, after which it was intermittent again as fry numbers began to decrease. Estimates for unsampled nights were interpolated from adjacent nights. Six sampling nets were used at the upstream fry enumeration fence and three at the downstream enumeration fence. Sampling time varied through the sampling period and was dependent on the number of fry; for example, during periods of high fry emigration the sampling time was 1-5 minutes/hour and during periods of low fry emigration the sampling time was 30-

60minutes/hour. Total fry estimates were arrived at by expanding the counts by time and by the ratio of the channel width divided by the width of the nets (which was a factor of 12.944 for the upstream fence and 22.3 at the downstream fence).

Fry estimates were determined by the following example calculation:

$$\frac{60 \text{ min.}}{\text{sampled period}} \times \frac{\text{creek width}}{\text{width of nets}} \times \text{number of fry in nets} = \text{total fry in 60 minutes}$$

In general, fry were sampled hourly from 20:00 to 24:00 then expanded out over the remainder of the night by applying expansion factors for the 02:00 and to dawn period which were determined by previous sampling; however when sampling occurred in that period the actual fish numbers were used.

Kokanee Adult Spawner Returns

Kokanee spawners were counted through the downstream enumeration fence (Figure 3) between August 23 and September 26, 2023. Weekend monitors for the month of September continued to be available during the visitor opening hours of 1000 to 1400 to answer questions from the public.

Kokanee spawning in Meadow Creek downstream of the spawning channel were counted on September 28 as a single bank count. A crew of 5 walked the creek, 3 scouted for bear activity while two counted the spawners. The final count was the average between the two counters.

A total of 1077 spawners were measured at the downstream fence for fork length and weight. A total of 60 females were sampled for fecundity. Otoliths were collected from 100 fish (50 females, 50 males). All biological sampling was spread across the duration of the run. Samples were also collected for DNA, though at this time were not analyzed and stored at the Nelson Ministry office. Egg retention was calculated by averaging the egg retention counted on 101 female mortalities. Egg deposition is calculated by subtracting the average egg retention from average fecundity and multiplying to the % female portion of the total run.

Standard fish health testing of kokanee spawners at Meadow Creek in 2023 was done by the Freshwater Fisheries Society of BC.

The 2023 eyed eggs were sourced from Hill Creek and the Columbia River near Fairmont and reared in the Freshwater Fisheries Society of BC (FFSBC) Kootenay Trout Hatchery at Bull River before being planted into egg tubes (Figure 7) from Leg 2 – Leg 3 above the upstream fry counting fence (Figure 3). This location was chosen as it had uniform flow across the width of the channel and there was no stagnant backwater (caused by the barrier). Eyed egg plants are part of the Kootenay Lake recovery plan.

Water level monitoring occurred all year at the channel ensuring flows are adequate to optimize egg incubation, to prevent channel bank erosion, reduce stop log scouring, to minimize sediment transport and deposition into spawning gravel and maintain channel habitat for other fish species and aquatic life.

