Subject Matter Expert Report: WILDLIFE PREDATION. Evaluation of Cause – Decline in Upper Fording River Westslope Cutthroat Trout Population

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Cover photo: *Left* – River otters on the Elk River. Photo taken by Ashley Taylor, Elko, British Columbia. *Right* – Photo of an American Mink adopted from Wikipedia: https://en.wikipedia.org/wiki/Mink

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EXECUTIVE SUMMARY

The upper Fording River (UFR) contains westslope cutthroat trout (WCT), the only fish species occurring in this river system. Between September 2017 and September 2019 (defined as the Decline Window), the adult UFR fish population declined by 93%. An investigation was initiated into the population decline, and one of the potential stressors identified was predation by wildlife. Two mammalian predators (North American river otter and American mink) were selected to represent wildlife predators for the investigation to determine whether it is possible that their foraging activities could explain the decline in the UFR WCT population. This report provides a summary of these selected wildlife predators based on the available literature, a winter track survey that was completed in Feb-Mar 2020, and a suite of theoretical feed consumption rate calculations based on the technical information obtained from the literature review of each species' foraging ecology. The plausibility of the theoretical feed consumption calculations is provided and is backed by findings from the literature review. Any gaps or uncertainty regarding predator occupancy rates during the fish population Decline Window are identified. Based on the findings from the information reviewed, mammalian wildlife predators are not likely to be to the cause of the UFR fish population decline, but wildlife predation may contribute to the UFR fish population decline in combination with other stressors.

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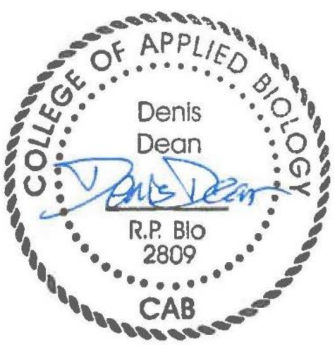
QUALIFICATIONS

Denis Dean is a Senior Wildlife Biologist with VAST Resource Solutions Inc. and has over 20 years of experience working in the environmental field. Throughout his career, Denis has been involved in completing surveys for meso-carnivores such as American badger (*Taxidea taxus*), swift fox (*Vulpes velox*), red fox (*Vulpes vulpes*), arctic fox (*Vulpes lagopus*), North American river otter (*Lontra canadensis*), American mink (*Mustela vison*), American marten (*Martes americana*), fisher (*Martes pennanti*), striped skunk (*Mephitis mephitis*), Canada lynx (*Lynx canadensis*), wolverine (*Gulo gulo*), black-footed ferret (*Mustela nigripes*), least weasel (*Mustela nivalis*), and ermine (*Mustela erminea*). Denis' experience also includes completing literature reviews for various meso-carnivores, data compilation and analysis from surveys completed, and report writing based on the survey findings. Denis is a Registered Professional Biologist with British Columbia's College of Applied Biology, and a Professional Biologist with the Alberta Society of Professional Biologists.

Denis is the lead author of this report. Additional personnel from VAST Resource Solutions Inc. provided support in completing this report. Cameron Smaldon completed literature reviews and report writing, and participated in the winter track survey. Becky Phillips (RBTech) participated in the winter track survey and report writing. Andy Wright and Jeremy Benson (BIT) participated in the winter track survey. Darcy Hlushak provided Geographic Information System support for the winter track survey. Ben Meunier reviewed some of the theoretical feed consumption calculations. Cody Fouts (RPBio) reviewed the theoretical sensitivity analyses and provided overall internal review of this report.

I certify that the work described herein fulfills standards acceptable of a Professional Biologist.



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Date: March 23, 2021

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ACRONYMS AND ABBREVIATIONS

FRO	Fording River Operation
GHO	Greenhills Operations
LCO	Line Creek Operation
PCB	Polychlorinated Biphenyl
PIT	Passive Integrated Transponder
SME	Subject Matter Expert
UFR	upper Fording River
WCT	westslope cutthroat trout

READER'S NOTE

What is the Evaluation of Cause and what is its purpose?

The Evaluation of Cause is the process used to investigate, evaluate and report on the reasons the Westslope Cutthroat Trout population declined in the upper Fording River between fall 2017 and fall 2019.

Background

The Elk Valley is located in the southeast corner of British Columbia (BC), Canada. It contains the main stem of the Elk River (220 km long) and many tributaries, including the Fording River (70 km long). This report focuses on the upper Fording River, which starts 20 km upstream from its confluence with the Elk River at Josephine Falls. The Ktunaxa First Nation has occupied lands in the region for more than 10,000 years. Rivers and streams of the region provide culturally important sources of fish and plants.

The upper Fording River watershed is at a high elevation and is occupied by only one fish species, a genetically pure population of Westslope Cutthroat Trout *(Oncorhynchus clarkii lewisi)* — an iconic fish species that is highly valued in the area. This population is physically isolated because Josephine Falls is a natural barrier to fish movement. The species is protected under the federal Fisheries Act and the Species at Risk Act. In BC, the Conservation Data Center categorized Westslope Cutthroat Trout as "*imperiled or of special concern, vulnerable to extirpation or extinction.*" Finally, it has been identified as a priority sport fish species by the Province of BC.

The upper Fording River watershed is influenced by various human-caused disturbances including roads, a railway, a natural gas pipeline, forest harvesting and coal mining. Teck Coal Limited (Teck Coal) operates the three surface coal mines within the upper Fording River watershed, upstream of Josephine Falls: Fording River Operations, Greenhills Operations and Line Creek Operations.

Evaluation of Cause

Following identification of the decline in the Westslope Cutthroat Trout population, Teck Coal initiated an Evaluation of Cause process. The overall results of this process are reported in a separate document (Evaluation of Cause Team, 2021) and are supported by a series of Subject Matter Expert reports.

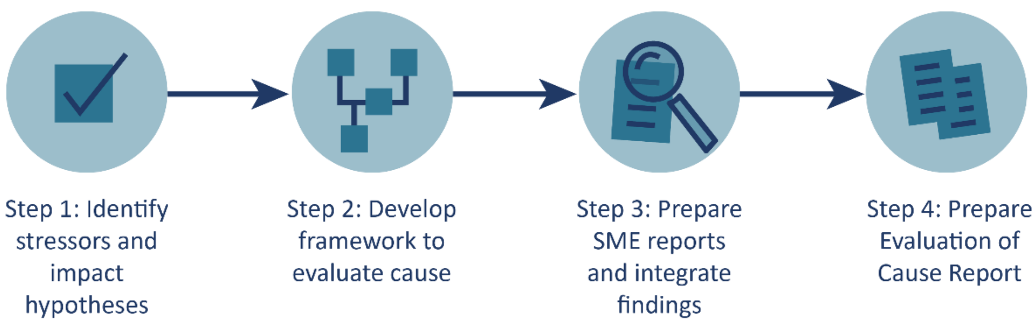
The report that follows this Reader's Note is one of those Subject Matter Expert Reports.

Monitoring conducted for Teck Coal in the fall of 2019 found that the abundance of Westslope Cutthroat Trout adults and sub-adults in the upper Fording River had declined significantly since previous sampling in fall 2017. In addition, there was evidence that juvenile fish density had decreased. Teck Coal initiated an *Evaluation of Cause* process. The overall results of this process are reported separately (Evaluation of Cause Team, 2021) and are supported by a series of Subject Matter Expert reports such as this one. The full list of SME reports follows at the end of this Reader's Note.

Building on and in addition to the Evaluation of Cause, there are ongoing efforts to support fish population recovery and implement environmental improvements in the upper Fording River.

How the Evaluation of Cause was approached

When the fish decline was identified, Teck Coal established an *Evaluation of Cause Team* (the Team), composed of *Subject Matter Experts* and coordinated by an Evaluation of Cause *Team Lead.* Further details about the Team are provided in the Evaluation of Cause report. The Team developed a systematic and objective approach (see figure below) that included developing a Framework for Subject Matter Experts to apply in their specific work. All work was subjected to rigorous peer review.



Conceptual approach to the Evaluation of Cause for the decline in the upper Fording River Westslope Cutthroat Trout population.

With input from representatives of various regulatory agencies and the Ktunaxa Nation Council, the Team initially identified potential stressors and impact hypotheses that might explain the cause(s) of the population decline. Two overarching hypotheses (essentially, questions for the Team to evaluate) were used:

- Overarching Hypothesis #1: The significant decline in the upper Fording River Westslope Cutthroat Trout population was a result of a single acute stressor[1] or a single chronic stressor[2].
- Overarching Hypothesis #2: The significant decline in the upper Fording River Westslope Cutthroat Trout population was a result of a combination of acute and/or chronic stressors,

[1] Implies September 2017 to September 2019.

[2] Implies a chronic, slow change in the stressor (using 2012–2019 timeframe, data dependent).

which individually may not account for reduced fish numbers, but cumulatively caused the decline.

The Evaluation of Cause examined numerous stressors in the UFR to determine if and to what extent those stressors and various conditions played a role in the Westslope Cutthroat Trout's decline. Given that the purpose was to evaluate the cause of the decline in abundance from 2017 to 2019[3], it was important to identify stressors or conditions that changed or were different during that period. It was equally important to identify the potential stressors or conditions that did not change during the decline window but may, nevertheless, have been important constraints on the population with respect to their ability to respond to or recover from the stressors. Finally, interactions between stressors and conditions had to be considered in an integrated fashion. Where an *impact hypothesis* depended on or may have been exacerbated by interactions among stressors or conditions, the interaction mechanisms were also considered.

The Evaluation of Cause process produced two types of deliverables:

1. **Individual Subject Matter Expert (SME) reports** (such as the one that follows this Note): These reports mostly focus on impact hypotheses under Overarching Hypothesis #1 (see list, following). A Framework was used to align SME work for all the potential stressors, and, for consistency, most SME reports have the same overall format. The format covers: (1) rationale for impact hypotheses, (2) methods, (3) analysis and (4) findings, particularly whether the requisite conditions[4] were met for the stressor(s) to be the sole cause of the fish population decline, or a contributor to it. In addition to the report, each SME provided a summary table of findings, generated according to the Framework. These summaries were used to integrate information for the Evaluation of Cause report. Note that some SME reports did not investigate specific stressors; instead, they evaluated other information considered potentially useful for supporting SME reports and the overall Evaluation of Cause, or added context (such as in the SME report that describes climate (Wright et al., 2021).
2. **The Evaluation of Cause report** (prepared by a subset of the Team, with input from SMEs): This overall report summarizes the findings of the SME reports and further considers interactions between stressors (Overarching Hypothesis #2). It describes the reasons that most likely account for the decline in the Westslope Cutthroat Trout population in the upper Fording River.

[3] Abundance estimates for adults/sub-adults are based on surveys in September of each year, while estimates for juveniles are based on surveys in August.

[4] These are the conditions that would need to have occurred for the impact hypothesis to have resulted in the observed decline of Westslope Cutthroat Trout population in the upper Fording River.

Participation, Engagement & Transparency

To support transparency, the Team engaged frequently throughout the Evaluation of Cause process. Participants in the Evaluation of Cause process, through various committees, included:

Ktunaxa Nation Council
BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
BC Ministry Environment & Climate Change Strategy
Ministry of Energy, Mines and Low Carbon Innovation
Environmental Assessment Office

Citation for the Evaluation of Cause Report

When citing the Evaluation of Cause Report use:

Evaluation of Cause Team, (2021). *Evaluation of Cause — Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Evaluation of Cause Team.

Citations for Subject Matter Expert Reports

Focus	Citation for Subject Matter Expert Reports
Climate, temperature, and streamflow	Wright, N., Greenacre, D., & Hatfield, T. (2021). *Subject Matter Expert Report: Climate, temperature, and streamflow trends. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Ecofish Research Ltd.
Ice	Hatfield, T., & Whelan, C. (2021). *Subject Matter Expert Report: Ice. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. Report Prepared by Ecofish Research Ltd.
Habitat availability (instream flow)	Healey, K., Little, P., & Hatfield, T. (2021). *Subject Matter Expert Report: Habitat availability. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Ecofish Research Ltd.
Stranding – ramping	Faulkner, S., Carter, J., Sparling, M., Hatfield, T., & Nicholl, S. (2021). *Subject Matter Expert Report: Ramping and stranding. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Ecofish Research Ltd.
Stranding – channel dewatering	Hatfield, T., Ammerlaan, J., Regehr, H., Carter, J., & Faulkner, S. (2021). *Subject Matter Expert Report: Channel dewatering. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited by Ecofish Research Ltd.

Focus	Citation for Subject Matter Expert Reports
Stranding – mainstem dewatering	Hocking M., Ammerlaan, J., Healey, K., Akaoka, K., & Hatfield T. (2021). *Subject Matter Expert Report: Mainstem dewatering. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd. and Lotic Environmental Ltd. Zathey, N., & Robinson, M.D. (2021). *Summary of ephemeral conditions in the upper Fording River Watershed. In Hocking et al. (2021). Subject Matter Expert Report: Mainstem dewatering. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd. and Lotic Environmental Ltd.
Calcite	Hocking, M., Tamminga, A., Arnett, T., Robinson M., Larratt, H., & Hatfield, T. (2021). *Subject Matter Expert Report: Calcite. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd., Lotic Environmental Ltd., and Larratt Aquatic Consulting Ltd.
Total suspended solids	Durston, D., Greenacre, D., Ganshorn, K & Hatfield, T. (2021). *Subject Matter Expert Report: Total suspended solids. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Ecofish Research Ltd.
Fish passage (habitat connectivity)	Harwood, A., Suzanne, C., Whelan, C., & Hatfield, T. (2021). *Subject Matter Expert Report: Fish passage. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd. Akaoka, K., & Hatfield, T. (2021). Telemetry Movement Analysis. In Harwood et al. (2021). *Subject Matter Expert Report: Fish passage. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Ltd. by Ecofish Research Ltd.
Cyanobacteria Algae / macrophytes	Larratt, H., & Self, J. (2021). *Subject Matter Expert Report: Cyanobacteria, periphyton and aquatic macrophytes. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Larratt Aquatic Consulting Ltd.

Focus	Citation for Subject Matter Expert Reports
Water quality (all parameters except water temperature and TSS [Ecofish])	Costa, EJ., & de Bruyn, A. (2021). *Subject Matter Expert Report: Water quality. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd. Healey, K., & Hatfield, T. (2021). *Calculator to assess Potential for cryoconcentration in upper Fording River.* In Costa, EJ., & de Bruyn, A. (2021). *Subject Matter Expert Report: Water quality. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd.
Industrial chemicals, spills and unauthorized releases	Van Geest, J., Hart, V., Costa, EJ., & de Bruyn, A. (2021). *Subject Matter Expert Report: Industrial chemicals, spills and unauthorized releases. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd. Branton, M., & Power, B. (2021). *Stressor Evaluation – Sewage.* In Van Geest et al. (2021). *Subject Matter Expert Report: Industrial chemicals and unintended releases. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Golder Associates Ltd.
Wildlife predators	Dean, D. (2021). *Subject Matter Expert Report: Wildlife predation. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by VAST Resource Solutions Inc.
Poaching	Dean, D. (2021). *Subject Matter Expert Report: Poaching. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by VAST Resource Solutions Inc.
Food availability	Orr, P., & Ings, J. (2021). *Subject Matter Expert Report: Food availability. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Minnow Environmental Inc.
Fish handling	Cope, S. (2020). *Subject Matter Expert Report: Fish handling. Evaluation of Cause – Decline in upper Fording River Westslope*

Focus	Citation for Subject Matter Expert Reports
	Cutthroat Trout population. Report prepared for Teck Coal Limited. Prepared by Westslope Fisheries Ltd.
	Korman, J. (2021). *Effects of capture and handling on Westslope Cutthroat Trout in the upper Fording River: A brief review of Cope (2020) and additional calculations.* Report prepared for Teck Coal Limited. Prepared by Ecometric Research.
Infectious disease	Bollinger, T. (2021). *Subject Matter Expert Report: Infectious disease. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by TKB Ecosystem Health Services Ltd.
Pathophysiology	Bollinger, T. (2021). *Subject Matter Expert Report: Pathophysiology of stressors on fish. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by TKB Ecosystem Health Services Ltd.
Coal dust and sediment quality	DiMauro, M., Branton, M., & Franz, E. (2021). *Subject Matter Expert Report: Coal dust and sediment quality. Evaluation of Cause – Decline in upper Fording River Westslope Cutthroat Trout population.* Report prepared for Teck Coal Limited. Prepared by Azimuth Consulting Group Inc.
Groundwater quality and quantity	Henry, C., & Humphries, S. (2021). *Subject Matter Expert Report: Hydrogeological stressors. Evaluation of Cause - Decline in upper Fording River Westslope Cutthroat Trout population.* Report Prepared for Teck Coal Limited. Prepared by SNC-Lavalin Inc.

1.0 INTRODUCTION

The upper Fording River (UFR) is the portion of the Fording River watershed located upstream of Josephine Falls. Westslope cutthroat trout (*Oncorhynchus clarki lewisi*; WCT*)* is the only fish species that occurs within the UFR. Recently, the UFR WCT population has experienced a decline. Snorkel surveys completed in September 2017 and again in September 2019 identified >90% WCT population decline in the UFR (Cope 2020). This time period has been identified as the Westslope Cutthroat Trout Population Decline Window (herein referred to as the 'Decline Window').

Teck Coal Limited (Teck Coal) has a number of coal mining operations that occur within or adjacent to the UFR valley. The Fording River Operation (FRO) is located within the UFR valley, located just south of the UFR headwaters. The FRO coal mining activities occur on either side of the UFR. The northern extent of the Greenhills Operation (GHO) abuts the southwest boundary of the FRO, and GHO's coal mining activities occur on portions of the UFR valley's east-facing slopes. The Line Creek Operation (LCO) is located south of the UFR valley; however, the northern extent of the LCO occurs within the Dry Creek valley, and Dry Creek flows into the UFR. The proximity of these coal mine operations in relation to the UFR resulted in monitoring of environmental attributes which lead to identifying the WCT population decline in the UFR. Upon identifying this decline, Teck Coal initiated an investigation into what may have caused the UFR fish population decline (herein referred to as the Evaluation of Cause [EoC]).

Wildlife predators may prey on fish located within the UFR and its tributaries. Some wildlife predators may occur year-round, while other wildlife predators may move through or temporarily occur within the UFR valley. Understanding the role wildlife predators may have on the UFR fish population dynamics requires an understanding of the local predator community, their behaviour, and foraging ecology. This understanding informs the potential impacts wildlife predation may have on the UFR fish population.

Teck Coal retained VAST Resource Solutions Inc. (VAST) to investigate the potential impacts of wildlife predation on fish in the UFR. At the start of the investigation, the Decline Window was identified as the time period when snorkel surveys were completed to estimate the UFR fish population status (i.e. September 2017 – September 2019). It was recognized at the start of the investigation that efforts would be made to evaluate and potentially reduce the time period defined as the Decline Window. Given the uncertainty regarding the Decline Window, discussions occurred to determine which wildlife predators should be investigated. Sixteen wildlife predators potentially occur in the UFR valley that may prey on fish, including avian predators (e.g., hawks, eagles), large mammalian carnivores (e.g., bears, wolves), and mammalian meso-carnivores (e.g., foxes, weasels). Of these predators, two species were selected to be evaluated as representatives for wildlife predation in this investigation: the North American river otter (*Lontra canadensis*) and the American mink (*Mustela vison*). These species were selected for the following reasons: 1) each species are known fish predators; 2) each species spend time in water, increasing the likelihood of preying on fish; and 3) these species may occur within the UFR valley at any time of year.

