



Keeyask Generation Project Aquatic Effects Monitoring Plan

Lake Whitefish Movement Monitoring Report

AEMP-2022-03



KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2022-03

LAKE WHITEFISH MOVEMENT MONITORING IN THE NELSON RIVER BETWEEN CLARK LAKE AND THE LIMESTONE GENERATING STATION, SEPTEMBER 2020 TO OCTOBER 2021: YEAR 8 CONSTRUCTION

Prepared for

Manitoba Hydro

By

K. Small and C.L. Hrenchuk

June 2022



North/South Consultants Inc.
Aquatic Environment Specialists

83 Scurfield Blvd.
Winnipeg, Manitoba, R3Y 1G4
Website: www.nscons.ca

Tel.: (204) 284-3366
Fax: (204) 477-4173
E-mail: nscons@nscons.ca

This report should be cited as follows:

Small, K. and C.L. Hrenchuk. 2022. Lake Whitefish movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, September 2020 to October 2021: Year 8 Construction. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2022-03. A report prepared for Manitoba Hydro by North/South Consultants Inc. xvii + 130 pp.

SUMMARY

Background

The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the Keeyask Generating Station (GS) on the environment. Besides measuring the accuracy of the predictions made and actual effects of the GS on the environment, monitoring results will provide information on how construction and operation of the GS will affect the environment and if more needs to be done to reduce harmful effects.

Construction of the Keeyask GS began in mid-July 2014 and instream work was completed in 2020. The reservoir was impounded with water levels being raised to full supply level between August 31 and September 5, 2020. Commissioning of the powerhouse turbines was initiated after impoundment and five of seven units were in-service by fall 2021. During commissioning and as units came into service, substantial flows continued through the spillway until the summer of 2021 when more flow was going through the powerhouse than spillway. By mid-September the spillway was closed and barely used in the fall.

The movements of Lake Whitefish over Birthday Rapids and Gull Rapids were monitored prior to construction, but because different methods are being used to collect data under the Aquatic Effects Monitoring Plan (AEMP), the results of the two programs can't be compared. Pre-construction movement studies demonstrated that Lake Whitefish were able to move upstream and downstream over both Gull Rapids and Birthday Rapids. Lake Whitefish also congregated in the area below Gull Rapids during the fall spawning season.

This report presents results of Lake Whitefish movement monitoring from September 2020 to October 2021 and provides a summary of data collected since the monitoring program was initiated in the fall of 2014. Monitoring fish movements is an important component of the overall plan to monitor the impacts of construction and operation of the Keeyask GS on fish. Lake Whitefish were identified as one of the key species to monitor because they are: of commercial and domestic importance; known to pass through Gull Rapids in either direction; and resilient enough to survive the acoustic tagging procedure.

Movements have been monitored for approximately six years of construction (October 2014 to September 2020), and just over one year after impoundment (September 23, 2020 to October 10, 2021). Upstream of the GS, the reservoir was flooded in 2020 so changes associated with impoundment may be seen. The Keeyask GS powerhouse is still under construction, so the full effects of operation haven't happened in Stephens Lake yet.

Why is the study being done?

Monitoring during the end of construction of the GS during the first year after the reservoir was flooded is being done to answer five questions:

How often do Lake Whitefish move downstream through the Keeyask GS and when are the movements occurring?

This is important because if Lake Whitefish move downstream through the GS, they cannot move back upstream. If a large number move downstream, it could impact the upstream population.

Are there Lake Whitefish close to the construction site, particularly during spawning?

If Lake Whitefish are in the river close to the construction area, they could be harmed by high amounts of mud in the water.

What types of habitat are Lake Whitefish using in the Keeyask reservoir (i.e., are fish staying far upstream from the GS, or closer to it)?

Habitat conditions of the river, rapids, lakes, bays, and tributaries that make up the Keeyask reservoir have changed since impoundment. This may lead to Lake Whitefish using different areas of the reservoir.

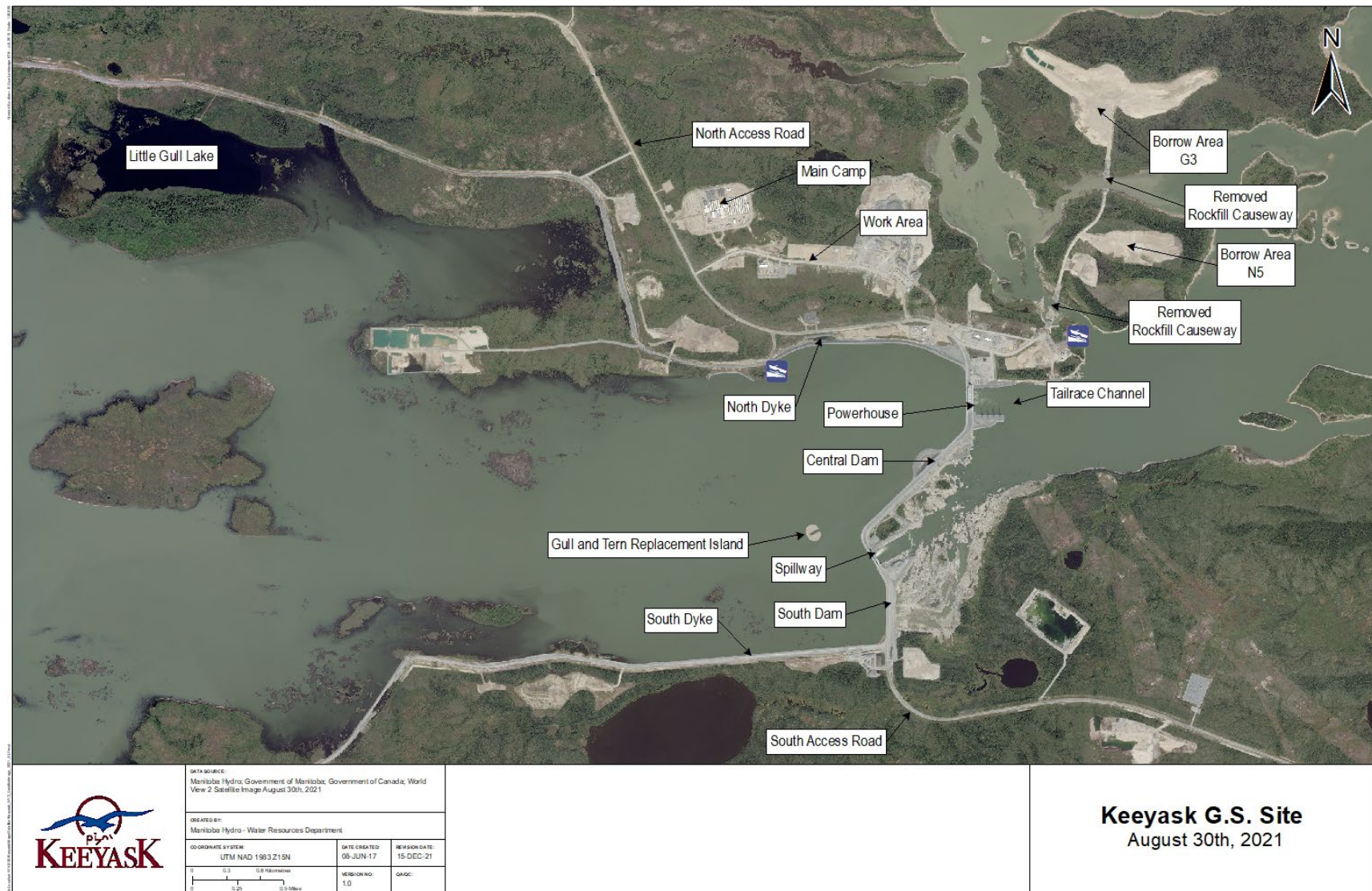
How many Lake Whitefish move upstream past Birthday and/or Long Rapids?

Flooding Gull Lake has changed available habitat within what is now the Keeyask reservoir. Because of this, Lake Whitefish may move upstream and leave the Keeyask areait.

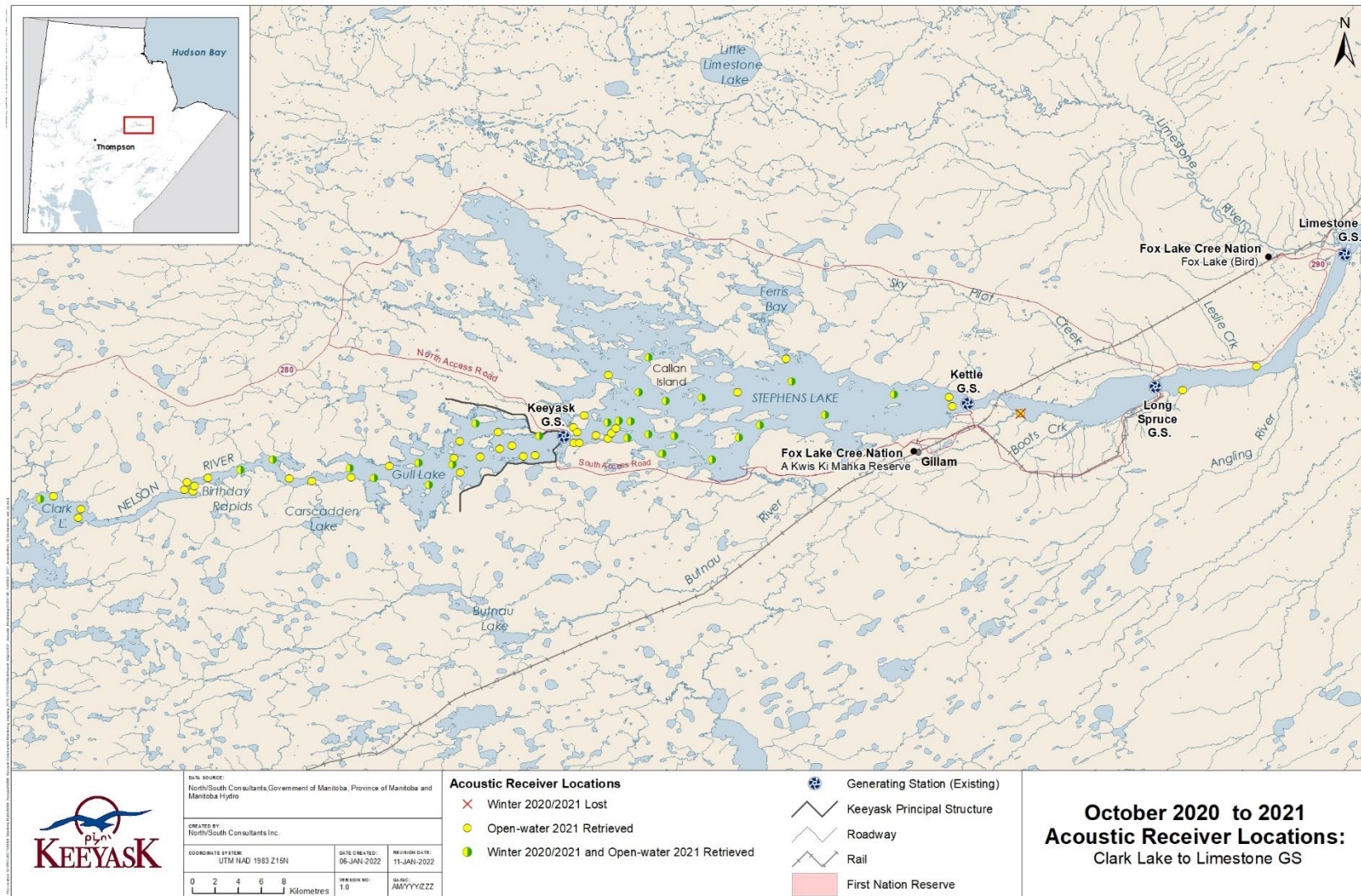
What was done?

Movements of Lake Whitefish were tracked using acoustic telemetry. This is a technique in which a tag (transmitter) is surgically implanted inside a fish. Each tag sends out a sound signal (called a “ping”) that is picked up by receivers that were placed along the Nelson River between Clark Lake and the Limestone Generating Station (see the study area map below). Each fish is given a transmitter that sends out a unique ping, and pings can be detected up to 1 kilometre (km) away from a receiver. By looking at the detections recorded by different receivers, the movement of each fish can be tracked. The tags are powered by batteries with a 4-year lifespan.

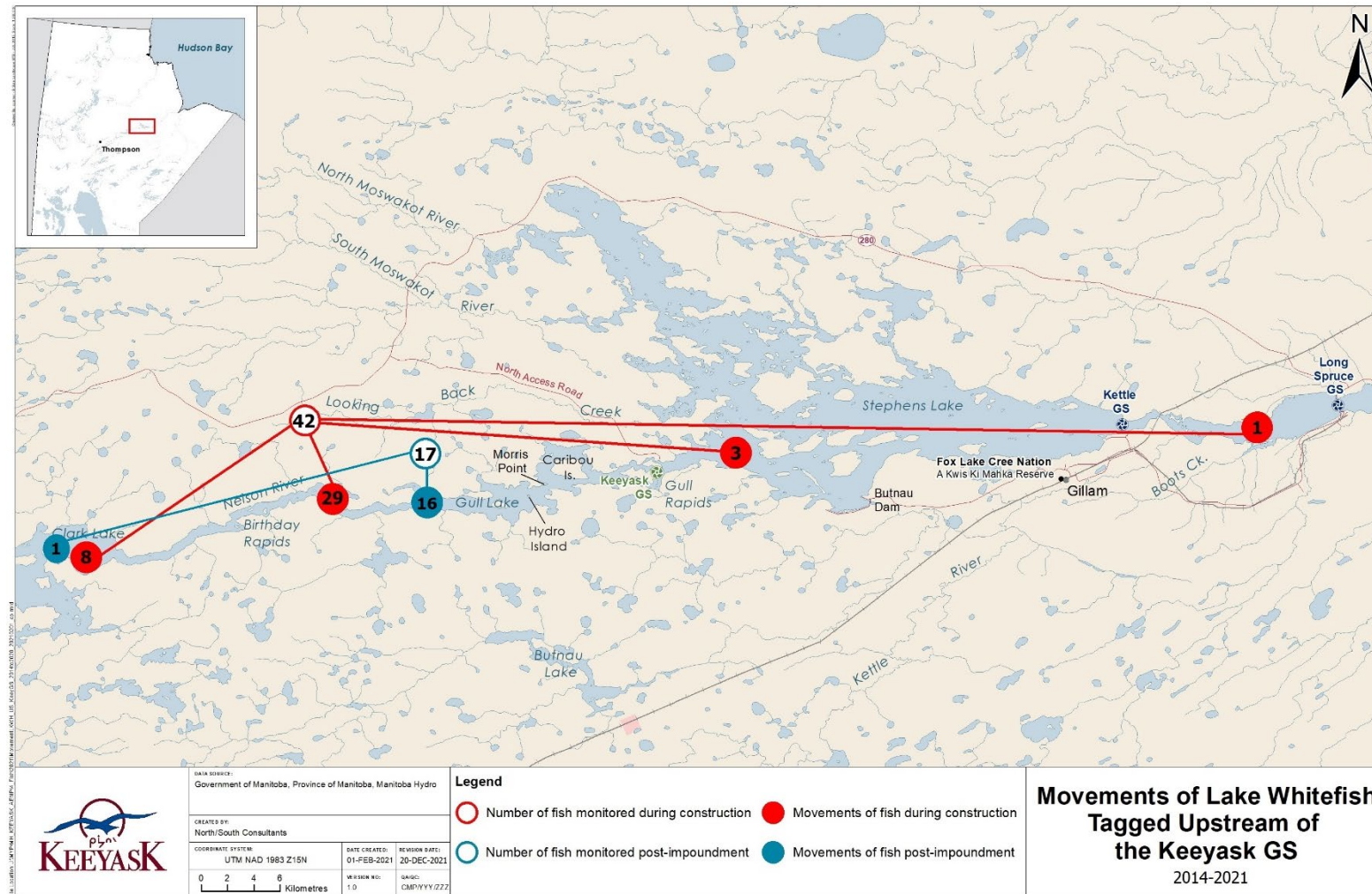
Sixty Lake Whitefish were tagged in 2014, 20 upstream and 40 downstream of Gull Rapids. Because the batteries in these transmitters expired in winter 2017, 62 additional transmitters were implanted into Lake Whitefish in October 2017. This will extend the tracking of Lake Whitefish movements until summer 2022.



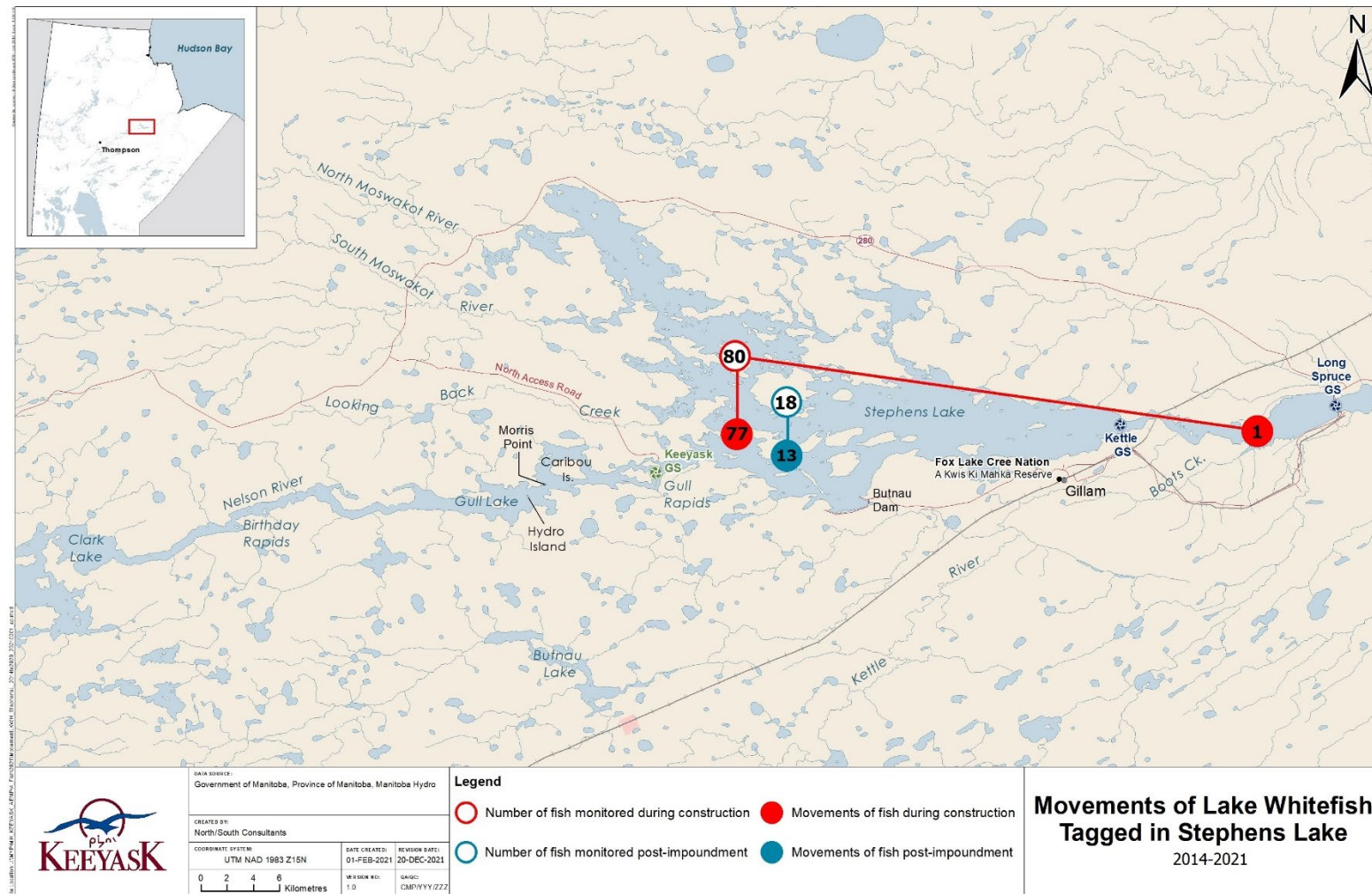
Map illustrating instream structures at the Keeyask Generating Station site after reservoir flooding, August 2021.



Map showing the study area (pre-flooding shoreline). The dots represent the locations of receivers in the river. The different colours represent receivers that were in the river at different times of the year.



Map showing how many Lake Whitefish moved upstream out of Gull Lake, stayed in Gull Lake, and moved into Stephens Lake during construction (red) and after reservoir impoundment (blue). Movements of fish due to tagging stress or mortality were not included. Numbers of fish monitored (hollow circles) represent the number of fish tagged while the number of fish movements (solid circles) represent the number of fish detected.



Map showing how many Lake Whitefish moved upstream through Gull Rapids, stayed in Stephens Lake, and moved downstream through the Kettle GS during construction (red) and after reservoir impoundment (blue). Movements due to tagging stress and mortality were not included. Numbers of fish monitored (hollow circles) represent the number of fish tagged while the number of fish movements (solid circles) represent the number of fish detected.

What was found?

Results from seven years of tracking the movements of Lake Whitefish suggest that movement through the Keeyask GS (previously Gull Rapids) is rare. Of the 20 whitefish tagged in Gull Lake in 2014 and tracked until the end of the 2017 open-water period, two moved downstream. Of the 22 whitefish tagged in Gull Lake in 2017, three moved downstream, one of which may be related to tagging stress. No tagged whitefish have moved upstream through Gull Rapids since the start of the study. Since the Keeyask GS spillway was built in 2018, upstream movements are no longer possible. All movements of fish out of Gull and Stephens lakes since studies began are shown in the maps above.

Since the start of construction, fish tagged upstream from the Keeyask GS spent a large part of their time far upstream in the Keeyask Reservoir/Gull Lake during the open-water period and have not been observed using habitat directly upstream of the GS. Prior to reservoir impoundment, some of the detected fish made upstream movements out of Gull Lake to the base of Birthday Rapids in the fall. These upstream movements are believed to be for spawning. In the first year since full impoundment, with the exception of a single fish that moved into Clark Lake and then back in fall 2020, the majority of tagged Lake Whitefish have not moved out of the reservoir.

Since the start of construction, Lake Whitefish tagged downstream in Stephens Lake have been more evenly spread throughout the lake. Many tagged whitefish have been located closer to the base of the Keeyask GS in the fall, likely because it is a spawning area. Based on detections in the northern arm of Stephens Lake, it is suspected that some fish spend most of their time there, and some of these fish move to the Keeyask GS in the fall to spawn.

What does it mean?

So far, monitoring has shown that Lake Whitefish are using habitat at Birthday Rapids and immediately downstream of the Keeyask GS for spawning. Movements through Gull Rapids (or the Keeyask GS since 2018) have been rare, as only five tagged fish have moved downstream. Based on tagged individuals, the number of Lake Whitefish moving past Keeyask GS or Kettle GS has not increased. There has been no mass movement of Lake Whitefish upstream out of the reservoir.

What will be done next?

Ongoing tracking of fish will continue and will provide additional information on where and how many Lake Whitefish are moving, what kinds of habitats these fish need to live their lives, when and where they are spawning, and where they are feeding.

ACKNOWLEDGEMENTS

We would like to thank Manitoba Hydro for the opportunity and resources to conduct this study.

Grant Connell, Grant Massan, Leslie Flett, Mark Garson, Kelvin Kitchokeesik, Tyler Kitchokeesik and Terry Kitchokeesik of Tataskweyak Cree Nation are thanked for their local expertise and assistance in conducting the field work.

The collection of biological samples described in this report was authorized by Manitoba Conservation and Water Stewardship, Fisheries Branch, under terms of the Scientific Collection Permit #08-2021.