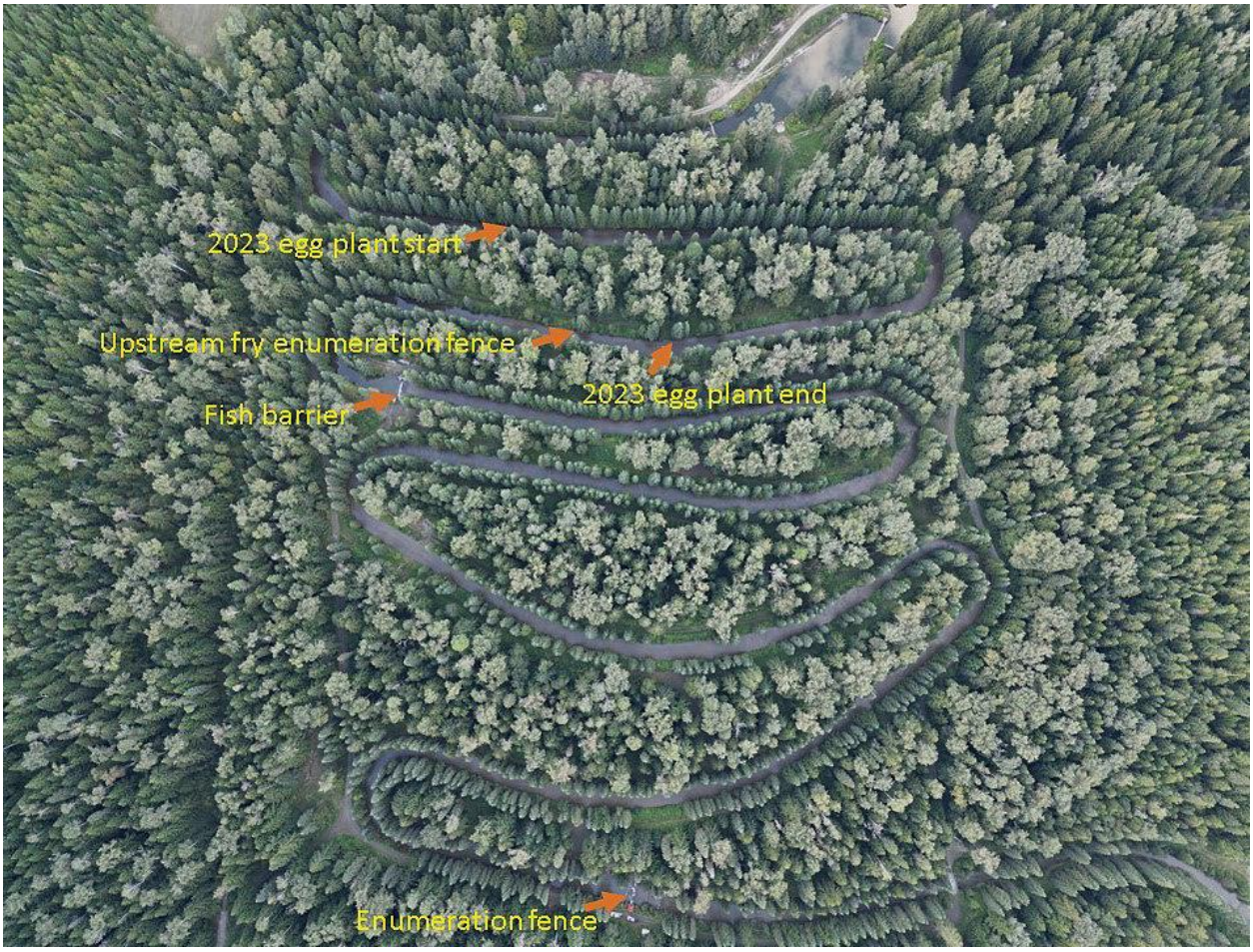

Figure 3. Aerial view of Meadow Creek Spawning Channel showing location of the fish barrier. Water flow proceeds from the settling pond at the top of the photo towards the bottom. The spawning channel downstream of the barrier was surrounded with electric fencing to protect the low escapement of adult kokanee from bear predation in the channel. The approximate location of the eyed egg plants is between "2023 egg plant start" and "2023 egg plant end". The Upstream Fence is the enumeration location for the fry of upstream plants, and the lower enumeration fence is for counting returning spawning kokanee in fall and naturally spawned fry in spring.

Results

Kokanee Fry Outmigration

Total channel production in the spring of 2023 was estimated to be 5,532,027 fry, including both wild spawned (4,839,318 fry) and from eyed egg plants (692,709 fry). Fry emigration peaked on May 15th for at both fences (Figure 4.). In the fall of 2022, 1,376,218 eyed eggs were

planted resulting in an egg to fry survival rate of 50% for planted eggs. The wild spawned egg deposition in 2022 was estimated at 3,790,115 by Bassett & Bendis (2023), resulting in an impossibly high wild egg to fry survival estimate of 128%. There was uncertainty around the 2022 egg deposition calculation due to a low sample size of measured fecundity (n=16 due to the exceptionally low 2022 spawner return) however that does not appear to be the cause of the impossibly high survival (rather, resolving the biased fecundity estimate only increases survival even higher; see Appendix 1 for further details and revised 2022 fecundity and egg deposition estimates).

