TRIP REPORT

State of Alaska
Department of Fish and Game

Field Dates:	May 8 - 19, 2023
Location:	**Fort Knox Mine – Water Supply Reservoir (WSR) and Wetlands**
Objectives:	1) Spring Arctic grayling sampling in WSR and wetlands complex
	2) Water temperature monitoring in Pond F outlet and RO Channel
Participants:	Chad Bear, Lauren Yancy, Maria Wessel, Todd Nichols, Olivia Edwards, Kieren Vasquez, Chelsea Clawson, and Jake Wade.
Weather:	Sunny, rain, wind, snow, hail, air temperature between -2°C and 10°C
Access:	State truck to Fish Creek

On April 27, 2023, Chad Bear and Lauren Yancy traveled to the Fort Knox Mine to determine the spring thaw timing and deploy two HOBO water temperature probes in the wetlands complex. One probe was placed in Fish Creek at the Pond F outlet and one in the Reverse Osmosis (RO) Channel downstream of RO Outfall 002 (Figure 1). The majority of Fish Creek was ice covered. Ice appeared soft and thin but very little flowing water was visible. The water temperature of Fish Creek at Pond F was -0.1°C. The RO Channel was completely frozen over with glaciated ice throughout the valley floor. The RO Channel did not have an open flowing channel like past years. The water temperature was 2.69°C taken at the outlet of Pond AB, but -0.8°C taken in the lower RO Channel where water flowed over the glaciated ice in the valley. Conditions were determined to be appropriate to begin fyke netting Arctic grayling on May 8. The spring of 2023 was relatively cold, with sampling starting six days later than in 2022 and nine days later than in 2021.

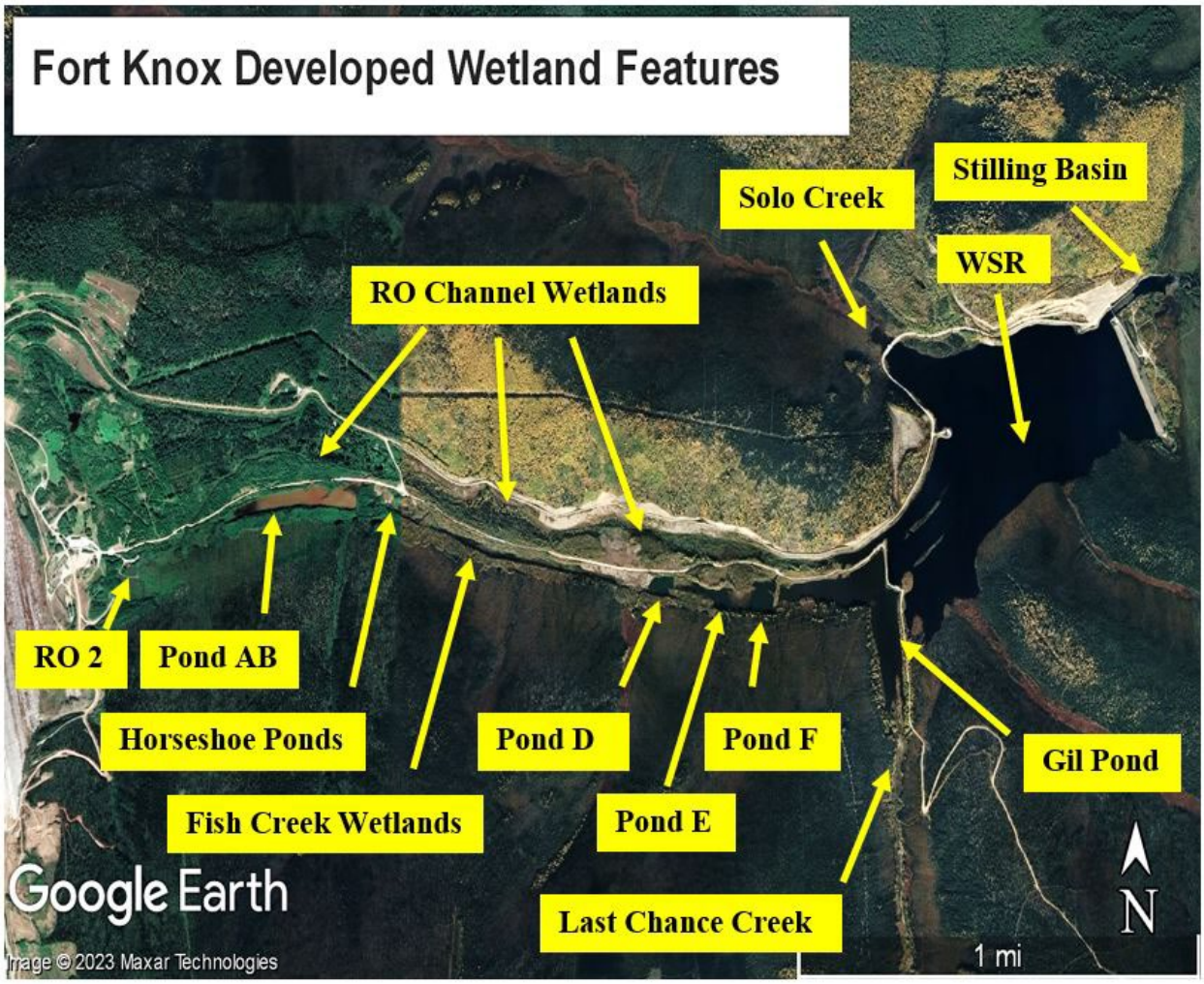

Figure 1. Fish Creek and RO Channel wetlands features.