STUDY TEAM

Data Collection

Brock Kramble

Claire Hrenchuk

Grant Connell

Grant Massan

James Aiken

Jenelle Ehn

Joe Mota

Jon Peake

Laura Henderson

Leslie Flett

Kelvin Kitchekeesik

Mark Garson

Reid Minary

Tyler Kitchekeesik

Zachary Thiessen

Data Analysis, Report Preparation, and Report Review

Ashley Moore

Cam Barth

Candace Parker

Claire Hrenchuk

Dirk Schmidt

Friederike Schneider-Vieira

Kendra Small

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
2.0	STUDY SETTING.....	3
2.1	FLOWS, WATER LEVELS, AND KEEYASK OPERATIONS	3
3.0	METHODS	6
3.1	ACOUSTIC TELEMETRY	6
3.1.1	Acoustic Transmitter Application.....	6
3.1.2	Acoustic Receivers	6
3.1.2.1	Winter 2020/2021	7
3.1.2.2	Open-water 2021	7
3.1.3	Data Analysis	8
4.0	RESULTS	10
4.1	2017-2021 RESULTS SUMMARY	10
4.1.1	Upstream of the Keeyask GS	10
4.1.2	Stephens Lake	11
4.2	WINTER 2020/2021	13
4.2.1	Upstream of the Keeyask GS	13
4.2.2	Stephens Lake	13
4.3	OPEN-WATER 2021	14
4.3.1	Acoustic Receiver Retrieval	14
4.3.2	Upstream of the Keeyask GS	14
4.3.2.1	Proportional Distribution	14
4.3.2.2	Movement Patterns	15
4.3.3	Stephens Lake	15
4.3.3.1	Proportional Distribution	16
4.3.3.2	Movement Patterns	16
4.3.4	Long Spruce and Limestone Reservoirs	17

5.0	DISCUSSION	18
5.1	EVALUATION OF METHODOLOGY	18
5.2	WINTER MOVEMENT	18
5.3	OPEN-WATER MOVEMENT	19
5.4	KEY QUESTIONS	19
6.0	SUMMARY AND CONCLUSIONS	22
7.0	LITERATURE CITED	23

LIST OF TABLES

Table 1:	Acoustic-tag and biological information for each Lake Whitefish tagged with an acoustic transmitter in the Nelson River upstream of the Keeyask GS, fall 2017.....	27
Table 2:	Acoustic-tag and biological information for each Lake Whitefish tagged with an acoustic transmitter in Stephens Lake, fall 2017.	28
Table 3:	Proportion of time spent in each river zone by Lake Whitefish implanted with acoustic transmitters upstream of the Keeyask GS and in Stephens Lake during a portion of the 2015 (June 4 to October 11), 2016 (June 4 to October 19), 2017 (June 7 to October 16), 2018 (June 6 to October 10), 2019 (June 2 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods.	29

LIST OF FIGURES

Figure 1:	Locations of stationary acoustic receivers (dashes) in relation to the base of the Keeyask GS (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Limestone GS between September 2020 and May 2021.....	31
Figure 2:	Locations of stationary acoustic receivers (dashes) in relation to the base of the Keeyask GS (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake (Zone 1) and the Limestone GS (Zone 9) between June and October, 2021.....	32
Figure 3:	Water temperature in the Nelson River mainstem from September 23, 2020, to October 3, 2021.....	33
Figure 4:	Detection ranges for individual Lake Whitefish (n = 22) tagged with acoustic transmitters upstream of the Keeyask GS during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods.	34
Figure 5:	Relative number of detections at each acoustic receiver set between Clark Lake and the Keeyask GS during winter 2020/2021 (September 24, 2020 to April 30, 2021).	35
Figure 6:	Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods.	36
Figure 7:	Relative number of detections at each acoustic receiver set in Stephens Lake during winter 2019/2020 (September 24, 2020 to April 30, 2021).	38
Figure 8:	Detection ranges for individual Lake Whitefish (n = 22) tagged with acoustic transmitters upstream of the Keeyask GS during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods.	39
Figure 9:	Proportional distribution of Lake Whitefish with acoustic transmitters tagged in 2014 and 2017 within seven river zones between Clark Lake and the Kettle GS during a portion of the 2015 (June 4 to October 11), 2016 (June 25 to October 19), 2017 (June 7 to October 16), 2018 (June 6 to October 10), 2019 (June 2 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods.	40
Figure 10:	Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and the Keeyask GS during the 2021 open-water period (May 1 to October 10).	41

Figure 11:	Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods.	42
Figure 12:	Relative number of detections at each acoustic receiver set in Stephens Lake during the 2021 open-water period (May 1 to October 10).	44
Figure 13:	Map showing how many Lake Whitefish moved upstream to Clark Lake, stayed in Gull Lake, moved into Stephens Lake, and moved downstream through the Kettle GS during construction (red) and after reservoir impoundment (blue).	45
Figure 14:	Map showing how many Lake Whitefish moved upstream through Gull Rapids, stayed in Stephens Lake, and moved downstream through the Kettle GS during construction (red) and after reservoir impoundment (blue).	46

LIST OF MAPS

Map 1:	Map of the Nelson River showing the site of the Keeyask Generating Station and the Lake Whitefish movement monitoring study setting.	48
Map 2:	Map of instream structures at the Keeyask Generating Station site after reservoir flooding, August 2021.	49
Map 3:	Locations of stationary receivers set in the Nelson River from Clark Lake to the Keeyask GS between September 2020 and May 2021.	50
Map 4:	Locations of stationary receivers set in Stephens Lake from the Keeyask GS to Kettle GS between September 2020 to May 2021.	52
Map 5:	Locations of stationary receivers set in the Nelson River from Clark Lake to the Keeyask GS between June and October 2021.	53
Map 6:	Locations of stationary receivers set in Stephens Lake between June and October 2021.....	54
Map 7:	Locations of stationary receivers set between the Kettle and Limestone Generating Stations, June to October 2021.....	55

LIST OF APPENDICES

Appendix 1: Detection Summaries for Lake Whitefish Tagged and Monitored in the Keeyask Study Area between 2017 and 2021	57
Appendix 2: Location Summary for Individual Acoustic-Tagged Lake Whitefish in Gull Lake, October 2017 to October 2021	64
Appendix 3: Location Summary for Individual Acoustic-Tagged Lake Whitefish in Stephens Lake, October 2017 to October 2021	88

1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt (MW) hydroelectric generating station at Gull (Keeyask) Rapids on the lower Nelson River in northern Manitoba. The Project is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, where Gull Lake flows into Stephens Lake, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gillam (Map 1). Construction of the Project began in July 2014.

The *Keeyask Generation Project: Response to EIS Guidelines*, completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. Technical supporting information for the aquatic environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs, is provided in the *Keeyask Generation Project Environmental Impact Statement: Aquatic Environment Supporting Volume* (AE SV). As part of the licensing process for the Project, an Aquatic Effects Monitoring Plan (AEMP) was developed detailing the monitoring activities of various components of the aquatic environment including the focus of this report, Lake Whitefish (*Coregonus clupeaformis*) movements, for the construction and operation phases of the Project.

Pre-construction (baseline) movements of Lake Whitefish were monitored from 2001 to 2005 (Barth *et al.* 2003; Murray *et al.* 2005; Murray and Barth 2007). Radio and acoustic telemetry studies focused specifically on detecting the upstream and downstream movements of fish over rapids in the study area (Birthday Rapids and Gull Rapids). Pre-construction movement data revealed that a proportion (28%) of Lake Whitefish did make movements both upstream and downstream over Gull or Birthday rapids. The pre-construction movement data also recorded Lake Whitefish congregating in the area below Gull Rapids during the fall, presumably for spawning. As pre-Project studies were not designed to record detailed movement patterns of Lake Whitefish in the Clark Lake to Stephens Lake reach as a whole, results are not directly comparable to the movement data being collected under the AEMP.

In fall 2014, 60 adult Lake Whitefish were implanted with acoustic transmitters to assess the frequency of movement through Gull Rapids and to monitor the potential impact construction of the Keeyask GS may have on Lake Whitefish. Annual reports detailing the 2014 to 2019 results are provided in Hrenchuk and Barth (2015), Lavergne and Hrenchuk (2016), Burnett and Hrenchuk (2017), Lacho and Hrenchuk (2018), Lacho and Hrenchuk (2019), and Hrenchuk (2020, 2021). Results from September 23, 2020 to October 10, 2021 are presented in this report.

Lake Whitefish movements in the main flow of the Nelson River near the construction site may be affected by constructed instream structures that block upstream and downstream movements (Map 2), altered flow patterns, and disturbances such as blasting that may increase emigration from the construction area. Previous studies have shown that Lake Whitefish congregate in the area below Gull Rapids to spawn (Pisiak 2005a, b; Murray and Barth 2007). The broad objective of Lake Whitefish movement monitoring is to better understand their movements and habitat use during generating station construction and operation, with particular focus on movements in the vicinity of Gull Rapids (now the Keeyask GS).

Impoundment of the Keeyask reservoir was completed on September 5, 2020 and monitoring in the Keeyask reservoir in 2021 represented the first full year that water levels and flows were the same as they will be during GS operation. Monitoring in Stephens Lake, however, represented a transition between construction and operation as a considerable portion of the flow was still being passed through the spillway, and only a few turbines were operating in the powerhouse. Due to Keeyask reservoir impoundment, several key questions identified in the AEMP that have not been previously discussed are addressed below.

- What is the frequency of downstream movement through the Keeyask GS and when are the movements occurring?
- Are whitefish utilizing habitat in the vicinity of the construction site (particularly during spawning)?
- What types of habitat are Lake Whitefish utilizing in the Keeyask reservoir (i.e., are fish using the upper, middle, or lower end of the reservoir)?
- What proportion of the fish population moves from the Keeyask reservoir upstream past Birthday and/or Long rapids?

This report provides results from September 2020 to October 2021, which is the sixth winter and seventh open-water period of monitoring conducted since construction of the Keeyask GS began in July 2014. This report includes data collected during the first year (September 5, 2020 to October 10, 2021) after impoundment of the Keeyask reservoir.

2.0 STUDY SETTING

The study area encompasses an approximately 110 km long reach of the Nelson River from Clark Lake to the upstream end of the Limestone Reservoir (Map 1). This section of river offers a diversity of physical habitat conditions, including a variety of substrate types, and variable water depths (range 0–30 m) and velocities. Clark Lake is located immediately downstream of Split Lake, and approximately 42 km upstream of the Keeyask GS (formerly Gull Rapids) (Map 1). Current is restricted to the main section of the lake, with off-current bays outside the main channel. The Assean River is the only major tributary to Clark Lake and flows into the north side. Downstream from the outlet of Clark Lake, the Nelson River narrows and water velocity increases for a 3 km stretch, known as Long Rapids. For the next 7 km, the river widens, and water velocity decreases. The area between Clark Lake and the Keeyask GS is considered the Keeyask reservoir.

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of Gull Rapids/the Keeyask GS (Maps 1 and 2) and marks the upstream end of major water level changes as a result of impoundment by the Keeyask GS. The drop in elevation from the upstream to downstream side of Birthday Rapids was approximately 2 m prior to impoundment but is now a nearly level, albeit fast-flowing section of river. The 14 km reach of the Nelson River between Birthday Rapids and Gull Lake was characterized as a large and somewhat uniform channel with medium to high water velocities and a few large bays. This area is now within the Keeyask reservoir, though flooding was limited to mainly shoreline areas.

Prior to impoundment, Gull Lake was a widening of the Nelson River, with moderate to low water velocity beginning approximately 20 km upstream of Gull Rapids/the Keeyask GS. Water levels on Gull Lake increased by several metres following impoundment and flooding along the shoreline and small tributaries entering this reach was extensive. Although this area is now a portion of the Keeyask reservoir, it is referred to herein as Gull Lake.

Just below the Keeyask GS, the Nelson River enters Stephens Lake. Stephens Lake was formed in 1971 by construction of the Kettle GS. Construction of the Keeyask GS has altered the flow distribution immediately downstream of the station.

Construction of the Kettle GS flooded Moose Nose Lake (north arm) and several other small lakes that previously drained into the Nelson River, as well as the old channels of the Nelson River that now lie within the southern portion of the lake (Map 3). Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. Looking Back Creek is a second order stream that drains into the north arm of Stephens Lake (Map 1). Kettle GS is located approximately 40 km downstream of the Keeyask GS

2.1 FLOWS, WATER LEVELS, AND KEEYASK OPERATIONS

From October 2020 to mid-June 2021 the calculated Split Lake outflow varied about the median flow of about 3,300 m³/s, ranging between about 3,000 m³/s and 3,900 m³/s. From mid-June to

mid-August, the flows steadily decreased from about 3,700 m³/s to about 2,000 m³/s, which is approximately the 5th percentile low flow. Low flow conditions persisted from summer into winter, with flows dropping to a low of about 1,800 m³/s at the end of November 2021. These are the lowest flows that have occurred during Keeyask construction. It is not since 2005 that flows this low have occurred on the Nelson River.

Water levels on Gull Lake have been held steady between about 158.8-159 m since reservoir impoundment in September 2020. Upstream of Gull Lake at gauges below and above Birthday Rapids the levels were about 0.5 m and 2 m higher than on Gull Lake, a smaller difference than would have occurred prior to the project. Upstream levels increased about 3-4 m at these sites in winter due to ice effects as in previous years. Due to low flows in summer 2021 the water surface was relatively flat from Gull Lake to the gauge just upstream of Birthday Rapids, with a difference of only about 0.8-0.9 m between the two.

Keeyask is transitioning from a construction project to an operating station (Map 2). In 2021, the work at site has been focused on bringing units into service. By the end of April 2021, prior to the start of aquatic monitoring, Unit 1 and Unit 2 were in service. Throughout the open water period more units were being tested and brought into service one at a time. As units came into service, the distribution of flow between the spillway and powerhouse has gradually shifted, as summarized below. By the end of October 2021 five units were fully in service.

Discharges from the spillway and powerhouse are not measured but have been estimated based on performance design curves. For reference it is noted that the design discharge capacity of the powerhouse is 4,000 m³/s, giving each turbine unit a discharge capacity of approximately 570 m³/s.

Table below outlines Keeyask GS operation, including powerhouse and spillway flows, in 2021.

Dates	Powerhouse Units	Spillway Gate Operation	Powerhouse	Spillway	Keeyask Total
			Discharge (m ³ /s)		
End Apr. - end June 2021	Unit 2 online; Unit 3 testing	Gates 1, 2, 3, 5, 7 in use until mid-June. Gates 1, 3, 5, 7 primarily mid- to end-June.	Steady at about 1,100 varying down to 600 on a few intermittent days and up to 1,650 during two weeks of Unit 3 testing.	Generally, 2,200-2,800 except during Unit 3 testing it varied from about 1,400-2,400.	Generally, 3,400-3,900 except during Unit 3 testing it varied from 2,600-3,600.
End June – mid-Sept. 2021	Unit 3 online; Unit 5 testing	Generally, Gates 1,3, 5, 7 until mid-July. Gates 3, 5, 7 until end of July. Various gates used in Aug. Gates 1 and 7 used in Sept. until closure of all gates on Sept. 11.	About 1,650, but reduced to 1,100 for two weeks with a unit shut down and varying up to 2,100 during two weeks of Unit 5 testing.	From end of June to mid-Aug Nelson R inflow declined from about 3,600 to about 1,800-2,200 and has remained steady around 2,000-2,200 since then – corresponding spillway discharge gradually declined from about 2,400 to 0 by mid-Sept. when Unit 5 came into service although daily variations of +/- 200-400 or more in a few instances occurred during this time.	Total Keeyask discharge declined from about 3,600 to an average of about 2,000-2,200 corresponding to the decrease in Nelson R inflow, and daily variation of about +/- 200-400 depending on spillway and powerhouse operations.
Mid-Sept. – end Oct. 2021	Unit 5 online; Unit 4 testing; Unit 4 online Oct. 25	Various gates used very sporadically. First reopening on Sept. 28.	Average discharge about 2,000-2,200 with typical daily variation from 1,600-2,200 and a maximum variation between 1,000-2,800 depending on unit operations and Unit 4 testing.	No spillway flow except for a few intermittent days of up to 1,000.	Same as powerhouse.

3.0 METHODS

3.1 ACOUSTIC TELEMETRY

Acoustic telemetry involves tracking movements of fish surgically implanted with internal acoustic transmitters (tags). Each transmitter emits a unique signal, recognizable by stationary receivers. When tagged fish come into the detection range of a receiver (generally within 500 m to 1 km, depending on conditions), the transmitter code number, as well as the date and time, are stored in the receiver. Initially, the receiver array used in this study was designed to monitor adult Lake Sturgeon (Hrenchuk and Small 2022); however, the same array is also used to monitor juvenile Lake Sturgeon (Funk and Hrenchuk 2022), Walleye (Small and Hrenchuk 2022), and Lake Whitefish (the focus of this report).

3.1.1 ACOUSTIC TRANSMITTER APPLICATION

Acoustic transmitters (Vemco V13-1x, estimated 1,141 day battery life) were applied to 60 fish in September and October, 2014; 20 upstream and 40 downstream of Gull Rapids (now the Keeyask GS) (Tables 1 and 2). Tagged Lake Whitefish had fork lengths ranging from 372 to 565 mm. As the batteries in these tags were due to expire during winter 2017/2018, an additional 62 tags (V13-1x, estimated 1,737 day battery life) were applied to Lake Whitefish in October 2017; 22 upstream and 40 downstream of the Keeyask GS (Tables 1 and 2). Lake Whitefish tagged in October 2017 had fork lengths ranging from 406 to 540 mm (Lacho and Hrenchuk 2018).

3.1.2 ACOUSTIC RECEIVERS

Since 2011, stationary acoustic receivers (VEMCO model VR2W) have been used to continuously monitor tagged adult Lake Sturgeon in the Nelson River between Clark Lake and the Long Spruce GS. In spring 2016, the receiver array was extended to the upper Limestone reservoir, with the placement of two receivers downstream of the Long Spruce GS. The intent of adding these receivers was to determine whether fish that had moved into the Long Spruce reservoir had continued to move downstream.

During the six years of the construction phase of the Project (beginning in July 2014), receivers were deployed at the same sites as those established during the pre-construction phase (2011–2013). During the open-water period, receivers were deployed in calm water with a flat bottom free of large debris to maximize detection range, and spaced along the main river channel throughout the study area to maximize spatial coverage. In Stephens Lake, receivers were placed at locations within pre-flood river channels, based on the observation that sturgeon tend to stay within river channels, even in flooded environments. At constrictions within the river channel, a

series of receivers were deployed to create “gates” with the intent of recording all fish that passed by the river cross-section (described in Section 3.1.2.2).

The retrieval of receivers deployed during winter has proven challenging and several were lost in previous winters, likely moved by ice (Hrenchuk and Barth 2013). Because it appears that receivers will only remain safe from ice if deployed in calm areas at depths greater than 10 m, the number of possible receiver locations during winter is limited, especially in areas upstream of the Keeyask GS.

3.1.2.1 WINTER 2020/2021

The stationary acoustic receiver array for the winter 2020/2021 (September 24, 2020, to April 30, 2021) period consisted of 28 receivers. Ten were set upstream of the Keeyask GS, 17 throughout Stephens Lake, and one in the Long Spruce forebay (Maps 3, 4, and 7). Forebay impoundment in fall 2020 allowed for additional receivers to be set in the reservoir, due to the increase in deep off-current areas. An additional five receivers were set including one in the riverine portion of the reservoir between Birthday Rapids and Gull Lake (#114230; rkm -26.4), one at the inlet of Gull Lake (#122779; rkm -19.5), one at the mouth of the flooded backbay at Rabbit Creek (#114226; rkm -17.4), one north of Caribou Island (#129182; rkm -7.9), and one immediately upstream of the powerhouse (#127100; rkm -2.2) (Map 3). One additional receiver was set in Stephens Lake, closer to the GS (#125557; rkm 3.9) (Map 4).

3.1.2.2 OPEN-WATER 2021

An array of 64 acoustic receivers was used during the 2021 open-water period (defined as May 1 to October 10, 2021). Thirty-one were set both upstream of the Keeyask GS and in Stephens Lake (Maps 5 and 6). The 2021 open-water array differed slightly from the array used in 2020. Three additional receivers were set upstream of the GS: one in the reservoir upstream of Gull Lake (#114235; rkm -22.6), one south of Caribou Island (#114232; rkm -7.7), and one immediately upstream of the Keeyask GS spillway (#129192; rkm -2.5) (Map 5).

Water levels downstream of the Keeyask GS in spring and summer 2021 were lower than in previous years, preventing access to the receiver set downstream of the Kettle GS. Several attempts were made to access the site throughout the open-water period. A boat was successfully launched downstream of the Kettle GS in October 2021, however, the single receiver set during winter 2020/2021 could not be retrieved. Despite this, two receivers were set downstream of the Long Spruce GS for the duration of the 2021 open-water period (Map 7).

Similar to previous years, receiver “gates” were established in several key areas selected by river morphology (channel restrictions) and habitat characteristics (areas with low velocity adjacent to the main flow of the river). Receiver “gates” consisted of two or more acoustic receivers set parallel to flow to provide complete (or nearly complete) signal coverage of a river cross-section. Areas between the “gates” were referred to as river zones. Receiver gates provide confidence that movements past key points are being detected, which allows for extrapolation of coarse-scale positions (*i.e.*, which zone) during periods when fish remain undetected. When analyzing data,

fish detected within a zone that subsequently go undetected for a period of time without passing through a gate, are assumed to be within the zone in which they were last detected.

Four gates were established between Clark Lake and the Keeyask GS (44.0, 34.0, 19.0, and 10.0 rkms upstream of the GS), and two were established in Stephens Lake (4.5 and 40.0 rkms downstream of the GS) (Maps 5 and 6). The location of the “gates” has remained consistent since 2013.

To describe fish movements for reporting purposes, the study area was divided into nine different zones. The area upstream of the Keeyask GS was divided into five zones (Map 5; Zones 1–5), while Stephens Lake was divided into two zones (Map 6; Zones 6 and 7). The Long Spruce reservoir is referred to as Zone 8 and the Limestone reservoir as Zone 9.

Water temperature within the Nelson River mainstem was recorded with a HOBO Water Temperature Pro data logger from September 24, 2020, to October 3, 2021. Lake Whitefish spawn during fall when water temperatures are between 6 and 9°C, often forming pre-spawning aggregations (Green and Derksen 1987; Scott and Crossman 1998; Stewart and Watkinson 2004). Thus, data collected during this temperature range was considered as the “spawning period”.

By October 11, 2021, the majority of receivers were removed, and a subset ($n = 27$) were redeployed to monitor movements during winter 2021/2022.

3.1.3 DATA ANALYSIS

False detections can arise on acoustic telemetry receivers due to code collisions and/or environmental noise (Pincock 2012). To filter out false detections, a fish was required to be detected at least two times within a 30-minute interval at a given stationary receiver. Single detections were filtered and not used in most analyses; however, in instances when fish went undetected for lengthy periods, and/or rapid movements were suspected, raw data were also explored. In no instance did examination of raw data suggest that consideration of a single detection would result in a different behaviour or movement pattern compared with the result when single detections were removed.

Movements were analysed in terms of rkm distance, with the base of the Keeyask GS representing a distance of 0 rkm. The area located downstream of the Keeyask GS (i.e., Stephens Lake and the Long Spruce Reservoir) were given positive (+) distance values from the GS, while the area located upstream (i.e., Gull and Clark lakes) were given negative (-) distance values (Figures 1 and 2). The average rkm distance from the GS was calculated over a 4-hour interval and plotted versus time for each fish. Total detection ranges were calculated by subtracting the furthest downstream detection location from the location of the furthest upstream detection. The proportion of time that all fish spent within each river zone during each 4-hour interval was plotted and presented as a percentage of the study period. For example, a fish spent 44% of the time between May 1 and May 31 within Zone 4 means that the fish was detected within Zone 4 for 44% of the 186 4-hour intervals between May 1 and May 31.