The impossibly high egg to fry survival rate for 2022/23 is an anomaly in the long-term dataset at Meadow Creek. Presumably, the error was in the fry estimate, which, unlike channel spawner estimates (absolute abundance fence counts), is based on spatial and temporal expansion of subsampling. Although the methodology did not differ in 2023 from other years, it is possible the very low egg deposition/fry abundance was a factor and subsampling intensity, or historic expansion factors were not suitable. Given the substantially higher egg deposition in 2023, we expect this will not be an issue for the fry counts in 2024 and have not planned for reviewing/adjusting the fry sampling methodology. However, if an impossibly high egg to fry survival is measured again in the future, or extremely low egg deposition occurs again, the fry count methodology should be reviewed, and consideration given to increasing sampling intensity.

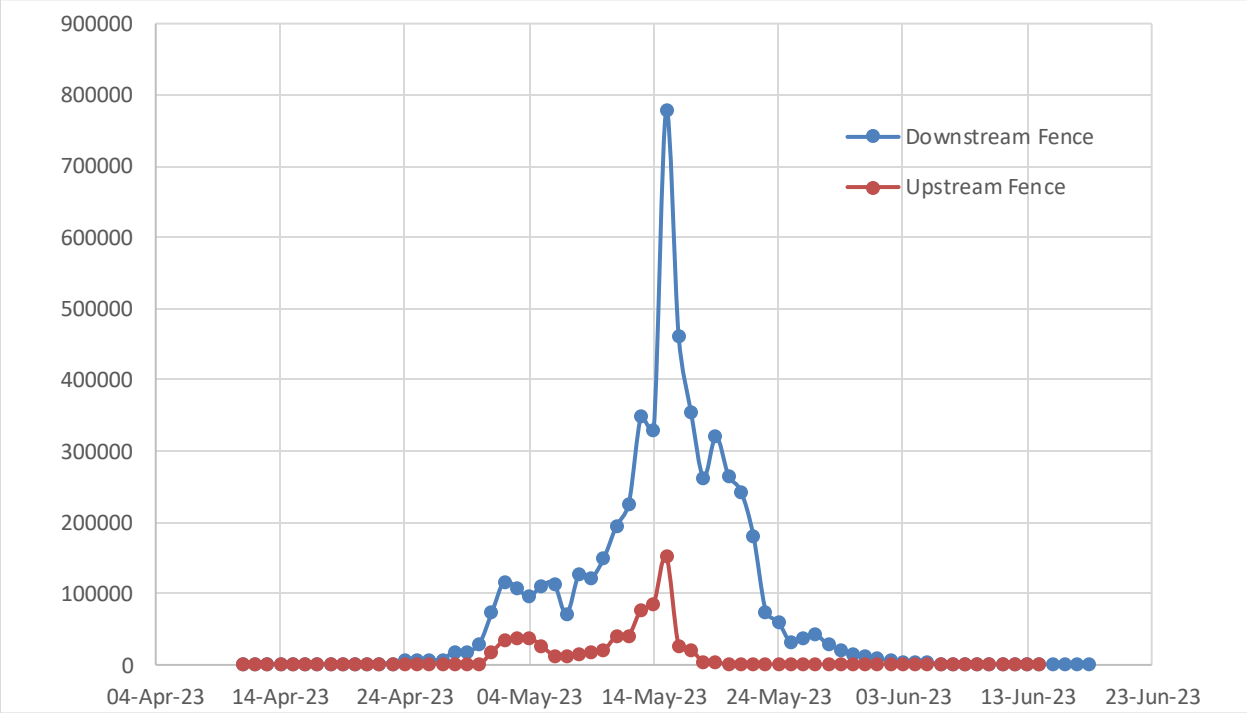

Figure 4. Daily fry emigration enumerated at the Downstream Fence (blue) and the Upstream Fence (red).