The 2023 Arctic grayling sampling methods included fyke nets, angling, and visual observations. One fyke net was set in Fish Creek at the Pond F outlet and one in Pond AB on May 8 (Figure 2). The RO Channel fyke net could not be set at its confluence with Fish Creek until the aufeis thawed on May 15. Fyke nets were checked daily until they were removed on May 19.

Fyke nets in Fish Creek and the RO channel were used to capture Arctic grayling moving from the Water Supply Reservoir (WSR) into the wetlands complex for spawning (Figures 3 and 4). Additionally, the RO Channel net was used to assess Arctic grayling use of the wetland habitats created by the RO discharge waters. The Pond AB fyke was used to determine if fish were still residing in the uppermost waterbody in the wetlands complex that was first documented in the 2022 spring Arctic grayling sampling (Figure 5).

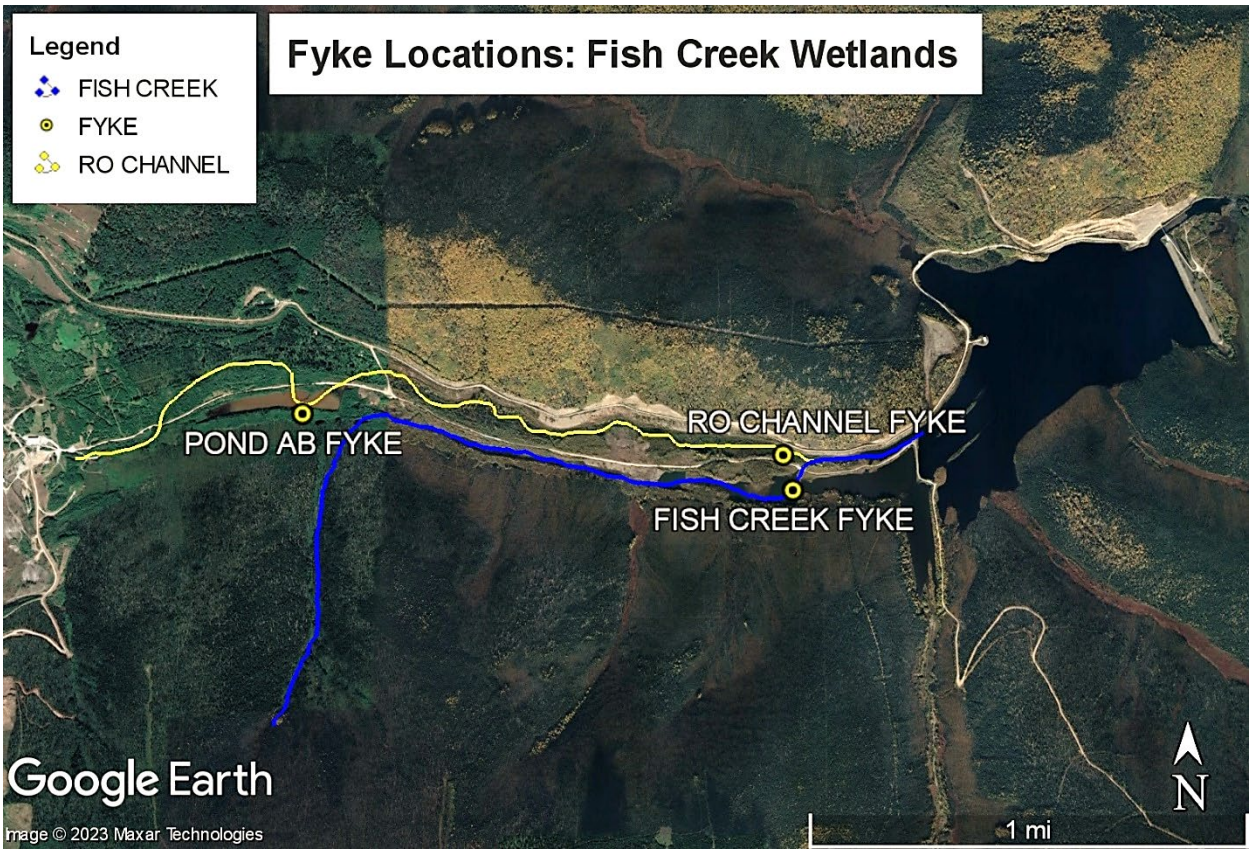

Figure 2. Fish Creek wetlands fyke locations, 2023.

Figure 3. Fyke net location in Fish Creek at Pond F Outlet, May 8, 2023.

Figure 4. Fyke net location in RO Channel near confluence with Fish Creek, May 15, 2023.

Figure 5. Fyke net location in Pond AB near the outlet, May 17, 2023.

Arctic grayling were measured to fork length (FL, nearest mm), inspected for tags and spawning condition, and then released. Un-tagged Arctic grayling ≥200mm and burbot ≥300mm were tagged with a numbered Floy® T-bar internal anchor tag.

The 2023 Fish Creek daily peak water temperature taken at the Pond F outlet was similar when compared to previous years during similar timing (Figure 6). Fish Creek water temperature was 0.33°C on April 27 from natural spring melt water entering the drainage. The RO Channel water temperature was warmer at 2.98°C taken at Pond AB (Figure 7). The large volume of RO water dilutes the influx of cold spring melt water keeping Pond AB and the RO Channel warmer than Fish Creek in the upper part of the drainage. Lower in the RO Channel aufeis covered the valley floor and water flowing over the ice was near zero Celsius until a channel thawed and water temperature rose to 3.5°C on May 15 near the confluence with Fish Creek.