Rapid downstream movements observed within two weeks of tagging were classified as caused by tagging mortality or stress. If the fish made a rapid downstream movement within two weeks of tagging followed by upstream and downstream movements, it was classified as tagging stress. If a fish made a rapid downstream movement within two weeks of tagging and was not detected again or did not display upstream movements, it was classified as a tagging mortality. If a fish was not detected for more than one year, it was classified as missing.

4.0 RESULTS

Tagging and biological information for Lake Whitefish tagged in October 2017 upstream and downstream of Gull Rapids can be found in tables 1 and 2. Table 3 summarizes the time fish spent in each river zone during the six years Lake Whitefish have been monitored, including fish tagged in both 2014 and 2017. Figures 1 and 2 show the receiver locations upstream and downstream of Gull Rapids during the 2020/2021 winter and 2021 open-water periods. Figure 3 provides water temperatures in the Nelson River mainstem between September 2020 and October 2021. Figures 4 to 16 provide movement range and proportional distribution of tagged fish both upstream and downstream of the construction site by season. A detection summary by season and year, including the farthest upstream and downstream detection locations for each tagged whitefish, are presented in Appendix 1. Individual movement summaries for each Lake Whitefish tagged in 2017 are presented in Appendices 2 and 3.

4.1 2017-2021 RESULTS SUMMARY

4.1.1 UPSTREAM OF THE KEEYASK GS

Twenty-two Lake Whitefish were tagged upstream of the Keeyask GS in October 2017. Prior to winter 2020/2021, three moved downstream through the Keeyask GS into Stephens Lake:

- #31727 was tagged on October 12, 2017 immediately downstream of Birthday Rapids and moved downstream through Gull Rapids between November 10, 2017, and May 30, 2018. It made multiple upstream and downstream movements before moving to rkm 16.8 on June 25, 2018. It has been detected constantly at this location since that time, displaying no upstream or downstream movements. It is likely that this fish is a mortality, and the tag has remained within the detection range of this receiver (Appendix A2-3). This fish is not discussed in the remainder of the report.
- #31738 was tagged on October 11, 2017 immediately downstream of Birthday Rapids and moved downstream through Gull Rapids on July 26, 2018 (Appendix A2-14).
- #31740 moved downstream through Gull Rapids immediately after it was tagged on October 11, 2017. It was detected in Stephens Lake for 20 days before moving downstream through the Kettle GS. It was first detected in the Long Spruce reservoir on January 29, 2018 (Appendix A2-16).

Three fish are missing and, based on the time since tagging, it is likely that these tags have now expired.

- #31728 was last detected in the riverine area between Birthday Rapids and Gull Lake on October 6, 2019 (Appendix A2-4).

- #31737 was last detected downstream of Birthday Rapids on October 9, 2020 (Appendix A2-13).
- #31744 was last detected in the riverine portion of the Nelson River downstream of Birthday Rapids (rkm -26.5) on June 7, 2018 (Appendix A2-20).

Therefore, accounting for the three fish that moved downstream and the three fish that are considered missing, 16 Lake Whitefish were available to be detected upstream of the Keeyask GS at the beginning of the 2020/2021 winter period.

4.1.2 STEPHENS LAKE

Forty Lake Whitefish were tagged in Stephens Lake in October 2017. Twenty-seven fish were only detected briefly after tagging and/or are missing and, based on the time since tagging, likely have tags that have expired. These fish are not discussed for the remainder of the report.

- #31698 was last detected in the upstream portion of Stephens Lake on October 15, 2017 (Appendix A3-1).
- #31701 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was never detected after tagging (Appendix A3-4).
- #31704 was last detected in upper Stephens Lake on October 1, 2020 (Appendix A3-7).
- #31706 was tagged on October 9, 2017 immediately downstream of the GS construction site. It moved immediately downstream and was last detected 6.5 km downstream of the GS on October 15, 2017 (Appendix A3-9).
- #31707 was last detected in upper Stephens Lake on February 28, 2019 (Appendix A3-10).
- #31708 was last detected on September 15, 2018 in upper Stephens Lake (Appendix A3-11).
- #31710 was last detected in upper Stephens Lake on September 10, 2019 (Appendix A3-13).
- #31711 was detected for eight days in 2017 and was last detected on October 26, 2017 (Appendix A3-14).
- #31712 was last detected on July 1, 2018, 16.8 km downstream of the GS (Appendix A3-15).
- #31713 was last detected on October 14, 2017 moving between upper and lower Stephens Lake (Appendix A3-16).
- #31717 was last detected on October 20, 2017 in lower Stephens Lake (Appendix A3-20).

- #31718 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was detected briefly near the GS after tagging, and was located in upper Stephens Lake for two days in June 2018 (Appendix A3-21).
- #31719 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was detected briefly in upper Stephens Lake after tagging (Appendix A3-22).
- #31720 was detected in upper Stephens Lake until October 15, 2017 (Appendix A3-23).
- #31721 was last detected on October 15, 2017 in upper Stephens Lake (Appendix A3-24).
- #31723 moved between upper and lower Stephens Lake and was last detected on October 22, 2017 (Appendix A3-25).
- #31724 was last detected in upper Stephens Lake on August 11, 2020 (Appendix A3-26).
- #31725 was last detected on July 7, 2018 in lower Stephens Lake (Appendix A3-27).
- #31747 was last detected in upper Stephens Lake in September 2018 (Appendix A3-28).
- #31748 was last detected immediately upstream of the Kettle GS on June 14, 2019 (Appendix A3-29).
- #31749 was last detected in lower Stephens Lake in June 2018 (Appendix A3-30).
- #31751 was last detected on August 10, 2018 in lower Stephens Lake (Appendix A3-32).
- #31752 displaying upstream and downstream movements throughout Stephens Lake until November 30, 2017 (Appendix A3-33).
- #31755 moved throughout upper Stephens Lake after tagging and was last detected on October 14, 2017 (Appendix A3-36).
- #31757 was last detected on September, 2018 in lower Stephens Lake (Appendix A3-38).
- #53761 was last detected in lower Stephens Lake on July 28, 2019 (Appendix A3-39).
- #53762 was last detected on June 9, 2018 in lower Stephens Lake (Appendix A3-40).

One fish moved downstream out of Stephens Lake through the Kettle GS into the Long Spruce reservoir:

- #31756 was tagged on October 8, 2017 immediately downstream of the GS construction site. It moved between upper and lower Stephens Lake until October 26, 2017, when it began to move downstream. It was last detected in Stephens Lake on October 29, 2017. It was detected in the Long Spruce reservoir on November 1, 2017 (Appendix A3-37).

In summary, 40 Lake Whitefish were tagged in Stephens Lake in 2017, 27 of which are missing or have expired tags, and one of which moved downstream through the Kettle GS. Three fish moved downstream from Gull Lake, two of which continue to be detected (section 4.1.1). Therefore, 14 fish were available to be detected in Stephens Lake during winter 2020/2021.

4.2 WINTER 2020/2021

4.2.1 UPSTREAM OF THE KEEYASK GS

All ten receivers deployed between Clark Lake and the Keeyask GS during the 2020/2021 winter period were retrieved. (Figure 1). Sixteen Lake Whitefish were located a total of 31,470 times (range: 32–13,266 detections per individual) (Figure 4; Appendix A1-1). Fish were detected on three to 151 days of the 219-day winter period (1–69% of the time) for an average of 34 days, or for 16% of the study period (standard deviation [StDev] = 41 days). Detections were logged at all receivers, with the farthest upstream in Clark Lake (rkm -48.2; one fish; 6%) and the farthest downstream near the powerhouse (rkm -2.2; one fish; 6%).

The majority of detections were logged by receivers located in the middle basin of Gull Lake at rkm -12.9 (n = 31,470; 47%; Figure 5). Movements were as follows:

- Three fish (19% of all fish detected) remained within the Gull Lake portion of the reservoir, moving no farther upstream than rkm -19.5 and no farther downstream than rkm -10.1.
- Twelve (71%) moved between Gull Lake and the riverine portion of the reservoir between Birthday Rapids and Gull Lake. These fish were detected as far upstream as rkm -29.3 (just downstream of Birthday Rapids) and as far downstream as lower Gull Lake (rkm -7.9).
- One (6%) moved between Clark Lake (rkm -48.2) and the lower portion of the reservoir immediately upstream of the powerhouse (rkm -2.2).

Individual movement graphs can be found in Appendix 2.

4.2.2 STEPHENS LAKE

All of the 17 receivers deployed in Stephens Lake during the 2020/2021 winter period were retrieved. Eleven Lake Whitefish were located a total of 86,776 times (range: 7–50,822 detections per individual) (Figure 6; Appendix A1-2). Fish were detected on one to 199 days of the 219-day winter period (0.5–91% of the time) for an average of 41 days, or 19% of the study period (StDev = 76 days). The farthest upstream detections occurred at rkm 3.9 (by seven fish; 64%), while the farthest downstream occurred at rkm 16.3 (by one fish; 9%). The average total movement range was 3.9 rkm (range: 0.0–9.5 rkm).

The majority of detections were logged by a single fish (#31727) in the northern portion of Stephens Lake at rkm 16.3 (n = 33,204; 38%) and in the southern portion of Stephens Lake by a second fish (#31699) at rkm 13.4 (n = 18,200; 21%) (Figure 7). The remaining nine fish moved throughout the upper portion of Stephens Lake, as far upstream as rkm 3.9 and as far downstream as rkm 10.2.

Individual movement graphs can be found in Appendix 3.

4.3 OPEN-WATER 2021

4.3.1 ACOUSTIC RECEIVER RETRIEVAL

All stationary acoustic receivers deployed upstream of the Keeyask GS (n = 31), in Stephens Lake (n = 31), and the Limestone reservoir (n = 2) during the 2021 open-water period were successfully retrieved (Maps 5, 6, and 7).

Water temperature reached 12°C on September 25, 2021, and measured 10°C by the end of the study period on October 10 (Figure 3). Based on these water temperatures, the time between September 25 and October 10 is referred to as the spawning period.

4.3.2 UPSTREAM OF THE KEEYASK GS

A total of 16 Lake Whitefish were detected upstream of the Keeyask GS during the 2021 open-water period. Fish were detected 919–16,638 times for 17–103 days of the 162-day open-water period (10–64% of the time) (Appendix A1-3). The average movement range was 17.9 rkm (StDev = 9.8 rkm; range: 0.0–30.5 rkm). The farthest upstream detections occurred immediately upstream of Birthday Rapids at rkm -34.3 (by nine fish; 56%), while the farthest downstream detections occurred in lower Gull Lake at rkm -3.8 (by three fish; 19%) (Figure 8; Map 5). No tagged fish moved downstream through the Keeyask GS. Most detections were logged at two receiver “gates”: one immediately downstream of Birthday Rapids (rkms -33.9 and -33.8; n = 30,784; 27%; Figure 10; Map 5) and another at the Gull Lake inlet (rkms -19.5 and -19.4; n = 31,671; 27%).

Several Lake Whitefish continued to move upstream to Birthday Rapids during the spawning period. During this time (September 25 to October 10, 2021), 72% of all detections were logged immediately downstream of Birthday Rapids (rkms -33.9 and -33.8; n = 14,059).

One fish was located after not being detected since 2018. Fish #31735 was last detected at rkm -4.8 on July 18, 2018 and was located in the same area of lower Gull Lake (rkm -4.0) on August 10, 2021.

4.3.2.1 PROPORTIONAL DISTRIBUTION

As in previous years, individual Lake Whitefish were detected most often in Zone 4 (upper basin of Gull Lake), spending an average of 69% of the study period in this zone (StDev = 36%, range: 0–100%) (Table 3; Figure 9). Lake Whitefish were detected for an average of 2% of the study period in Zone 2 (between Clark Lake and Birthday Rapids), 13% of the study period in Zone 3

(between Birthday Rapids and Gull Lake; StDev = 25%; range: 0–100%) and 16% in Zone 5 (lower basin of Gull Lake; StDev = 31%, range: 0–100%). No whitefish were detected in Zone 1 (Clark Lake).

The current study year represents the full open-water period after reservoir impoundment (completed on September 5, 2020). Relative to previous years of study, there was no obvious change in proportional distribution of tagged Lake Whitefish. As in previous years, the use of Zone 3 (the area downstream of Birthday Rapids) increased near the end of the study period (Figure 9).

4.3.2.2 MOVEMENT PATTERNS

Of the 16 fish detected during the 2021 open-water period:

- Three remained exclusively in Gull Lake:
 - Two (#31726 and #31734) remained exclusively in the upper basin of Gull Lake (Zone 4), moving as far upstream as the inlet to the Lake (rkm -19.5).
 - #31735 remained in the lower basin of Gull Lake (Zone 5; rkm -4.0).
- Twelve remained in Gull Lake for most of the open-water period:
 - Eight (#31729, #31732, #31736, #31739, #31741, #31742, #31743, and #31745) made distinct upstream movements to Birthday Rapids (Zone 2; rkm -34.3) in fall. All of these fish, except for #31739, have displayed a similar pattern since 2019.
 - Three (#31722, #31730, and #31746) travelled upstream to the middle of the riverine area between Birthday Rapids and Gull Lake in fall (Zone 3; between rkms -22.6 and -24.2).
 - #31731 was first detected in the riverine area between Birthday Rapids and Gull Lake at rkm -26.4 on July 3, but immediately moved downstream and stayed near the Gull Lake inlet for the remainder of the open-water period.
- #31733 remained at rkm -26.4 in the riverine area between Birthday Rapids and Gull Lake (Zone 3) for most of the open-water period. This fish moved upstream and was detected at Birthday Rapids during the spawning period.

No obvious changes in movement patterns were observed in the first open-water period following the completion of reservoir impoundment on September 5, 2020.

4.3.3 STEPHENS LAKE

A total of 12 of 14 available fish (86%) were detected in Stephens Lake during the 2021 open-water period. These fish were detected between nine and 38,325 times over two to 146 days of the 162-day open-water period (1–90% of the time) (Appendix A1-4). The average total movement range was 6.4 rkm (StDev = 8.3 rkm; range: 0.0–24.1 rkm) (Figure 11). The farthest upstream detections occurred near the Keeyask GS spillway at rkm 0.8 (by four fish; 33%), while the farthest downstream detections occurred in lower Stephens Lake at rkm 24.9 (by one fish;

9%). As in previous years, the highest number of detections ($n = 38,909$; 56%) were recorded by the receiver located nearest the Keeyask GS, near the North shore, at rkm 1.2 (Figure 12). During the spawning period (September 25 to October 10, 2021), 74% of detections were logged at this receiver (Figure 12).

One fish was located after not being detected since 2018. Fish #31700 was last detected at rkm 2.7 on September 15, 2018 and was located near the North shore upstream of the Keeyask GS at rkm 1.2 on both August 5 and September 9, 2021.

4.3.3.1 PROPORTIONAL DISTRIBUTION

Overall, Lake Whitefish spent more time in Zone 7 (farther away from the Keeyask GS) than in Zone 6 during the 2021 open-water period (Figure 9; Table 3). On average, fish spent 65% of the time in Zone 7 (StDev = 48%; range: 0–100%) and 35% in Zone 6 (StDev = 48%, range: 0–100%). As in previous years, the use of Zone 6 (closest to the GS) increased near the end of the study period.

4.3.3.2 MOVEMENT PATTERNS

Of the 12 Lake Whitefish detected in Stephens Lake during the 2021 open-water period:

- Four remained exclusively near the Keeyask GS (Zone 6):
 - Two (#31716 and #31738) were detected exclusively at the receiver located near the Keeyask GS tailrace (rkm 1.2). Both fish have shown this pattern since July 2018.
 - Two (#31700 and #31705) moved between rkms 0.8 and 1.9.
- Four (#31702, #31715, #31727, and #31750) remained exclusively in northern Stephens Lake.
- Four moved more extensively throughout the lake:
 - Three (#31699, #31753, and #31754) remained in the southern portion of the Lake, moving between rkms 0.8 and 18.8.
 - #31703 moved extensively throughout Stephens Lake, using both the northern and southern portions (between rkms 0.8 to 24.9).

During the spawning period (September 25 to October 10, 2021) five fish (42%) were located within 1.3 rkm of the Keeyask GS. No Lake Whitefish were observed moving downstream out of Stephens Lake.

4.3.4 LONG SPRUCE AND LIMESTONE RESERVOIRS

Due to low water levels that prevented boat access downstream of the Kettle GS throughout the majority of the open-water period, no acoustic receivers were set in the Long Spruce reservoir. No Lake Whitefish were detected within the Limestone reservoir in 2021.

5.0 DISCUSSION

Lake Whitefish movement monitoring was initiated in 2014 to describe movements during the construction, and post-reservoir impoundment/operation phases (September 2020–October 2021) of the Keeyask Project. The intent of the study was to determine if habitat changes associated with construction and operation of the GS would alter habitat use and coarse-scale movement patterns. The discussion below highlights movement patterns that have been observed and discusses the key questions (presented in the AEMP) with respect to potential impacts of construction and impoundment on Lake Whitefish and their movements.

5.1 EVALUATION OF METHODOLOGY

Fish movement monitoring, via acoustic telemetry, is a significant component of the AEMP for the Keeyask GS Project, and used to assess potential impacts of GS construction on several fish species including Lake Sturgeon (adults and juveniles), Walleye, and Lake Whitefish. Of these fish species/life stages, the methodology is most effective for monitoring movements of adult and juvenile Lake Sturgeon. Lake Sturgeon have a low natural mortality rate, occupy main channel habitats where the receivers are located, and in the case of juveniles, rarely move long distances. Monitoring movements of Walleye and Lake Whitefish via acoustic telemetry has been less effective relative to Lake Sturgeon. This is because: i) tagged individuals are detected less frequently due to more frequent use of shallow water habitat outside the detection range of receivers; ii) potential use of tributaries and off-current embayments where receivers are not located; iii) stress from the tagging procedure may cause an initial downstream movement of some individuals which complicates data interpretation; and iv) a higher natural mortality rate relative to Lake Sturgeon causes a greater proportion of tags to go missing. Despite this, the data collected to date (2014 to 2021) provides a good understanding of Lake Whitefish movements. This has been facilitated by the extensive array of stationary acoustic receivers spread over a ~100 km length of the Nelson River between Clark Lake and the Limestone GS, and the inclusion of receiver gates which provide confidence that movements of Lake Whitefish past key points are being detected.

5.2 WINTER MOVEMENT

Prior to reservoir impoundment in 2020, tracking during the winter period was limited by ice conditions which prevented use of a large receiver array, and only four receivers were set upstream of the Keeyask GS. However, forebay impoundment in fall 2020 allowed for an additional six receivers to be set in the reservoir, due to the increase in deep off-current areas. During the 2020/2021 winter period, all 16 fish available for detection were located for an average of 34 days (16% of the study period). This represents an increase from previous years when the average number of detection days were relatively low (four days in 2014/15, seven days in 2015/16, six days in 2016/17, four days in 2017/18, two days in 2018/19, and three days in

2019/2020). The winter receiver array in Stephens Lake is more extensive than the array upstream of the Keeyask GS and thus more fish can be tracked for a greater proportion of the winter period. The majority of fish were detected using the area closest to the Keeyask GS (Zone 6). This is different from winter 2019/2020, when no fish were detected in Zone 6 and the majority (63%) were detected in the northern portion of the lake.

5.3 OPEN-WATER MOVEMENT

Detection rates of individual tagged Lake Whitefish have remained high upstream of the Keeyask GS during the open-water period: in 2018 all fish (available to be detected) were detected, 89% in 2019, 94% in 2020 and all fish in 2021. This was higher than the 47–80% detection rates observed prior to 2018. In Stephens Lake, 86% of fish were detected compared to 49%–69% in previous years (Lavergne and Hrenchuk 2016; Burnett and Hrenchuk 2017; Lacho and Hrenchuk 2018; Lacho and Hrenchuk 2019; Hrenchuk 2020; Hrenchuk 2021). Although detection rates have increased, the number of fish available to be detected has decreased due to fish moving through a GS, going missing, tags expiring, and/or mortalities.

As in previous years, Lake Whitefish tagged upstream of the Keeyask GS continued to spend most of the open-water period (69%) in the Gull Lake portion of the reservoir, with some remaining here for the entire open-water period and some moving upstream to Birthday Rapids during the fall. In all study years, Lake Whitefish have been detected at the base of Birthday Rapids during the spawning period (*i.e.*, when water temperatures fell below 12°C). In 2020, Keeyask GS reservoir impoundment was completed prior to the spawning period (*i.e.*, on September 5). Three fish (19%) in 2020 made distinct movements to Birthday Rapids during the spawning period. In 2021, one-year post-impoundment, nine fish (56%) made distinct upstream movements to Birthday Rapids (rkm -34.3) during the fall spawning period. These data suggest that Lake Whitefish continue to use habitat in the vicinity of Birthday Rapids for spawning post-impoundment.

Lake Whitefish in Stephens Lake continue to display movement patterns similar to those observed since 2018, spending more time in Zone 7 farther from the Keeyask GS than Zone 6. This is the opposite of what was observed for fish tagged in 2014, when fish were located in Zone 6 for the majority of the open-water period. However, fish continued to use both zones and were detected at all receivers except for the three farthest downstream during the 2021 open-water period.

5.4 KEY QUESTIONS

Impoundment of the Keeyask reservoir was completed on September 5, 2020 and sampling in the Keeyask reservoir in 2021 represented the first year that the reservoir was at full supply level. Monitoring in Stephens Lake, however, represented a transition between construction and operation as a considerable portion of the flow was still being passed through the spillway in spring and early summer when only a few units were in-service. Later in the summer and early

fall as additional units became operational all the entire flow of the river was going through the powerhouse. Due to Keeyask reservoir impoundment, several key questions identified in the AEMP that have not been previously discussed are addressed below.

Are tagged Lake Whitefish utilizing habitat in the vicinity of construction activities (particularly during spawning)?

Instream construction activities related to the Keeyask GS concluded prior to open-water 2021. During the construction period, Lake Whitefish spent little time near the construction site. A maximum of two fish were detected within 5.8 rkm each year. In contrast, Lake Whitefish in Stephens Lake were frequently detected in the vicinity of the construction site since the study began.

Monitoring has taken place for a full year since the first unit of the powerhouse was commissioned, causing flow alterations downstream of the GS in Stephens Lake. Commissioning of the GS coincided with the Lake Whitefish spawning period in fall 2020 and 88% of all detections (four fish; 44%) occurred within 1.2 rkm of the Keeyask GS during this time. A total of five powerhouse units were commissioned by the end of the 2021 open-water period, further altering flows downstream of the GS. Despite this, five fish (42%) were detected within 1.3 rkm of the Keeyask GS. Since 2015, Lake Whitefish have been consistently detected in the downstream vicinity of the Keeyask GS during the spawning period.

As construction is now complete, this question is no longer relevant and will not be discussed going forward.

What is the frequency of downstream movement through the Keeyask GS and when are the movements occurring?

Monitoring the movement of Lake Whitefish for the last seven years has shown that movements past Gull Rapids (now the Keeyask GS) are rare. Three of the 22 (14%) Lake Whitefish tagged upstream of Gull Rapids in 2017 have moved downstream into Stephens Lake (one in 2017 and two in 2018) (Figure 13). It is likely that at least one of these fish is a tagging mortality. Of the 20 fish tagged upstream in 2014, two (10%) moved downstream during the three-years the tags were active. No Lake Whitefish moved downstream through the Keeyask GS since reservoir impoundment in 2020.

What types of habitat are Lake Whitefish utilizing in the Keeyask reservoir (i.e., are fish using the upper, middle, or lower end of the reservoir)?

Lake Whitefish have continued to spend the majority of the open-water period in the upper basin of Gull Lake (Zone 4) since the study began in 2014. During the spawning period, many Lake Whitefish move upstream to the area immediately downstream of Birthday Rapids (Zone 3). Results suggest that impoundment and initial operation of the Keeyask GS has not affected Lake Whitefish movement patterns.

What proportion of the fish population moves from the Keeyask reservoir upstream past Birthday and/or Long rapids?