Kokanee Adult Spawner Returns and Estimated Egg Deposition

A total of 71,423 kokanee spawners were enumerated in Meadow Creek in the fall of 2023, a significant increase from the previous decade of lower spawner returns. Of those, 65,417 spawners entered the channel. Below the channel, 6006 fish were enumerated (via a single unexpanded bank count). Average fork lengths for females and males were less than previous post-kokanee collapse years at 31.2 cm and 32.8 cm respectively (Figure 5). Average female weight was 360 g and males averaged 458 g.

The spawners in the channel were 51% female. Fecundity was counted on 60 females over the course of the return, the average length of the females collected was 31.6 cm, and there was not a significant difference between the females collected for length (31.2 cm) and the females collected for fecundity (p=0.47). Egg deposition in the channel was estimated to be 18.2 million eggs from natural spawning in MSCS, 1.67 million eggs below the channel[1], for a total of 19.9 million eggs in 2023 (Figure 6). An additional 2.5 million eyed eggs were planted in MCSC. The estimated egg deposition in Meadow Creek, including the spawning channel, below the channel, and planted eyed eggs was 22.4 million eggs.

Kokanee samples (18 female and 18 male) were sent to FFSBC health testing facility to screen for various viruses (Freshwater Fisheries Society of BC 2023). Positive results were observed in 6/12 original filtrate pools (method: qPCR TaqMan) for Infectious Hematopoietic Necrosis (IHNv). All samples tested negative for *Myxobolus cerebralis* (whirling disease) and *Flavobacterium psychrophilu* (FFSBC, 2023).

Otolith samples (50 females and 50 males) were collected from August 25 to September 25, 2023 but ageing was not yet completed at time of reporting. Preliminary length frequency analysis suggests that approximately 40% were age 2 and 60% were age 3, meaning the fish were from the 2020 and 2019 brood years.

[1] This estimate is based on the unexpanded bank count below the channel thus underestimates true egg deposition.