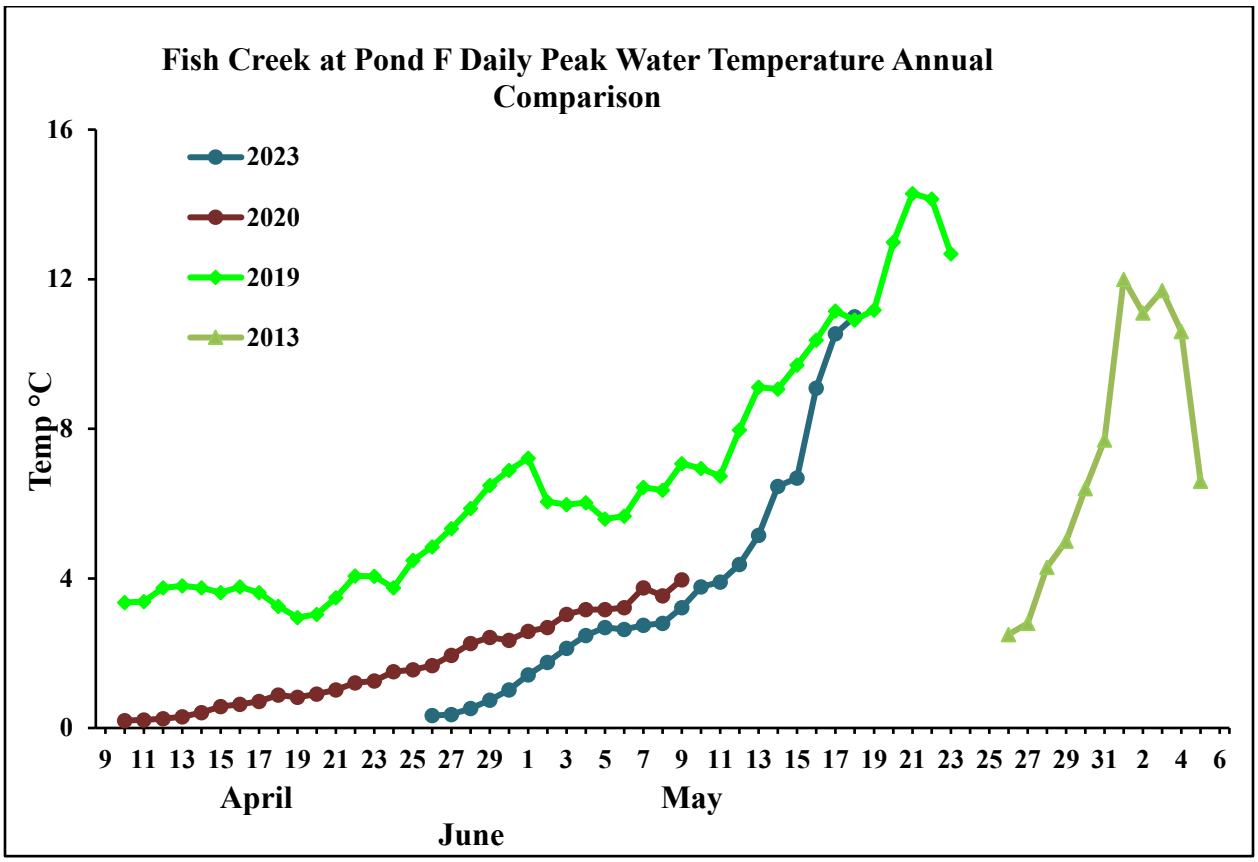

Figure 6. Fish Creek at Pond F daily water temperature maximums; select years for reference.

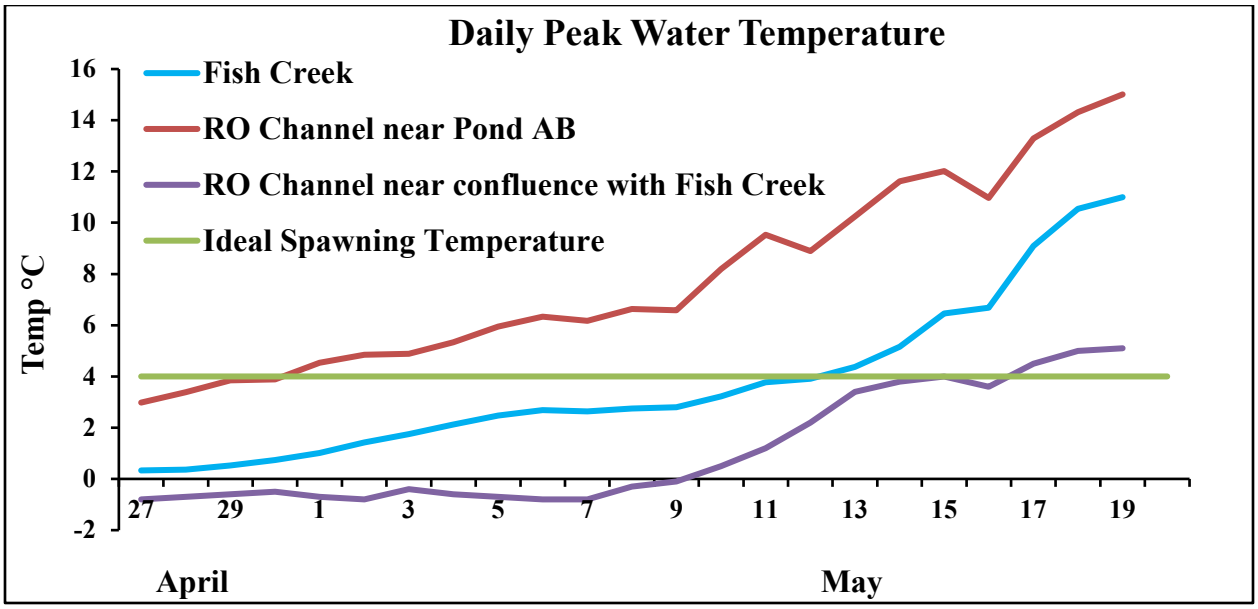

Figure 7. Fish Creek at Pond F, RO Channel at Pond AB and RO Channel near confluence with Fish Creek daily peak water temperature, 2023.