During the construction period, only fish tagged in 2014 moved upstream into Clark Lake. Of the 20 fish tagged in 2014, eight fish (40%) moved upstream through Birthday Rapids into Clark Lake (Figure 17). One fish made two upstream movements in both 2016 and 2017.

In the first year of monitoring following reservoir impoundment, a single fish (6% of all detected fish in winter 2020/2021) tagged in 2017 moved upstream to Clark Lake. However, this fish returned downstream and has since displayed the same movements observed since the open-water period of 2018: remaining in Gull Lake throughout the summer and moving to Birthday Rapids during the fall spawning period.

6.0 SUMMARY AND CONCLUSIONS

- In open-water 2021, as in previous years, Lake Whitefish upstream of the Keeyask GS spent most of their time in upper Gull Lake, with some making upstream movements out of the lake during fall, likely related to spawning. Lake Whitefish have been detected at Birthday Rapids during the spawning period for the entirety of this study, although a higher proportion of fish made the upstream movement in 2021.
- In Stephens Lake, movement patterns reflect those of previous years with Lake Whitefish spending more time closer to the Keeyask GS during the spawning period. For the remaining part of the year, fish spent more time in the northern and southern portions Stephens Lake.
- The key questions as described in the AEMP for Lake Whitefish movement monitoring during construction and impoundment of the Keeyask GS are:

- *Are tagged Lake Whitefish utilizing habitat in the vicinity of construction activities (particularly during spawning)?*

Lake Whitefish tagged upstream of the Keeyask GS rarely use habitat in the vicinity of the construction site (\leq rkm -5.8). In contrast, a large proportion of whitefish tagged in Stephens Lake continue to use the area immediately downstream of the Keeyask GS, especially during the spawning period. As construction is now complete, this question is no longer relevant and will not be discussed going forward.

- *What is the frequency of downstream movement through the Keeyask GS and when are the movements occurring?*

It is rare that Lake Whitefish move downstream through the Keeyask GS. A maximum of 14% of fish tagged in 2014 (two of 20 fish; 10%) and 2017 (three of 22 fish; 14%) have made this movement, with one considered a tagging mortality. No Lake Whitefish have moved through the Keeyask GS since reservoir impoundment in 2020.

- *What types of habitat are Lake Whitefish utilizing in the Keeyask reservoir (i.e., are fish using the upper, middle, or lower end of the reservoir)?*

Lake Whitefish tagged in both 2014 and 2017 used the upper basin of Gull Lake most frequently. Post-impoundment, fish continued to move upstream to Birthday Rapids in fall, likely related to spawning.

- *What proportion of the fish population moves from the Keeyask reservoir upstream past Birthday and/or Long rapids?*

During the construction period, only fish tagged in 2014 moved upstream into Clark Lake. Of the 20 fish tagged in Gull Lake in 2014, eight (40%) moved upstream through Birthday Rapids and into Clark Lake. During the year of monitoring following reservoir impoundment, one fish moved upstream to Clark Lake (in winter 2020/2021). This fish returned to lower Gull Lake shortly after.

7.0 LITERATURE CITED

- Barth, C.C., Neufeld, L.J. and Olynik, J.R. 2003. Movements of Northern Pike, Walleye, and Lake Whitefish tagged with radio and acoustic transmitters in the Gull (Keeyask) Study Area, 2001/2002. A report prepared for Manitoba Hydro by North/South Consultants Inc., December 2003. 119 pp.
- Burnett, D.C. and Hrenchuk, C.L. 2017. Lake Whitefish movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2015 to October 2016: Year 3 Construction. Keeyask Generation Project, Aquatic Effects Monitoring Plan Report #AEMP-2017-03. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2017. xiv + 125 pp.
- Green, D.J. and Derksen, A.J. 1987. Observations on the spawning of Lake Whitefish (*Coregonus clupeaformis*) in the Poplar River area of Lake Winnipeg, 1974 – 1977. Manitoba Department of Natural Resources, Fisheries Branch Manuscript Report 87-24: 86 pp.
- Hrenchuk, C.L. 2020. Lake Whitefish movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2018 to October 2019: Year 6 Construction. Keeyask Generation Project, Aquatic Effects Monitoring Plan Report #AEMP-2020-03. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2020. xv + 128 pp.
- Hrenchuk, C.L. 2021a. Adult Lake Sturgeon movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2019 to September 2020: Year 7 Construction. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2021-01. A report prepared for Manitoba Hydro by North/South Consultants Inc.
- Hrenchuk, C.L. 2021b. Juvenile Lake Sturgeon movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2019 to September 2020: Year 7 Construction. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2021-02. A report prepared for Manitoba Hydro by North/South Consultants Inc.
- Hrenchuk, C.L. 2021c. Walleye movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2019 to September 2020: Year 7 Construction. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2021-04. A report prepared for Manitoba Hydro by North/South Consultants Inc.
- Hrenchuk, C.L. and Barth, C.C. 2013. Results of adult Lake Sturgeon movement monitoring in the Nelson River between Clark Lake and the Long Spruce Generating Station, October 2011 to October 2012. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2013. 137 pp.

- Hrenchuk, C.L. and Barth, C.C. 2015. Lake Whitefish movement monitoring 2014: Preliminary results. A report prepared for Manitoba Hydro by North/South Consultants Inc., January 2015. 12 pp.
- Keeyask Hydropower Limited Partnership. 2014. Keeyask Generation Project: Aquatic effects monitoring plan. A report prepared by Keeyask Hydropower Limited Partnership, Winnipeg, MB. 216 pp. + appendices.
- Lacho, C.D. and Hrenchuk, C.L. 2018. Lake Whitefish movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2016 to October 2017: Year 4 Construction. Keeyask Generation Project, Aquatic Effects Monitoring Plan Report #AEMP-2018-05. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2018. xv + 129 pp.
- Lacho, C.D. and C.L. Hrenchuk. 2019. Lake Whitefish movement monitoring in the Nelson River between Clark Lake and the Limestone Generating Station, October 2017 to October 2018: Year 5 Construction. Keeyask Generation Project Aquatic Effects Monitoring Plan Report #AEMP-2019-03. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2019. xv + 128 pp.
- Lavergne, S.C. and Hrenchuk, C.L. 2016. Lake Whitefish movement monitoring in the Nelson River between Clark Lake and the Long Spruce Generating Station, October 2014 to October 2015: Year 2 Construction. Keeyask Generation Project Aquatic Effects Monitoring Report #AEMP-2016-06. A report prepared for Manitoba Hydro by North/South Consultants Inc., June 2016. xii + 105 pp.
- Manitoba Hydro Public Affairs. December 1999. Long Spruce Generating Station. Brochure. 4 pp.
- Murray, L. and Barth, C.C. 2007. Movements of radio- and acoustic-tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2003 to October 2004, and a summary of findings from 2001–2005. A report prepared for Manitoba Hydro by North/South Consultants Inc., April 2007. 95 pp.
- Murray, L., Barth, C.C. and Olynik, J.R. 2005. Movements of radio- and acoustic-tagged Northern Pike, Walleye, and Lake Whitefish in the Keeyask Study Area: May 2002 to April 2003. A report prepared for Manitoba Hydro by North/South Consultants Inc., August 2005. 107 pp.
- Pincock, D.G. 2012. False detections: What they are and how to remove them from detection data. VEMCO, DOC-004691, Bedford, Nova Scotia. Available: www.vemco.com/pdf/false_detections.pdf. (April 2013).
- Pisiak, D.J. 2005a. Results of summer index gillnetting studies in Stephens Lake, Manitoba, and seasonal investigations of adult and larval fish communities in the reach of the Nelson River between Gull Rapids and Stephens Lake, 2002. A report prepared for Manitoba Hydro by North/South Consultants Inc., January 2005. xv + 159 pp.

- Pisiak, D.J. 2005b. Results of summer index gillnetting studies in Stephens Lake, Manitoba, and seasonal investigations of fish communities in the reach of the Nelson River between Gull Rapids and Stephens Lake, 2003, year 3. A report prepared for Manitoba Hydro by North/South Consultants Inc., October 2005. xxi + 289 pp.
- Scott, W.B. and Crossman, E.J. 1998. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184: 966 pp.
- Stewart, K. and Watkinson, D. 2004. Freshwater fishes of Manitoba. University of Manitoba Press. 276 pp.

TABLES

Table 1: Acoustic-tag and biological information for each Lake Whitefish tagged with an acoustic transmitter in the Nelson River upstream of the Keeyask GS, fall 2017. Tag id highlighted yellow = missing tag. Tag id highlighted purple = fish moved downstream through the Keeyask GS. Tag id highlighted red = fish moved downstream through the Kettle GS.

Acoustic Tag ID	Floy Tag #	Date Tagged	Tag Life (days)	Expiry Date	Fork Length (mm)	Weight (g)
31722	101750	07-Oct-17	1737	10-Jul-22	460	2275
31726	109695	12-Oct-17	1737	15-Jul-22	468	2575
31727	109696	12-Oct-17	1737	15-Jul-22	465	2075
31728	109688	14-Oct-17	1737	17-Jul-22	486	2550
31729	109689	14-Oct-17	1737	17-Jul-22	483	2350
31730	109690	14-Oct-17	1737	17-Jul-22	448	1850
31731	109691	14-Oct-17	1737	17-Jul-22	490	2500
31732	109697	12-Oct-17	1737	15-Jul-22	455	1750
31733	109692	14-Oct-17	1737	17-Jul-22	488	2725
31734	109693	14-Oct-17	1737	17-Jul-22	435	1925
31735	109694	12-Oct-17	1737	15-Jul-22	495	2250
31736	109698	12-Oct-17	1737	15-Jul-22	528	3425
31737	109699	12-Oct-17	1737	15-Jul-22	454	1500
31738	109700	11-Oct-17	1737	14-Jul-22	432	1425
31739	109654	11-Oct-17	1737	14-Jul-22	491	2475
31740	109652	11-Oct-17	1737	14-Jul-22	509	2950
31741	109653	11-Oct-17	1737	14-Jul-22	467	1725
31742	109655	11-Oct-17	1737	14-Jul-22	482	2525
31743	109656	11-Oct-17	1737	14-Jul-22	529	3050
31744	109657	11-Oct-17	1737	14-Jul-22	501	2350
31745	109658	11-Oct-17	1737	14-Jul-22	533	2675
31746	109659	11-Oct-17	1737	14-Jul-22	450	1500

Table 2: Acoustic-tag and biological information for each Lake Whitefish tagged with an acoustic transmitter in Stephens Lake, fall 2017. Tag id highlighted yellow = missing tag. Tag id highlighted red = moved downstream through the Kettle GS.

Acoustic Tag ID	Floy Tag #	Date tagged	Tag life (days)	Expiry date	Fork length (mm)	Weight (g)
31698	101729	09-Oct-17	1737	12-Jul-22	476	1900
31699	101728	09-Oct-17	1737	12-Jul-22	423	1375
31700	101727	09-Oct-17	1737	12-Jul-22	446	2125
31701	101726	09-Oct-17	1737	12-Jul-22	524	2450
31702	101744	09-Oct-17	1737	12-Jul-22	406	1100
31703	101730	09-Oct-17	1737	12-Jul-22	525	2400
31704	101731	09-Oct-17	1737	12-Jul-22	504	2600
31705	101732	09-Oct-17	1737	12-Jul-22	495	2375
31706	101733	09-Oct-17	1737	12-Jul-22	522	2300
31707	101734	09-Oct-17	1737	12-Jul-22	456	1750
31708	101740	09-Oct-17	1737	12-Jul-22	455	1500
31709	101738	09-Oct-17	1737	12-Jul-22	480	2050
31710	101737	09-Oct-17	1737	12-Jul-22	426	1250
31711	101736	09-Oct-17	1737	12-Jul-22	494	2075
31712	101735	09-Oct-17	1737	12-Jul-22	413	1400
31713	101739	09-Oct-17	1737	12-Jul-22	519	2450
31714	101743	09-Oct-17	1737	12-Jul-22	455	1725
31715	101745	09-Oct-17	1737	12-Jul-22	490	2500
31716	101747	08-Oct-17	1737	11-Jul-22	417	1075
31717	101749	08-Oct-17	1737	11-Jul-22	504	2100
31718	101741	09-Oct-17	1737	12-Jul-22	486	2050
31719	101742	09-Oct-17	1737	12-Jul-22	505	2000
31720	101746	09-Oct-17	1737	12-Jul-22	512	2300
31721	101748	08-Oct-17	1737	11-Jul-22	519	2900
31723	109673	10-Oct-17	1737	13-Jul-22	511	2250
31724	109664	10-Oct-17	1737	13-Jul-22	494	2150
31725	109663	10-Oct-17	1737	13-Jul-22	447	1525
31747	109660	10-Oct-17	1737	13-Jul-22	490	2525
31748	109661	10-Oct-17	1737	13-Jul-22	410	1000
31749	109662	10-Oct-17	1737	13-Jul-22	422	1250
31750	109665	10-Oct-17	1737	13-Jul-22	499	2150
31751	109666	10-Oct-17	1737	13-Jul-22	540	2550
31752	109667	10-Oct-17	1737	13-Jul-22	537	2250
31753	109668	10-Oct-17	1737	13-Jul-22	468	2175
31754	109669	10-Oct-17	1737	13-Jul-22	471	1875
31755	109670	10-Oct-17	1737	13-Jul-22	512	2350
31756	109671	10-Oct-17	1737	13-Jul-22	496	1775
31757	109672	10-Oct-17	1737	13-Jul-22	516	2125
53761	109674	10-Oct-17	1737	13-Jul-22	502	1975
53762	109675	09-Oct-17	1737	12-Jul-22	508	2275

Table 3: Proportion of time spent in each river zone by Lake Whitefish implanted with acoustic transmitters upstream of the Keeyask GS and in Stephens Lake during a portion of the 2015 (June 4 to October 11), 2016 (June 4 to October 19), 2017 (June 7 to October 16), 2018 (June 6 to October 10), 2019 (June 2 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods.

Tagging Year	Study Year	Upstream of Gull Rapids					Stephens Lake	
		1	2	3	4	5	6	7
2014	2015	0.2	0.5	32.0	45.4	21.9	66.4	45.2
	2016	6.6	5.6	20.8	50.3	16.6	55.3	44.7
	2017	18.8	0.5	19.1	51.3	10.2	52.4	47.62
2017	2018	0.0	0.0	21.6	55	23.4	43.2	56.8
	2019	0.0	0.0	16.8	66.9	16.3	36.4	63.6
	2020	0.0	0.0	8.7	69.4	22.0	19.8	80.2
	2021	0.0	2.3	13.4	68.5	15.7	35.5	64.5

FIGURES

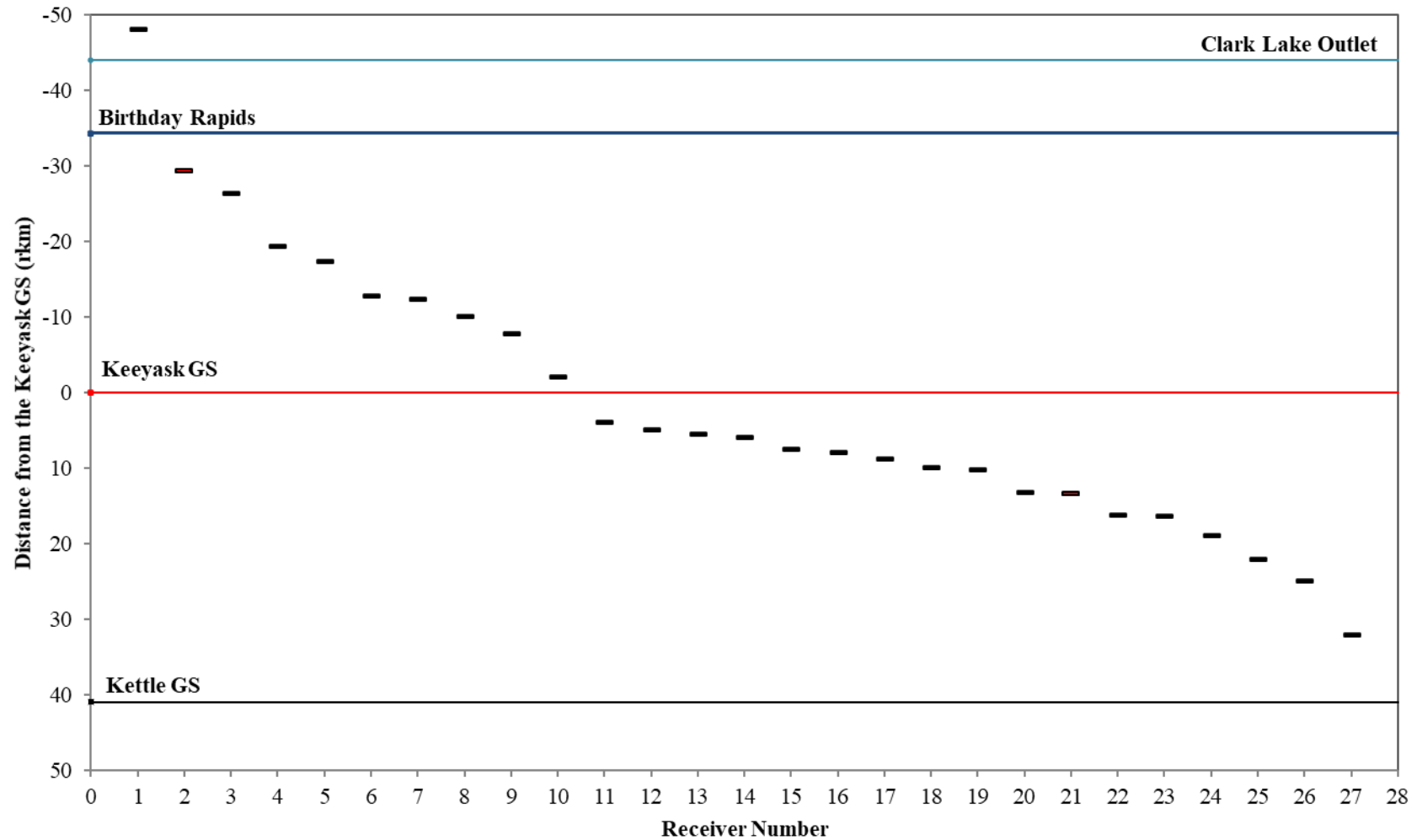


Figure 1: Locations of stationary acoustic receivers (dashes) in relation to the base of the Keeyask GS (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Limestone GS between September 2020 and May 2021. A red dash indicates a receiver that was lost.

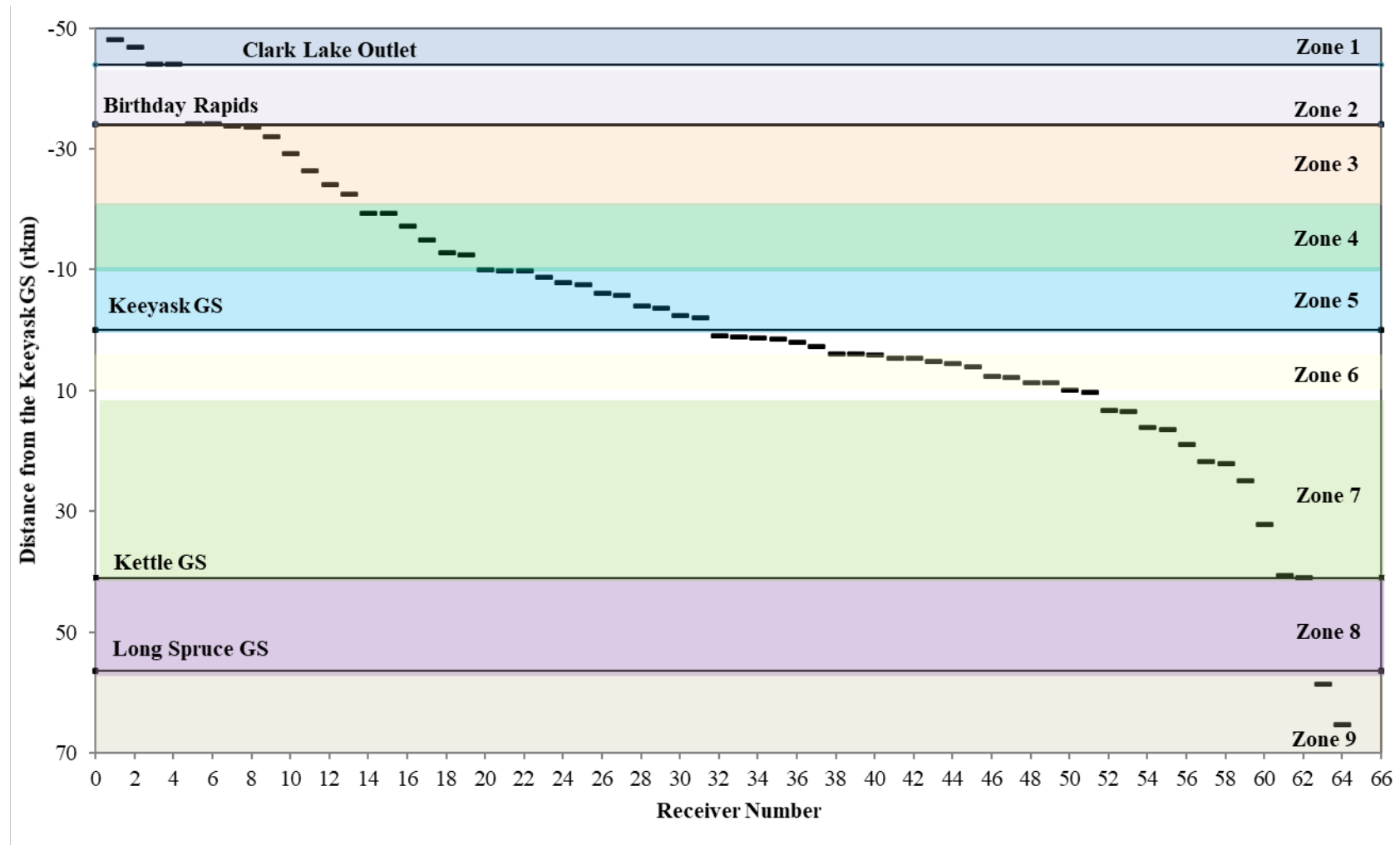


Figure 2: Locations of stationary acoustic receivers (dashes) in relation to the base of the Keeyask GS (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake (Zone 1) and the Limestone GS (Zone 9) between June and October, 2021. River zones upstream and downstream of Gull Rapids are indicated by shading.