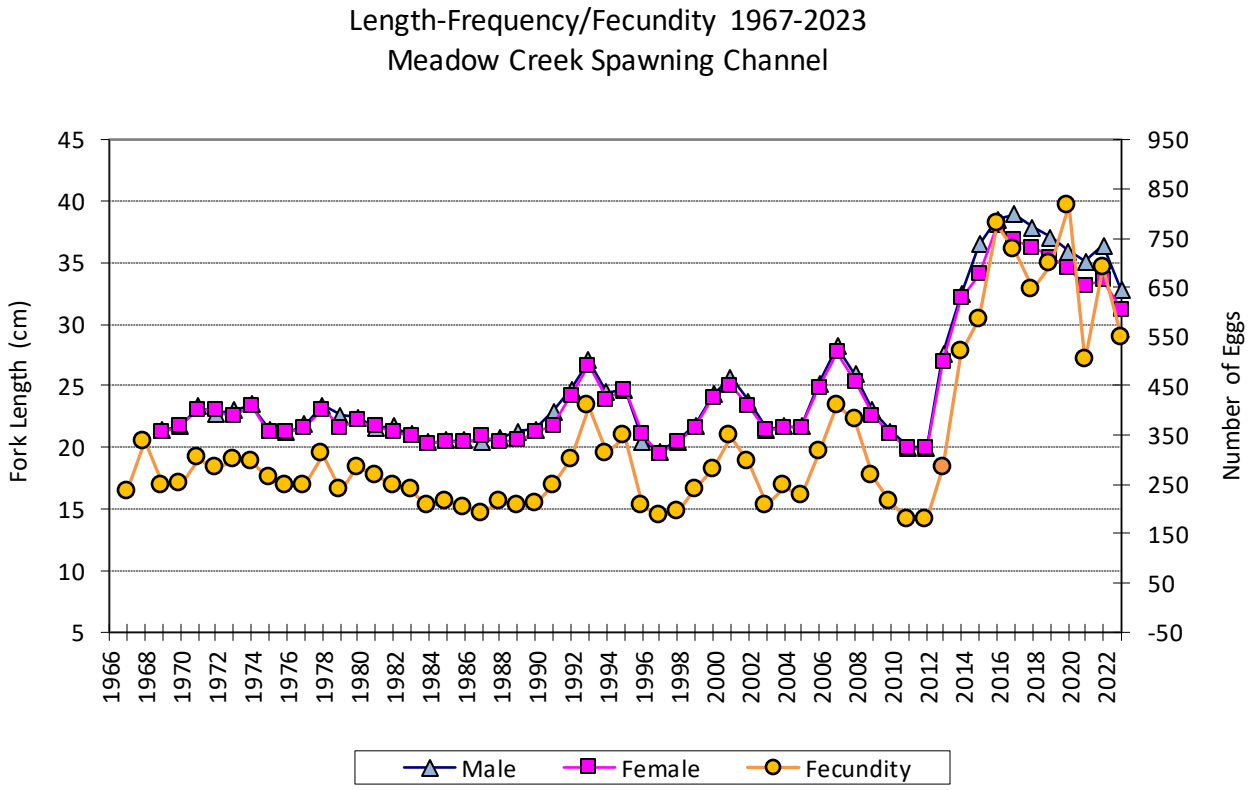

Figure 5. Average fork length for males and females, and average number of eggs (fecundity) for kokanee spawning in Meadow Creek spawning channel, 1967-2023.