From May 8 - 19, all fish caught in fyke nets were handled with the majority being Arctic grayling. The Arctic grayling catch per unit of effort (CPUE) in Fish Creek varied during the first few days of sampling and peaked at 5.98 fish/hour on May 16. The RO Channel CPUE reached a high of 5.79 fish/hour on May 17 before catch rates declined (Figure 8). Water temperatures remained cool in the lower RO Channel, 4.0°C on May 19, compared to 10.99°C in Fish Creek. The fyke nets were removed on May 19.

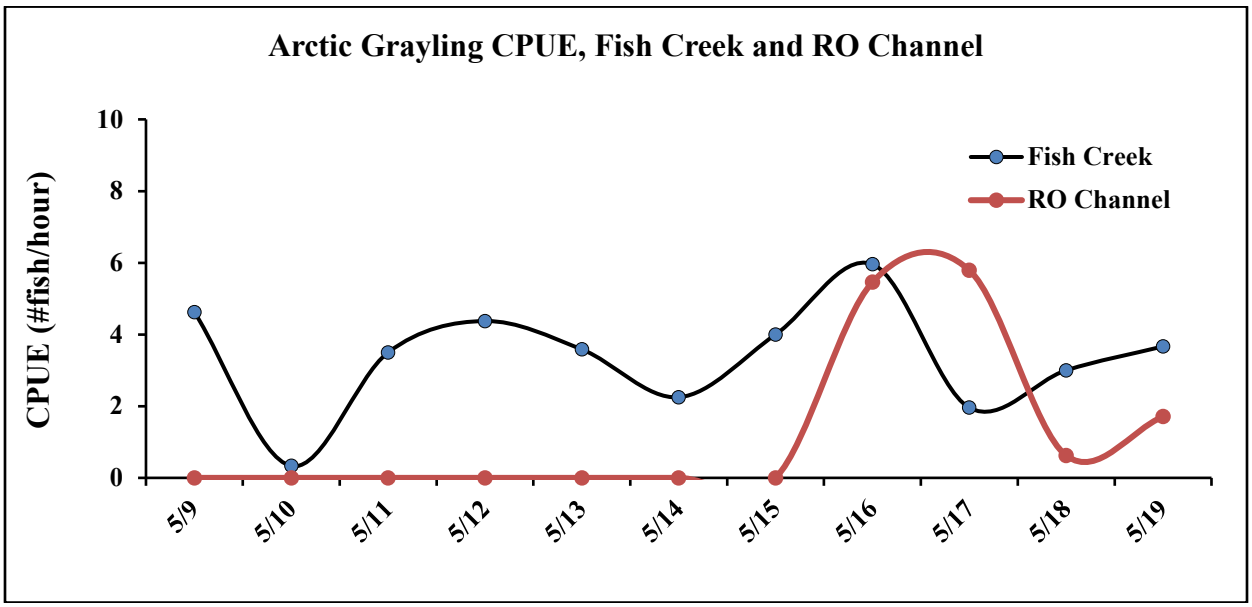

Figure 8. Catch per unit of effort (CPUE) in #fish/hr at the Pond F and the RO Channel fyke nets in the wetlands complex, 2023.

Female Arctic grayling were categorized as not ripe, ripe, or spent, based on their spawning condition (Figure 9). On the first day of fish capture (May 9), 96% of the female Arctic grayling were categorized as not ripe. The number of not ripe females decreased throughout the sampling period to 9% on May 19. On May 9, 4% of the female Arctic graying were classified as ripe. The number of ripe females increased to 91% on May 19 when sampling concluded. Very few fish were classified as spent during the first eight days of sampling and 13% of females were spent on May 18.

Recruitment is defined as those fish ≥200mm captured in spring 2023 that would have been too small to mark in 2022 (generally less than 240 mm). Recruitment is highly variable among the sampling years. Recruitment was high in 2017, declined from 2018 to 2021, and then increased in 2022 and 2023 (Figure 10). Substantial recruitment was observed in the spring of 2004, 2010, 2014, 2017 and 2022. A substantial recruitment event was defined as ≥300 fish captured. In 2023, the recruitment was 224 Arctic grayling (200 to 240mm long).