The information provided herein includes an ecology summary for North American river otter and American mink. Theoretical feed consumption calculations were completed for each predator based on daily feed consumption rates calculated from information obtained in literature reviews, as well as fish physiology information and fish population estimates from studies completed for Teck on the UFR. Conclusions are made as to the plausibility of the theoretical feed consumption calculations being representative of wildlife predation to explain the UFR fish population decline.

This document is one of a series of subject matter expert (SME) reports that support the overall Evaluation of Cause into the UFR Westslope Cutthroat Trout population decline. For general information, see the preceding Reader's Note.

1.1 Objective

The objective of this report is to review available information on the focal predators for their occurrence and distribution within the UFR and portions of its associated tributaries, and to assess the potential impacts their foraging activities (i.e., predation) may have had on the WCT population within the UFR. The specific impact hypothesis evaluated was:

- Can wildlife predators' foraging activities cause or contribute to the UFR WCT fish population decline?

Wildlife predation has the potential to impact all life-stages of the WCT population. However, the WCT population decline that triggered this investigation was based on a reduction in both adult and juvenile WCT. The wildlife predators selected are known to prey on both adult and juvenile fish.

2.0 METHODS

2.1 Data Queries

Data queries were completed of existing databases to understand predator occurrence and distribution in the UFR valley. Queries included reviewing Teck Coal's wildlife observations database for North American river otter (herein referred to as 'river otter') and American mink (herein referred to as 'mink') from their Operations (i.e., FRO, GHO, and LCO). Each of these Operations is either located within or adjacent to the UFR valley. Queries were also made with regional government biologists regarding any studies on river otter and/or mink that have occurred within the Elk Valley.

2.2 Literature Reviews

Literature reviews were completed to better understand river otter and mink ecology. Given the extensive range of both species throughout North America, the literature reviews were primarily focused on the ecology of each species in mountainous, freshwater environments. Review and synthesis included conversations with experts who study these species. Information obtained on the ecology of each predator species was summarized to provide species-specific context on foraging ecology. The information summary of each predator species included distribution, physiology, reproduction, sexual dimorphism, desirable habitat features, and diet. This information informed theoretical feed consumption calculations for each species, and to demonstrate the potential impacts of each species on fish populations.

2.3 Winter Track Survey

A winter track survey was completed along the UFR between Josephine Falls and Henretta Lake. The purpose of the winter track survey was to determine predator occurrence and their distribution along the UFR during the winter period. The winter track survey focused on accessible portions of the mainstem of the UFR, as well as some of the lower portions of adjoining tributaries where juvenile WCT are known to overwinter. Details on the winter track survey methods and findings can be found in Appendix A.

2.4 Theoretical Feed Consumption Calculation

Based on the foraging ecology information obtained for river otter and mink, a theoretical feed consumption calculation was completed to evaluate the theoretical ability/feasibility of each predator to consume the WCT population from the UFR. The theoretical feed consumption calculation used representative information for both males and females of each predator species based on average body mass, daily food consumption rates, and the proportion of diet that is comprised of fish.

Adult Predator Mass per Sex	X	Predator Daily Food Consumption Rate	X	Proportion of Fish in Predator's Diet	=	Total Daily Fish Biomass Consumed

The Cope (2020) report entitled *Upper Fording River Westslope Cutthroat Trout Population Monitoring Project: 2019* provides adult WCT fish population model estimates for the UFR for the years 2012, 2013, 2014, 2017, and 2019. Pooled Peterson estimates reported for the 2017 UFR westslope cutthroat trout population were 3690, 4908, and 6240 fish. These population estimates were used to construct the feed consumption calculations.

The WCT population in the UFR provides a unique instance for understanding fish biomass for the system, given that WCT is the only known species to occur in the system, as well as fisheries studies that have occurred at the UFR. Fork length and weight data from fish captured during the 2012-2014 UFR fish telemetry study, as well as from fish studies where passive integrated transponder (PIT) tags were implanted into fish by Teck from 2016-2019. Data were pooled to obtain a representative sample of fish biomass for adult fish (i.e., WCT >200 mm fork length). A weighted average was calculated based on 10 millimetre (mm) increment fork lengths from the representative sample. The largest fork length range of fish between 450 mm - 489 mm was pooled together to calculate a weighted average based on the low sample size for this fork length (i.e., 1-3 fish per 10 mm increments). The proportional biomass values from each fork length size increment were summed to provide a total fish biomass value for each 2017 pooled Peterson population estimate.

Cope (2020) identified the WCT adult fish population potentially reduced by up to 93% between the 2017 and 2019 snorkel surveys. This percentage was applied to the total fish biomass values calculated for each 2017 pooled Peterson population estimate to identify the amount of fish biomass removed from the UFR fish population. If a theoretical fish population is comprised of different sizes of fish that could potentially be consumed by a predator, some individuals would be consumed in their entirety (i.e., smaller fish), while only portions of larger individuals would be consumed. To account for the variation in individual fish size that could be consumed by a predator, the feed calculations assume that 70% of every fish harvested by a predator is consumed. This percentage was applied to the calculated fish biomass removed from the UFR fish population for each of the 2017 pooled Peterson fish population estimates.

Total Biomass per 2017 pooled Peterson Fish Population Estimate	X	Adult Fish Population Reduction Percentage	X	Proportion of Fish Consumed	=	Total Fish Biomass Available in UFR

Finally, the total daily fish biomass consumed by each adult sex of a predator was divided by the total fish biomass available to determine how many days it would take for an adult male and female of each predator to consume the UFR fish population.

$$\frac{\text{Total Daily Fish Biomass Consumed per Sex of each Predator}}{\text{Total Fish Biomass Available in UFR}} = \text{Total Number of Days for a Predator of each Sex to Consume the UFR Fish Population}$$

Fish size was also categorized into six total length classes: 200-249 mm, 250-299 mm, 300-349 mm, 350-399 mm, 400-449 mm, and 450-499 mm. The size of fish was expressed using relative frequency (i.e., the number of fish in a size category divided by the total number of fish in the sample size) to better understand the proportion of different sized adult fish from the representative sample for the UFR.

A sensitivity analysis was completed based on assumed adult predator occupancy rates within the UFR valley. Assumed occupancy rates were 25%, 50%, 75%, and 100% of time spent by an adult predator in the UFR valley. Assumed occupancy rates were applied to the calculated predator daily biomass consumed values, and then divided by the calculated UFR fish population biomass values to determine the total number of days to consume the total UFR fish biomass for each assumed occupancy rate.

$$\frac{\text{Total Daily Fish Biomass Consumed per Sex of each Predator} \times \text{Assumed Occupancy Rate}}{\text{Total Fish Biomass Available in UFR}} = \text{Theoretical Total Number of Days for a Predator of each Sex to Consume the UFR Fish Population Based on Assumed Occupancy Rate}$$

A second sensitivity analysis was completed to estimate the theoretical number of adult predators of each sex that would consume the total fish biomass in the UFR valley in specified time periods (i.e., months). The purpose of this analysis was to provide context of how the foraging activity of each sex of predator can influence the total fish biomass in the UFR valley, as there is variation in the amount of fish biomass consumed by the sex of each predator assessed. This calculation was derived using the calculated total daily fish biomass consumed value for a representative adult male and female predator, and multiplying it by the number of days per month (i.e., 30.4 days for 12 months. A year was assumed to be 365 days). This resulted in a value of total biomass consumed per month by the sex of each predator, considering the number of months being evaluated. This value was divided by the total UFR fish biomass value to theoretically estimate the number of adult predators of each sex that would need to be foraging in the UFR to consume the total UFR fish biomass within a specified number of months.

$$\frac{\text{Total Daily Fish Biomass Consumed per Sex of each Predator} \times \text{Number of Days Per Month}}{\text{Total Fish Biomass Available in UFR}} = \text{Theoretical Estimated Number of Adult Predators of each Sex to Consume the Total UFR Fish Biomass in Specified Number of Months}$$

2.5 Evaluation of Requisite Conditions

As identified in the preceding Reader's Note, requisite conditions are defined as the conditions that would need to have occurred for the impact hypothesis to have resulted in the observed decline of the WCT population in the UFR. The requisite conditions took into consideration both spatial and temporal extents, as well as the intensity of foraging activities for each predator species that would be required to explain the WCT decline (i.e., the cause of the decline). Each of the requisite conditions must be met to support wildlife predation to be the cause of the WCT population decline. The requisite conditions for wildlife predation are:

Spatial Extent – wildlife predation of the WCT population occurs throughout the UFR located upstream of Josephine Falls and its associated tributaries.

Duration – wildlife predation of the WCT population must occur during the Decline Window (i.e., Sept 2017 – Sept 2019).

Location – Wildlife predators target specific areas for foraging activities where WCT are known to congregate (e.g., spawning areas, wintering areas, barriers to fish passage).

Timing – Predation by wildlife predators occurs during time periods when WCT are known to congregate (i.e., during the over-wintering and spawning periods as identified in the WCT periodicity table [see Appendix B]).

Intensity – foraging pressure at a high enough rate to substantially decrease the WCT population in the UFR.

3.0 NORTH AMERICAN RIVER OTTER

3.1 Distribution

River otter occur throughout North America, with the exception of the permafrost areas of northern Canada and the dry southeastern areas of the United States (Melquist et al. 2003). Agricultural expansion resulting in wetland and watercourse habitat destruction, overharvesting of animals for their furs, and other consequences of human settlement in North America resulted in the extirpation of river otters in the central United States and southern areas of Canadian Prairie Provinces (Halter et al. 2003, Melquist et al. 2003). Successful efforts to reintroduce river otter into extirpated areas has resulted in river otter returning to most of its historic range (Boyle 2006, Melquist et al. 2003, Serfass & Rymon 1985).

River otter occur throughout British Columbia (Figure 3-1) and their distribution is not believed to have changed since pre-European settlement and development (Hatler et al. 2003). Extensive research of river otter distribution throughout British Columbia has not occurred; however, the diversity of habitats occupied and the considerable capacity of the species to cover long distances on land indicate that areas with adequate prey and shelter features could host this species (Melquist & Hornocker 1983, Reid et al. 1994, Testa et al. 1994, Boyle 2006).

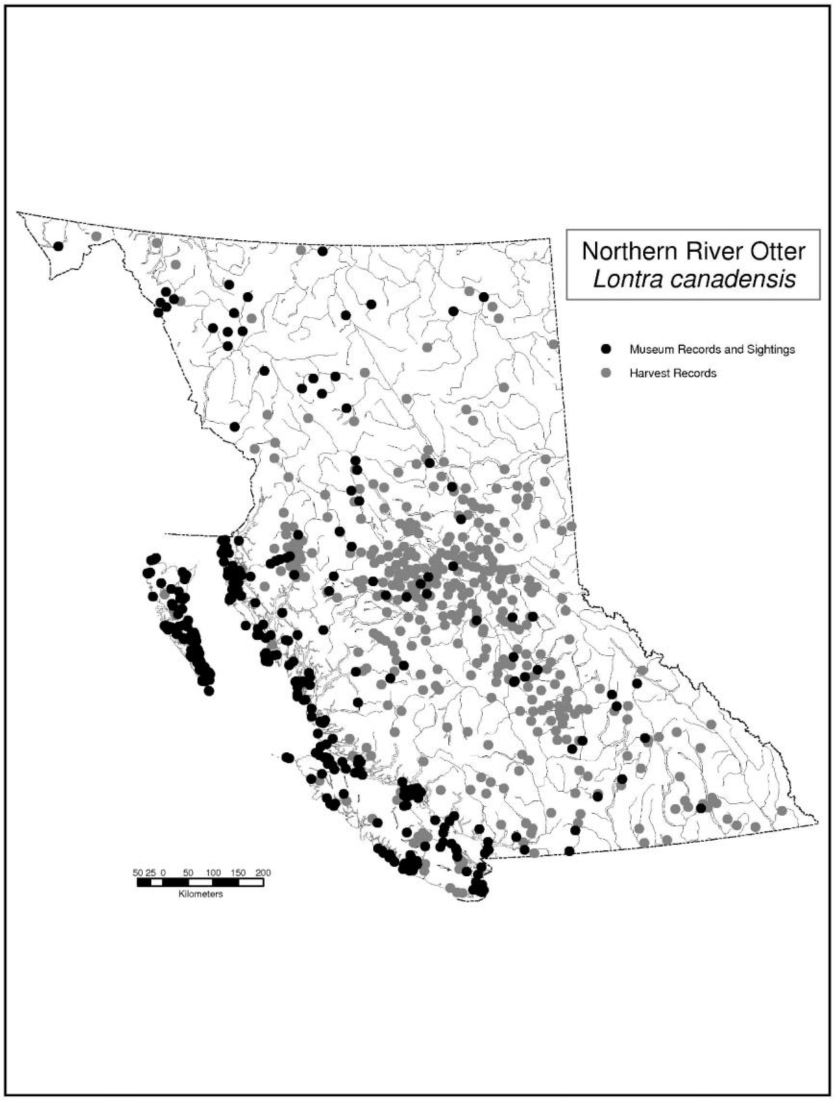


Figure 3-1. Distribution of the Northern River Otter, *Lontra canadensis*, in British Columbia based on harvest records, museum records, and sightings, 2008. Adapted from E-fauna BC: *Lontra canadensis* (Schreber, 1777). Retrieved from https://ibis.geog.ubc.ca/biodiversity/efauna/.

A review of harvest records from 1983-2018 for the local area (i.e., Wildlife Management Unit 4-23) revealed low reported river otter harvests. One river otter was identified in the harvest records between 1983 and 2001. Since 2002, river otter harvests have been reported sporadically, with low reported harvest numbers (0-3 individuals per year). No harvested river otter were reported in 2016 or 2017. The local trapper has trapped six (6) otters about one kilometre (km) south of the Fording River Operation (FRO) on the UFR over the last 20 years (Thorner pers. comm. 2019). River otter were documented at the FRO in 2015 and 2019 based on Teck Coal's wildlife observation records. There is no known present or historic river otter density estimates in the Elk Valley (which includes the UFR).

The winter track survey completed in February-March 2020 identified river otter occurrence along the UFR. River otter tracks were identified along the UFR south of the multi-plate culvert and west of the FRO administration buildings, along the UFR mainstem in between Swift Creek and Chauncey Creek, as well as along Ewin Creek. Further details on the winter track survey findings can be found in Appendix A.

3.2 Physiology

Adult river otter range from 89-137 cm in length (Melquist et al. 2003). The tail makes up about 1/3 of their total length (Boyle 2006), and they usually reach their maximum size by 3-4 years in age (Melquist et al. 2003). River otter can weigh between 5 and 14 kilograms (kg) (Melquist et al. 2003, Boyle 2006). Adult males are typically larger than females. Mean weight of adult male and adult female river otter are as follows: northern Alberta were 8.6 kg and 7.4 kg (Reid et al. 1994), 9.2 kg and 7.9 kg in west central Idaho (Melquist and Hornocker 1983), and 9.4 kg and 8.4 kg in Alaska (Duffy et al. 1994).

3.3 Reproduction and Movement

River otter of both sexes typically reach reproductive maturity at two years of age (Hamilton & Eadie 1964, Stenson 1985); however, age of sexual maturity can be higher for females (as identified by pregnancy rates of marine river otters in British Columbia: 55% for females two years of age and 90% for females three years of age and older [Stenson, 1985]). The mating season initiates in late January to February, as males begin travelling to find females, and is finished by the end of April/mid-May (Halter et al. 2003, Stenson 1985). Copulation occurs in water or on land and has been recorded to last for over an hour if the mating pair is undisturbed by other river otters (Shannon 1991).

Delayed implantation occurs where a fertilized egg remains inactive for 9-11 months and is implanted in December-January of that year for southern latitudes (Roberts et al. 2012), and January-February of the following year for northern latitudes (Stenson 1985, Hamilton & Eadie 1964). Time of implantation is believed to be in response to photoperiod (Stenson 1985). Gestation lasts for two months (Stenson 1985, Roberts et al. 2012) with parturition occurring in February-March for southern latitudes (Roberts et al. 2012) and in March-April for northern latitudes (Hamilton & Eadie 1964, Stenson 1985, Melquist & Hornocker 1983).

River otter have litters ranging from 1 and 6 pups, but the litter size is typically 2-3 pups on average (Hamilton & Eadie 1964, Melquist & Hornocker 1983, Stenson 1985). Family groups have been observed with litter mixing sometimes occurring, and/or another lone adult (most often a female) joining a family group that sometimes helps with raising the pups (Melquist & Hornocker 1983; Rock et al. 1994). River otter pups are altricial (i.e., born in an underdeveloped state and requiring care and feeding) with the female caring for the pups. The timing of the river otter pups development is somewhat variable. Pups gain sight between 22-35 days and are dependent on their mother's milk until week 12 (Halter et al. 2003). Melquist and Hornocker (1983) found a female with young had activity confined to about a one kilometre stretch of a water body in early June, but moved from this area by July. They also noted that *"the length of time family groups remain together ranged from 7.5-11.5 months".*

Young river otters tend to become independent from their mother after their first winter, with dispersal typically occurring in April and May (Hornocker and Melquist 1983, Halter et al. 2003). Dispersing juveniles typically move between 3-4 km/day; however, movements of up to 42 km in a single day by a dispersing male have been identified (Hornocker and Melquist 1983). Mack et al. (1994) identified mean consecutive-day movements for males was 11.6 km, compared to 2.0 km for females.

3.4 Prey

River otter are considered the apex terrestrial predator of aquatic systems in North America (Melquist et al. 2003). Fish comprise 80-90% of a river otter's diet (Toweill 1974, Melquist and Hornocker 1983, Reid et al. 1994, Melquist et al. 2003, Crait and Ben-David 2006). Melquist et al. (2003) summarized a list of studies that have examined major food categories from scats, stomachs, digestive tracts, or intestines of river otter in North America. A review of 15,103 samples identified that fish remains had the highest frequency of occurrence, occurring in 80-100% of samples analyzed (Melquist et al. 2003). Small fish are usually eaten whole while the otter is swimming, typically starting with the head (Larivière and Walton 1998, Guertin pers. comm. 2020). Larger fish are taken to shore and consumed (Larivière and Walton 1998); however, only portions of larger fish are typically consumed. Either the head or tail, or both fish parts are sometimes not consumed and found at otter latrine sites (Crowley pers. comm. 2020, Guertin pers. comm. 2020). The river otter's foraging behaviour predominantly targets small fish as prey (Kruuk 2006, Stearns and Serfass 2011). Stearns and Serfass (2011) found that 61.1% of the fish species consumed by river otter in North Dakota were up to 20 centimetres (cm) in fork length. However, the relative frequency of smaller size classes was likely underestimated based on the fish scale scat analysis method used (Stearns and Serfass 2011).

River otter target slow-moving fish species as prey. Suckers (Catostomidae), sculpins (Cottidae), carp and minnows (Cyprinidae), sunfish and bass (Centrarchidae), and catfish (Ictaluridae) are commonly identified river otter prey (Melquist and Hornocker 1983, Serfass 1990, Reid et al. 1994, Boyle 2006, Stearns and Serfass 2011). Salmonids are also consumed as prey, but are relatively fast swimmers and are likely more difficult to capture or in lesser numbers compared to other fish species in an aquatic system (Melquist et al. 2003, Boyle 2006). River otter prey on salmonids during spawning runs, when these species are in large concentrations with potentially decreased energy after spawning, making them easier to capture (Toweill 1974, Melquist and Hornocker 1983, Reid et al. 1994, Hansen 2003, Crait and Ben-David 2006). Hornocker and Melquist (1983) noted that when spawning fish became scarce, river otter returned to a pattern of frequent movement. Salmonids were the second most frequently identified fish family identified in digestive tracts of river otter during the winter from a study in Oregon (Toweill 1974).