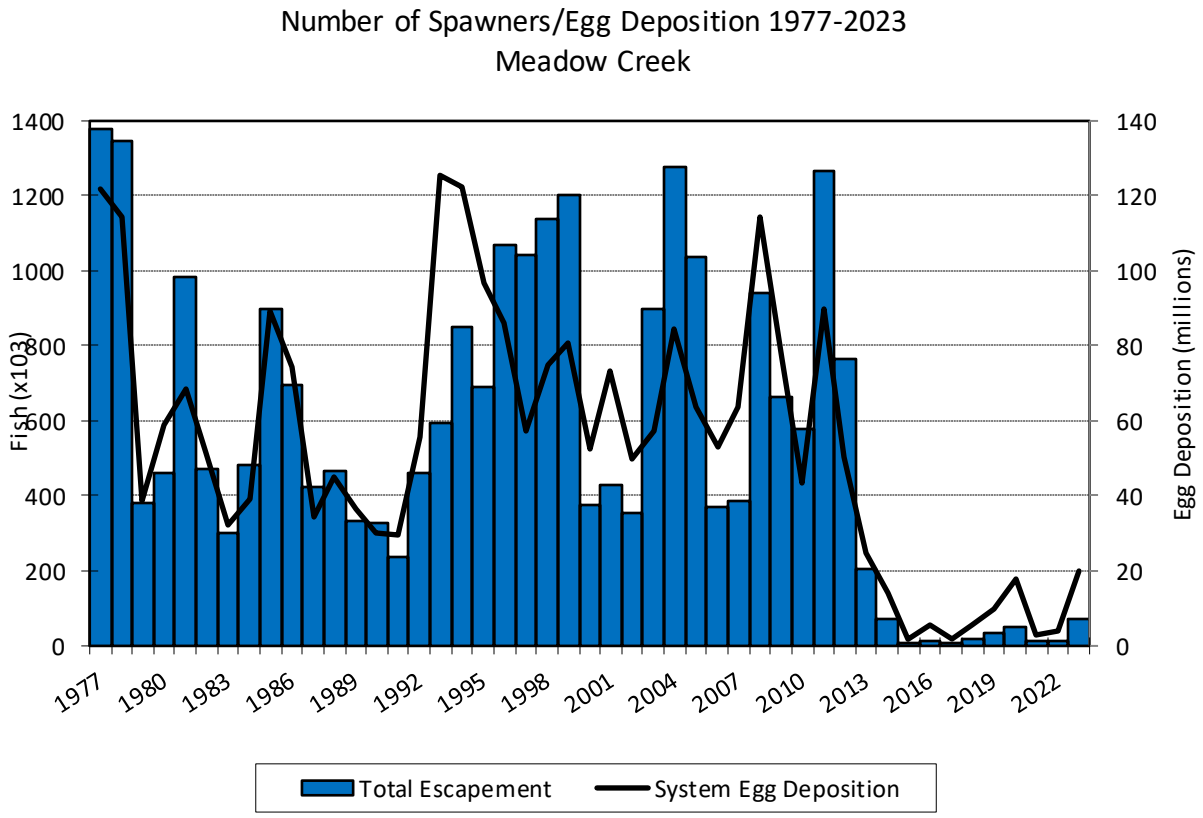

Figure 6. Kokanee spawner number (escapement) and estimated egg deposition in Meadow Creek Spawning Channel, 1967-2023.This does not include supplemented eggs from the eyed egg plants.

Figure 7. Sterilized egg tubes containing~10,000 eyed eggs, photo taken Oct 2023 at MCSC.

Operation and Maintenance Activities

Spawning Channels require an extensive amount of maintenance on the channel and supporting infrastructure. Mechanical gravel scarification occurs annually and took place between July 15th and August 15th in 2023. After machine scarification, the channel was raked by hand to ensure gravel was evenly distributed, which a time intensive activity with 100 person hours in 2023. Channel and access road improvements were completed by removing danger trees and vegetation. Excess sediment build-up was removed from all four diversion locations (Meadow Creek, John Creek, John/meadow confluence, and meadow/channel confluence), and from the settling pond before the water enters the channel (Figure 8). Metal screening was placed on the downstream side of the fish barrier (located at the beginning of Leg 4) to prevent adult access upstream to isolate the supplementary eyed egg plants upstream of the barrier. Additional work on the John Creek diversion channel below MCSC was completed in 2023 to ensure that the series of smaller settling ponds on the diversion channel were cleared in the event of high spring run-offs in future years.

Figure 8. Main settling pond. Clearing out accumulated sediment upstream of the hatchery diversion fence (A). Bottom of main settling pond scraped clean of accumulated sediment (B).

The channel was drained and dried out from August 11 – 17 to reduce the persistence of the IHN virus. Immediately following de-watering of the channel on August 11, a fish salvage was completed to move any fish species to below the confluence. The salvage was completed with help from Ministry staff, contractors, and a First Nations staff from Nupqu Resource Limited Partnership Consulting.

In anticipation of low numbers of kokanee spawners and as in previous years, an electric fence was constructed from the enumeration fence upstream to the barrier to prevent bears from entering the active spawning area of channel (Figure 9). This strategy protects the redds from bear disturbance during the ongoing period of low kokanee returns. Bears still have access to kokanee in the creek downstream of the channel.

Figure 9. Grizzly bear and cub shown downstream of electric fence placed at the enumeration fence.

Public Open House and First Nation Engagement

We held the annual public Open House on Sept 9, which was well attended with 90 visitors from the local area and further afield. Ministry staff, contractors, and volunteers were on site to provide information on the Kootenay Lake Nutrient Restoration Program, Meadow Creek Spawning Channel, and the current state of kokanee recovery.

We had Westbank and Penticton First Nations attend a First Nation Open House on Sept 8. The invitation for this Open House was extended to First Nations with interest in Kootenay Lake and kokanee recovery.

We had 14 members from Kootenai Tribe of Idaho and Idaho Fish & Game come for a personalized tour on Sept 14 (Figure 10).

Figure 10. Fisheries teams from the Kootenai Tribe of Idaho and Idaho Fish & Game at their personalized tour on Sept 14.

Wildlife Projects

In 2023 the MCSC contractor helped with additional wildlife projects at the channel. An artificial roost for bats near the hatchery building was installed as part of Wildlife Conservation Society Canada's Bat Roost Habitat Monitoring Project. We also built and monitored an electric fence to protect captive beavers held at an outbuilding near the hatchery. The beavers were held at MCSC for 4-5 weeks before their release in the North Kootenay Lake estuary as part of BC Conservation Foundation's Habitat Restoration for Beavers along the Duncan Lardeau Floodplains project.