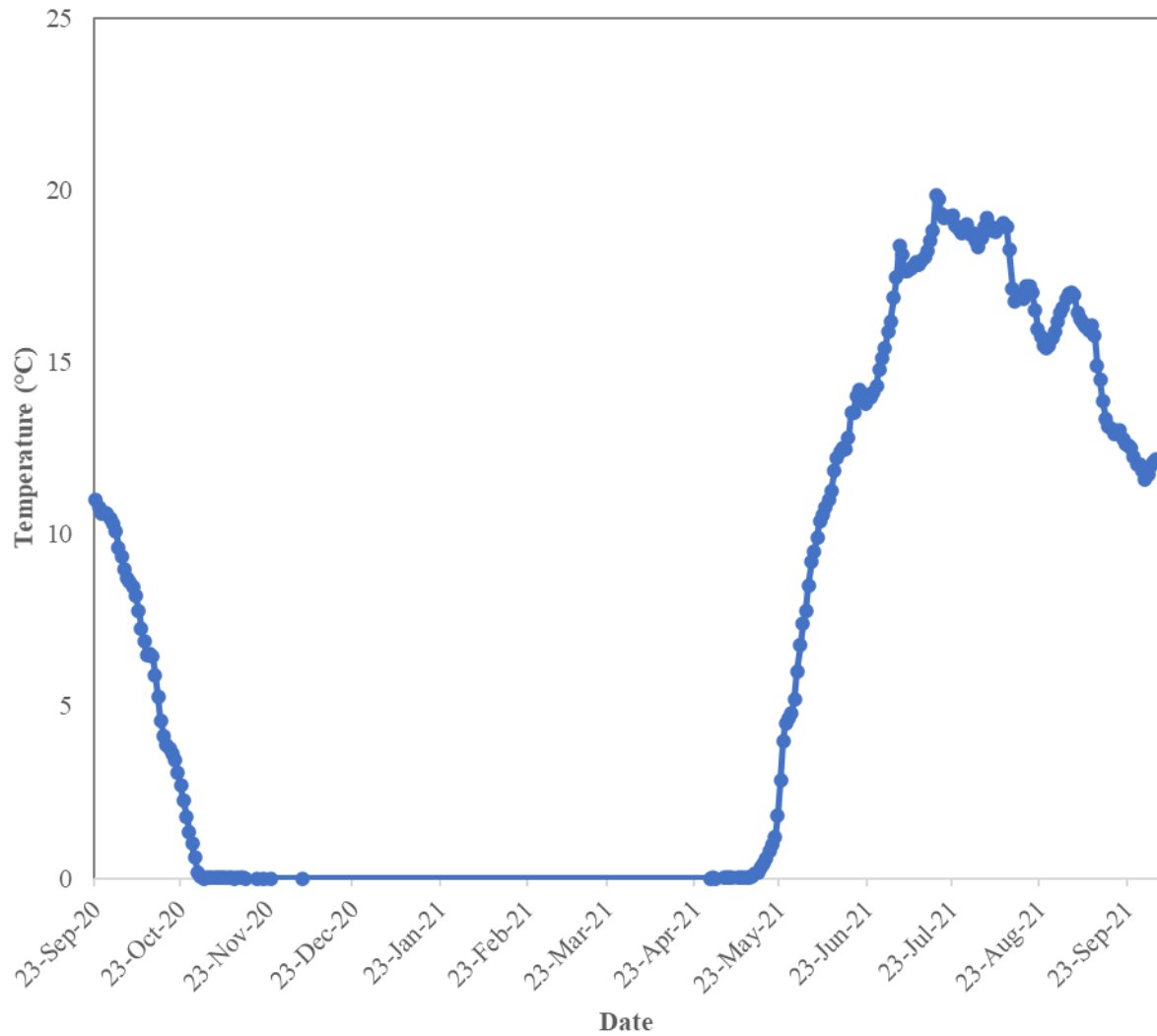


Figure 3: Water temperature in the Nelson River mainstem from September 23, 2020, to October 3, 2021.

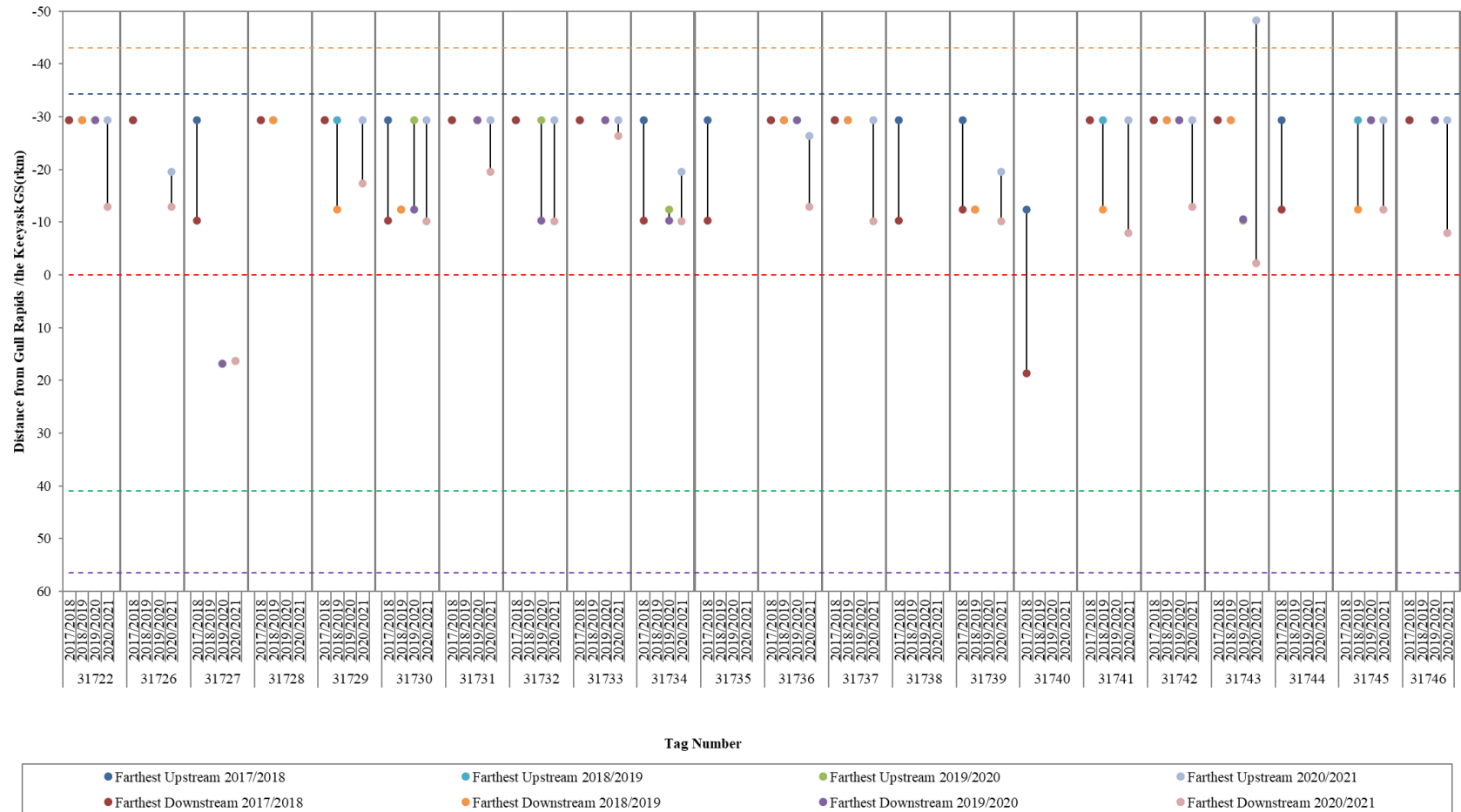


Figure 4: Detection ranges for individual Lake Whitefish (n = 22) tagged with acoustic transmitters upstream of the Keyyask GS during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids; red = Gull Rapids; green = Kettle GS; purple = Long Spruce GS).

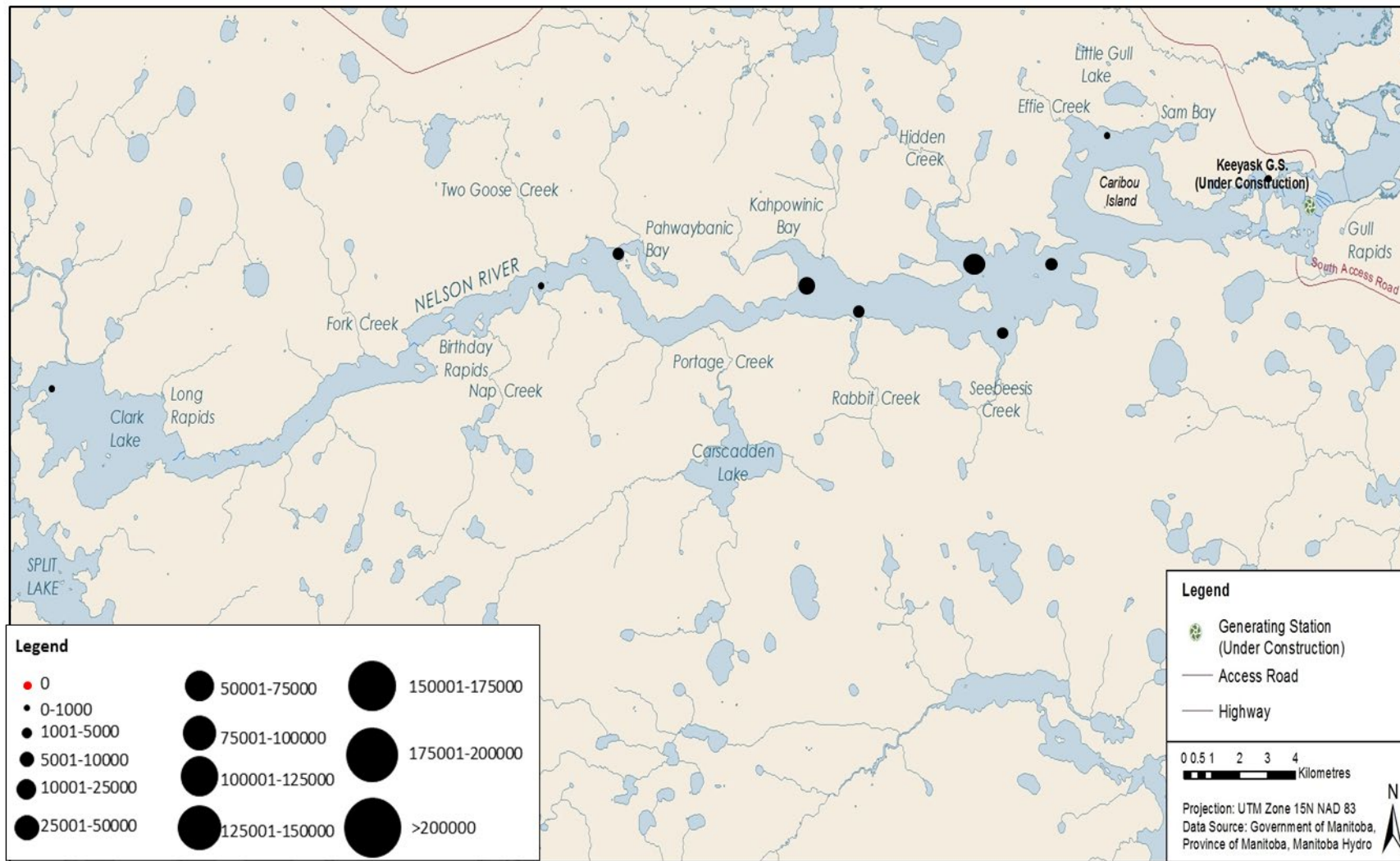


Figure 5: Relative number of detections at each acoustic receiver set between Clark Lake and the Keeyask GS during winter 2020/2021 (September 24, 2020 to April 30, 2021). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

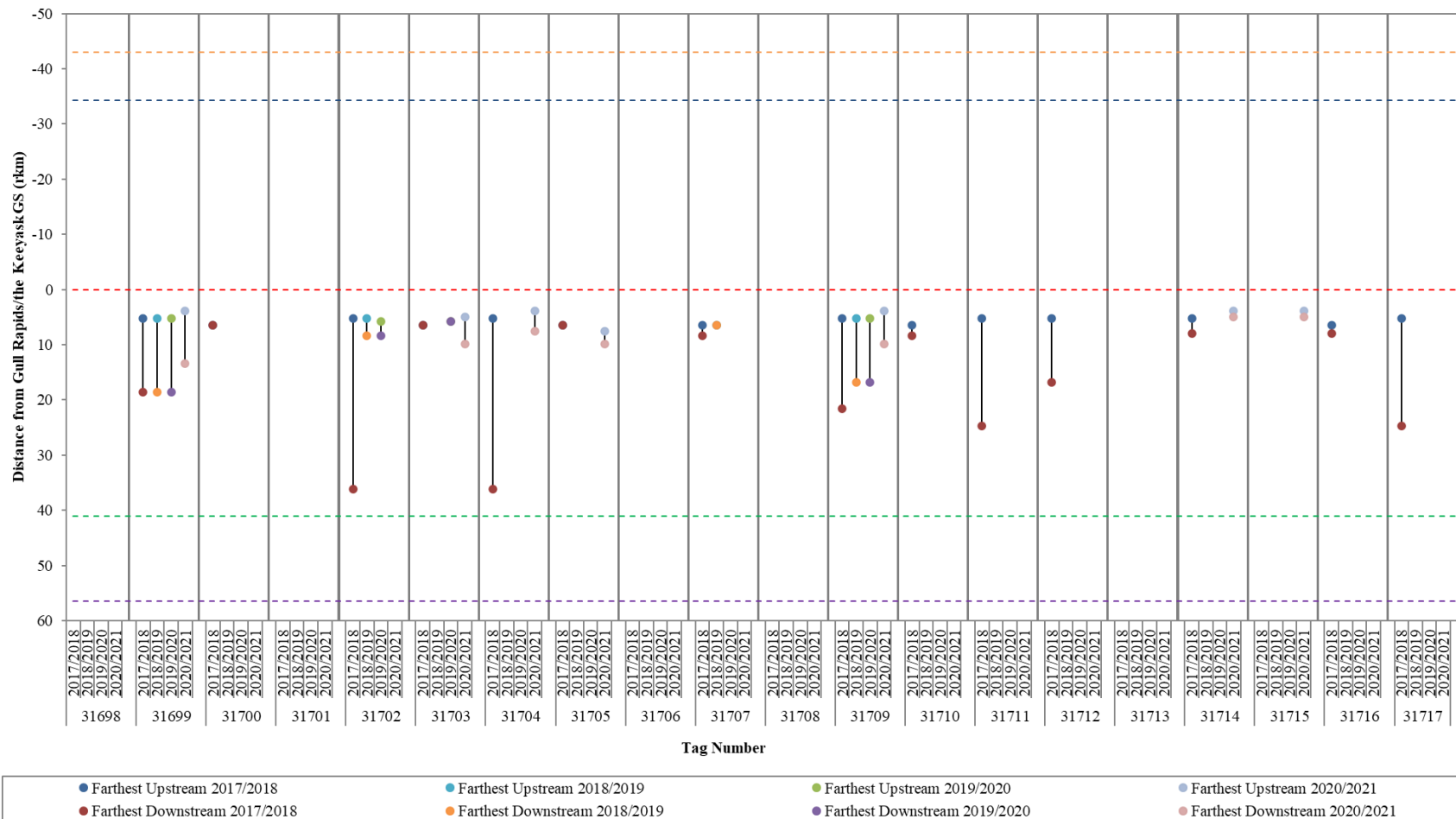


Figure 6: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids; red = Gull Rapids; green = Kettle GS; purple = Long Spruce GS).

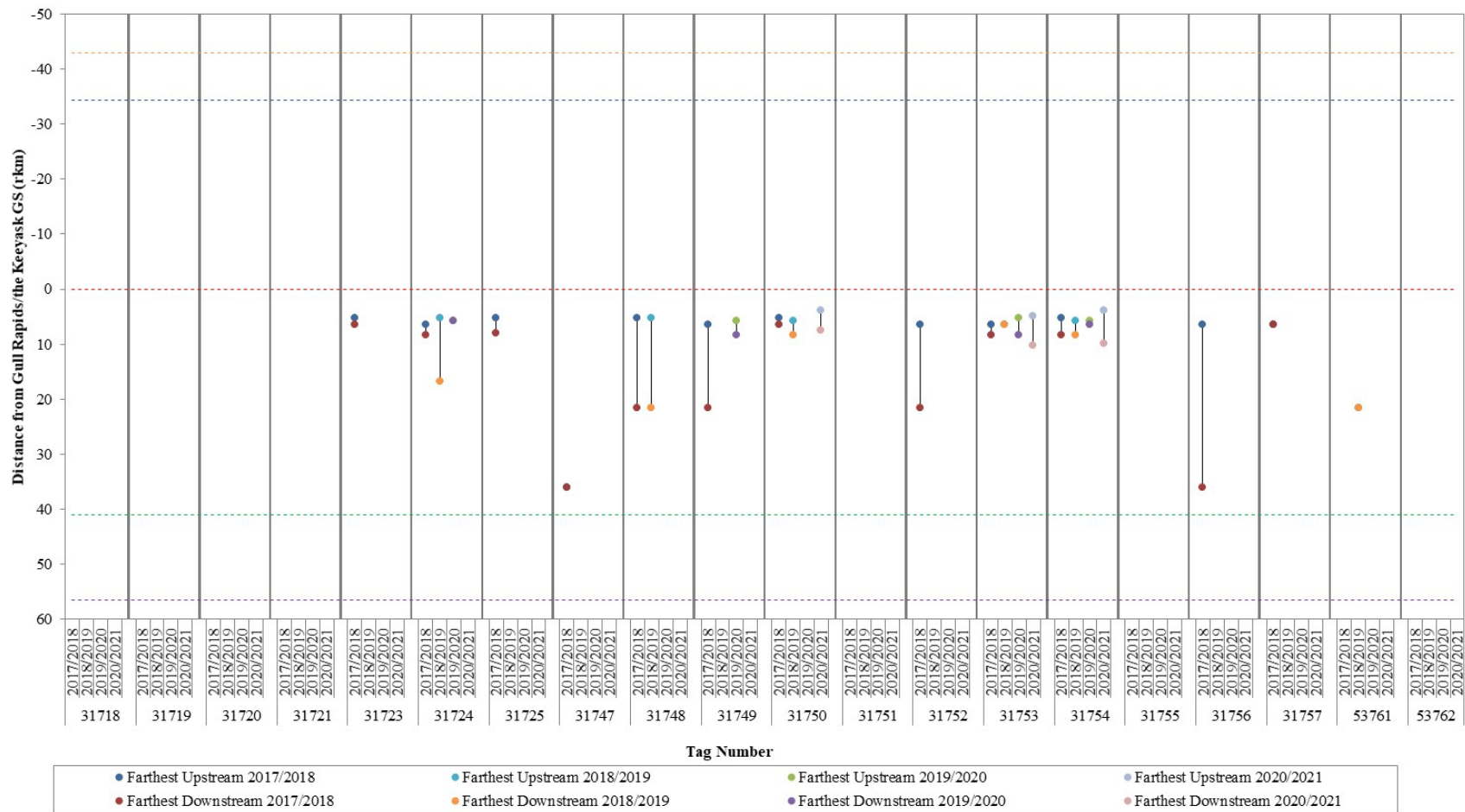


Figure 6: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids; red = Gull Rapids; green = Kettle GS; purple = Long Spruce GS) (continued).

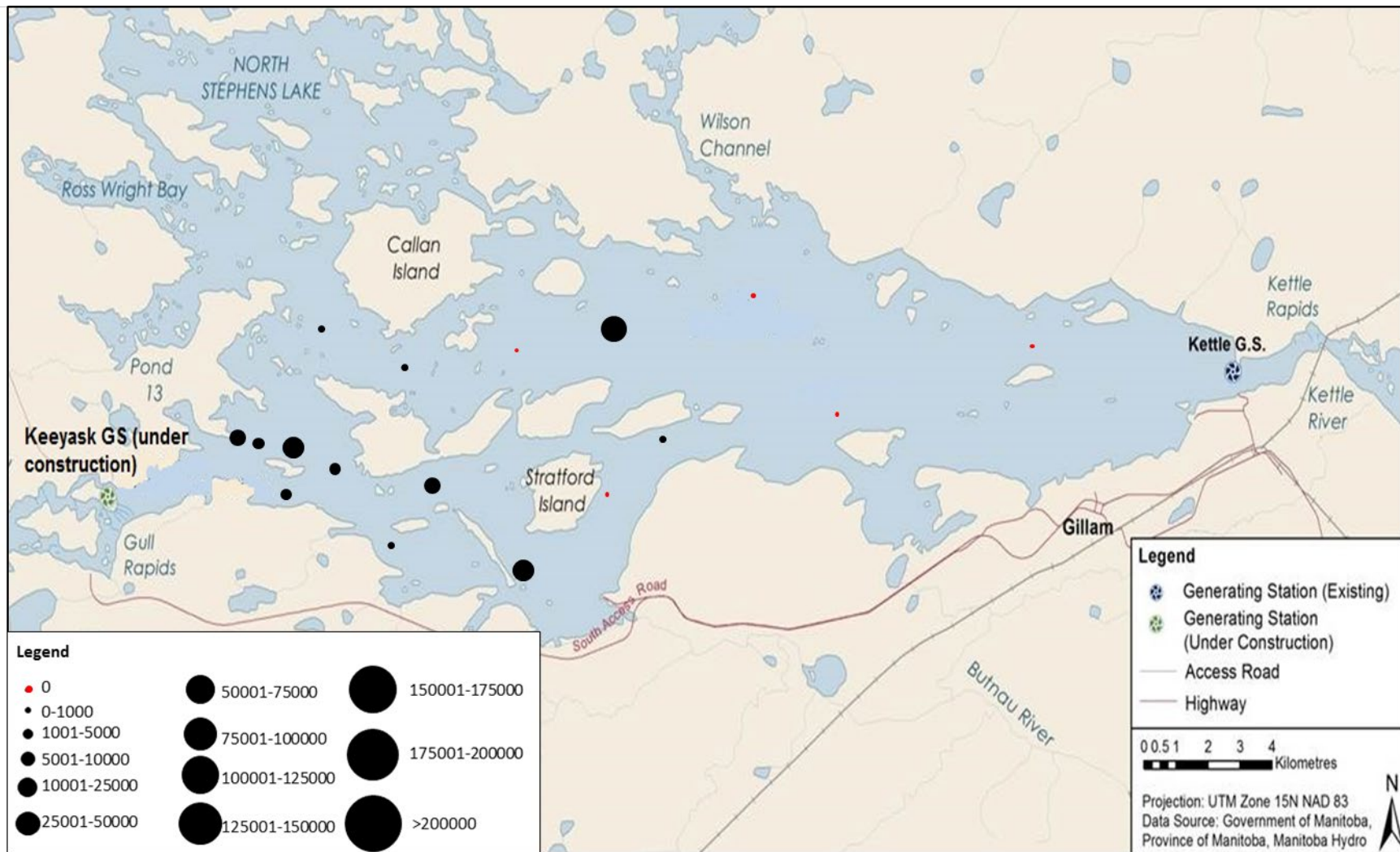


Figure 7: Relative number of detections at each acoustic receiver set in Stephens Lake during winter 2019/2020 (September 24, 2020 to April 30, 2021). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

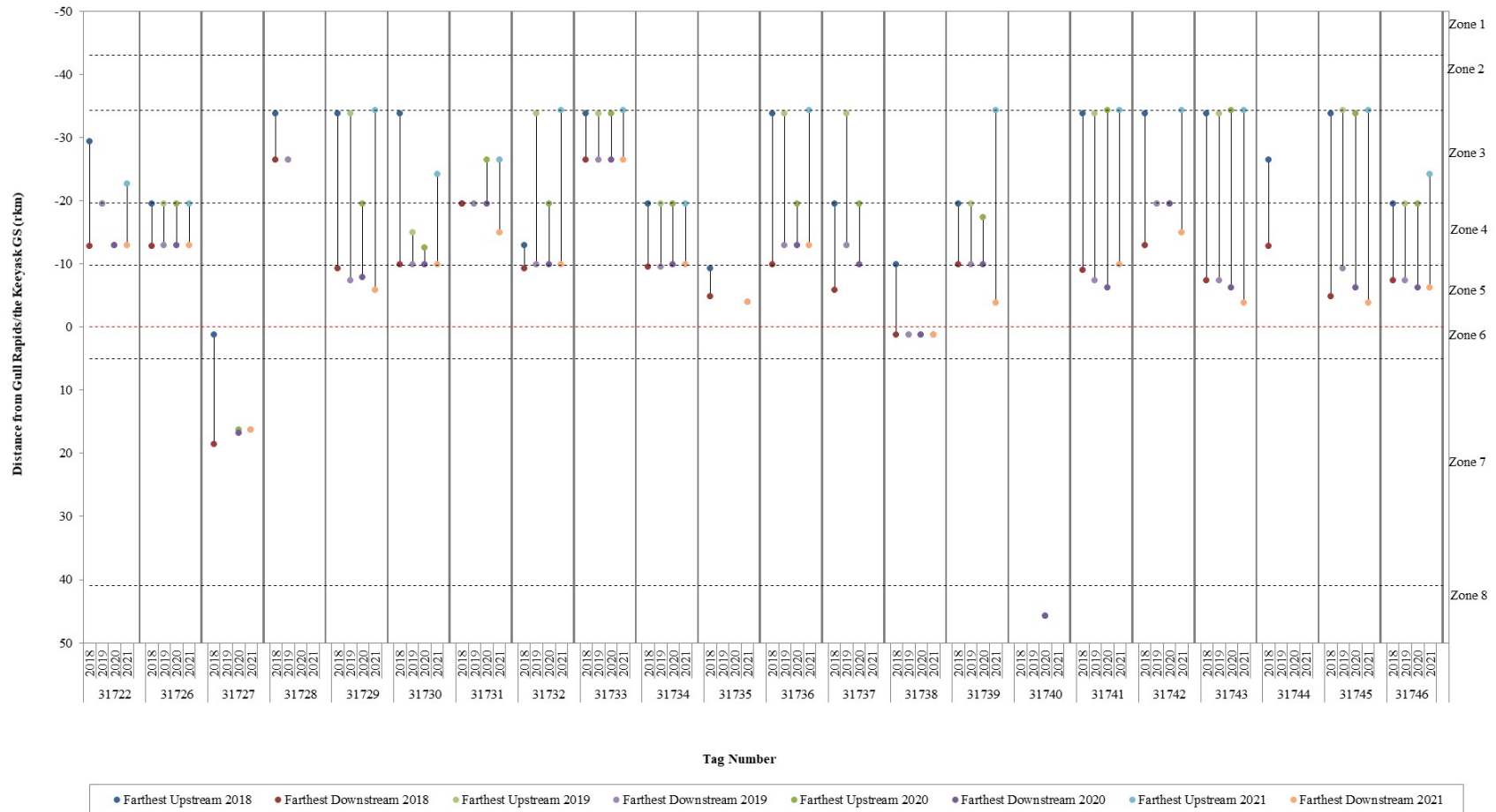


Figure 8: Detection ranges for individual Lake Whitefish ($n = 22$) tagged with acoustic transmitters upstream of the Keyyask GS during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods. Horizontal dotted lines demarcate zones with the red line representing the Keyyask GS.