River otter has been known to perform a "predation event" on fish in closed system waterbodies (e.g., small isolated ponds, dugouts) such as fish hatcheries (Scarratt 2018, Bullock 2020, DNR 2020) and ornamental garden ponds (Davey 2011, Bains 2018). During these predation events, one or more river otter harvest a number of fish. Some of the harvested fish are consumed while others are either partially consumed or not consumed at all. Some of the fish that survive a predation event show injury scars, particularly to their dorsal fins where a river otter attacked them (Bullock 2020). It is unknown why river otter initiates these predation events resulting in more fish being harvested than consumed.

Other prey species consumed by river otter include: crustaceans, mollusks, amphibians, aquatic birds, insects, reptiles, muskrats, and beavers (Toweill 1974, Melquist and Hornocker 1983, Reid et al. 1994, Berg 1999, Melquist et al. 2003). Many of these species are secondary prey to fish during the summer period (Melquist and Hornocker 1983, Boyle 2006, Hatler et al. 2003). Some species like muskrat and beaver may be preyed upon throughout the year, but they are not likely a substantial prey item for river otter (Reid et al. 1994, Hatler et al. 2003). River otter tend to avoid consuming carrion (Melquist and Dronkert 1987 *in* Hanson 2003, Crowley pers. comm. 2020); however, river otter populations in other parts of North American have been identified to scavenge on fish carcasses (Unger and Hickman 2019).

3.4.1 Consumption rates

Studies have identified the amount of fish consumed daily by river otter. Given their high metabolic rate (Estes 1989 *in* Melquist et al. 2003, Owens et al. 2009), river otter can consume a substantial amount of food. Serfass and Brooks (1990) state that adult river otter consume between 1-1.5 kg of fish daily. Owens et al. (2009) found that wild otters may spend up to 60% of their time hunting and foraging for food: with a high metabolic rate and rapid progression in digestion, an otter may consume up to 20% of its body weight per day. Wild otters (unidentified species) rarely ate more than 500 g of fish at a time, but were estimated to consume approximately 20% of their own body weight daily (Duplaix-Hall 1975 *in* Henry et al. 2012).

3.5 Desirable Habitat Features

River otter habitat selection criteria is fundamentally based on availability of prey and shelter (Anderson & Woolf 1987, Melquist & Hornocker 1983, Reid et al. 1994). They generally inhabit streams, lakes, wetlands (Newman & Griffin 1994), reservoirs, marine coasts (Blundell et al. 2002a, Bowyer et al. 1995, Boyle 2006; Testa et al. 1994), mudflats, marshes, and backwater sloughs (Melquist & Hornocker 1983). They can hunt in both marine and freshwater habitats. Desirable habitat features in marine environments are the intertidal and subtidal zones (Bowyer et al. 1995). Desirable habitat features in freshwater environments include lowland marshes, swamps, and bogs, along with meandering streams and lakes (Melquist and Hornocker 1983, Reid et al. 1994, Boyle 2006). River otter is common in many major river systems (Boyle 2006), but they become less common in heavily settled areas, particularly if the waterways are polluted, and in food-poor mountain streams (Melquist et al. 2003).

River otter rely on existing features as refuge, and do not dig their own dens (Melquist & Hornocker 1983, Reid et al. 1994). Commonly used shelter features include log jams (Anderson & Woolf 1987), beaver lodges, beaver bank dens, muskrat houses, dense riparian vegetation (Reid et al. 1994), red fox burrows, protruding rock, and talus (Boyle 2006). Features that provide both shelter and prey access are used more exclusively by river otter, such as log jams and riparian vegetation (Reid et al. 1994). The river otter is opportunistic and will use multiple resting sites and dens within their home range, such as the 88 different sites recorded for an individual during a 16-month period in Idaho (Melquist & Hornocker 1983). Some individuals will remain at a single den for long periods of time: such is the case for females with dependent pups (Melquist & Hornocker 1983, Reid et al. 1994). During instances of prolonged use, river otter are capable of physically altering resting and den sites as needed (Melquist & Hornocker 1983, Reid et al. 1994).

Beavers (*Castor canadensis*) create many valuable features that river otter use. Beavers create ponds that host prey, resting sites, dens, and heavy vegetative cover (Dubuc et al. 1990, Newman & Griffin 1994, Reid et al. 1994, Swimley et al. 1998). Beavers also construct stream bank dens and tunnel networks, which are sometimes used by river otter as shelter features (Boyle 2006, Melquist et al. 2003, Reid et al. 1994). Some individuals have been known to use beaver lodges as refuge (Melquist et al. 2003).

Surface water freezing during winter reduces habitat availability for river otter. Features that allow reliable two-way access above and below the water surface are important for prey access during this time (Boyle 2006, Hodder & Rea 2006). Examples of these are beaver lodges, bank tunnels, stream inlets into lakes that restrict the surface water from freezing (Boyle 2006, Reid et al. 1994), and ice openings caused by underwater spring upwelling's in lakes (Hodder & Rea 2006). Preference was identified for features that provided a network of multiple above- and below-water entrances (Boyle 2006, Reid et al. 1994). River otter will create tunnels beneath the snow to access resting sites and dens, as well as creating snow and ice caves if existing sites aren't available (Melquist & Hornocker 1983). River otter have been known to stay under the ice surface for extended periods during the winter, likely in voids between the ice layer and water (Crowley pers. comm. 2020).

3.6 Social Behaviour

Social behaviour of the river otter can be variable, dependent on prey availability, strategic foraging advantages (Blundell et al. 2002a), reproductive behaviour (Melquist & Hornocker 1983), shelter availability, seasonal changes (Reid et al. 1994), and geographic location. Differences between freshwater and coastal river otter are best demonstrated by male sociality: freshwater adult males form groups of two to three individuals for multiple weeks during open water periods and are otherwise solitary during the breeding season. This behaviour maximizes access to breeding females and during winter months reduces competition for limited shelter and prey (Reid et al. 1994). Adult male groups typically occur during the spring and summer (Reid et al. 1994). Alternatively, adult males in marine environments are commonly found travelling and foraging in groups (Albeke et al. 2015) of four to nine individuals (Blundell et al. 2002a), also observed as high as 18 individuals (Testa et al. 1994). These groups last throughout the year, with the exception of the month-long breeding season (Blundell et al. 2002b). Adult females are typically solitary throughout the year; however, they can be found in family groups (Reid et al. 1994) that consist of a mother with juvenile pups and occasionally other female adults (Rock et al. 1994) and unrelated juvenile pups (Melquist & Hornocker 1983). Natal dispersal occurs by juvenile river otter of both genders; however, not all juveniles disperse outside of their natal home range (Blundell et al. 2002b, Melquist & Hornocker 1983). Known dispersal rates for freshwater river otter are 3.5 km/day for males and 3.8 km/day for females (Melquist & Hornocker 1983).

The river otter is primarily a nocturnal species, with activity typically beginning near dusk and occurring throughout the night until mid-morning (Melquist and Hornocker 1983). This nocturnal activity period consistently occurs during the spring, summer, and fall. Diurnal activity by river otter has been identified during the winter period, as well as in areas containing little human disturbance (Melquist and Hornocker 1983).

3.7 Home Range

Home range size can be variable for river otter due to inter-individual differences in foraging strategies (Blundell et al. 2002a), breeding success, age class, topography, habitat differences, and seasonal influence (Melquist & Hornocker 1983, Reid et al. 1994). Home range overlap of solitary river otter occurs extensively for breeding purposes, but also as a result of food availability, such as fish spawning (Melquist & Hornocker 1983). Eight out of ten river otters that were tracked in west central Idaho had larger home range lengths in winter than fall (Melquist & Hornocker 1983). Home ranges for river otter are typically larger for males than females. A study in boreal Alberta reported the home range of males was 271.9 km^2 and females were 15.8 km^2 (Reid et al. 1994), substantially larger than those in other areas. Helon et al. (2004) report river otter in north-eastern Ohio had an average home range of 11 km^2 for males and 8 km^2 for females. Melquist & Hornocker (1983) observed river otter on the Payette River drainage in west central Idaho with seasonal shoreline home ranges between 10-81 km. Mack et al. (1994) found the average home range length for male river otter on the Clearwater River in Idaho was 106 km, while the average home range length for female river otters was 26 km. River otter that occur in the marine environment of coastal Alaska had a shoreline home range length of approximately 21 km for males and 8 km for females (Bowyer et al. 1995). Boyle (2006) notes that river otter density is difficult to measure, such that abundance and density estimates are rarely available.

3.8 Latrine Sites

Latrine sites are areas where a river otter deposits feces, scent-marks, and/or rolls around in terrestrial vegetation and debris (Kruuk 2006, Crowley 2009). Latrine sites are widely used by all otter species and serve an important role in their ecology (Crowley 2009, Swimley et al. 1998). Crowley (2009) found that latrine sites typically included vertical cover > 2 metres (m) tall and trees > 50 cm diameter at breast height (dbh), while areas containing trees < 29 cm dbh were typically avoided for use as a latrine site. Latrine sites consistently used by river otter tended to have large diameter conifer trees with a large drip-line[5] extent and increased horizontal cover. Horizontal cover was more a function of large diameter conifer trees with low hanging branches, rather than dense vegetation from shrubs.

Some latrine sites are frequently used by river otter, while others may be ephemeral in use for a single point in time (Crowley 2009). Large logs, rocks, logjams, sandbars, points of land, beaver bank dens and lodges, stream confluences, and any object that protrudes from the water may be used as a latrine site (Melquist and Hornocker 1983, Boyle 2006, Kruuk 2006, Crowley 2009). Latrine sites are typically located close to shore, usually within 10 m of the shoreline (Swimley et al. 1998, Crowley 2009). Latrine sites are difficult to identify during the winter due to snow cover. Some latrine sites occur in the area in between ice cover and water during the winter period (Crowley, pers. comm. 2020).

4.0 WILDLIFE PREDATION – AMERICAN MINK

4.1 Distribution

Mink is a generalist predatory species with a variable diet and adaptability to environmental conditions. The mink's opportunistic feeding and efficient reproductive capabilities are represented by their broad North American distribution (Larivière, 2003) and invasive success throughout Europe and South America (Bonesi & Palazon 2007, Valenzuela et al. 2013). The mink's North American range is only limited by the dry southwestern states of Arizona, California, Nevada, Utah, New Mexico and Texas, as well as the northern Canadian tundra and islands of the Northwest Territories and Nunavut (Larivière, 2003).

Mink are found throughout mainland British Columbia and Vancouver Island (Figure 4-1**).** A review of harvest records from 1983-2018 for the local area (i.e., Wildlife Management Unit 4-23) revealed that harvested mink had been consistently reported from the area. Numbers of harvested animals have decreased over this time period. Mink have not been reported on wildlife observation forms at any of the coal mine operations. There is no known present or historic mink density estimates in the Elk Valley (which includes the UFR).

[5] dripline – distance from tree trunk to the outer edge of the longest branches in the direction of the water.

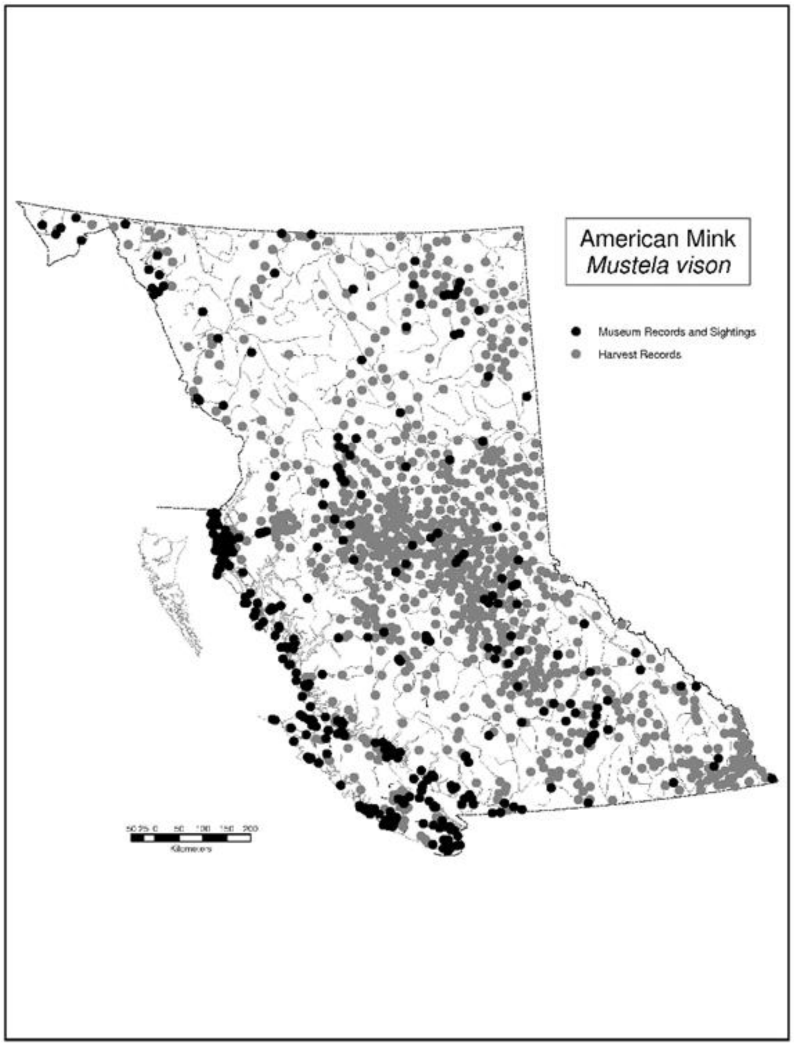


Figure 4-1. Distribution of American mink, *Mustela vison*, in British Columbia based from harvest records, museum records and sightings, 2008. Adapted from E-fauna BC: *Neovison vison (Schreber, 1777)*. Retrieved from https://ibis.geog.ubc.ca/biodiversity/efauna/.

The winter track survey completed in February-March 2020 identified mink occurrence along the UFR from the confluence of Swift Creek to about one kilometre south of the Chauncey Creek confluence, as well as Ewin Creek. Mink tracks were also identified at Greenhills Creek and near its confluence with the UFR. Further details on the winter track survey findings can be found in Appendix A.

4.2 Physiology

Mink, like many mustelids (i.e., weasels), have a streamlined shape that reduces water drag at high speeds. Other than body shape and minimal webbing of their feet, they do not have physiological features beneficial for underwater movement (Williams 1983). Their tubular shape allows access to burrows of their prey, such as hares, rabbits and muskrats, for hunting and for females keeping their young (Larivière 2003). A disadvantage of the mink's body shape is its large surface area-to-volume ratio. Cold stressed weasels have a metabolism 50-100 percent higher when compared to similarly weighted mammals of normal body shape (Brown & Lasiewski 1972).

Mink are a small mustelid and typically weigh between 500 grams (g) and 1500 g (Larivière 2003). In British Columbia, adult male mink weigh 1200-1500 g, with the largest individuals occurring in coastal habitats (Hatler and Beal 2003). The largest average mink weights is from Bleavins and Aulerich (1981), which identified 1823 g for males, and 873 g for females. Larivière (2003) also summarized that other studies on mink elsewhere in North America identified average body mass of male and female mink in Idaho was 780 g and 525 g, respectively (Whitman 1981); North Dakota mink were 1523 g and 852 g, respectively (Eagle et al. 1984); and in Saskatchewan 1160 g and 760 g, respectively (Larivière et al. 2000).

4.3 Sexual Dimorphism

Mink are sexually dimorphic, a phenomenon in which the physical and physiological appearance differs notably between sexes. Adult males can be up to double the body mass and 10% longer in body length compared to adult females. These differences are not found in juvenile mink, which implies that males gain weight more rapidly than females during development (Thom et al. 2004). Adult male mink also exhibit wider canine teeth and longer upper and lower carnassials than adult females, believed to facilitate capture of larger prey (Thom et al. 2004). Less expressive differences are a variety of skull size differences between the two genders (Thom et al. 2004). Mink exhibit geographic differences in body mass and length with a general trend of western individuals being larger than eastern individuals (Larivière 2003). Western mink can be up to 50% larger than eastern mink (Larivière 2003).

Sexual dimorphism in mink can affect the availability of prey species to each sex: larger males commonly prey on larger species than females (Birks & Nunstone 1985, Sealander 1943). General diet trends for male mink in coastal Scotland were toward lagomorphs, the largest-sized abundant prey, while females targeted fish and crustacea (Birks & Nunstone 1985). Female mink preyed on juvenile lagomorphs rather than adults, supporting the results of mink targeting prey respective to their size differences (Birks & Nunstone 1985).

4.4 Reproduction

Mink are solitary species. Females are sexually mature within their first year at approximately ten months of age (Larivière 2003). The mating season lasts for three weeks, which is typically initiated between February and March. The initiation date and length can differ geographically due to their sexual function's sensitivity to light and temperature (Hansson 1947) as well as to food availability for females (Ben-David 1997). Mating can be a violent occurrence, often initiated by cooing sounds and a chase until the male seizes the female with one bite to her neck. Copulation has been recorded to last for up to 14 hours (Hansson 1947).

Ovulation in mink is non-spontaneous, caused by the presence of males (Hansson 1947). Ovulation can occur multiple times with sequential matings, leading to multiple paternities within the same litter (Hansson 1947). Pregnancy in mink is variable and lasts for 51 days on average. Variability in pregnancy duration is dependent on the time of mating. Delayed implantation occurs where a partially developed fertilized egg remains inactive until it is implanted in the uterus. Implantation occurs as a response to photoperiod length; therefore, early mating activities increase the length of the gestation period (Sundqvist et al. 1989).

Males and females disperse post-copulation and the females locate a burrow to raise their young. Burrows are typically located near a watercourse. Mink litter size ranges from one to eight individuals (Hansson 1947). Offspring are altricial, requiring nutrition and temperature control from their mother (Brink &

Jeppesen 2005). The young are blind until they are 25 days old. Weaning occurs at five weeks and hunting occurs at eight weeks, with total independence in the fall (Larivière 2003).

4.5 Prey

Mink prey on a variety of species, most of which are animals, but some fruit and seed species may also be consumed (Arnold & Fritzell 1990, Sealander 1943, Wise et al. 2009). They are a semi-aquatic species that forage for both terrestrial and aquatic prey. Commonly targeted prey species are muskrats, lagomorphs (hares and rabbits), ground squirrels, voles, mice, rats, fish, crayfish, ground-nesting birds, amphibians, reptiles, and mollusks (Arnold & Fritzell 1990, Sealander 1943, Trani & Chapman 2007, Wise et al. 2009).

4.5.1 Fish

The Government of Canada (2012) Federal Contaminated Sites Action Plan reports that fish may comprise up to 30% of a mink's diet. From a study comparing feeding among mink, Wise et al. (2009) reported that fish comprised 31.6% of the diet of a mink over the course of a year in the UK. Mink capture several species of fish from all size ranges: 18-21 cm for common roach, 18-21 cm for perch, and 60-70 cm for pike (Wise et al. 2009). Larivière (2003) summarized that mink are not agile in the water, and typically prey on smaller and slow-moving fish more than larger (>20 cm) or fast-swimming fish like salmonids.