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Appendix

Appendix 1. 2022 egg deposition and fecundity

There was uncertainty around the 2022 egg deposition calculation, as the fecundity samples were low (n=16 due to the exceptionally low 2022 spawner return) and sampling was biased towards larger fish (Figure 1). Accordingly, the mean of measured fecundity in 2022 of 912 eggs/female was assumed to be biased high. Bassett and Bendis (2023) addressed this by predicting fecundity from fork length for all female fish measured in 2022 (n=56) using the exponential model regression from the 16 fish with measured for fecundity (Figure 12). The resulting mean fecundity, which combined the predicted estimates plus measured fecundity, was 786 eggs/female.

Following the observation of >100% egg to fry survival in the spring of 2023 discussed in this report, the 2022 fecundity estimate was revisited to ensure the error leading to impossibly high fecundity was not related to the fecundity estimate. We did not determine the fecundity estimate to be the source of the problem, rather, further investigation uncovered that the 2022 fecundity estimate of 786 reported by Bassett and Bendis (2023) was likely still biased high. This was based on a comparison with the combined 2013-2022 length/fecundity dataset shown in Figure 12, where it is apparent that the 2022 regression would substantially overestimate fecundity for smaller fish well beyond what was previously measured. Accordingly, we have revised the mean 2022 fecundity estimate to 690 by using the 2013-2022 fork length to fecundity regression to predict fecundity for all females measured for fork length then averaging those with the measured fecundities in 2022.

As a result of the revised fecundity estimate, the egg deposition estimate for 2022 for naturally spawned Meadow Creek Spawning Channel eggs has been updated to 3,321,109. The revised estimate exacerbates the egg to fry survival issue by increasing it to 146%. Regardless, as discussed in this report, the 2024 fry estimate appears to be the likely source of error leading to >100% survival.

Table 1 summarizes the three methods of calculating egg deposition and egg to fry survival that have been reported on to the 2022 spawner dataset, and notes on when these methods were reported out on.

Preliminary results in spring of 2024 suggested again a >100% survival rate of the planted eggs. These planted eggs are more accurate than egg deposition estimates, which suggests there may be some error in the expansion estimates.

Table 1. Summary of fecundity calculation methods used on the 2022 spawner dataset.

Method	Fecundity	Egg deposition[1]	Egg to fry survival [2]	Reporting notes
The average fecundity using the measured fecundity for 16 fish.	912	4,402,994	110%	Presentations to FWCP Fisheries Technical Committee (Fall 2022) and FWCP Board (Winter 2023)
The average fecundity using the measured fecundity for 16 fish and the 2022 fork length to fecundity regression.	786	3,790,115	128%	This was the method reported on in the 2022/F23 MCSC Activity Report (Bassett & Bendis, 2023)
The average fecundity using the measured fecundity for 16 fish and the 2013-2022 fork length to fecundity regression.	690	3,321,109	146%	This result is used in this report for fecundity (Figure 5) and egg deposition (Figure 6)