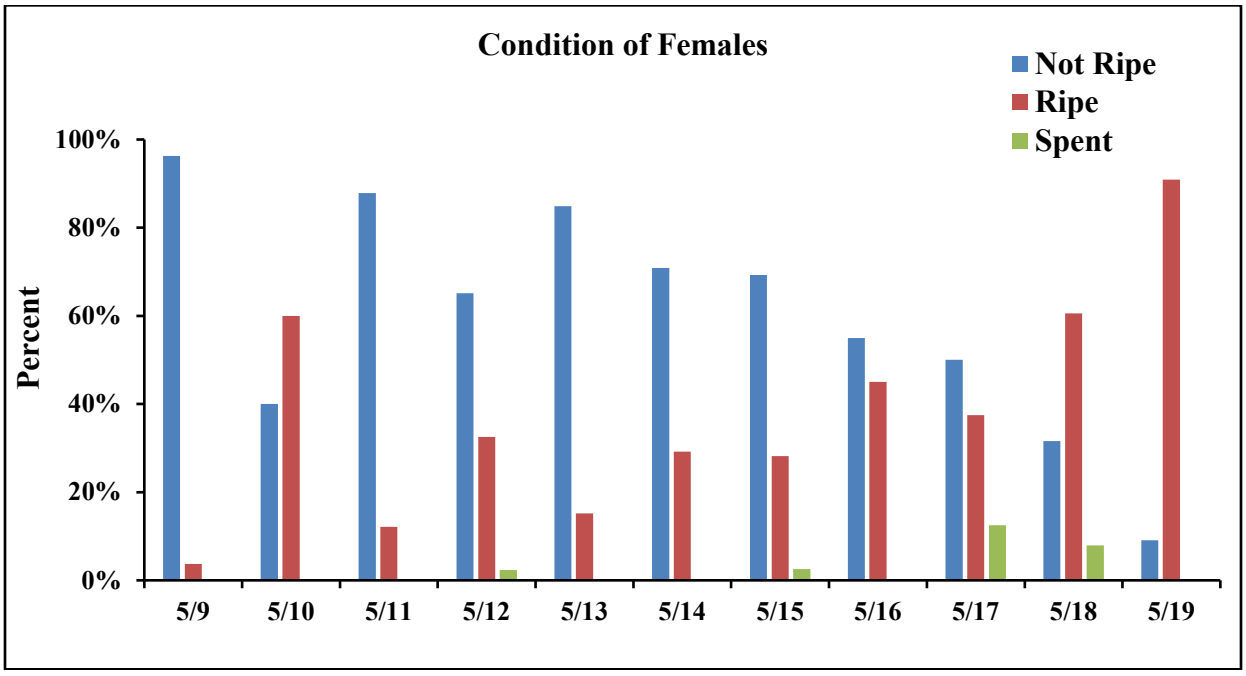

Figure 9. Spawning condition of Arctic grayling females categorized as: not ripe, ripe, or spent, 2023.

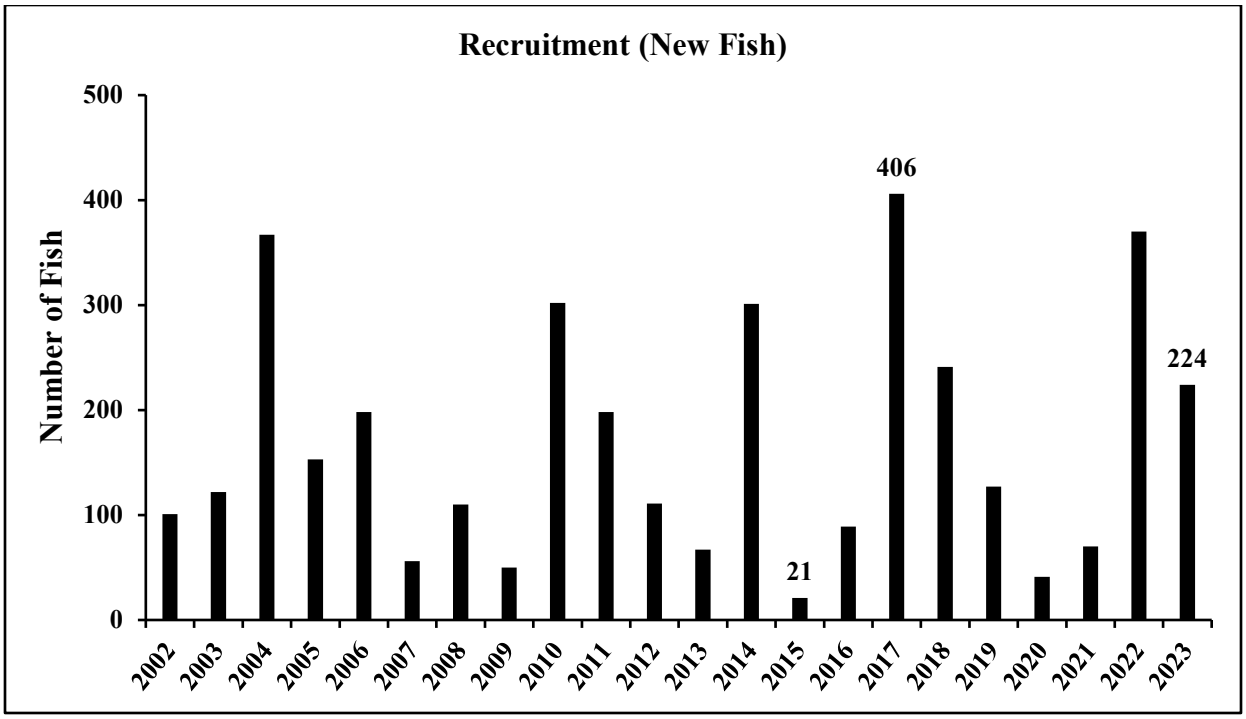

Figure 10. Number of new fish ≥ 200 mm that entered the population but would have been too small to tag in the previous year (generally ~240 mm).

The 2022 population abundance estimate of Arctic grayling in the WSR was calculated using spring 2022 as the mark event and spring 2023 as the recapture event. During the spring of 2023 976 Arctic grayling ≥240mm were captured, of those 184 were recaptures from the spring 2022 tagging event. The 2023 recapture number does not include fish that were less than 240mm as they were likely too small to tag in 2022.