A mink's diet is flexible; however, fish are an important prey species under certain circumstances. Many mammalian predators compete with avian predators over inland fish species; however, heavily forested areas restrict many bird species from accessing streams, resulting in a valuable food source for mink when other prey abundance is low (Burgess & Bider 1980). Also, in coastal environments, the abundance of spawning salmon can be large enough to influence the timing of reproductive functions in mink (Ben-David 1997).

4.5.2 Prey Availability

Mink are opportunistic foragers dependent upon prey availability. Prairie mink diets favour mammals for most of the year but change to avian prey during nesting seasons (Arnold & Fritzell 1990). Mink in central areas of the United States consumed crayfish and mammals as a majority of the diet (>83%; Wolff et al. 2015). Crayfish were most abundant during the summer months of this study and mink were more likely to occupy crayfish hotspots rather than other locations that had identified habitat features (Wolff et al. 2015). Unlike some mammals which enter seasonal metabolic depression, mink actively hunt throughout the year. It was found that mink do not have refined evolutionary adaptation for winter fasting. Therefore, access to consistent prey is crucial for seasonal survival (Mustonen et al. 2005).

4.5.3 Consumption Rates

As described by Bleavins & Aulerich (1981), the consumption rates for farmed (caged) mink were as follows: the average daily consumption of wet food per kilogram body weight (g wet feed/kg BW/day) was 119.4 g for adult males and 155.3 g for adult females; the average daily consumption of dry feed per kilogram body weight (g dry feed/kg BW/day) was 40.3 g for males and 52.5 g for females. The average food passage time was 186.2 minutes and 187.4 minutes for males and females, respectively.

4.6 Ecotoxicology

Biomagnification of polychlorinated biphenyl (PCB) compounds and mercury are of particular concern for top trophic level fish predators. Both toxins are readily soluble in lipids, causing it to bioaccumulate in fat tissues of fish (Suedel et al. 1994). Improper handling and effluent release from industry can result in the exposure of these toxins to water bodies. Toxicity effects of PCBs on mink include drastically reduced reproductive capabilities and enlarged livers. PCB's bioaccumulate in the adipose tissue of mink, concentrating further as fat storage is mobilized during winter or cold weather periods (Hornshaw et al. 1983). Mercury bioaccumulates, in order of highest to least concentration, in mink liver, kidney, muscle, and brain tissue (Wren & Stokes 1986, Wobeser et al. 1976).

4.7 Desirable Habitat Features

Mink require aquatic habitats for hunting such as wetlands, riparian areas (Arnold & Fritzell 1990), tidal pools, riverbanks, streams, swamps and marshes (Birks & Nunstone 1985, Larivière 2003, Trani & Chapman 2007). Mink may use muskrat burrows found along riverbanks and streams as den sites (Trani & Chapman 2007). Mink will also use brush piles, tree cavities and abandoned beaver lodges for their dens (Trani & Chapman 2007). Mink are capable of climbing and jumping between trees to reach den sites (Larivière 2003). Preferred river and stream habitat characteristics for mink often pair with features that support prey such as logjams, grassy or brushy banks, and overhanging banks (Larivière 2003). Defecation occurs around den locations (Birks & Nunstone 1985, Brinck et al. 1978). Defecation and anal gland secretions also occur as territorial scent marking, where individuals will mark near any intruding mink's scent location (Brinck et al. 1978).

4.8 Dispersal and Home Range

Information about mink dispersal in North America is sparse; however, studies have been completed on invasive mink populations in Europe. Oliver et al. (2016) found that mink in Northeast Scotland dispersed 15-35 km over 240 days for males and less than 10 km over 240 days for females. Also, these dispersal distances often joined river drainages (Oliver et al. 2016), suggesting that mink dispersal was primarily following aquatic systems.

Few studies have been completed on mink home range in North America. The average home range size for male mink in Manitoba was 7.7 km^2 (Arnold & Fritzell 1987). In Tennessee, male mink were found to use about a 7.5 km stretch of a river (Stevens et al. 1997). A study on the River Thames in the United Kingdom showed that males had a larger home range length along a watercourse than females, that being 6.8 km and 2.7 km, respectively (Yamaguchi & Macdonald 2003).

5.0 THEORETICAL FEED CONSUMPTION CALCULATIONS

5.1 Daily Consumption Rate

5.1.1 River Otter

A literature review revealed that river otters can weigh between 5 kg and 14 kg. A study completed in west-central Idaho (Hornocker and Melquist 1983) is the closest geographical location to the UFR, and is assumed the river otter population is likely most representative of body mass for the UFR. A summary of adult river otter masses based on sex for the individuals captured in Hornocker and Melquist's (1983) study is provided in Table 5-1. Data collected on juvenile river otter were not included in these calculations, as growth and subsequent foraging rate changes as they mature to adult stage would not reflect a representative consumption rate.

Table 5-1. River otter weights based on sex and age class for live-captured individuals, Hornocker and Melquist (1983).

Age and Sex	Mean Mass (kg)	# of Individuals	Standard Error
Adult Male	9.2	4	0.6
Adult Female	8	6	0.2

Owens et al. (2009) and Duplaix-Hall (1975) *in* Henry et al. (2012) both identify that a river otter's daily consumption rate can be up to 20% of its body mass. This percentage was used to conservatively assume river otter daily consumption rate. Numerous studies summarized in Melquist et al. (2003) identified that a river otter's diet is comprised of 80% - 90% fish, with more studies identifying diet values near 80%. Thus, the 80% value was used in the calculation. When factoring in daily consumption rate and the proportion of fish that comprises a river otter's diet, the potential biomass of fish an adult male and female may consume daily is 1472 g and 1280 g, respectively. These values are within the consumption range identified by Serfass and Brooks (1990) that estimated adult river otter consume between 1 kg - 1.5 kg of food daily.

5.1.2 Mink

Body mass for male and female mink were used based off of research completed by Bleavins and Aulerich (1981), consisting of 1823 g and 873 g, respectively. While these body mass values are larger than what has previously been identified for adult mink in British Columbia (Hatler and Beal 2003), these values are conservative when applying a feed consumption calculation. Bleavins and Aulerich (1981) found the average male mink consumes 119.4 g/kg wet weight of food per day. Females, being smaller than their male counterparts, consumed more than males relative to their body size, measured to be 155.3 g/kg wet weight of food per day. These values were used to support the daily food consumption rate. The Government of Canada (2012) identified that fish make up approximately 30% of a mink's diet. Based on the conservative mink body masses used, the food intake amounts for each sex, and the proportion of a mink's diet comprised of fish, the potential biomass of fish consumed daily by an adult male and female mink is 65.3 g and 40.1 g, respectively.

5.2 Upper Fording River Fish Biomass

A sample size of 773 adult fish (i.e., > 200 mm) were obtained from the Teck Coal's fish database (Table 5-1). The mean fork length from the representative adult fish sample was 282.6 mm (SD = 63.9 mm) and the mean weight was 378.2 g (SD = 287.3 g). The number of fish within each fork length increment typically decreased after the 350-399 mm increment (Table 5-1). The mean weight of each fork length increment increased among all increments, except for the 360-369 mm and 380-389 mm increments compared to their preceding fork length increments. The sample size as well as the range of fish weights were lower for the 360-369 mm increment than the preceding increment (Table 5-1). The 380-389 mm increment contained one more sample than its preceding increment, but the weight range for this size increment of fish was lower (Table 5-1). The relative frequency for the fork length size categories from the representative fish sample was 36.5% for 200-249 mm, 31.7% for 250-299 mm, 16.7% for 300-349 mm, 7.0% for 350-399 mm, 7.0 % for 400-450 mm, and 1.1% for 450-499 mm.

Table 5-1. Adult Westslope Cutthroat Trout (>200 mm) Dataset from the Telemetry Study and the Pit Tag Studies for the upper Fording River.

Fork Length Range (mm)	# Fish In Sample	Mean Weight (g)	Mean Weight Range (g)		Fork Length Range (mm)	# Fish In Sample	Mean Weight (g)	Mean Weight Range (g)
200-209	64	109	79 - 150		330-339	31	571	410 - 740
210-219	47	126	85 - 170		340-349	15	661	490 - 810
220-229	62	145	111 - 180		350-359	19	684	530 - 950
230-239	53	170	125 - 265		360-369	7	673	440 - 790
240-249	56	199	140 - 310		370-379	8	802	700 - 1020
250-259	62	225	149 - 390		380-389	9	796	665 - 920
260-269	55	264	180 - 410		390-399	11	882	705 - 1020
270-279	33	302	230 - 530		400-409	10	996	900 - 1140
280-289	38	349	225 - 530		410-419	14	998	780 - 1160
290-299	57	386	230 - 600		420-429	13	1010	720 - 1240
300-309	31	455	325 - 630		430-439	9	1089	890 - 1200
310-319	33	501	330 - 740		440-449	8	1146	1000 - 1400
320-329	19	509	380 - 740		450-489	9	1290	1080 - 1550

The estimated fish biomass for each 2017 UFR fish population estimate was 1,395.65 kg for population estimate #1 (i.e. 3,690 fish), 1856.33 kg for population estimate #2 (i.e. 4,908 fish), and 2,360.13 kg for fish population estimate #3 (i.e. 6,240 fish). Applying the suspected 93% population reduction as well as the assumed 70% of each fish harvested is consumed values to these biomass estimates, the potential fish biomass available for a predator to consume based off the three pooled Peterson UFR fish population estimates is summarized in Table 5-2.

Table 5-2. Estimated Westslope Cutthroat Trout Biomass in the upper Fording River Based on 93% of the Adult Fish Population Available and the Assumed 70% of each Fish Harvested in Consumed, Using the Three Pooled Peterson Fish Population Estimates from Cope (2020).

2017 UFR Pooled Peterson Adult Fish Population Estimate >200 mm (Cope 2020)	Total Estimated Biomass (kg)
3690	908.57
4908	1208.47
6240	1536.45

5.3 Predator Theoretical Feed Consumption Rate

5.3.1 River Otter

The calculated total number of days for an adult river otter of each sex to consume the total estimated adult fish biomass in the UFR are presented inTable 5-3. These values assume a 100% occupancy rate by each sex within the UFR.

Table 5-3. Theoretical Number of Days for an Adult River Otter to Consume the Estimated Westslope Cutthroat Trout Biomass within the upper Fording River. The years are in parenthesis.

2017 UFR Pooled Peterson Adult Fish Population Estimate >200 mm (Cope 2020)	Number of Days (years in parenthesis)	
	River Otter Adult Male	River Otter Adult Female
3690	617 (1.7)	710 (1.9)
4908	821 (2.2)	944 (2.6)
6240	1044 (2.9)	1200 (3.3)

5.3.2 Mink

Based on the estimated biomass for the three pooled Peterson fish population estimates for the UFR, the total number of days for an adult mink from each sex to consume the estimated fish population biomass is presented in Table 5-4.

Table 5-4. Theoretical Number of Days for an Adult River Otter to Consume the Estimated Westslope Cutthroat Trout Biomass within the upper Fording River. The years are in parenthesis.

2017 UFR Pooled Peterson Adult Fish Population Estimate >200 mm (Cope 2020)	Number of Days (years in parenthesis)	
	American Mink Adult Male	American Mink Adult Female
3690	13,914 (38.1)	22,650 (62.1)
4908	18,507 (50.7)	30,126 (82.5)
6240	23,530 (64.5)	39,714 (108.8)

5.4 Sensitivity Analysis

The assumed occupancy rates (i.e., 25%, 50%, 75%, 100% occupancy) were applied to the theoretical number of years for an adult river otter and mink of each sex to consume the estimated UFR fish biomass based on the three pooled Peterson fish population estimates. The results of the analysis for river otter and mink are presented in Tables 5-5 and 5-6, respectively.

Table 5-5. Theoretical Number of Years for an Adult River Otter to Consume the Total Fish Biomass within the upper Fording River Based on Assumed Occupancy Rates.

Assumed Occupancy Rate	Number of Years to Consume the 2017 UFR Pooled Peterson Adult Fish Population Estimate >200 mm (Cope 2020)					
	3690		4908		6240	
	Male	Female	Male	Female	Male	Female
25%	6.8	7.8	9.0	10.3	11.4	13.2
50%	3.4	3.9	4.5	5.2	5.7	6.6
75%	2.3	2.6	3.0	3.4	3.8	4.4
100%	1.7	1.9	2.2	2.6	2.9	3.3

Table 5-6. Theoretical Number of Years for an Adult Mink to Consume the Total Fish Biomass within the upper Fording River Based on Assumed Occupancy Rates.

Assumed Occupancy Rate	Number of Years to Consume the 2017 UFR Pooled Peterson Adult Fish Population Estimate >200 mm (Cope 2020)					
	3690		4908		6240	
	Male	Female	Male	Female	Male	Female
25%	152.5	654.6	202.8	870.7	257.9	1107.0
50%	76.2	124.1	101.4	165.1	128.9	209.9
75%	50.8	82.7	67.6	110.0	86.0	139.9
100%	38.1	62.1	50.7	82.5	64.5	104.9

The theoretical sensitivity analysis calculation of the number of adult river otter of each sex to consume the UFR fish population over specified time periods are provided in Figures 5-1 and 5-2, and adult mink of each sex are provided in Figures 5-3 and 5-4. The results compare the three pooled Peterson UFR fish population estimates as identified in Cope (2020), and assume a 100% occupancy rate by the adult predator of each sex in the UFR. Adult males are assumed to consume more fish biomass than adult females for each wildlife predator based on the proportional consumption rate in relation to their body size. The results presented are over a 24-month period, similar to the conservative time period identified for the Decline Window.

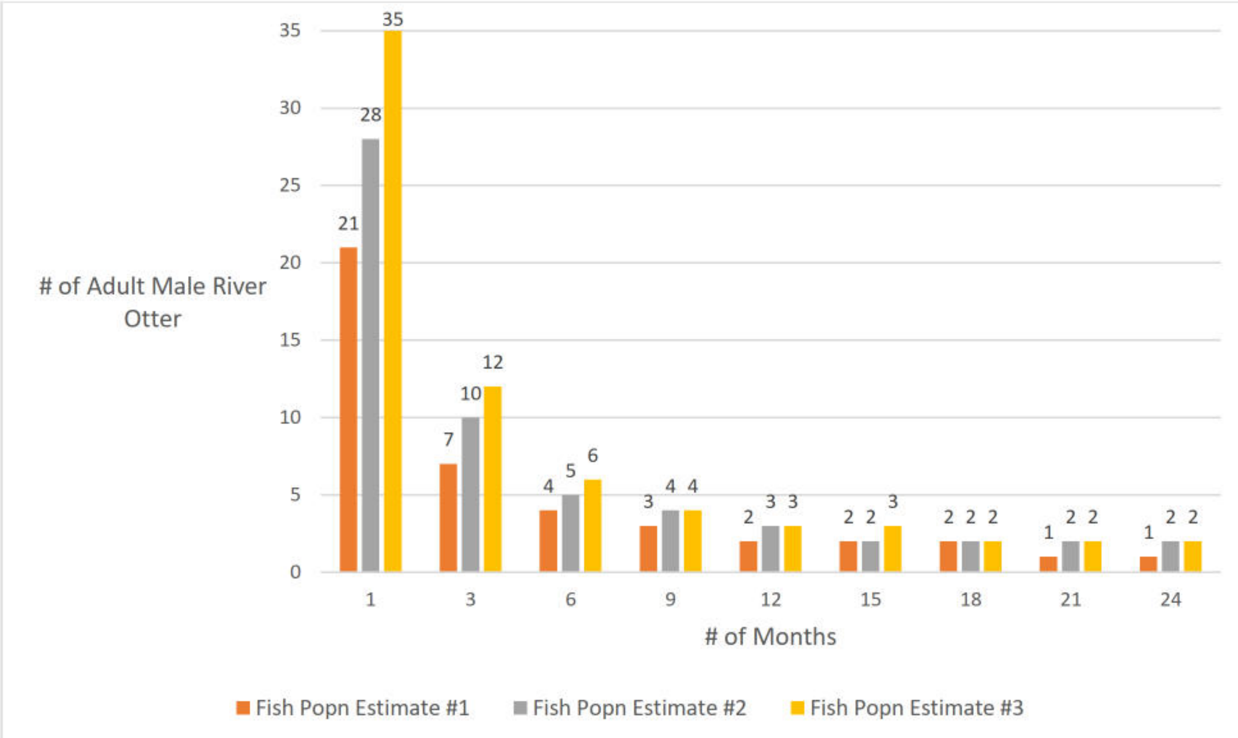


Figure 5-1. Theoretical Number of Adult Male River Otter Required to Consume the Total Fish Biomass of the upper Fording River in Months, Based on a 100% Occupancy Rate.

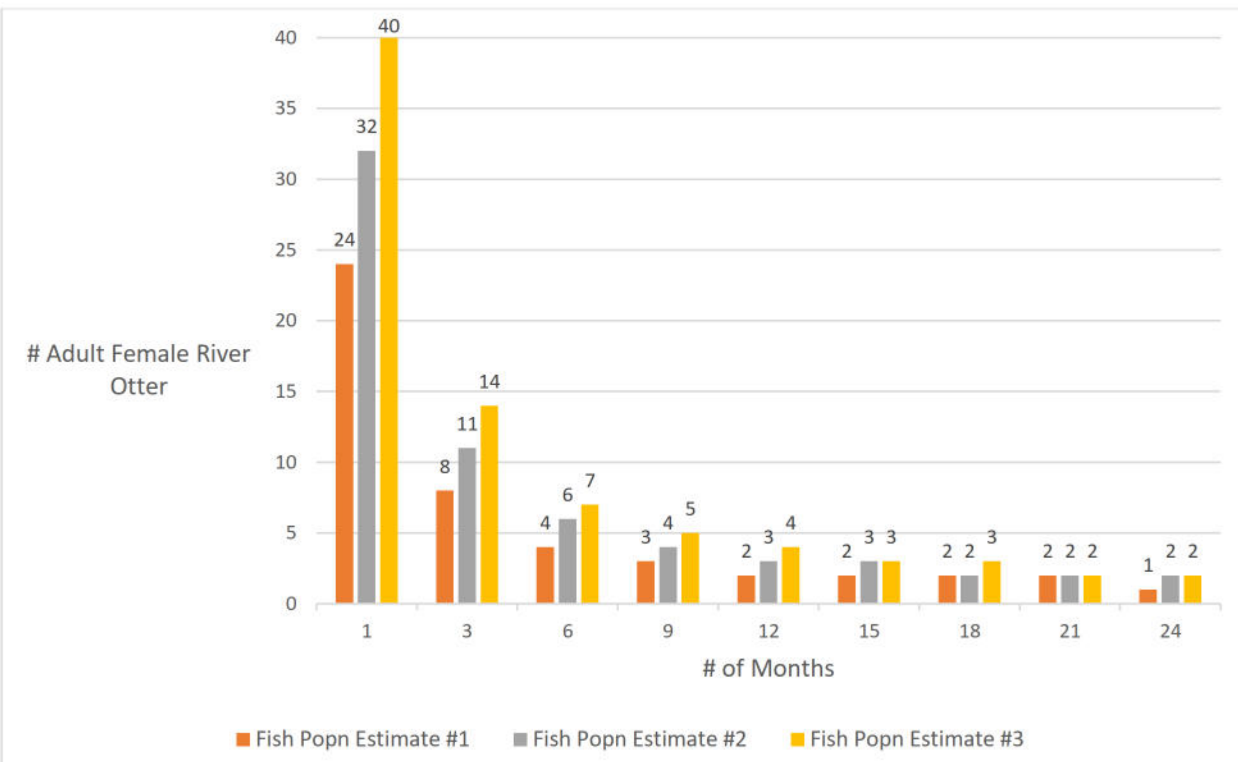


Figure 5-2 Theoretical Number of Adult Female River Otter Required to Consume the Total Fish Biomass of the upper Fording River in Months, Based on a 100% Occupancy Rate.