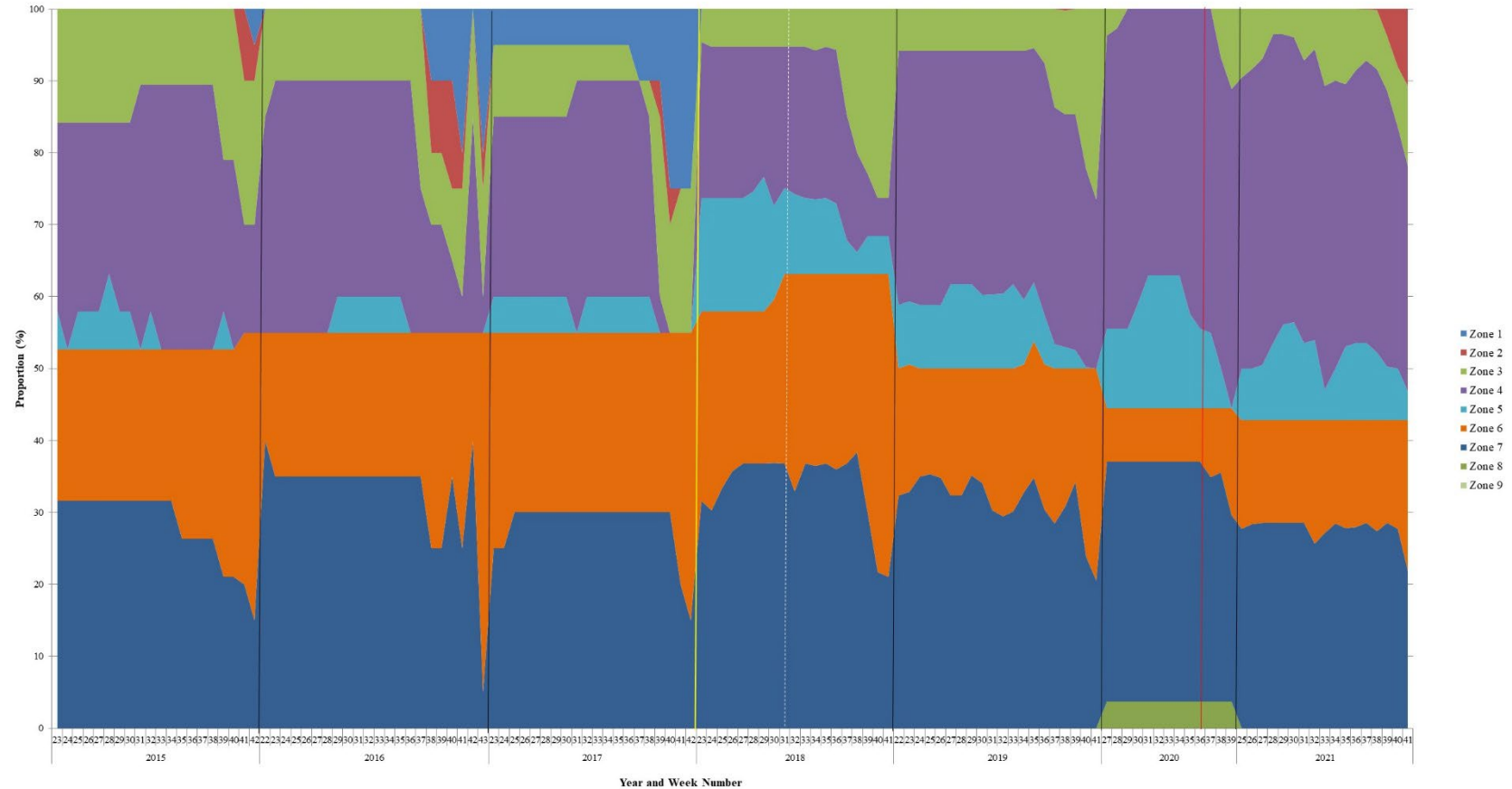


Figure 9: Proportional distribution of Lake Whitefish with acoustic transmitters tagged in 2014 and 2017 within seven river zones between Clark Lake and the Kettle GS during a portion of the 2015 (June 4 to October 11), 2016 (June 25 to October 19), 2017 (June 7 to October 16), 2018 (June 6 to October 10), 2019 (June 2 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods. Black lines demarcate years, yellow line indicates when tags expired and new fish were tagged, white dashed line indicates start of spillway operation, solid red line indicates to completion of impoundment.

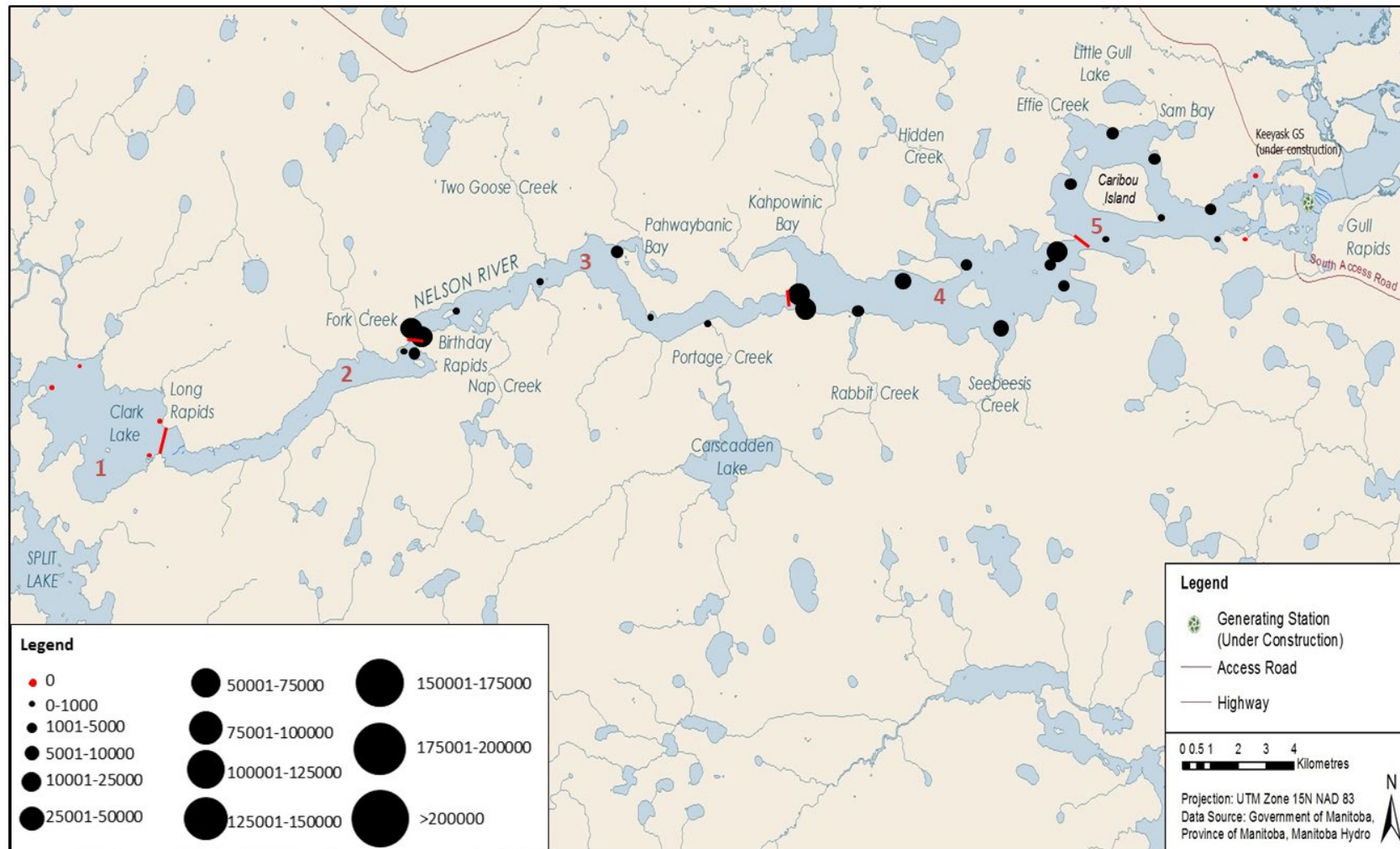


Figure 10: Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and the Keeyask GS during the 2021 open-water period (May 1 to October 10). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot. The river is divided into five "zones" based

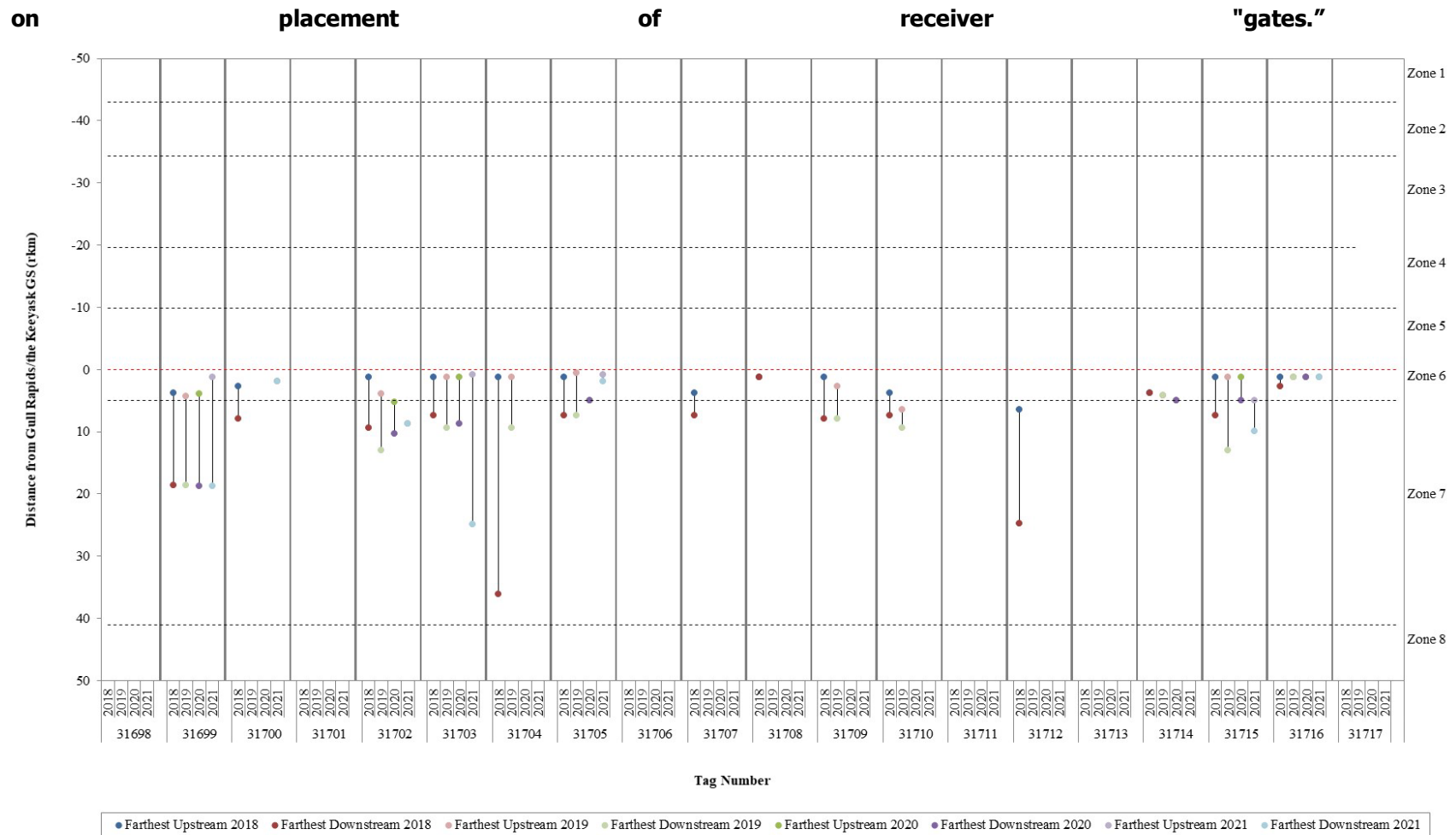


Figure 11: Detection ranges for individual Lake Whitefish ($n = 40$) tagged with acoustic transmitters in Stephens Lake during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods. Horizontal dotted lines demarcate zones with the red line representing the Keeyask GS.

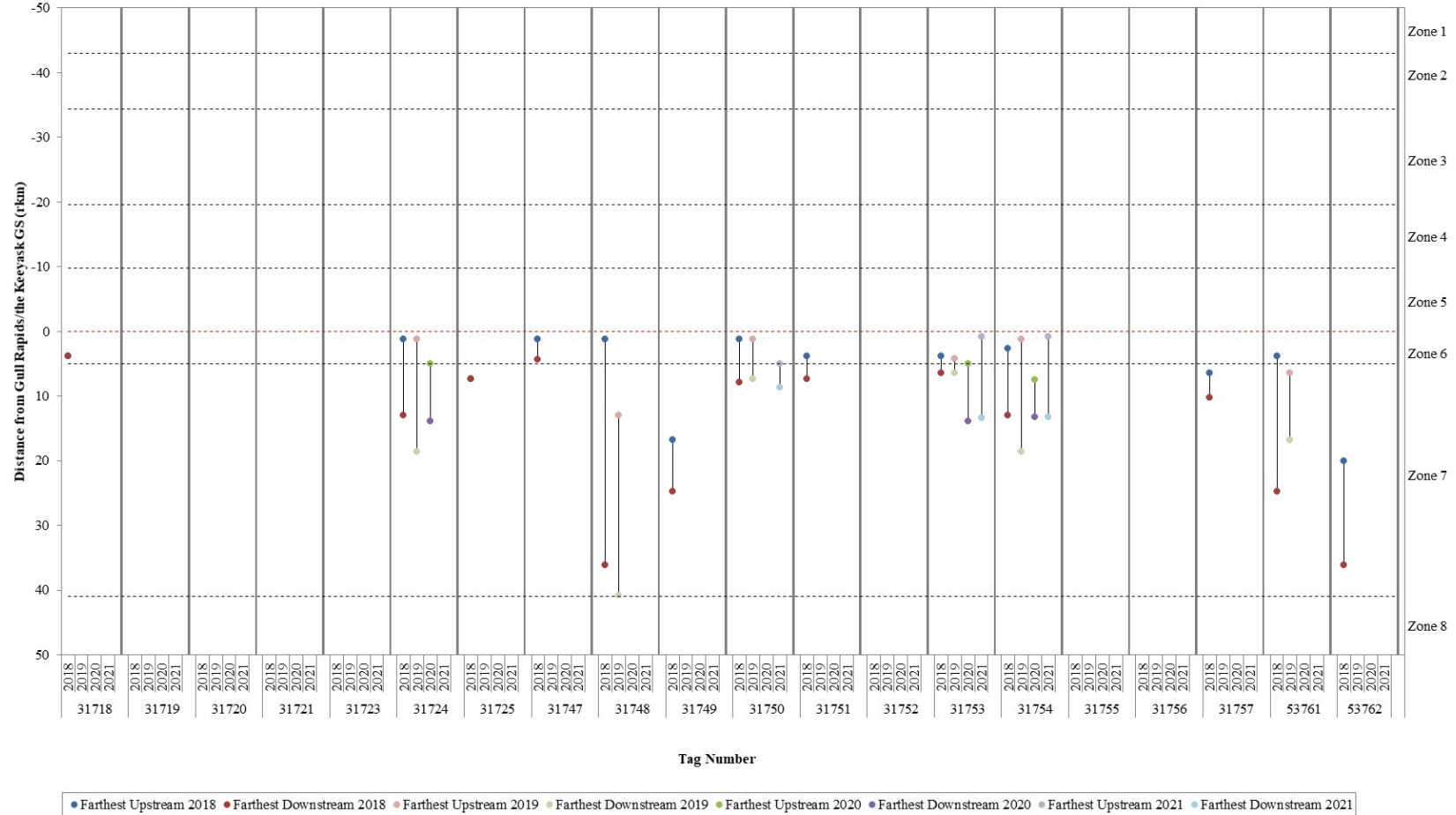


Figure 11: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (July 3 to September 23), and 2021 (June 13 to October 10) open-water periods. Horizontal dotted lines demarcate zones with the red line representing the Keeyask GS (continued).

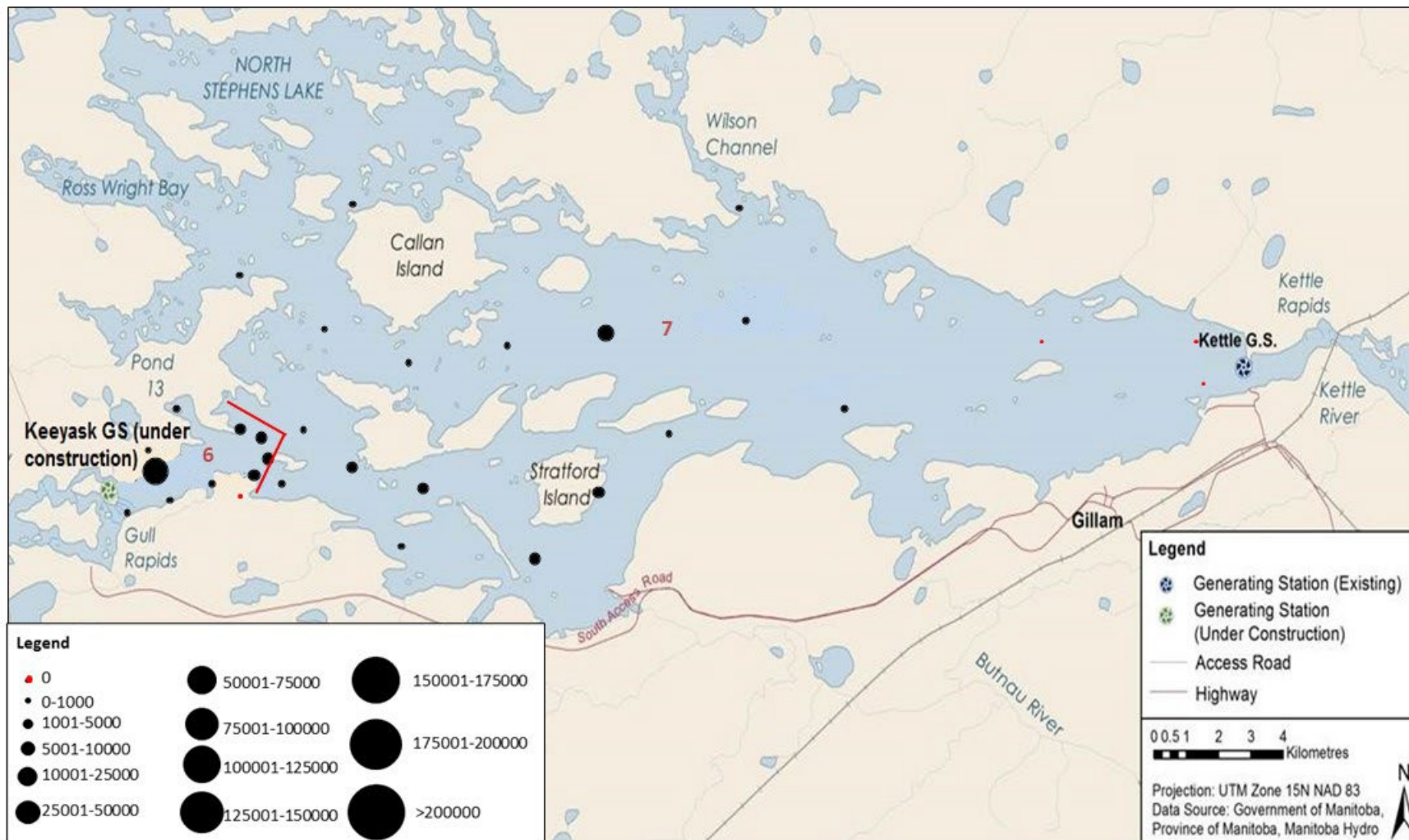
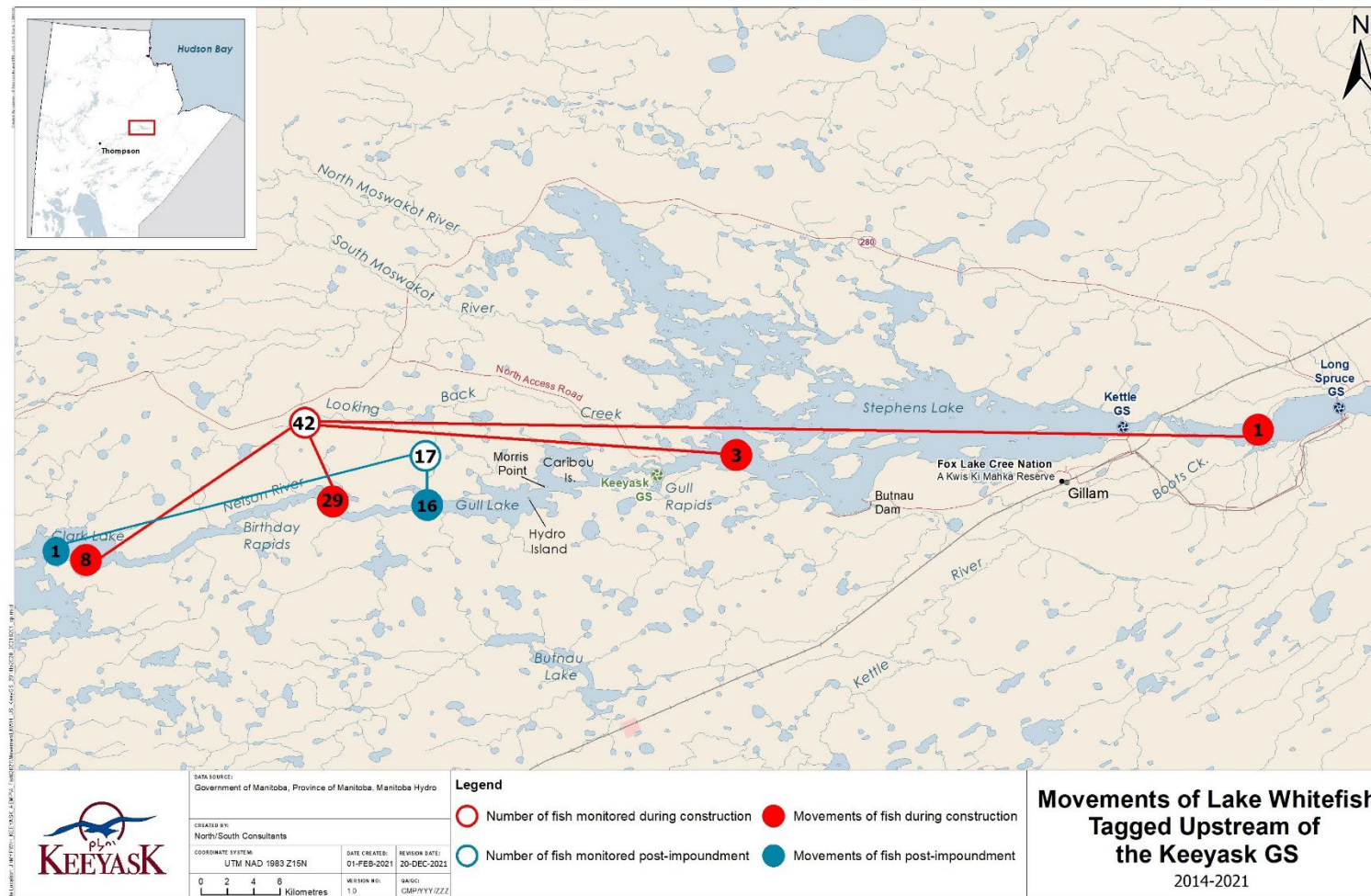


Figure 12: Relative number of detections at each acoustic receiver set in Stephens Lake during the 2021 open-water period (May 1 to October 10). Relative number of detections indicated by size of bubble. Receivers with no detections indicated with red dot. The river is divided into two "zones" based on placement of receiver "gates."