[1] egg retention was 9 eggs/female and % females was 46%

[2] 2023 spring fry = 4,839,318

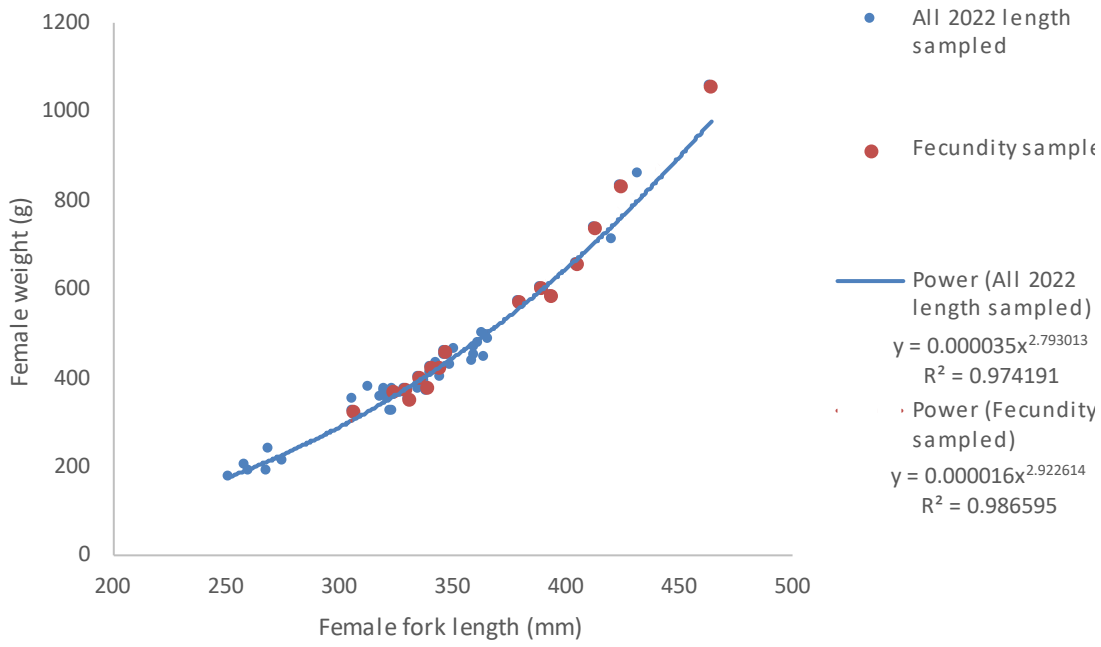

Figure 11. Length weight regressions for all females measured for fork length across the 2022 spawner return and for those with measured fecundity estimates.

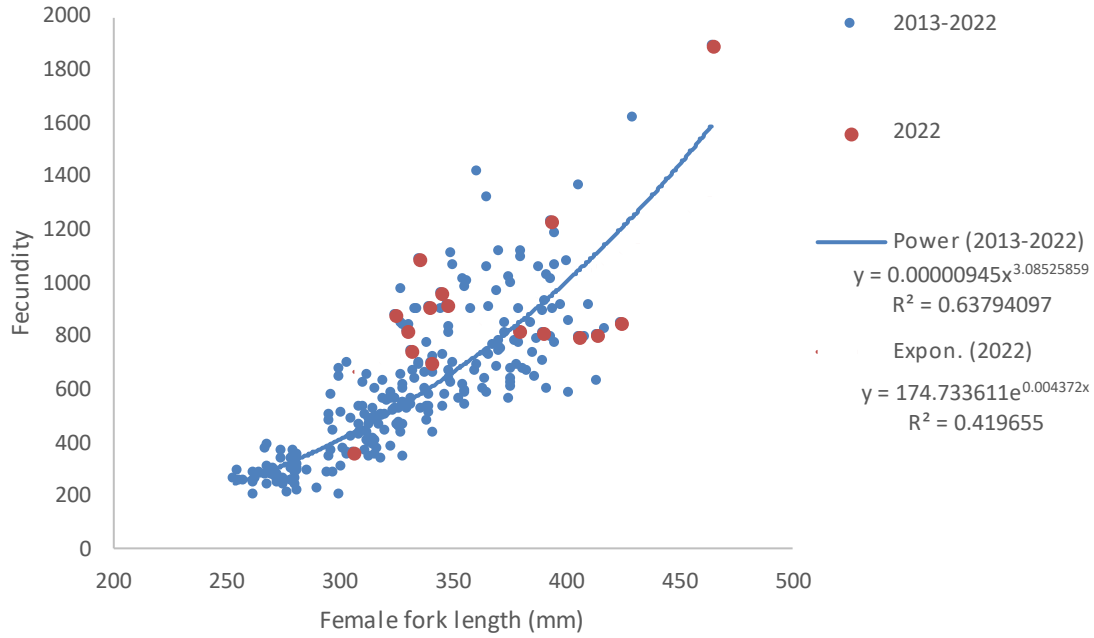

Figure 12. Best fit regression models for female fork length and fecundity for 2022 and for the combined 2013-2022 period.