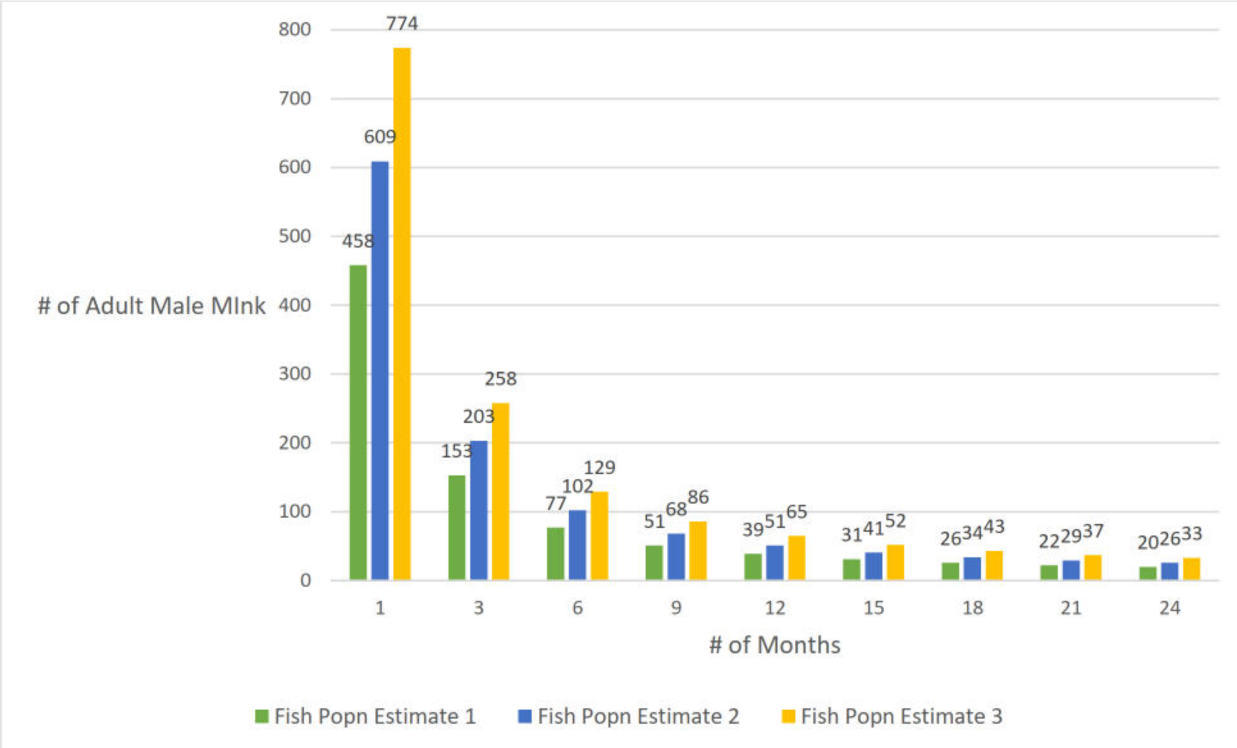


Figure 5-3: Theoretical Number of Adult Male Mink Required to Consume the Fish Biomass of the upper Fording River in Months, Based on a 100% Occupancy Rate.

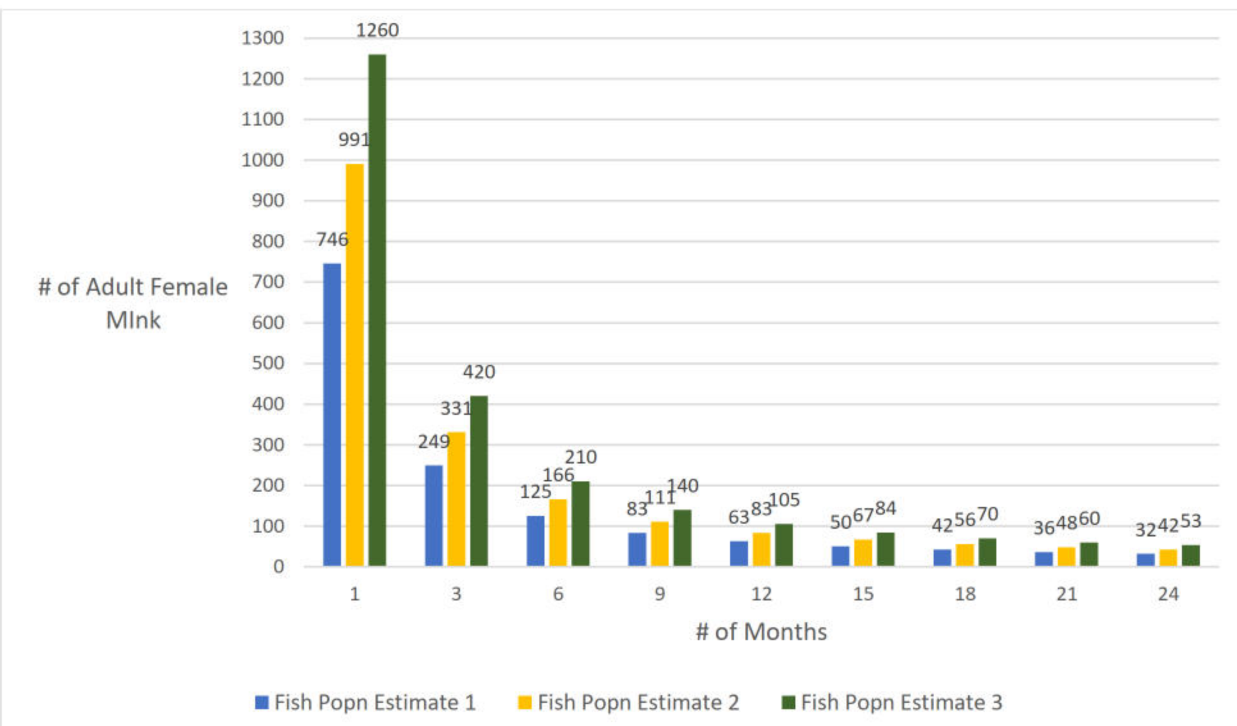


Figure 5-4: Theoretical Number of Adult Female Mink Required to Consume the Fish Biomass of the upper Fording River in Months, Based on a 100% Occupancy Rate.

5.5 Plausibility of Theoretical Feed Consumption Calculation Results

The results from the theoretical feed consumption calculations demonstrate potential wildlife predator foraging impacts on the UFR fish population. Based on these findings, it demonstrates that an adult river otter that maintains 100% occupancy within the UFR can consume a substantial number of fish which could impact the UFR fish population. The theoretical feed consumption calculation and the sensitivity analyses provide insight into the number of river otter required to impact the UFR fish population estimates over different time periods. The winter track survey completed in Feb-Mar of 2020 identified a number of wildlife predators (including both river otter and mink) within the UFR. However, there is no empirical evidence of river otter abundance or occupancy rates at the UFR and its associated tributaries during the Decline Window, creating a high level of uncertainty that predation by river otter could have caused the UFR fish population decline. To better understand river otter occupancy, marked individuals from the river otter population within the Elk Valley watershed would need to be tracked to better understand occupancy rates at various watercourses near the UFR, using the assumption that river otter has equal access to these other watercourses as the UFR and likely have similar prey species occurrence and potentially abundance, given their relatively close geographical proximity. This information could then be correlated to infer a better estimated predation rate, based on a potential occupancy rate derived from tracking marked individuals from the local river otter population.

Research papers have discussed river otter occurrence in relation to prey populations. Hornocker and Melquist (1983) completed a 5-year study on river otter in west central Idaho. From this study, they stated that "….*there was no evidence that otters seriously reduced prey populations. When an abundant prey source of food diminished, or other prey became more available, otters either moved to a new location or changed their feeding habits and selected the most available prey*". Boyle (2006) stated that river otter will physically move in response to shifting food availability. Crowley (2009) noted that "*responses to food resources will ultimately influence the distribution and density of otter populations*."

River otter typically prey on smaller fish than larger fish. This is likely due to the catchability of the prey. Stearns and Serfass (2011) identified that approximately 61.1% of the fish prey items consumed by river otter are <200 mm in length; therefore, smaller fish make up a large portion of a river otter's fish diet. The focus of the analysis completed herein was on adult fish >200 mm in length given this was the size class with a population estimate for the UFR. While an assumption was made to identify consuming smaller fish vs. larger fish (i.e., related to the proportion of the harvested fish consumed), the assumption could potentially have underestimated the overall use of smaller fish (i.e., <200 mm) by river otter as prey. Cope (2020) identified the juvenile fish age class (i.e., 0-200 mm) was approximately 33% more abundant than the adult fish age class in 2017. This identifies a larger prey base that are likely easier for a river otter to capture and consume than the larger and faster swimming adult fish population. A juvenile fish population estimate was not identified in Cope (2020); therefore, the UFR juvenile fish population was not included in the theoretical feed consumption calculation.

Wildlife predation rates on the UFR fish population were previously documented in the Cope et al. (2016) final report entitled *Upper Fording River Westslope Cutthroat Trout Population Assessment and Telemetry Project*. Mortality rates of marked fish were documented during this study which occurred between August 2012 and November 2015. From this study, the mortality rate of marked adult fish ranged between 21% and 32%. Approximately 44% of these mortality events were attributed to predation. This means the overall mortality caused by predation on the UFR fish population ranged from 9% - 14% during the study.

While river otter was identified as a contributor to predation events of marked fish, a higher proportion of predation events were attributed to avian predators (e.g., hawks, osprey, eagles, etc.). There is no empirical evidence to suggest the annual predation rate has increased 6-10 times above the previously measured predation rate on UFR fish over the course of the Decline Window.

Mink are identified to prey of fish; however, they tend to prey on smaller and slow-moving fish than larger (>20 cm) or fast-swimming fish like salmonids (Larivière 2003). While a mink may be able to harvest a larger salmonid under the right circumstances (e.g. stressed fish), they likely focus their fish foraging behaviour on smaller juvenile fish that are easier to catch. Mink are not as agile as other wildlife predators in swimming abilities (Larivière 2003), such as a river otter. As demonstrated in the theoretical feed consumption calculations for mink, the UFR would need to have experienced a significant increase in the number of mink within the UFR valley that were foraging on fish during the Decline Window to influence the UFR fish population. Given the age longevity of this species and likely their limited abilities to capture larger fish, it is not theoretically possible for mink to harvest all the fish in the UFR. Home range sizes of mink occupying mountainous habitats in North America are not well known; limited studies have been completed of mink home range sizes in Manitoba and Tennessee (Arnold & Fritzell 1987, Stevens et al. 1997). Mink have a smaller home range size relative to river otter and a generalist predator diet and foraging behaviour. The UFR valley likely contains a higher population of mink than other wildlife predators that reside in the UFR valley year-round.

6.0 REQUISITE CONDITIONS AND UNCERTAINTIES

This report summarizes the ecology of two representative wildlife predators that occur within the UFR valley. The information provided shows that these fish predators occur within the UFR valley during the winter period and were distributed throughout the UFR at the time of the winter track survey (see Appendix A). A previous study that documented marked adult fish provides context regarding the historic wildlife predation rates on the UFR fish population (Cope 2016).

A summary of the requisite conditions based on the findings from the investigation completed on wildlife predation are:

Spatial Extent: this requisite condition is met as wildlife predators were identified throughout the UFR based on historic wildlife occurrence data and the winter track survey results.

Duration: this requisite condition is not met as there is no empirical evidence that supports predator occupancy rates during the Decline Window. There is limited anecdotal knowledge on foraging rates at the UFR, with most knowledge occurring outside of the Decline Window.

Location: wildlife predators were identified to occur throughout the UFR based on winter track survey results. However, there was no evidence that identifies wildlife predators targeting specific areas for foraging activities where fish are known to congregate; therefore, this requisite condition was not met.

Timing: based on the findings from the investigation completed, it is assumed that wildlife predators were present in the UFR valley during the Decline Window. The winter track survey identified tracks of both river otter and mink at the UFR. However, there was no evidence identified that predation by wildlife predators occurred during time periods when fish are known to congregate in the UFR (e.g., spawning areas, wintering areas, barriers to fish passage). As such, this requisite condition is not met.

Intensity: this requisite condition is met as the theoretical feed consumption calculations shows that fish-specialist wildlife predators like river otter can exhibit foraging pressure at a rate that could potentially impact the UFR fish population.

As identified above, what is unknown regarding wildlife predators is the lack of data to support their occupancy rates within the UFR during the Decline Window, creating a high level of uncertainty as to their foraging impacts. Some of the theoretical feed consumption calculations and sensitivity analyses assumed the selected wildlife predators evaluated occur within the UFR valley 100% of the time. If this is correct, then the results of the theoretical feed consumption calculation do not reflect the previously measured predation rate identified in Cope (2016). However, if this is not true, this would likely mean there's been a change in predator species occurrence within the UFR valley from when the fish telemetry study occurred, resulting in an increased predation rate than what was previously measured during the fish telemetry study. There is no empirical evidence that the wildlife predator occupancy rates in the UFR valley have changed since the Cope (2016) study; therefore, the results of the theoretical fish consumption calculations must be carefully interpreted.

The influence of understanding wildlife predation on fish is challenged by the timeframe during which the population decline occurred. Based on the Decline Window periodicity evaluation completed in Chapter 4 of the EoC, the UFR fish population decline is suspected to have occurred after July 15, 2018 or November 1, 2018, and before March 30, 2019. With this understanding, only wildlife predators that occurred at the UFR during this timeframe that preyed on fish could have potentially impacted the UFR fish population. This supports why river otter and American mink were selected as the representative wildlife predators, as both of these species are: 1) wildlife species that are known to prey on fish; 2) wildlife species that spend time in water, thereby increasing the likelihood of preying on fish; and 3) wildlife species that are suspected to occur within the UFR at any time period within a given year. That being said, Cope (2016) identified that from the mortality events on marked adult UFR fish, predation was higher from avian predators than other wildlife predators where predation could be evaluated to species. However, the overall predation rate on the UFR fish population during the study ranged between 9% - 14%. Therefore, the Decline Window in relation to what wildlife predators may occur within the UFR valley is likely not a concern, given the previously measured predation rate on fish by wildlife predators. The uncertainty as to whether there was a change in wildlife predator occurrence, abundance, and occupancy rate during the Decline Window has been speculated; however, the lack of data or evidence of such a change makes this position indeterminant.

7.0 CONCLUSION

Based on the information summarized within this report, the impact hypothesis is indeterminant that the foraging activities of wildlife predators caused the UFR fish population decline. The lack of understanding wildlife predator occurrence, abundance, and occupancy rates during the Decline Window creates a high level of uncertainty as to the overall effect wildlife predation may have had on the UFR fish population. The theoretical feed consumption calculations completed for each species shows that a fish-specialist wildlife predator like river otter could potentially impact the UFR fish population based on their foraging activities and feed consumption rates. A predator generalist like mink likely does not have a profound effect on the UFR fish population unless there was an increased abundance of this predator over a defined time period, and that the predator is capable of harvesting both juvenile and adult fish equally. The findings from this investigation shows that the requisite conditions for spatial extent and intensity were met by the information compiled. The requisite conditions of duration, location, and timing were not met based on the information compiled in this investigation.

Wildlife predators within the UFR valley could potentially be a contributing stressor to a multi-stressor impact on the UFR fish population. If fish are impacted by a multi-stressor scenario, wildlife predation could potentially impact stressed fish and contribute to the population decline. Additionally, wildlife predators could potentially perform a 'predation event' on fish that have a decreased fitness from either natural causes (e.g., spawning event, overwintering period), are trapped by a barrier to fish passage, or other stressor event that makes a fish more susceptible to predation. Fish would likely need to be congregated and unable to avoid or escape a predator for a predation event to occur.

Wildlife predation could potentially impact the remaining UFR fish population. Efforts may be required to protect the remaining UFR fish population from wildlife predation in the future.

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APPENDIX A: WINTER TRACK SURVEY REPORT

Subject Matter Expert Report: WINTER TRACK SURVEY. Evaluation of Cause – Decline in Upper Fording River Westslope Cutthroat Trout Population

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1.0 INTRODUCTION

The westslope cutthroat trout (*Oncorhynchus clarki lewisi*) population in the Upper Fording River (UFR) has recently experienced a significant decline (Cope 2020). Through extensive fish research and monitoring program, westslope cutthroat trout have been identified as the only fish species in the UFR upstream of Josephine Falls. The recent findings of the fish population decline from Cope (2020) has prompted Teck Coal Limited (Teck) to investigate the potential cause of this decline. One of the stressors identified as a potential cause or contributor to the fish population decline are wildlife predators.

Wildlife predators that are known to prey on fish from the UFR include avian predators (e.g. osprey [*Pandion haliaetus*], bald eagle [*Haliaeetus leucocephalus*], mergansers [*Mergus spp.*], and hawks) and mammalian predators (e.g. American mink [*Neovison vison*], North American river otter [*Lontra canadensis*]). During the winter period, many avian predators have migrated south; however, some individuals from some species (e.g., bald eagle) may occur in the area. Most mammalian predators are present during the winter period, with a few exceptions (e.g., bears). Literature reviews and discussions with regulatory agencies about mammalian studies within the Elk Valley revealed a lack of data and understanding of mammalian occurrence. With the decline in the westslope cutthroat trout population, a better understanding of mammalian predator occurrence was warranted.

Teck retained VAST Resource Solutions Inc. (VAST) to help better understand the potential effects of wildlife predation on fish for the UFR. Given the lack of mammalian occurrence data, winter track surveys were proposed as an effective means of identifying species occurrence and distribution on a landscape.

The ability to correctly identify tracks is dependent on a combination of snow and weather conditions. Snowfall events and/or wind events can obscure tracks left by an animal; therefore, completing winter track surveys during these weather events potentially creates bias in species occurrence and distribution. Halfpenny et al. (1995) suggests that snow must be soft enough and at least 2-5 centimetres (cm) deep to allow tracks to register and be identifiable. Animals require time to move around and create tracks which can be identified by trained personnel. Halfpenny et al. (1995) recommended waiting until the second morning after a snowfall event to allow tracks to accumulate within a search area. As well, warming temperatures and direct solar radiation on tracks cause ‘track rot’, whereby the tracks either melt along their edges to appear larger, or become indiscernible (or disappear completely).

The purpose of the winter track survey was to determine predator occurrence and their distribution along the UFR during the winter period. The winter track survey focused on accessible portions of the mainstem of the UFR, as well as some of the lower portions of the adjoining tributaries where juvenile westslope cutthroat trout are known to overwinter.

2.0 METHODS

2.1 Winter Track Survey

The winter track survey consisted of personnel snowshoeing along the shorelines of the UFR and its tributaries (Figure 1) and recording all predator tracks identified. Personnel worked in pairs and navigated with an Apple iPad™ using the mobile map application Avenza Maps™ (Version 3.7.2). A handheld Global Positioning System (GPS; Garmin GPSmap 64st) was used to record a tracklog of each transect between the start and end points of each survey day. These data were used to determine the distance surveyed each day.