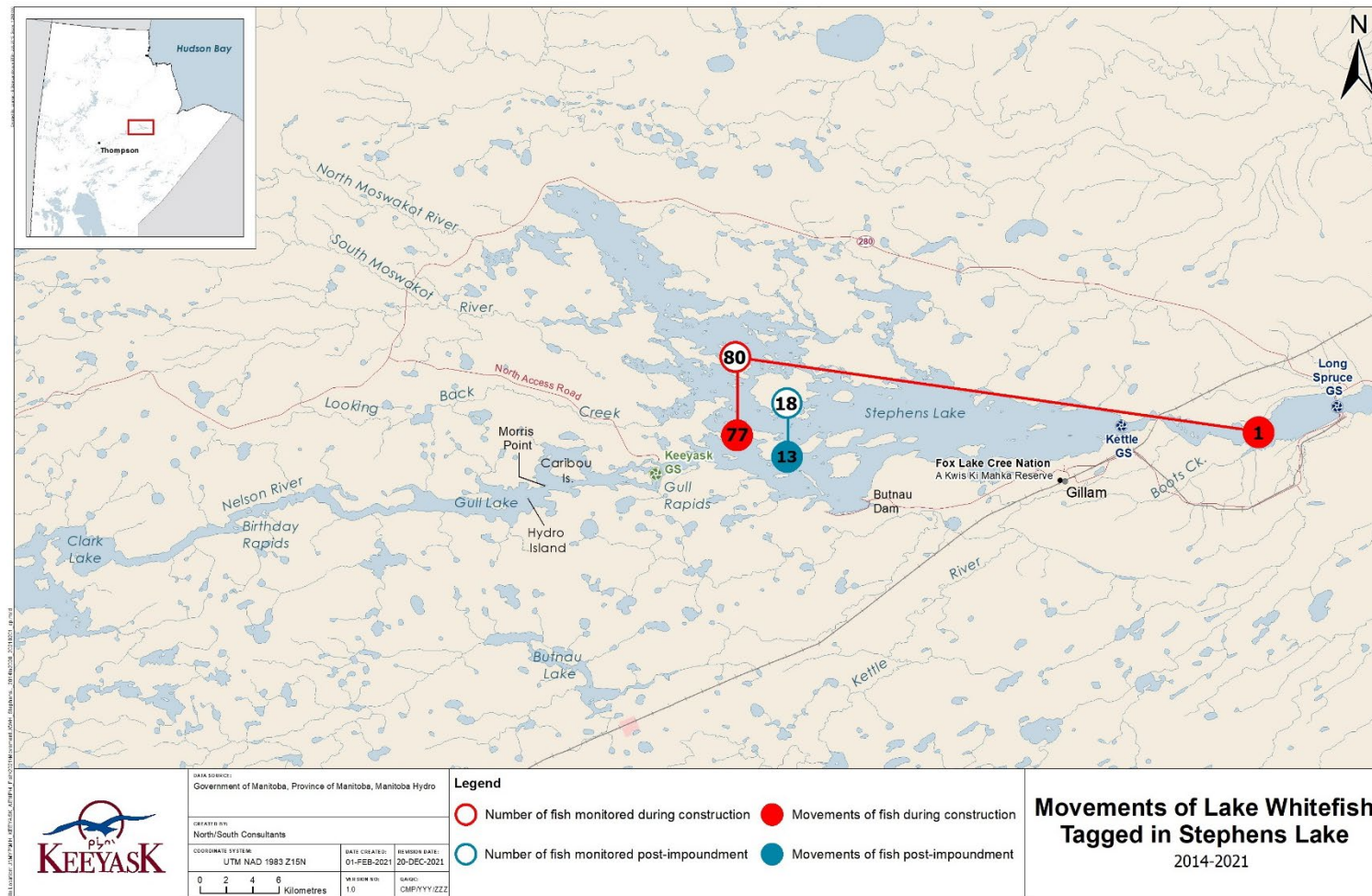
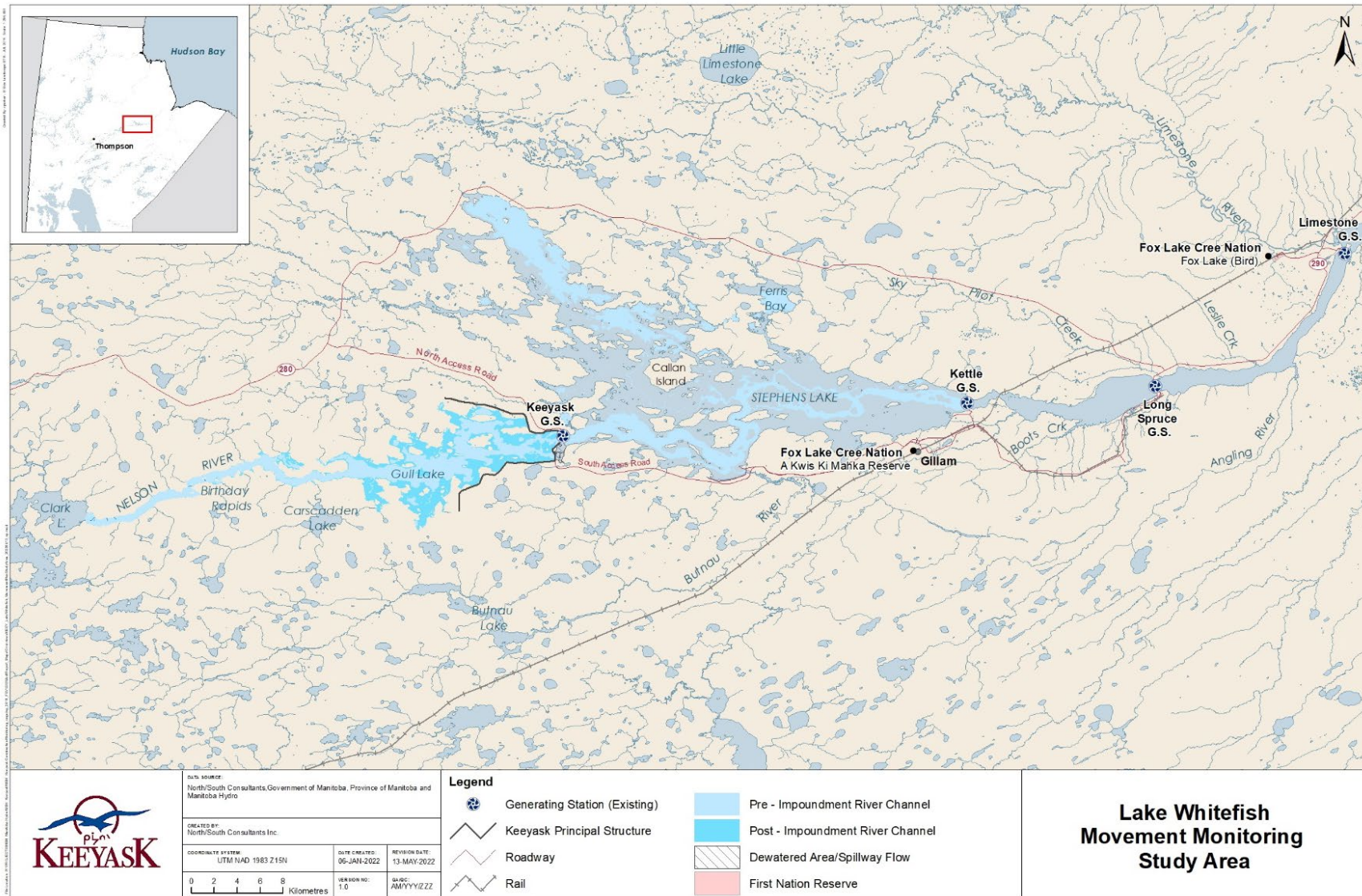
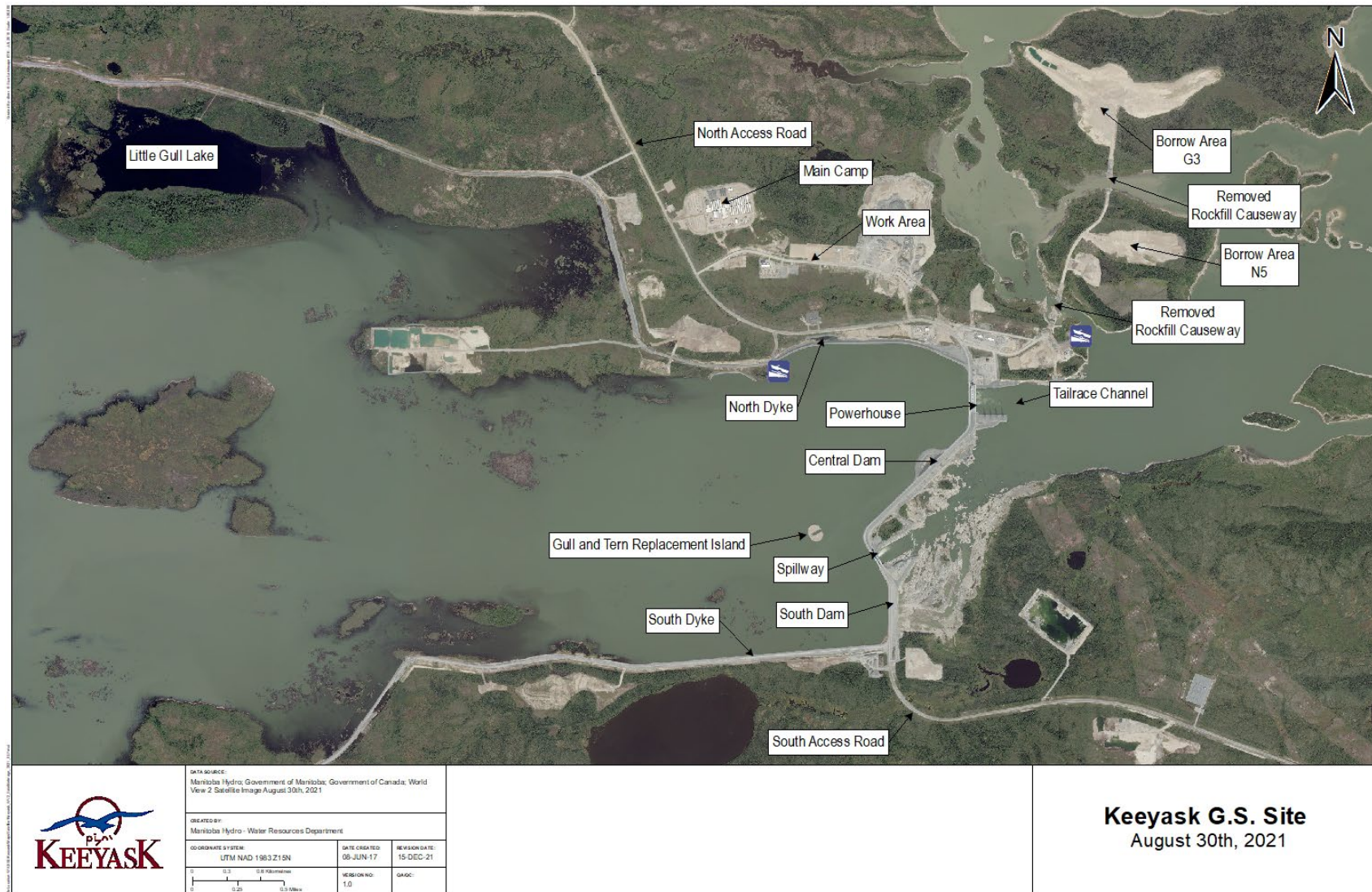


Figure 14: Map showing how many Lake Whitefish moved upstream through Gull Rapids, stayed in Stephens Lake, and moved downstream through the Kettle GS during construction (red) and after reservoir impoundment (blue). Movements of fish due to tagging stress or mortality were not included. Numbers of fish monitored (hollow circles) represent the number of fish tagged while the number of fish movements (solid circles) represent the number of fish detected.

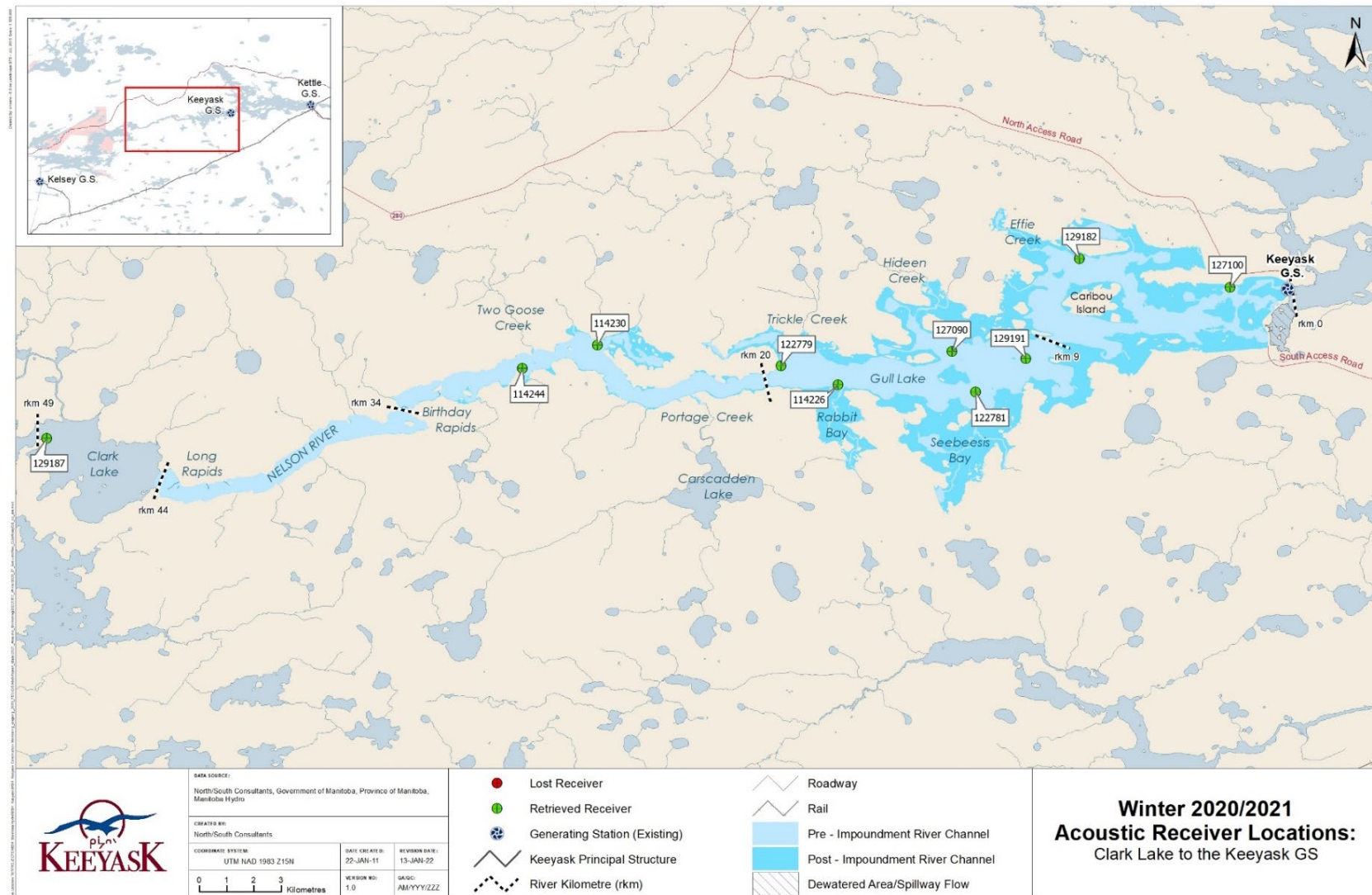
MAPS



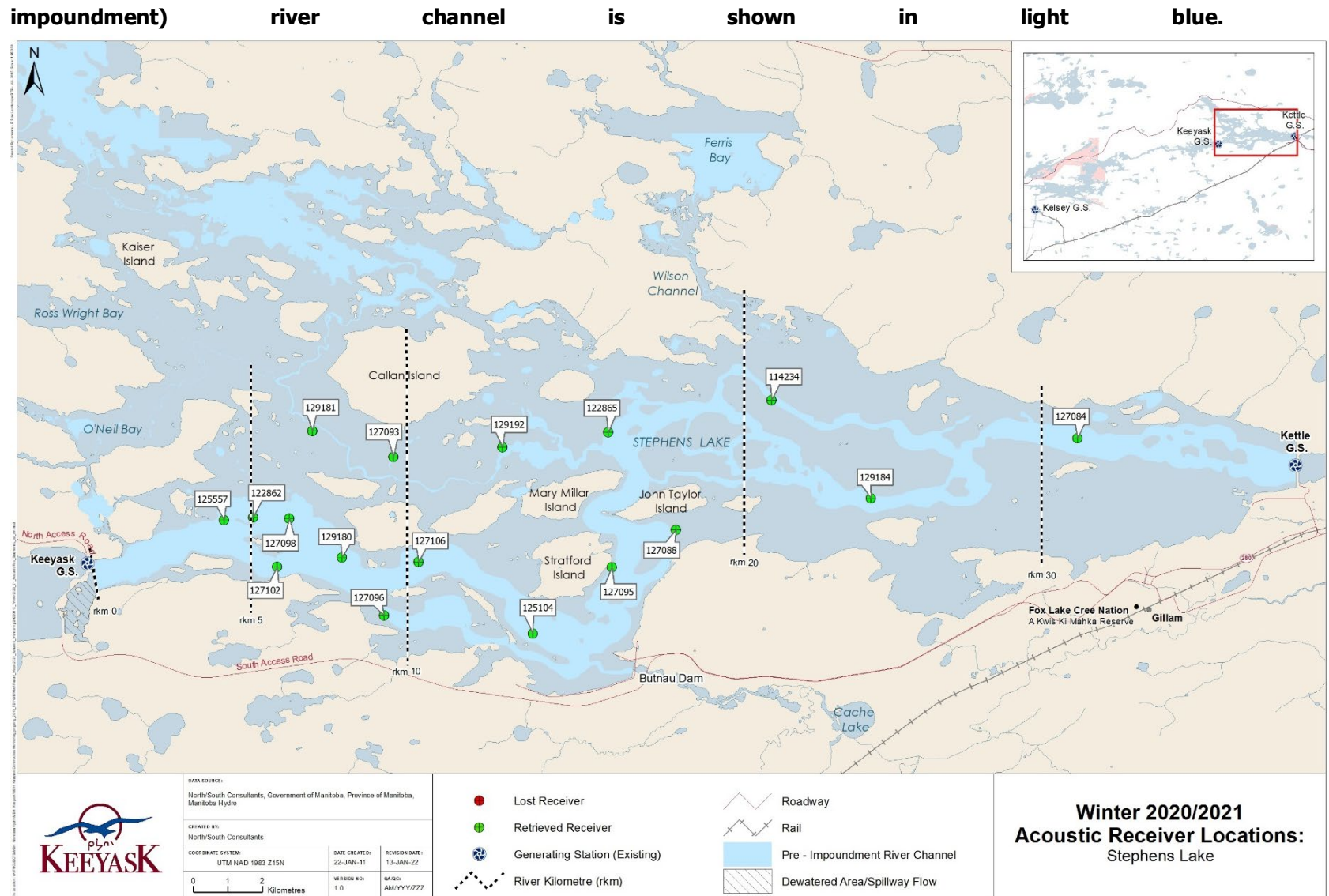
Map 1: Map of the Nelson River showing the site of the Keeyask Generating Station and the Lake Whitefish movement monitoring study setting.



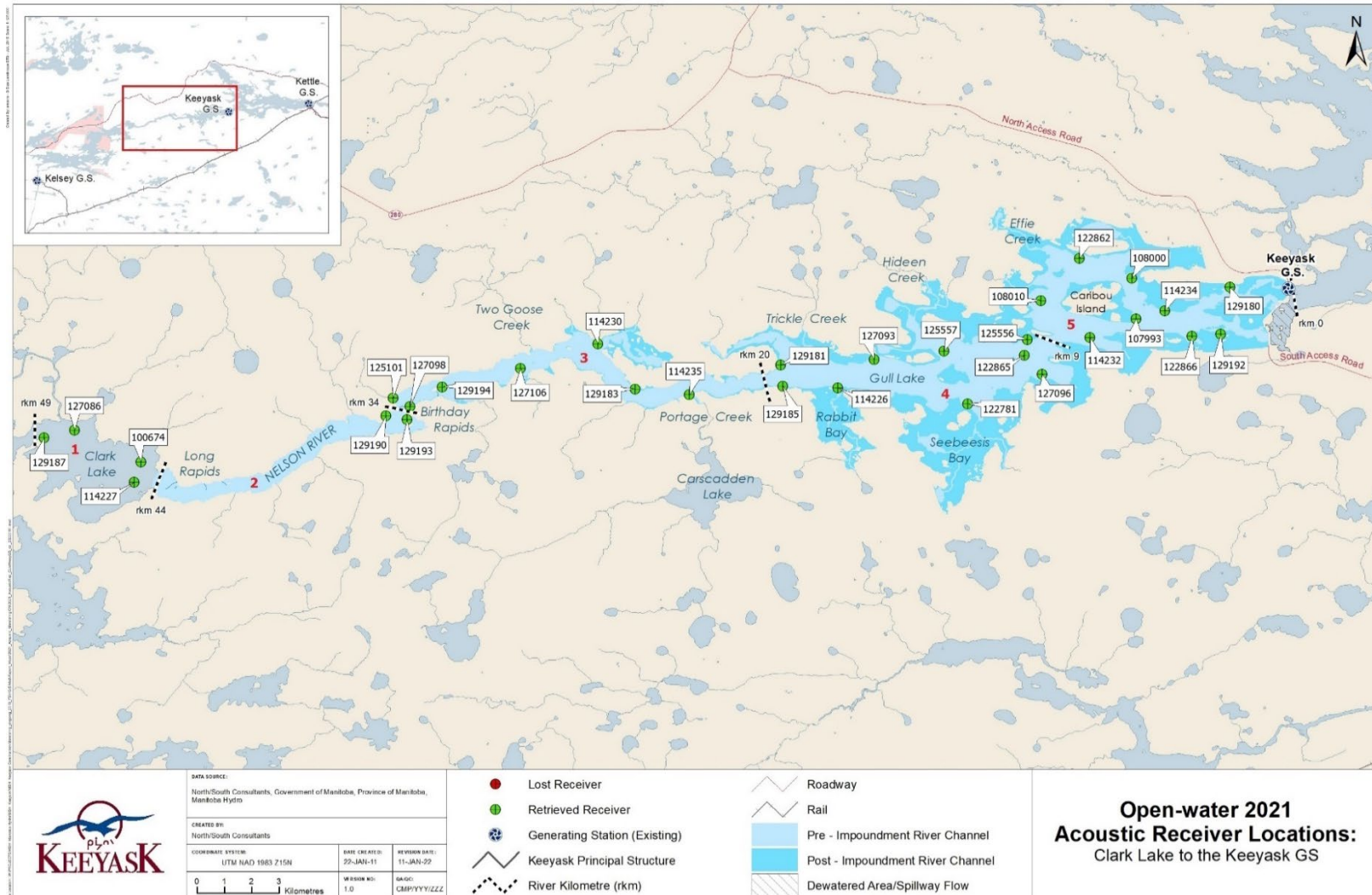
Map 2: Map of instream structures at the Keeyask Generating Station site after reservoir flooding, August 2021.