The spring 2022 population abundance estimate for Arctic grayling ≥200mm was 4,594 fish with a 95% CI of 4,066 to 5,121 fish (Figure 11). The population has declined since 2017 but increased in 2022 and remains above the post mining goal of 800 – 1,600 fish ≥200mm. This Arctic grayling population is anticipated to increase in the future with the substantial number of age-2 and age-3 Arctic grayling captured during the spring 2022 and 2023 sampling events.

Annual average growth of Arctic grayling in each size class has increased since the construction of the WSR in 1994. Average growth prior to the development of the WSR ranged from 3 to 17mm per year (Figure 12). In 2023, the average growth rate was 42mm (n = 24) for fish from 200 to 209mm at the time of marking. For fish from 270 to 279mm at mark, the average growth was 17mm (n = 16).

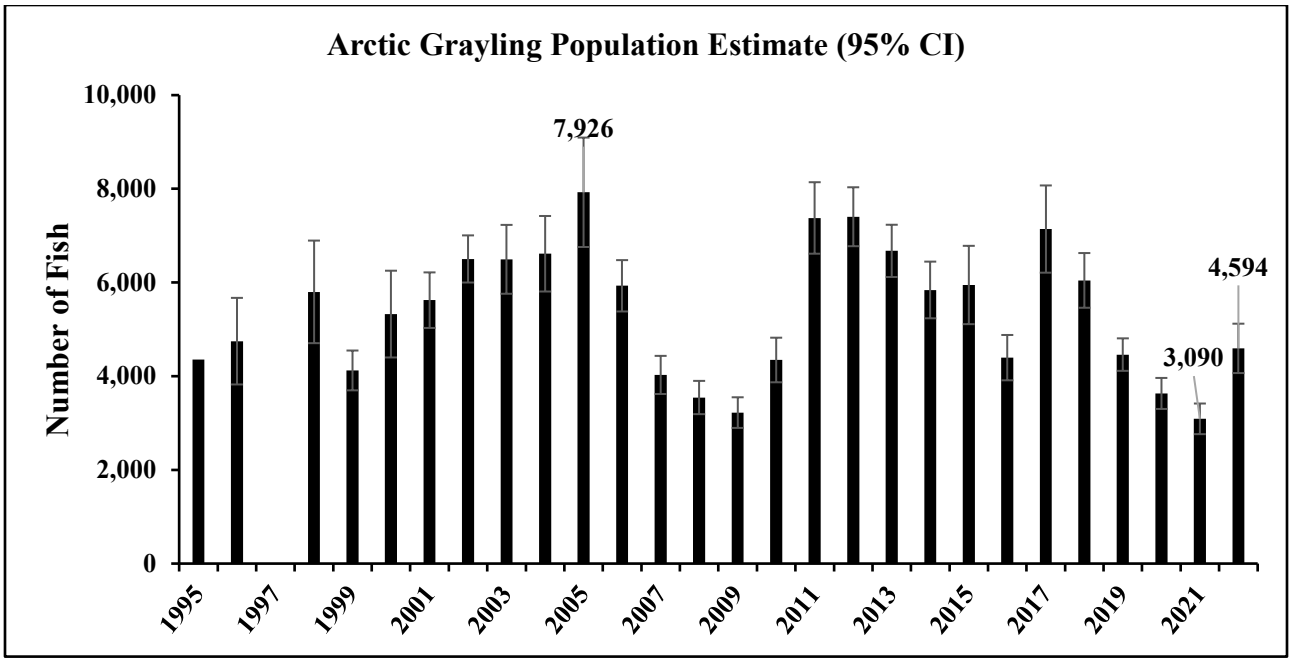

Figure 11. Estimates of the Arctic grayling population in the wetlands and WSR with 95% confidence intervals, 1998 – 2022.