Predator tracks were identified using the intercept method. Once the species was determined, surveyors determined and recorded the track type (i.e. track, trail or network; Jalkotzy and Young 2009). A "track" was recorded if a single animal made a crossing. A "trail" was recorded if multiple animals of the same species followed each other and crossed the transect. If a trail was recorded, personnel attempted to determine and record the number of individuals. If the number of individuals could not be determined, it was assumed three individuals used the trail. A "network" was recorded if multiple tracks of the same species crossed within a 10 metre (m) distance along the transect. If a network was recorded it was assumed seven individuals used the network.

Waypoints were taken with Avenza Maps at the start and end points of each survey day, as well as for any predator tracks identified. Data collected for each predator track identified included species, coordinates, type of track (track, trail or network), number of individuals, the position on the landscape (i.e. ice over water, shoreline, uplands, logjam, coarse woody debris [shoreline or uplands], beaver lodge), track quality (poor, acceptable, good, best), the number of days since the last snowfall, as well as any other comments about the track. Photos were often taken of the track intercepted.

Where possible, both shorelines of the UFR and its tributaries were searched in an effort to record all tracks. However, if terrain or river crossings were deemed unsafe, some portions were not searched.

The winter track surveys were heavily influenced by weather and environmental conditions. Surveys only occurred:

1. if snow was present;
2. no less than 24 hours after a fresh snowfall of more than two (2) cm;
3. on calm days (wind events blow snow, covering up tracks making them difficult to identify correctly); and,
4. when air temperatures were cooler (if too warm and track rot was occurring, surveys were stopped for the day).

2.2 Data Analysis

2.2.1 GIS Analysis- Calculation of Tracklog Distances

Software used to calculate tracklog distance included ArcGIS Pro 2.4.0 and ArcGIS Desktop 10.7.1. GPS tracklog data was converted into a Geodatabase feature class. The feature class linework was clipped to the nearest Point of Commencement waypoint and End of Line waypoint for each track, which was also captured by GPS at the time of survey. Track distances were calculated by ArcGIS geodatabase in NAD83/UTM 11 datum/projection.

2.2.2 Species Track Occurrence Analysis

Once the survey was completed, data were pooled into one database. Any trails or networks were adjusted to meet the assumptions outlined during data collection (see section 2.1).

Data were analyzed in terms of the number of tracks per species per kilometre (km)-day and were calculated by dividing the number of tracks observed for each species by the distance travelled times the number of days since last snowfall (Jalkotzy and Young 2009).

$$\text{Tracks per km-day (TKD)} = \frac{\text{number of tracks observed}}{\text{distance [km]} * \text{time since last snowfall [days]}}$$

This calculation was used for the tributaries as they were surveyed over one day. Because the UFR was surveyed over several days, the TKD for each species were averaged to provide accurate representation of track occurrence along it.

3.0 RESULTS

3.1 Survey effort

Winter track surveys occurred between February 25th and March 12th. Due to snowfall events, many survey days were postponed and some survey days were cut short due to warmer temperatures in the afternoon. Snow conditions ranged from poor to best during the survey. However, despite challenging weather, snow conditions were often good for registering identifiable tracks left by predators.

A total of 73.1 km of shoreline along the UFR and its tributaries were surveyed for predator tracks (Table 1; Figure 1).

Table 1. Total Distance Surveyed Along the Upper Fording River and its Tributaries.

Section Surveyed	Distance Surveyed (km)
Upper Fording River	63.9
Chauncey Creek	0.8
Ewin Creek	2.9
Greenhills Creek	2.0
Henretta Creek and Lake	3.4
Total	73.1

3.1.1 Species Track Occurrence

Seven mammalian predators were identified by tracks during the survey, which included North American river otter (Figure 1), American mink (Figure 2), weasel species (*Mustela spp*.; Figure 4), American marten (*Martes americana;* Figure 5), grey wolf (*Canis lupus;* Figure 6*),* coyote (*Canis latrans;* Figure 7), red fox (*Vulpes vulpes;* Figure 8) and canid (unknown) species (*Canis spp*.; Figure 9).

Overall, total track densities (all species combined) were higher along the tributaries than the UFR, except for Henretta Creek and Henretta Lake where no tracks were identified (Table 2). Ewin Creek had the highest total track density followed Chauncey Creek and Greenhills Creek.

When averaged over all areas surveyed, track densities were highest for American mink, followed by weasel species and canid (unknown) species (Table 2).

Predator track densities varied amongst the portions of each watercourse surveyed (Table 2). Track densities along the UFR were highest for American mink and weasel species, followed by canid (unknown) species. Ewin Creek had the highest predator track densities for American mink, followed by weasel species and American marten. Two predators were identified by tracks at Greenhills Creek, with track densities of American mink higher than weasel species. Chauncey Creek also had two predator species identified by tracks, consisting of weasel species at the highest track density and canid (unknown) species. No tracks were identified along Henretta Creek or Henretta Lake.

Table 2. Species Track Densities (Tracks per km-day; TKD) from the Winter Track Survey 2020.

	Total Track Density per km-day (TKD)					
Species	**Upper Fording Mainstem**	**Greenhills Creek**	**Ewin Creek**	**Chauncey Creek**	**Henretta Creek and Lake**	**Average Track Density**
North American River Otter	0.2	0	1.4	0	0	0.3
American Mink	0.7	10.9	12.6	0	0	4.8
Weasel species	0.7	0.5	7.1	6.5	0	3.0
American Marten	0.1	0	3.4	0	0	0.7
Grey Wolf	0.1	0	0	0	0	0.0
Coyote	0.2	0	0	0	0	0.0
Red Fox	0*	0	0	0	0	0
Canid (unknown) species	0.4	0	0	5.2	0	1.1
Total	2.4	11.4	24.5	11.7	0	

* Only one (1) red fox track identified during the winter track survey. Density calculation too small to register for total area searched along UFR.

3.1.2 Incidental Observations

Eleven incidental wildlife observations were also recorded during the winter track survey. Seven incidental observations were of North American beaver (*Castor canadensis*) sign (i.e. lodges, feed piles; Figure 10). One of the North American beaver observations was a visual of a North American beaver swimming. Fish were incidentally observed twice during the winter track surveys, with four fish identified (n=1 and n=3). All fish observed were alive and swimming within the mainstem of the UFR in between the confluences of Chauncey Creek and Porter Creek. A bald eagle and a snowshoe hare (*Lepus americanus)* were also incidentally observed during the winter track survey.

3.2 Distribution of Track Occurrence

Tracks were identified along much of the area surveyed; however, there were some areas where no tracks were identified. Sections where no tracks were identified included Henretta Lake, Henretta Creek, the UFR between the FRO south tailings pond and Swift Creek, and a section of the UFR north of Chauncey Creek (see section 4 for further explanation). The distribution of tracks by species varied. A description of the distribution of the smaller- and larger-sized predator tracks is provided below.

3.2.1 Smaller- sized Predators

Tracks of smaller-sized predators were not identified in the northern portion of the Fording River Operations (FRO; Figure 11). Tracks from North American river otter and weasel were identified in the southern portion of the UFR (Figure 2 and Figure 4). The number of tracks from small-sized predators were more frequent downstream of the FRO (i.e. south of Swift Creek confluence).

North American river otter tracks were identified in three areas. The northern most area was along the UFR located west of the FRO offices (Figure 2). These tracks were confined to the riverbed area and personnel were confident these tracks were left by one individual. North American river otter tracks were also identified along the mainstem between Swift Creek and Chauncey Creek, as well as Ewin Creek. Personnel were not able to determine with any confidence the number of North American river otter that made these tracks.

American mink tracks were primarily identified along the UFR south of Swift Creek confluence, as well as along Ewin Creek and Greenhills Creek (Figure 3). Tracks were suspected to have been left by multiple individuals; however, the number of individuals is unknown.

Weasel species tracks were identified below the FRO offices along the mainstem, south of Swift Creek confluence along the UFR (in concentrated location), as well as along Chauncey Creek, Ewin Creek and Greenhills Creek (Figure 4). Tracks were suspected to have been left by multiple individuals; however, the number of individuals is unknown.

American marten tracks were identified in the southern portion of the area surveyed, primarily along Ewin Creek and along the UFR near Ewin Creek's confluence (Figure 5). American marten tracks were also identified near the Greenhills Creek confluence with the UFR (Figure 5). Tracks were suspected to have been left by multiple individuals; however, the number of individuals is unknown.

3.2.2 Larger-sized Predators

Tracks of larger-sized predators were primarily identified in the northern portion of the surveyed area, with few tracks from large-sized predators identified south of the Chauncey Creek confluence. Grey wolf tracks were identified in two concentrated locations along the UFR north of the Chauncey Creek confluence (Figure 6). Coyote tracks were identified along the UFR near the Clode Creek confluence, the FRO south tailings pond, and near the Swift Creek confluence (Figure 7). One red fox track was identified along the UFR near the Swift Creek confluence (Figure 8). Unknown canid tracks were identified in several locations including near the Clode Creek confluence, at the Swift Creek confluence and south, a section between Swift Creek and Chauncey Creek, and along Chauncey Creek and its confluence (Figure 9).

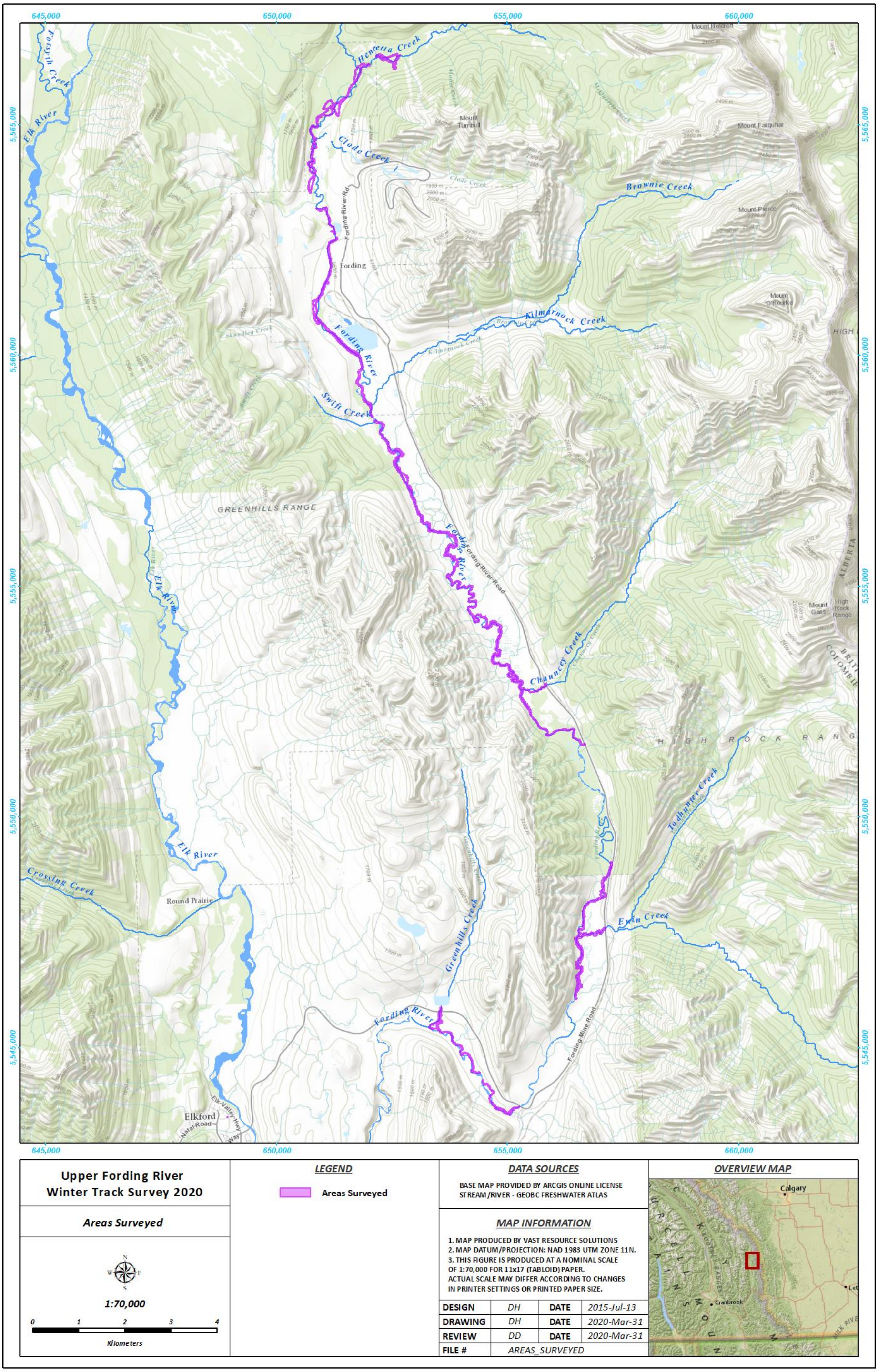

Figure 1. Areas surveyed during the Upper Fording River Winter Track Survey 2020.

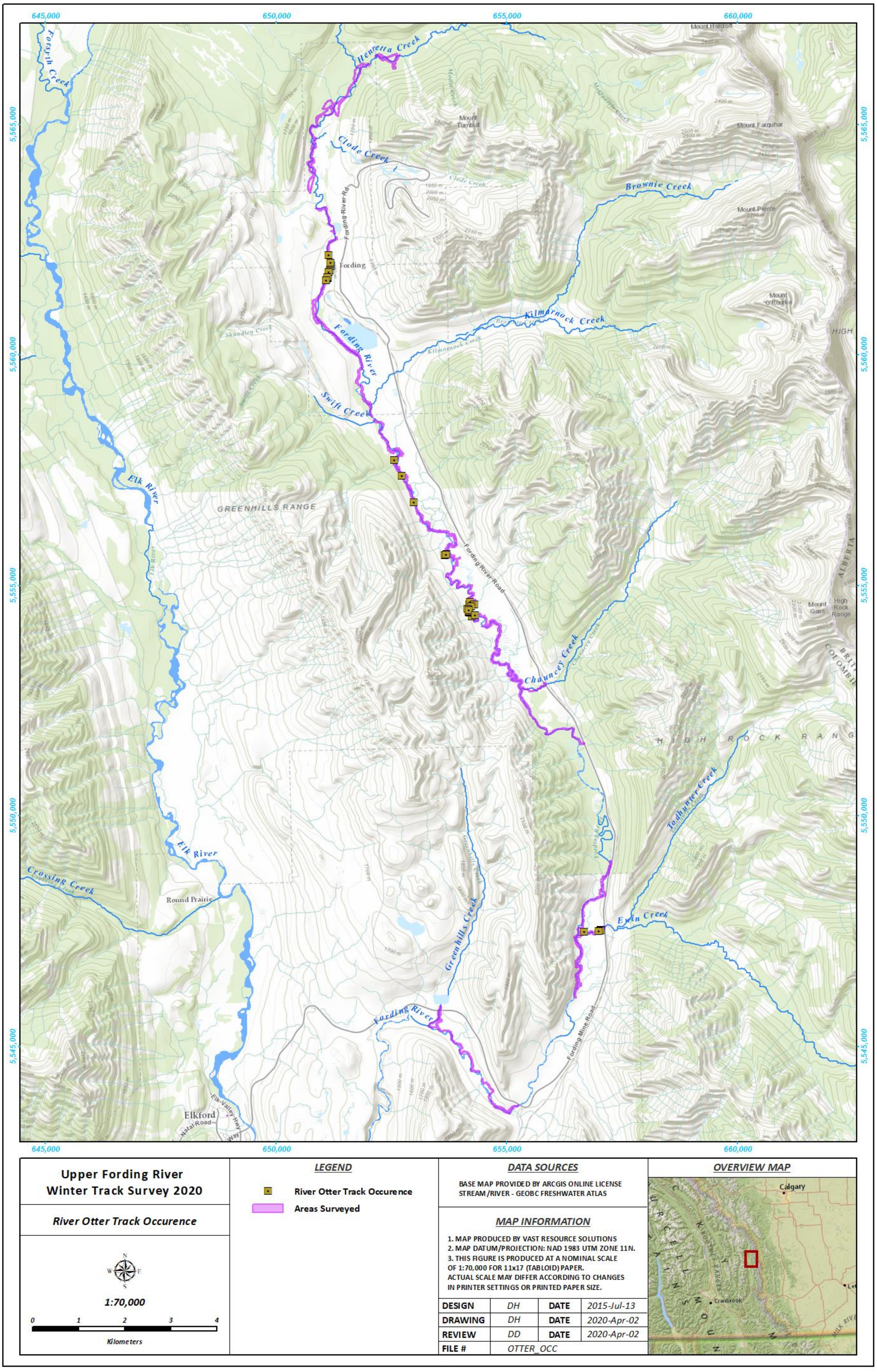

Figure 2. North American River Otter (*Lontra canadensis*) track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

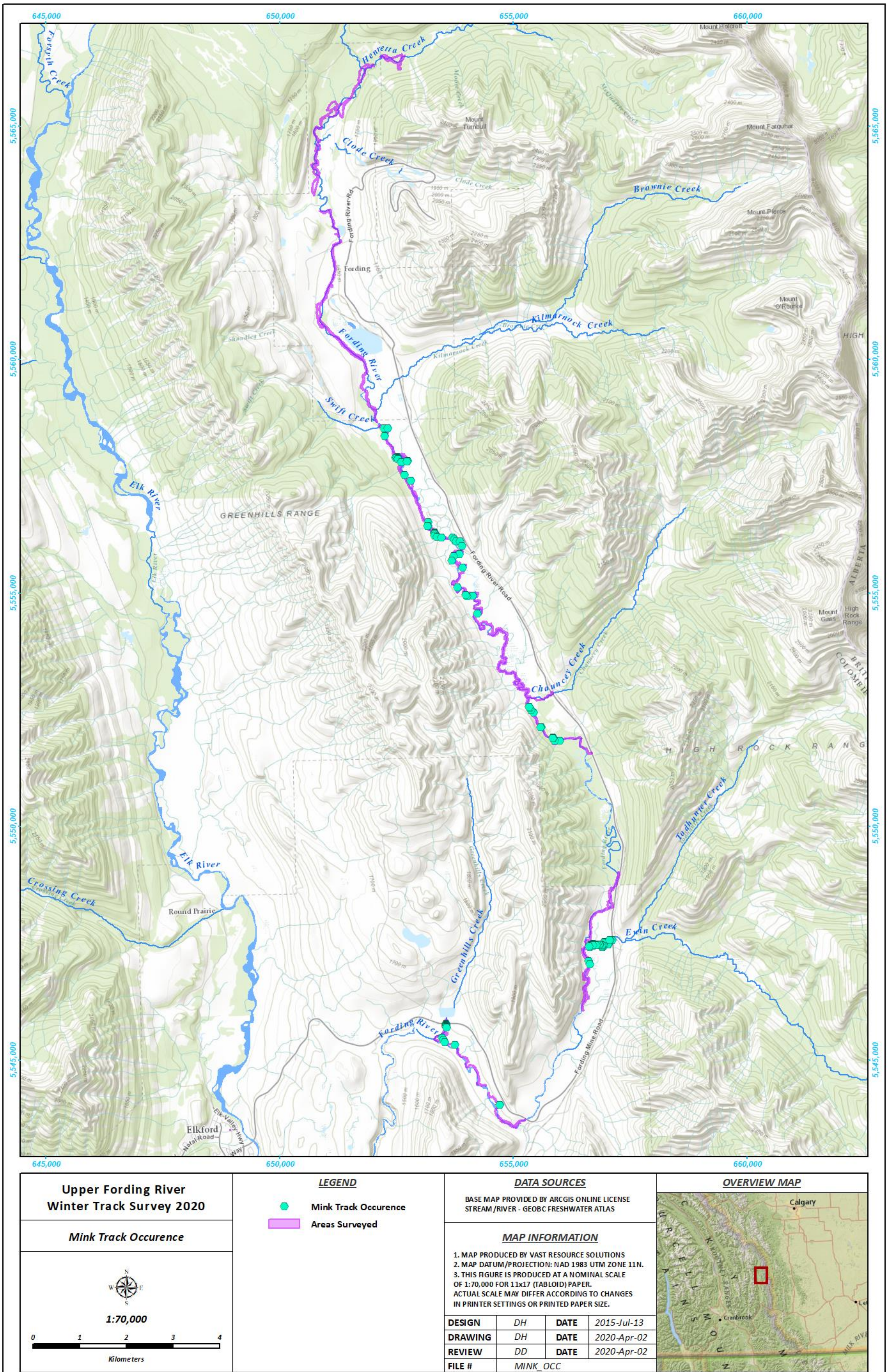

Figure 3. American mink track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