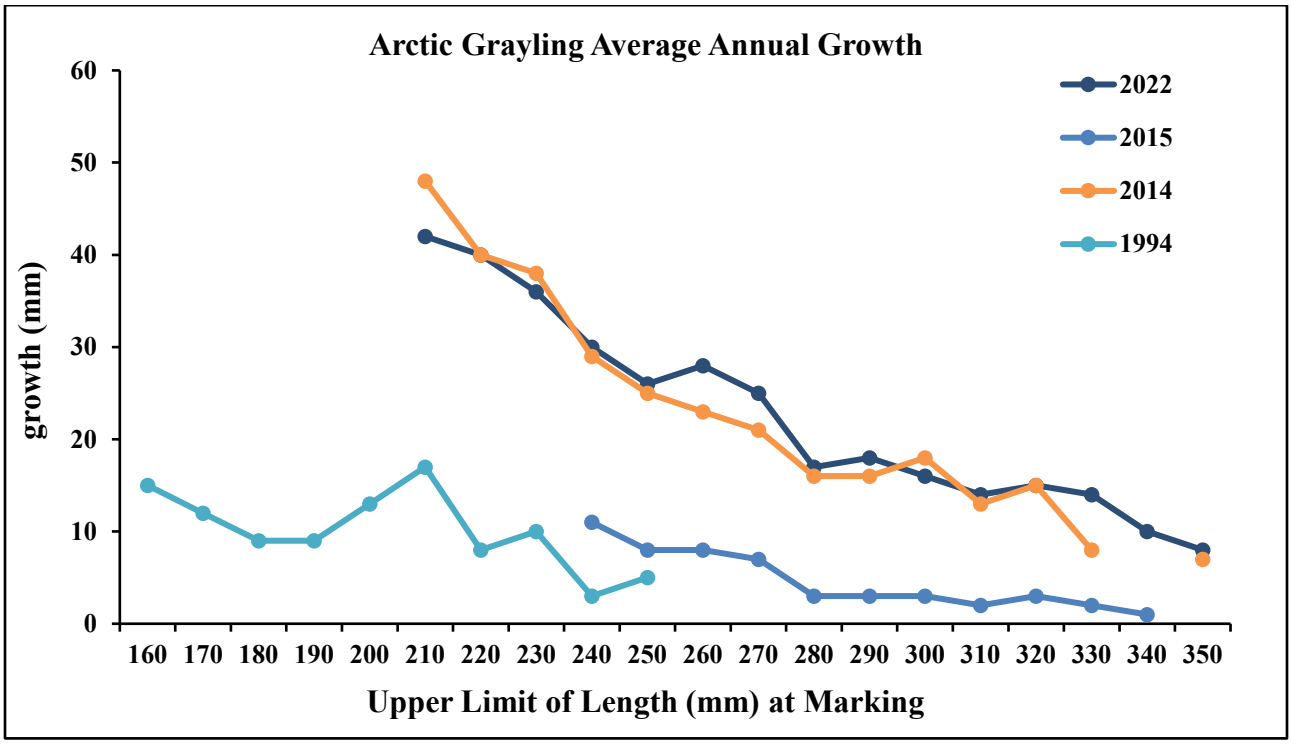

Figure 12. Average annual growth of Arctic grayling by size group in the WSR in selected years including baseline (before WSR) in 1994.

The 2023 length frequency distribution of Arctic grayling caught in Fish Creek and the RO Channel is presented in Figure 13. Data from 1995, before construction of the WSR, are included for comparison. The 1995 data set reflects the stunted condition of the population at that time. The current population appears to have fewer large Arctic grayling ≥300mm but an increase of juveniles ≤110mm (Figure 13).

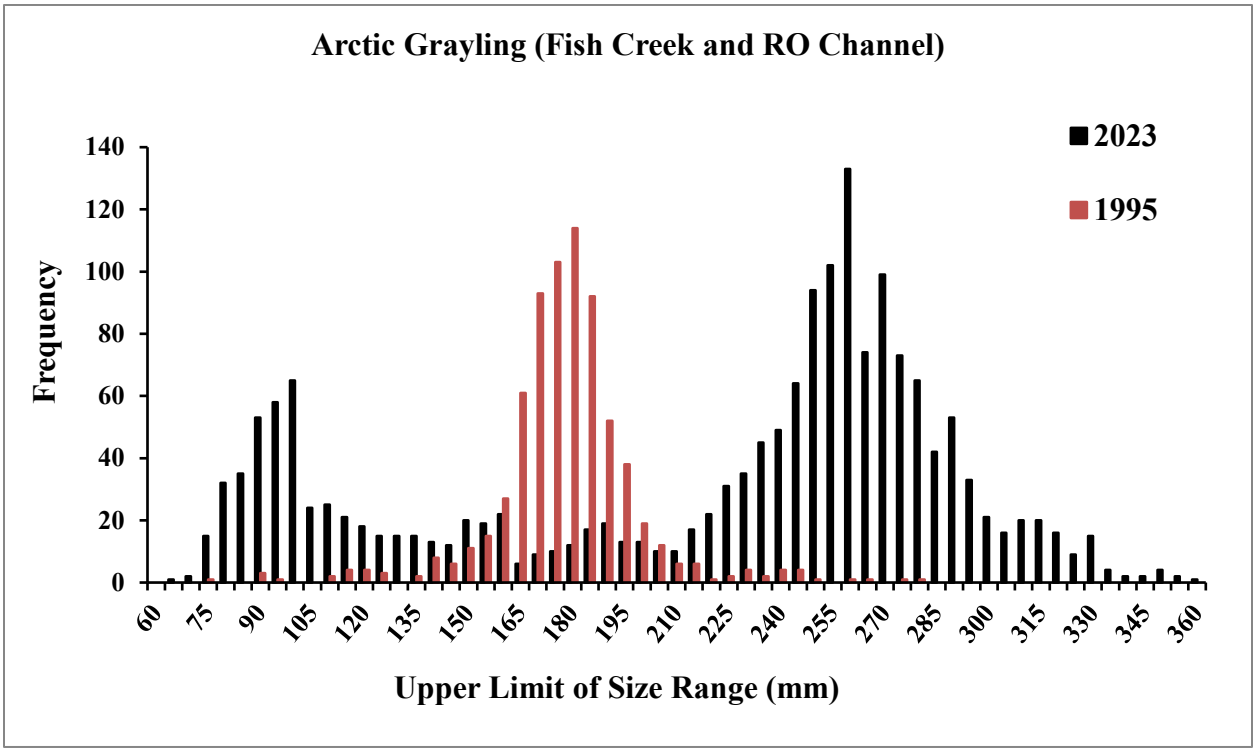

Figure 13. Length frequency distribution of Arctic grayling captured in spring 2023 and 1995.

The uppermost waterbody in the wetlands system located immediately downstream of the tailings dam is referred to as Pond AB. It is located below Outfall 002 in the RO Channel (Figures 1 and 2). The fyke net placed in Pond AB on May 8 captured 201 Arctic grayling between 101 and 291 mm with an average size of 237 mm. The 2022 and 2023 length frequency distribution of Arctic grayling caught in Pond AB is presented in Figure 14. 189 Arctic grayling were ≥200mm and tagged. Four Arctic grayling were recaptured from the 2022 sampling event, three of which were tagged in Pond AB. One Arctic grayling was captured in Pond AB during 2023 sampling had been handled and tagged in the two fyke nets located in the lower Fish Creek wetlands during 2022. This is the first tagged Arctic grayling documented to move from the lower wetlands into Pond AB.

Arctic grayling had access to Pond AB after RO water was released from Outfall 002 in 2019. Access to Pond AB from the lower wetlands was limited by an immediate increase in beaver activity. Some fish probably can still move upstream and downstream through the RO Channel with high water events, but passage is now more restricted by the numerous beaver dams and vertical obstructions.

Arctic grayling residing in Pond AB appear to be the same group of fish that has simply gotten larger from 2022 to 2023 (Figure 14). This can be seen in the length frequency as they increased from an average length of 173 mm to 237 mm from 2022 to 2023 with very few larger or smaller fish. Continued sampling of Pond AB will determine if the population remains isolated and if successful spawning occurs.

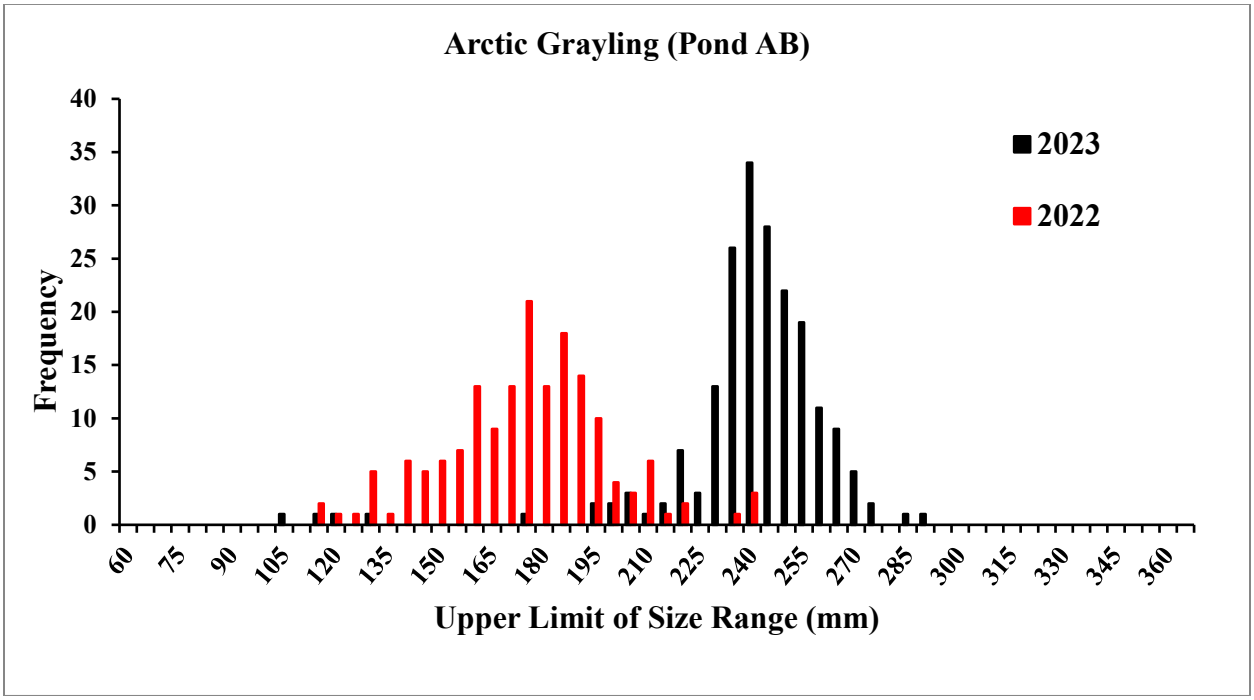

Figure 14. Arctic grayling length frequency captured in Pond AB, 2022 and 2023.

The 2022 population estimate of Arctic grayling in Pond AB was calculated using spring 2022 as the mark event and spring 2023 as the recapture event. During spring 2023, 50 Arctic grayling ≥250mm were captured, of those 3 were recaptures from the spring 2022 Pond AB tagging event. The spring 2022 Pond AB population estimate for Arctic grayling ≥200mm was 241 fish with a 95% CI of 60 to 422 fish. This is the first population estimate generated for the potentially isolated Pond AB population.

Beaver dams throughout the wetlands complex including the Pond D and F outlets were rebuilt during 2022. ADF&G staff removed the Pond D beaver dam on May 8, 2023, to allow access into Pond D and further up the wetlands (Figure 15). Fort Knox staff were successful in removing resident beavers from Fish Creek during the summer of 2022 to maintain fish passage, but the remaining beavers reestablished multiple dams. Access was limited by a 3-meter-tall beaver dam in the channel connecting Pond D and the Horseshoe Ponds. No Arctic grayling were observed upstream of this dam during the two weeks of sampling in spring 2023.

In the RO Channel, a series of six or more smaller beaver dams created ponds and were partial obstructions to fish in 2023. Arctic grayling appear to have adequate wetland areas to spawn and rear when the Pond D dam is consistently removed.

Figure 15. Beaver dam before (left) and after removal (right) by ADF&G from Pond D outlet, May 8, 2023.

In winter 2022/2023, aufeis in Fish Creek was minimal and water was open and flowing by May 8. The RO Channel had substantial aufeis and formed glaciers of frozen overflow two to three feet deep throughout the drainage. No thawed channel with open water was observed on April 27 through May 8. Since 2018, an open channel with warm RO water has been present, but with the reduced discharge of warm RO water from Outfall 002 during the winter of 2023, the lower channel was filled with ice. The RO water cooled and mostly froze in the valley during the winter or went subsurface before connecting with Fish Creek. Water flowing over the ice during the spring remained cold, -0.8°C, until a channel was thawed on May 15 (Figure 16).

Figure 16. RO Channel remained glaciated with cold water until May 15, 2023.