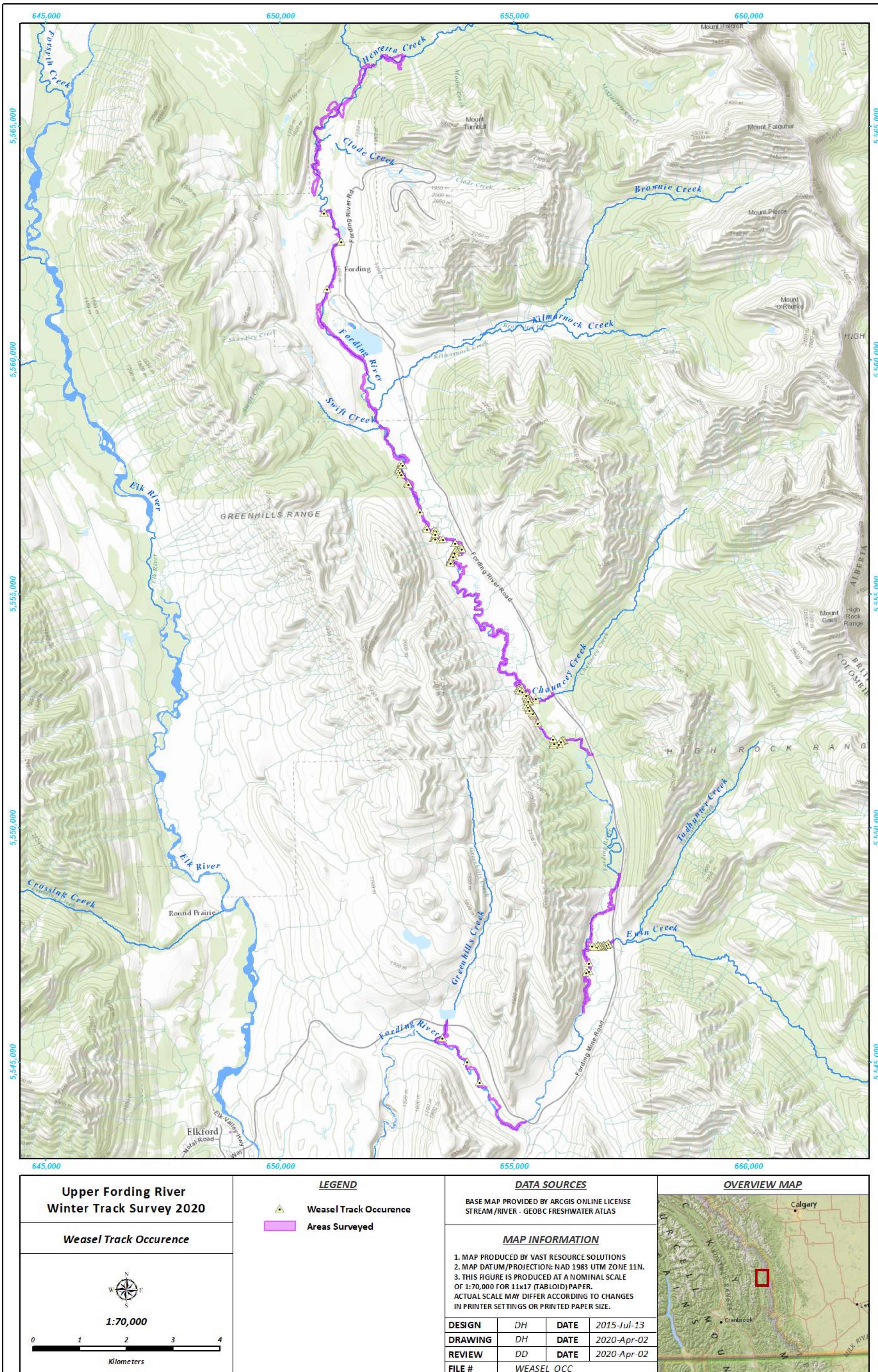

Figure 4. Weasel species (*Mustela spp.*) track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

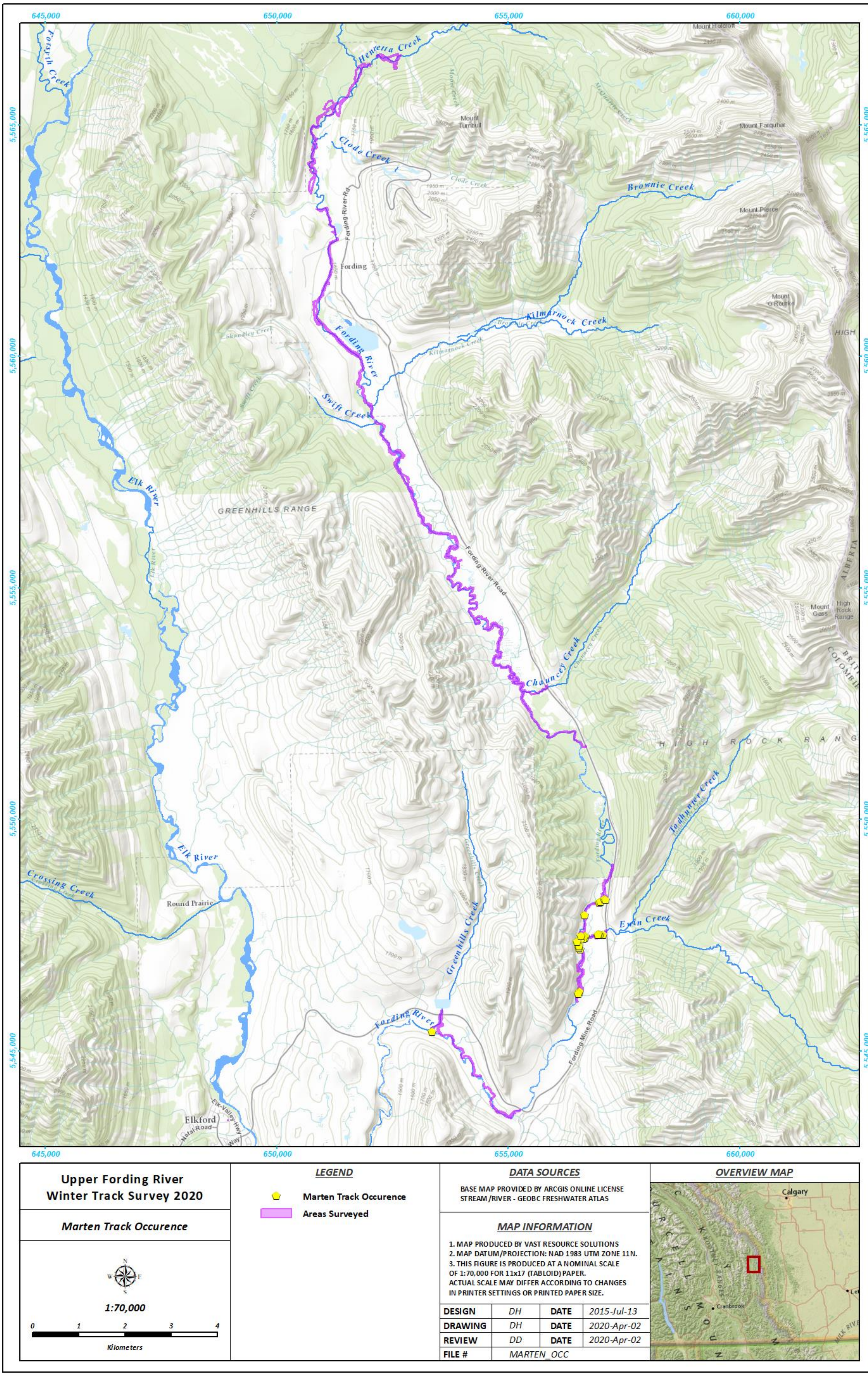

Figure 5. American marten (*Martes* Americana) track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

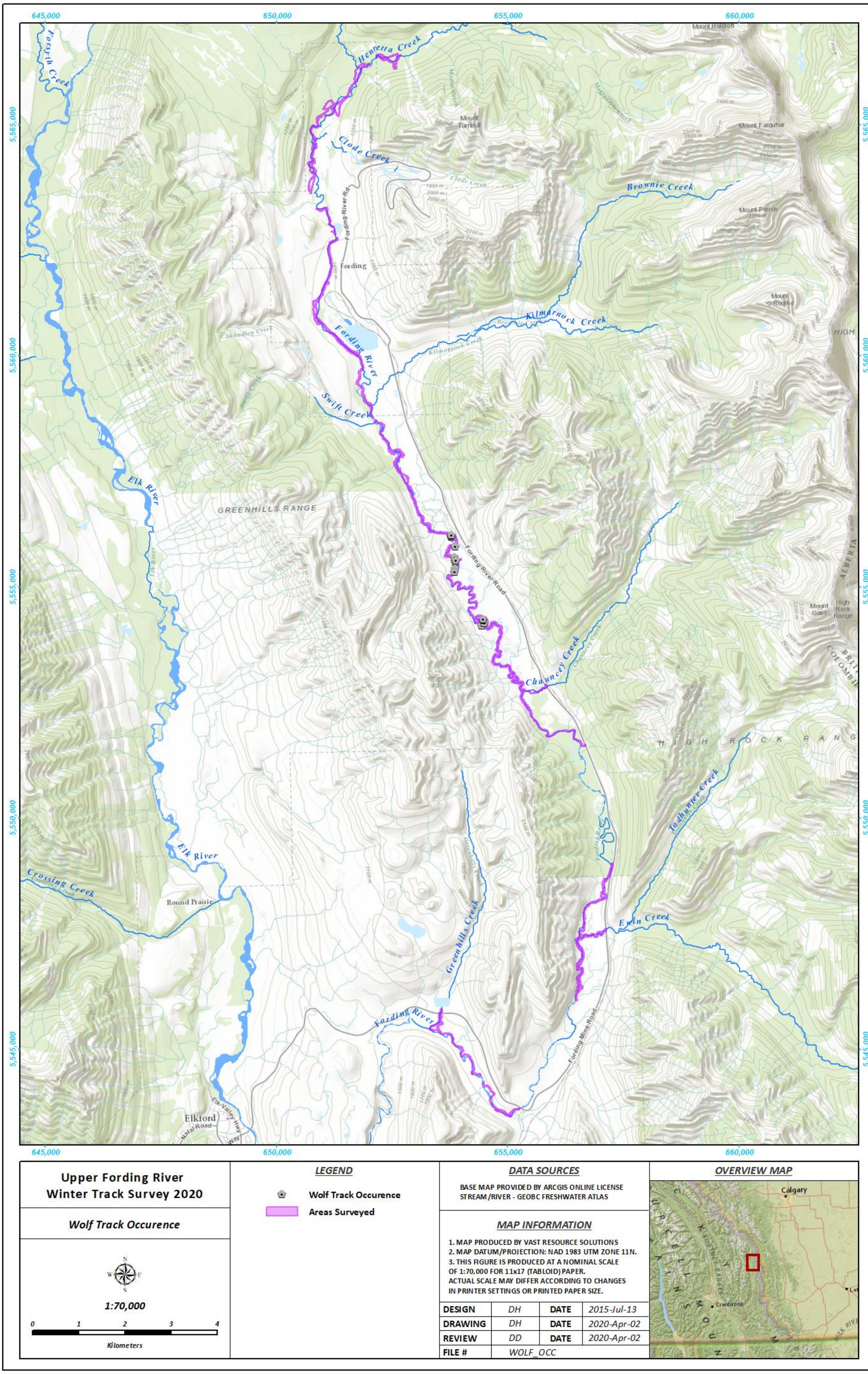

Figure 6. Grey wolf track (*Canis lupus*) occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

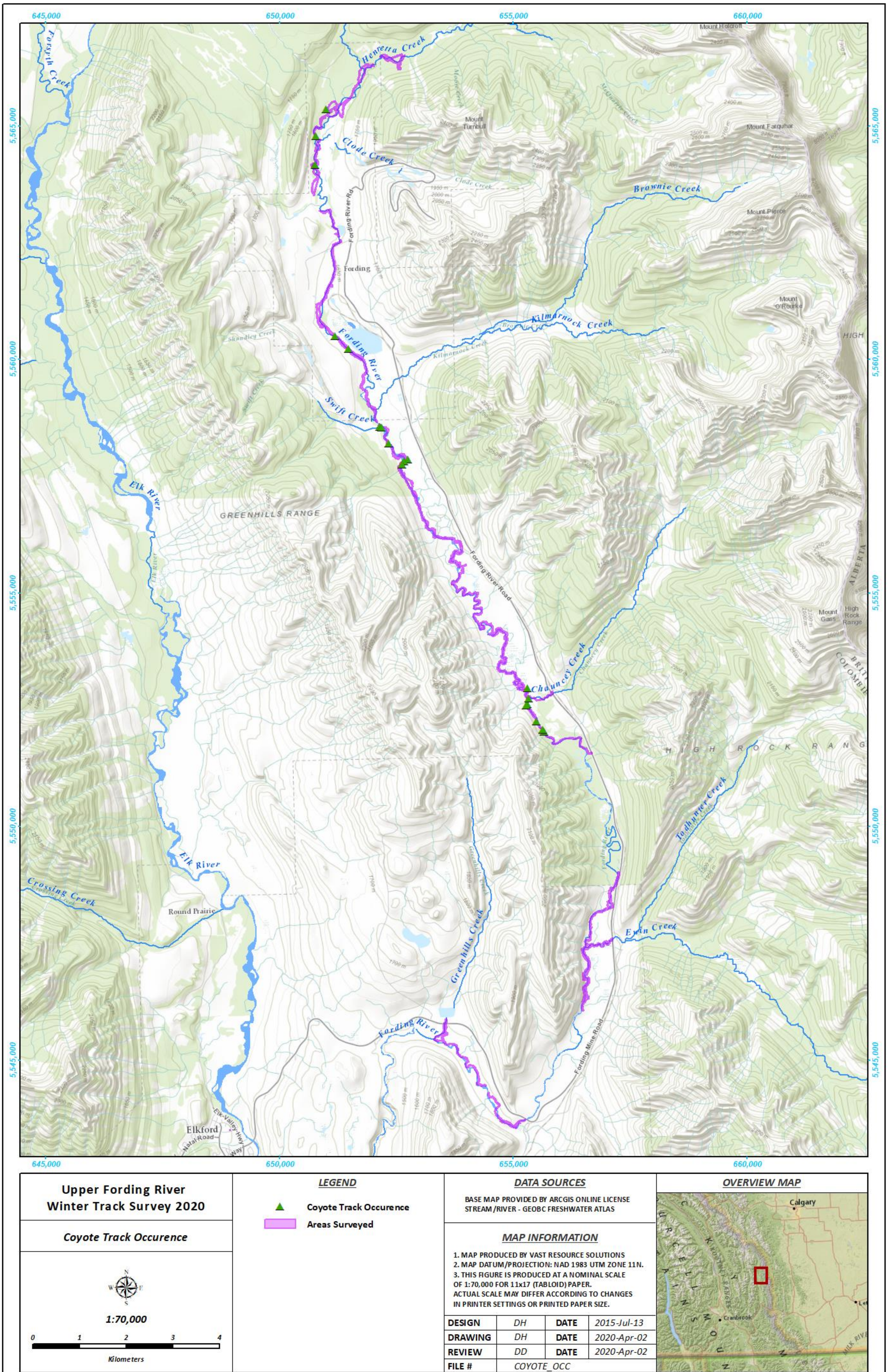

Figure 7. Coyote (*Canis latrans*) track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

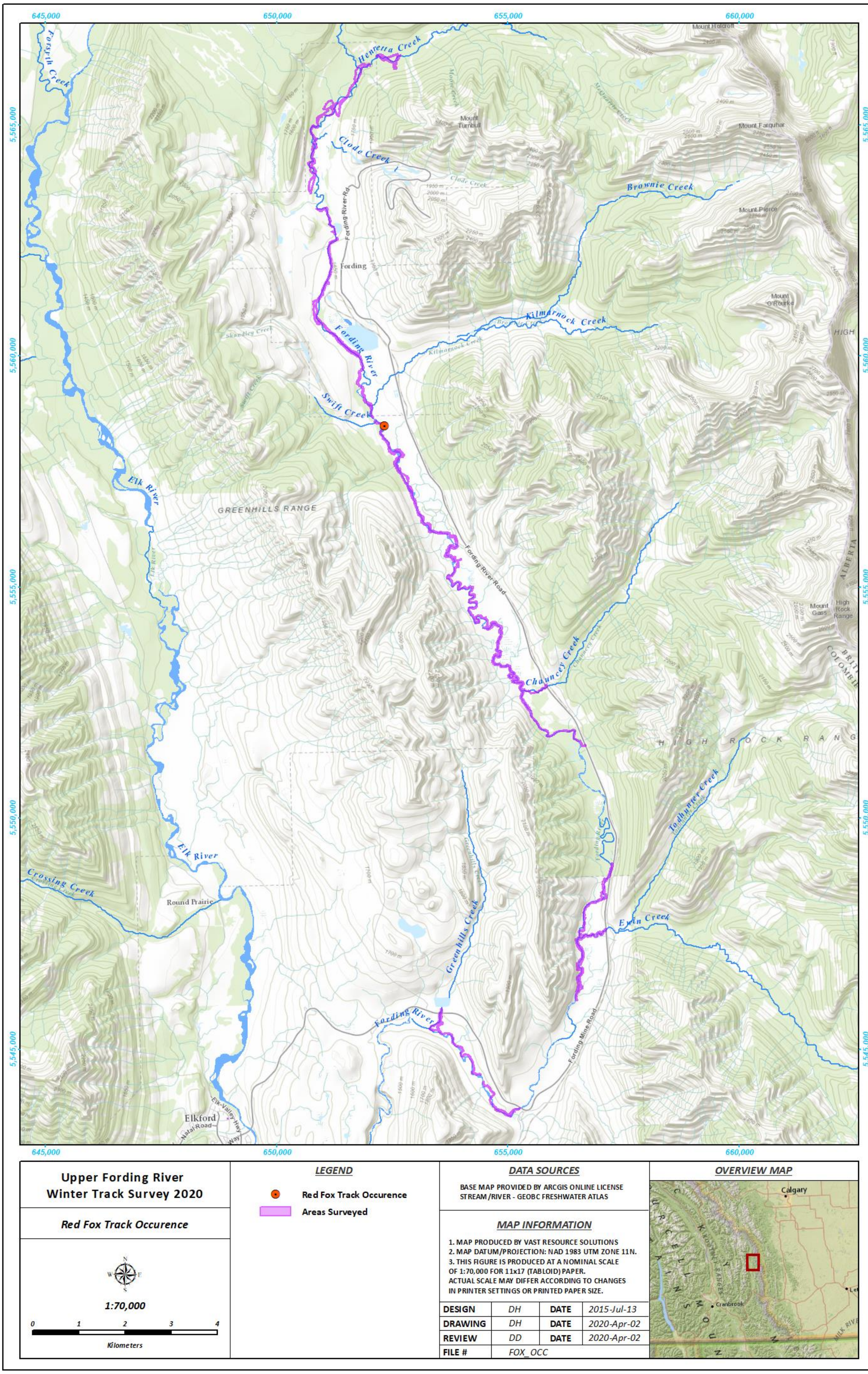

Figure 8. Red Fox (*Vulpes vulpes*) track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

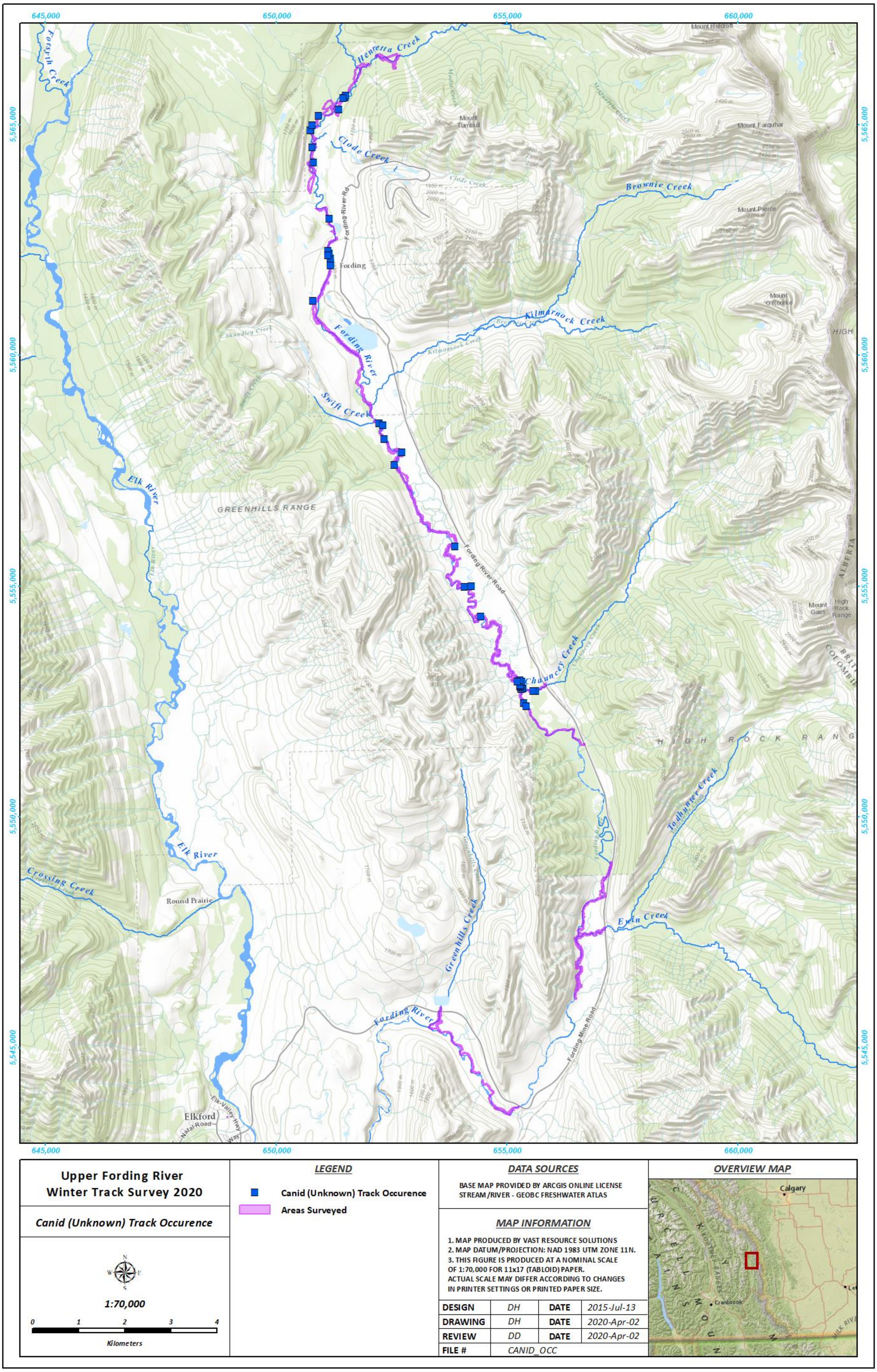

Figure 9. Canid (unknown species) track occurrence along the areas surveyed during the Upper Fording River Winter Track Survey 2020

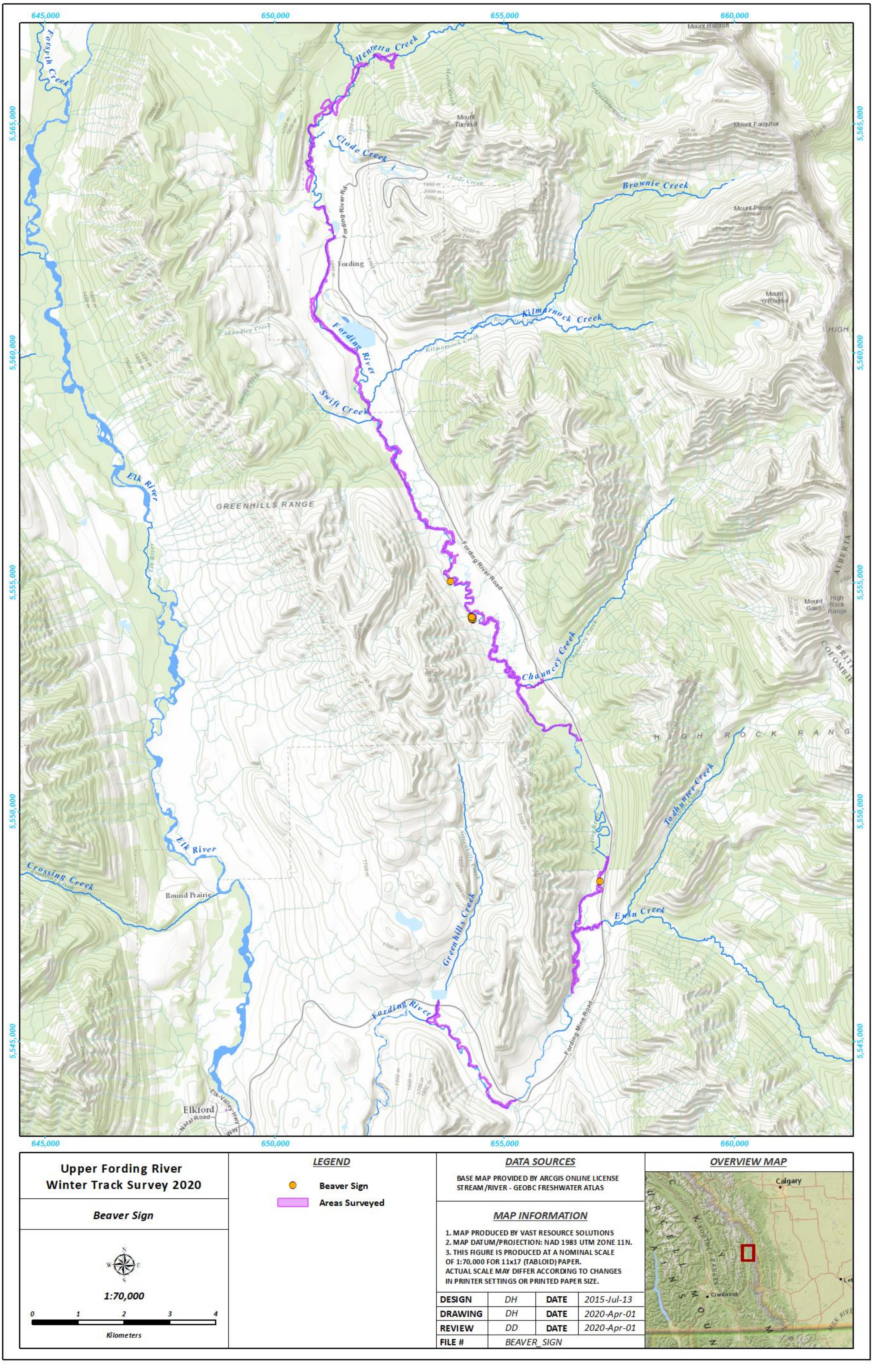

Figure 10. Beaver sign observed along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

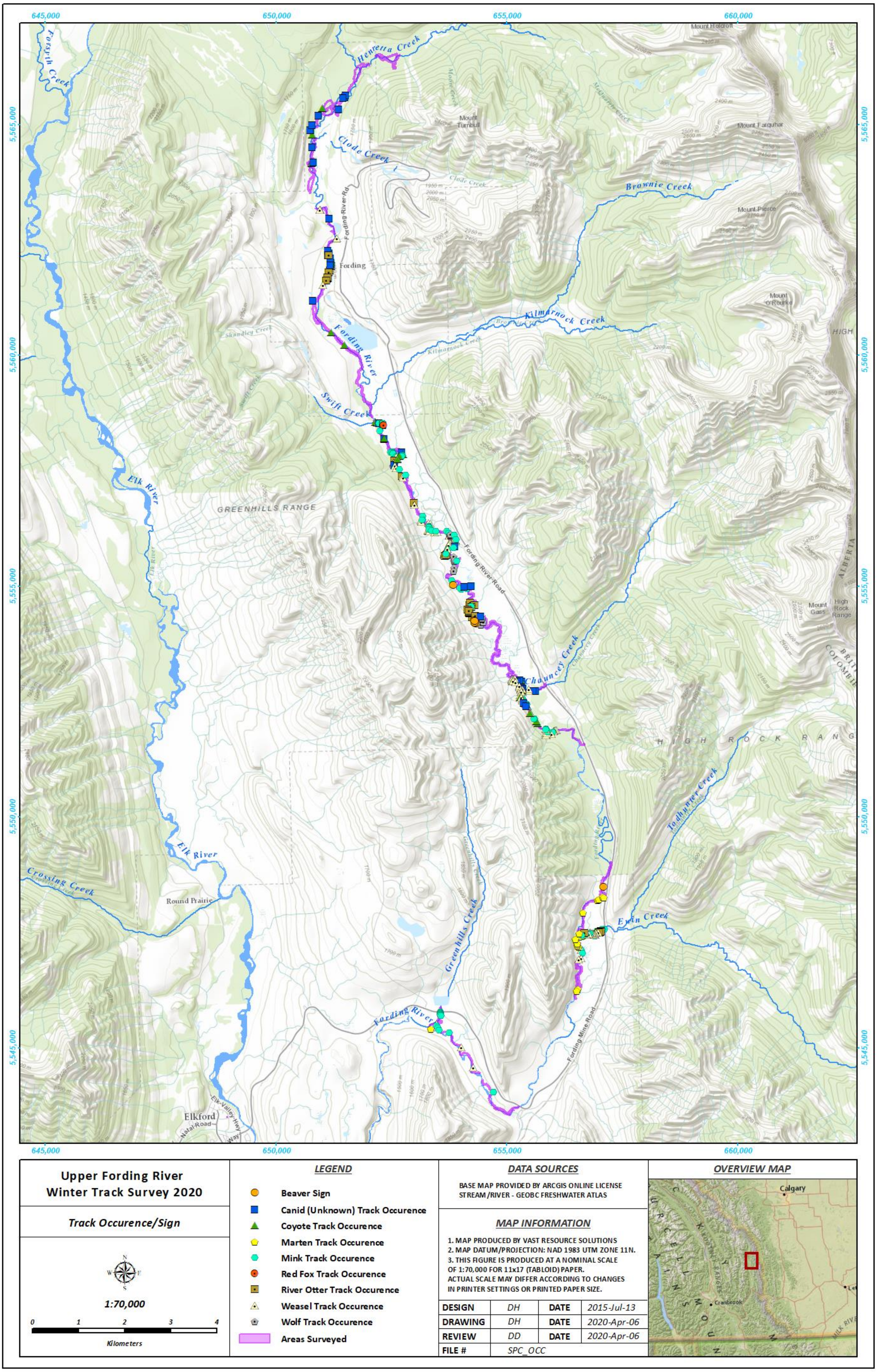

Figure 11. Track Occurrence/Sign along the areas surveyed during the Upper Fording River Winter Track Survey 2020.

4.0 SUMMARY

The winter track survey confirmed the presence of seven mammalian predators within the UFR valley during the winter period. Mammalian predator tracks were distributed throughout the area surveyed, with some portions of the UFR and the portions of the tributaries surveyed having higher track densities identified during the survey period. For example, track densities were highest along the UFR in between Swift Creek and Chauncey Creek (Figure 11). Each of the tributaries surveyed had higher predator track densities than the UFR, with Ewin Creek having the highest track densities for all species identified (Table 2). However, fewer predator species were identified along the tributaries compared to the UFR.

No wildlife tracks (predator or non-predator) were identified around Henretta Lake or the portion of Henretta Creek surveyed. Both of these waterbodies are located within a narrow valley, with mine spoils located in close proximity to them. As such, the majority of the landscape surrounding Henretta Lake and the portion of Henretta Creek surveyed contains very few trees. The lack of tree cover coupled with the narrow valley these waterbodies are located within would make this area receptive to wind events impacting snow conditions. During the survey of Henretta Lake, it was noted that snow conditions was fairly uniform and may have experienced a wind event prior to the survey being completed. As such, any wind event within these areas just before the survey occurred may have caused tracks to disappear.

Larger-sized predators track densities were lower than the smaller-sized predators and the distribution of these species were in the northern portion of the areas surveyed. Since these species are known for large movements, it is likely they would be observed anywhere within the surveyed area. For smaller-sized predators, tracks were observed in some of the same areas suggesting territories used by each species overlap and are not segregated.

Most of the UFR and the tributary portions surveyed were not frozen over at the time of survey. For the portions of the area surveyed that did have ice-cover, predator tracks were sometimes identified on the frozen surface, with the tracks either paralleling the watercourse, travelling across it, or else travelling from the shoreline to the frozen water's edge before turning around and travelling back into the uplands. Ewin Creek, Chauncey Creek, Greenhills Creek, and Henretta Lake were ice covered, while Henretta Creek was not ice covered at the time of survey. A portion of the UFR was predominantly ice-covered from near the Cataract Creek confluence downstream for approximately 2.5 km before ice covered disappeared.

The findings of the winter track survey provide a 'snapshot in time' of species occurrence in the area surveyed. Winter track surveys are typically completed to identify species occurrence in relation to different habitat types on the landscape. This in turn requires the study area to be surveyed multiple times within the different habitat types to understand species occurrence within each habitat type. This winter track survey focused on surveying either within each watercourse and/or the upland habitat immediately adjacent to the watercourse. Data was not collected to understand species occurrence in relation to habitat.

Winter snow track surveys are highly dependent on weather and environmental conditions. Snow conditions can deteriorate in warmer temperatures or on sunny days (Halfpenny 1995, Bayne et al. 2005). These conditions lead to track rot which makes tracks difficult to identify or even see in some instances. If conditions are windy, tracks can be blown in, also making identification difficult

(Bayne et al 2005). During the winter track survey, track rot was an issue during some of the warmer and/or sunnier days when surveys were occurring. In some instances, survey conditions were adequate in the morning but conditions would deteriorate in the afternoons. During these days, surveys were suspended when evidence of track rot was influencing the ability to correctly identify the tracks. As such, it is possible that some predator tracks may have been missed on survey days where warming trends were experienced.

Terrain and unsafe conditions limited access to some portions of the UFR for surveying. Surveys were not allowed along the UFR located adjacent to the Turnbull Spoils Restricted Access Zone due to potential avalanche concerns. Steep terrain along the south side of the UFR located near the Greenhills Operation (GHO) prevented surveys from occurring there. Adverse terrain and an abundance of coarse woody debris (CWD) along a portion of the UFR also restricted surveys in some areas. For example, the portion of the UFR located in between the highway bridge located south of the GHO up to Dry Creek was not surveyed based on these reasons after communications with fisheries consultants with knowledge of the UFR at this location (Cope, pers. comm. 2020). Access issues due to safety concerns between Greenhills Creek and Josephine Falls, as well as on portions of the UFR between Dry Creek and Chauncey Creek also limited surveys in those areas.

5.0 **LITERATURE CITED**

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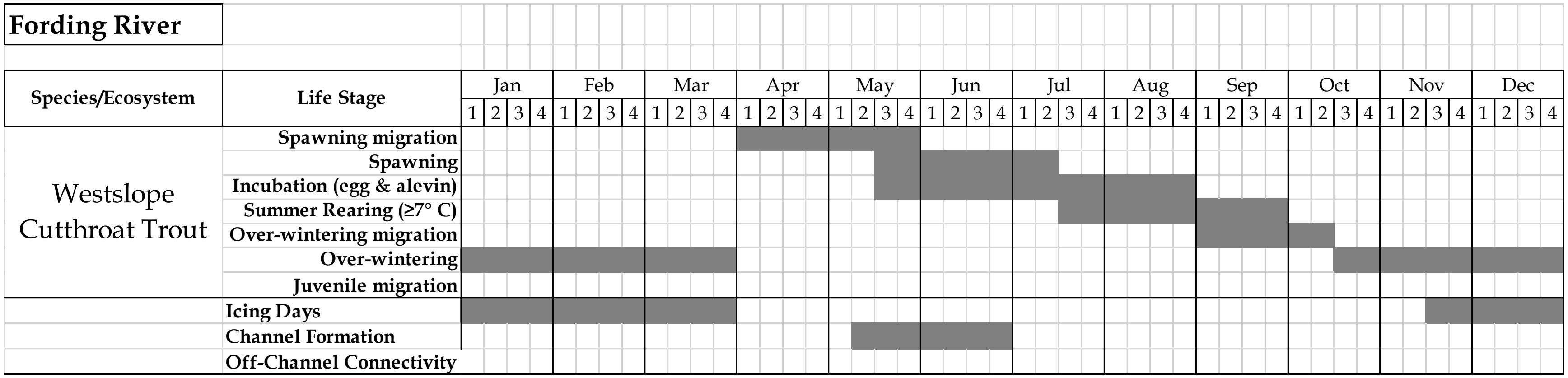
APPENDIX B: UPPER FORDING RIVER FISH PERIODICITY TABLE


Fording River
Species/Ecosystem
Life Stage
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1 2 3 4
Westslope Cutthroat Trout
Spawning migration
Spawning
Incubation (egg & alevin)
Summer Rearing (≥7° C)
Over-wintering migration
Over-wintering
Juvenile migration
Icing Days
Channel Formation
Off-Channel Connectivity