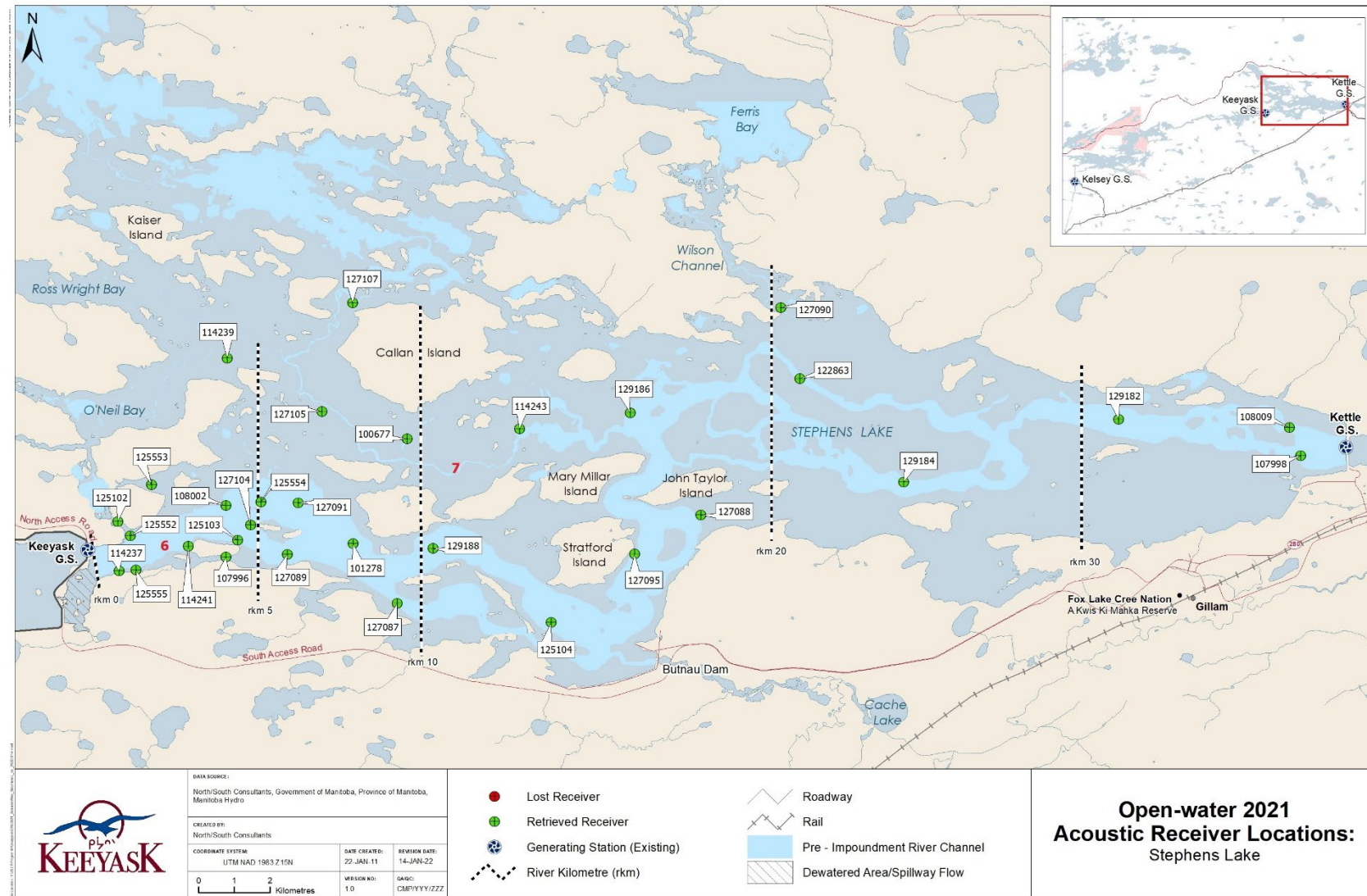
Map 3: Locations of stationary receivers set in the Nelson River from Clark Lake to the Keeyask GS between September 2020 and May 2021. River kilometer (rkm) distances are indicated with a dotted line. The former (pre-



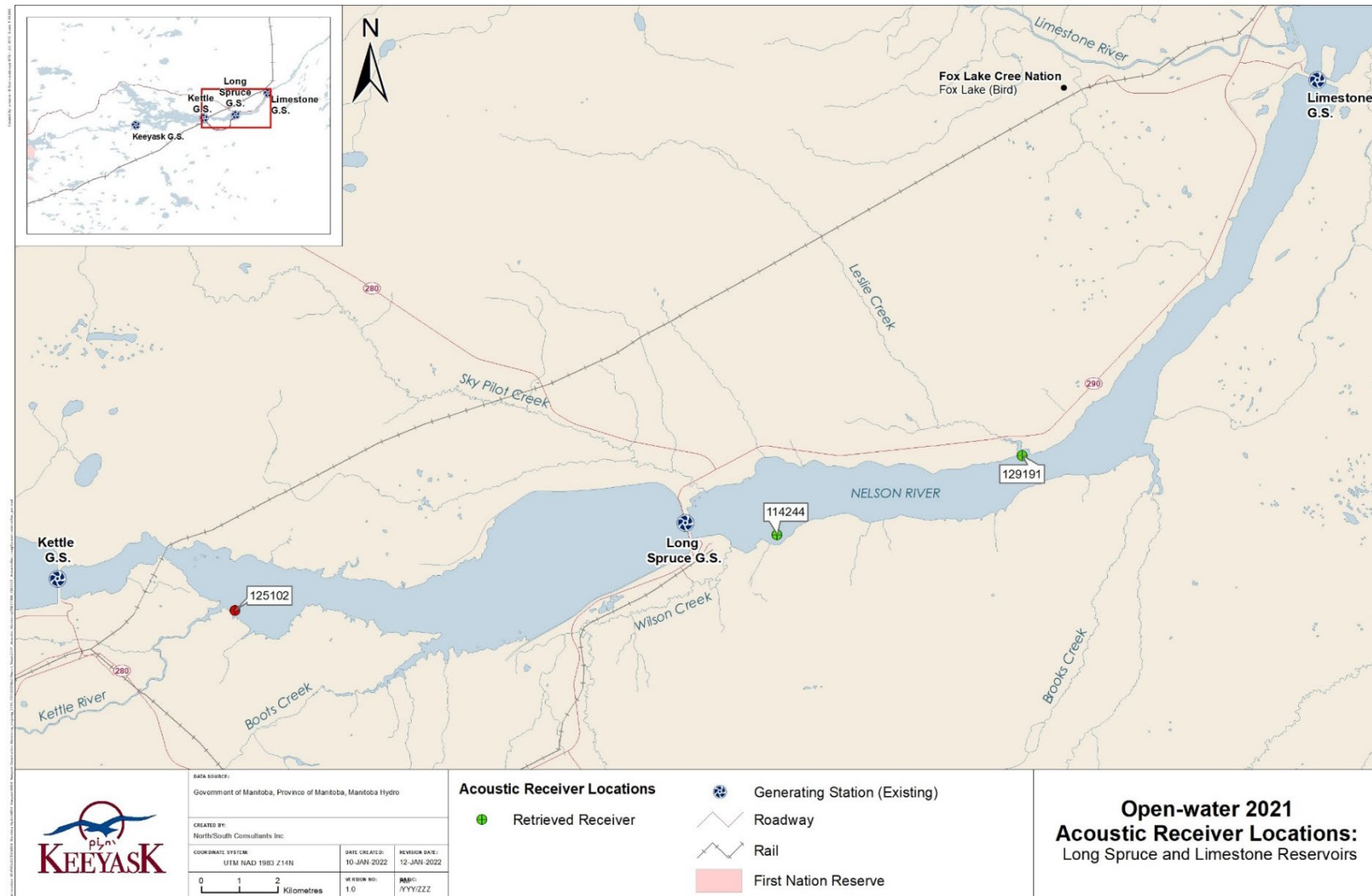
Map 4: Locations of stationary receivers set in Stephens Lake from the Keeyask GS to Kettle GS between September 2020 to May 2021. River kilometer (rkm) distances are indicated with a dotted line. The former (pre-impoundment) river channel is shown in light blue.



Map 5: **Locations of stationary receivers set in the Nelson River from Clark Lake to the Keeyask GS between June and October 2021. The river is divided into five "zones" based on placement of receiver "gates". River kilometer (rkm) distances at zone divisions are indicated with a dotted line. The former (pre-impoundment) river channel is shown in light blue.**



Map 6: Locations of stationary receivers set in Stephens Lake between June and October 2021. The river is divided into two "zones" based on placement of receiver "gates". The pre-impoundment river channel is shown in light blue. River kilometer (rkm) distances are indicated with a dotted line.



Map 7: Locations of stationary receivers set between the Kettle and Limestone Generating Stations, June to October 2021.

APPENDICES

APPENDIX 1:

DETECTION SUMMARIES FOR LAKE WHITEFISH

TAGGED AND MONITORED IN THE KEEYASK STUDY

AREA BETWEEN 2017 AND 2021.

Table A1-1:	Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged upstream of the Keeyask GS during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods.	58
Table A1-2:	Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods.	59
Table A1-3:	Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged upstream of the Keeyask GS during the 2018 (May 1 to October 10), 2019 (May 1 to October 17), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods.....	61
Table A1-4:	Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged in Stephens Lake during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods.....	62

Table A1-1: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged upstream of the Keeyask GS during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods. Tag id highlighted yellow = lost tags. Tag id highlighted purple = fish moved downstream through the Keeyask GS. Tag id highlighted red = fish moved downstream through the Kettle GS.

Tag ID	2017/2018					2018/2019					2019/2020					2020/2021				
	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)
31722	3	1	-29.4	-29.4	0.0	8	1	-29.4	-29.4	0.0	20	2	-29.4	-29.4	0.0	561	16	-29.3	-12.9	16.4
31726	13	2	-29.4	-29.4	0.0	-	-	-	-	-	-	-	-	-	-	13266	151	-19.5	-12.9	6.6
31727	132	5	-29.4	-10.3	19.1	92461	202	16.8	16.8	0.0	90685	201	16.8	16.8	0.0	33204	190	16.3	16.3	0.0
31728	8	1	-29.4	-29.4	0.0	15	1	-29.4	-29.4	0.0	-	-	-	-	-	-	-	-	-	-
31729	5	1	-29.4	-29.4	0.0	26	2	-29.4	-12.4	17.0	-	-	-	-	-	287	9	-29.3	-17.4	11.9
31730	106	3	-29.4	-10.3	19.1	6	1	-12.4	-12.4	0.0	10	3	-29.4	-12.4	17.0	363	22	-29.3	-10.1	19.2
31731	153	5	-29.4	-29.4	0.0	-	-	-	-	-	33	1	-29.4	-29.4	0.0	202	5	-29.3	-19.5	9.8
31732	14	1	-29.4	-29.4	0.0	-	-	-	-	-	114	7	-29.4	-10.3	19.1	2299	114	-29.3	-10.1	19.2
31733	9	1	-29.4	-29.4	0.0	-	-	-	-	-	4	1	-29.4	-29.4	0.0	1532	12	-29.3	-26.4	2.9
31734	5914	16	-29.4	-10.3	19.1	-	-	-	-	-	111	11	-12.4	-10.3	2.1	1100	28	-19.5	-10.1	9.4
31735	50	2	-29.4	-10.3	19.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31736	26	1	-29.4	-29.4	0.0	6	1	-29.4	-29.4	0.0	3	1	-29.4	-29.4	0.0	359	12	-26.4	-12.9	13.5
31737	138	4	-29.4	-10.3	19.1	39	3	-29.4	-12.4	17.0	-	-	-	-	-	365	10	-29.3	-10.1	19.2
31738	227	7	-29.4	-10.3	19.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31739	145	3	-29.4	-12.4	17.0	76	4	-12.4	-12.4	0.0	-	-	-	-	-	1113	32	-19.5	-10.1	9.4
31740	948	11	-29.4	18.6	48.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31741	9	1	-29.4	-29.4	0.0	22	2	-29.4	-12.4	17.0	-	-	-	-	-	3657	47	-29.3	-7.9	21.4
31742	3	1	-29.4	-29.4	0.0	9	1	-29.4	-29.4	0.0	45	1	-29.4	-29.4	0.0	1204	21	-29.3	-12.9	16.4
31743	4	1	-29.4	-29.4	0.0	10	1	-29.4	-29.4	0.0	2	1	-10.3	-10.3	0.0	2533	20	-48.2	-2.2	46.0
31744	280	14	-29.4	-12.4	17.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31745	-	-	-	-	-	170	5	-29.4	-12.4	17.0	7	1	-29.4	-29.4	0.0	32	3	-29.3	-12.4	16.9
31746	434	5	-29.4	-29.4	0.0	-	-	-	-	-	17	1	-29.4	-29.4	0.0	2597	46	-29.3	-7.9	21.4

Table A1-2: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods. Tag id highlighted yellow = lost tags. Tag id highlighted red = fish moved downstream through the Kettle GS.

Tag ID	Date tagged	2017/2018					2018/2019					2019/2020					2020/2021				
		n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)
31698	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31699	9-Oct-17	16567	160	5.2	18.6	13.4	36290	147	5.2	18.6	13.4	26940	153	5.2	18.6	13.4	50822	199	3.9	13.4	9.5
31700	9-Oct-17	69	3	6.5	6.5	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31701	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31702	9-Oct-17	8556	66	5.2	36.1	30.9	122	5	5.2	8.4	3.2	11939	41	5.8	8.4	2.6	-	-	-	-	-
31703	9-Oct-17	7	2	6.5	6.5	0.0	-	-	-	-	-	3	1	5.8	5.8	0.0	77	1	4.9	9.9	5.0
31704	9-Oct-17	1111	22	5.2	36.1	30.9	-	-	-	-	-	-	-	-	-	-	30	2	3.9	7.5	3.6
31705	9-Oct-17	44	1	6.5	6.5	0.0	-	-	-	-	-	-	-	-	-	-	66	1	7.5	9.9	2.4
31706	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31707	9-Oct-17	7193	61	6.5	8.4	1.9	5715	26	6.5	6.5	0.0	-	-	-	-	-	-	-	-	-	-
31708	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31709	9-Oct-17	841	18	5.2	21.6	16.4	163	2	5.2	16.8	11.6	669	8	5.2	16.8	11.6	1595	24	3.9	9.9	6.0
31710	9-Oct-17	34	3	6.5	8.4	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31711	9-Oct-17	154	5	5.2	24.7	19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31712	9-Oct-17	12134	73	5.2	16.8	11.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31713	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31714	9-Oct-17	77	3	5.2	7.9	2.7	-	-	-	-	-	-	-	-	-	-	7	1	3.9	4.9	1.0
31715	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	189	6	3.9	4.9	1.0
31716	8-Oct-17	426	3	6.5	7.9	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31717	8-Oct-17	173	2	5.2	24.7	19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31718	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A1-2: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), 2019/2020 (October 8, 2019 to April 30, 2020), and 2020/2021 (September 24, 2020 to April 30, 2021) winter periods. Tag id highlighted yellow = lost tags. Tag id highlighted red = fish moved downstream through the Kettle GS (continued).

Tag ID	Date tagged	2017/2018					2018/2019					2019/2020					2020/2021				
		n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)
31719	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31720	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31721	8-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31723	10-Oct-17	36	2	5.2	6.5	1.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31724	10-Oct-17	35	2	6.5	8.4	1.9	198	7	5.2	16.8	11.6	6	1	5.8	5.8	0.0	-	-	-	-	-
31725	10-Oct-17	29	1	5.2	7.9	2.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31747	10-Oct-17	46	2	36.1	36.1	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31748	10-Oct-17	52985	179	5.2	21.6	16.4	16765	135	5.2	21.6	16.4	-	-	-	-	-	-	-	-	-	-
31749	10-Oct-17	1100	13	6.5	21.6	15.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31750	10-Oct-17	503	5	5.2	6.5	1.3	64	4	5.8	8.4	2.6	967	11	5.8	8.4	2.6	189	8	3.9	7.5	3.6
31751	10-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31752	10-Oct-17	736	16	6.5	21.6	15.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31753	10-Oct-17	1414	10	6.5	8.4	1.9	16	3	6.5	6.5	0.0	567	17	5.2	8.4	3.2	208	7	4.9	10.2	5.3
31754	10-Oct-17	9850	73	5.2	8.4	3.2	593	7	5.8	8.4	2.6	114	2	5.8	6.5		389	10	3.9	9.9	6.0
31755	10-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31756	10-Oct-17	346	5	6.5	36.1	29.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31757	10-Oct-17	6	2	6.5	6.5	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53761	10-Oct-17	-	-	-	-	-	9	2	21.6	21.6	0.0	-	-	-	-	-	-	-	-	-	-
53762	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A1-3: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged upstream of the Keeyask GS during the 2018 (May 1 to October 10), 2019 (May 1 to October 17), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods. Tag id highlighted yellow = lost tags. Tag id highlighted purple = fish moved downstream through the Keeyask GS. Tag id highlighted red = fish moved downstream through the Kettle GS.

Tag ID	Date tagged	2018					2019					2020					2021				
		n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)
31722	7-Oct-17	6868	62	-29.4	-12.8	16.6	6733	58	-19.5	-12.9	6.6	6884	58	-12.9	-12.9	0.0	6928	83	-22.6	-12.9	9.7
31726	12-Oct-17	13454	93	-19.5	-12.8	6.7	3978	52	-19.5	-12.9	6.6	4155	46	-19.5	-12.9	6.6	2662	29	-19.5	-12.9	6.6
31727	12-Oct-17	6891	86	1.2	18.6	17.4	-	-	-	-	-	21964	123	16.3	16.8	0.5	7625	86	16.3	16.3	0.0
31728	14-Oct-17	16398	77	-33.8	-26.5	7.3	9171	67	-26.5	-26.5	0.0	-	-	-	-	-	-	-	-	-	-
31729	14-Oct-17	11540	70	-33.8	-9.3	24.5	12091	81	-33.8	-7.4	26.4	7792	59	-19.5	-7.9	11.6	6844	59	-34.3	-5.8	28.5
31730	14-Oct-17	18066	73	-33.8	-9.9	23.9	2797	43	-15	-9.9	5.1	5404	20	-12.5	-9.9	2.6	5661	60	-24.2	-9.9	14.3
31731	14-Oct-17	105	13	-19.5	-19.5	0.0	102	11	-19.5	-19.5	0.0	334	21	-26.4	-19.5	6.9	919	41	-26.4	-15.0	11.4
31732	12-Oct-17	3780	73	-12.9	-9.3	3.6	3773	24	-33.8	-9.9	23.9	4299	43	-19.5	-9.9	9.6	11861	86	-34.3	-9.9	24.4
31733	14-Oct-17	14460	74	-33.8	-26.5	7.3	8963	45	-33.8	-26.5	7.3	636	19	-33.8	-26.4	7.4	14188	60	-34.3	-26.4	7.9
31734	14-Oct-17	2432	26	-19.5	-9.9	9.6	491	27	-19.5	-9.9	9.6	4997	41	-19.5	-9.9	9.6	12716	70	-19.5	-9.9	9.6
31735	12-Oct-17	2746	25	-9.3	-4.8	4.5	-	-	-	-	-	-	-	-	-	-	3052	17	-4.0	-4.0	0.0
31736	12-Oct-17	16257	82	-33.8	-9.9	23.9	5103	66	-33.8	-12.9	20.9	2362	44	-19.5	-12.9	6.6	1288	46	-34.3	-12.9	21.4
31737	12-Oct-17	4807	62	-19.5	-5.8	13.7	2665	52	-33.8	-9	24.8	9975	52	-19.5	-9.9	9.6	-	-	-	-	-
31738	11-Oct-17	4222	73	-9.9	1.2	11.1	294	30	1.2	1.2	0.0	8	3	1.2	1.2	0.0	94	7	1.2	1.2	0.0
31739	11-Oct-17	4182	40	-19.5	-9.9	9.6	5998	79	-19.5	-9.9	9.6	9940	55	-17.4	-9.9	7.5	7420	69	-34.3	-3.8	30.5
31740	11-Oct-17	-	-	-	-	-	-	-	-	-	-	228	5	45.7	45.7	0.0	-	-	-	-	-
31741	11-Oct-17	17796	113	-33.8	-9	24.8	12895	59	-33.8	-7.4	26.4	3538	63	-34.3	-6.2	28.1	16638	103	-34.3	-9.9	24.4
31742	11-Oct-17	1990	36	-33.8	-12.9	20.9	325	14	-19.5	-19.5	0.0	2508	35	-19.5	-19.5	0.0	3272	68	-34.3	-15.0	19.3
31743	11-Oct-17	19757	92	-33.8	-7.4	26.4	19373	102	-33.8	-7.4	26.4	4394	50	-34.3	-6.2	28.1	5101	58	-34.3	-3.8	30.5
31744	11-Oct-17	440	7	-26.5	-12.8	13.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31745	11-Oct-17	9343	93	-33.8	-4.8	29.0	14373	69	-34.3	-9.3	25.0	5974	47	-33.8	-6.2	27.6	11229	69	-34.3	-3.8	30.5
31746	11-Oct-17	26627	121	-19.5	-7.4	12.1	22103	116	-19.5	-7.4	12.1	15247	81	-19.5	-6.2	13.3	6400	83	-24.2	-6.2	18.0

Table A1-4: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged in Stephens Lake during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods. Tag id highlighted yellow = lost tags. Tag id highlighted red = fish moved downstream through the Kettle GS.

Tag ID	Date tagged	2018					2019					2020					2021				
		n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)
31698	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31699	9-Oct-17	13497	113	3.8	18.6	14.8	18807	123	4.3	18.6	14.3	10373	86	3.9	18.8	14.9	23231	146	1.3	18.8	17.5
31700	9-Oct-17	1789	46	2.7	7.9	5.2	-	-	-	-	-	-	-	-	-	-	9	2	1.9	1.9	0.0
31701	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31702	9-Oct-17	11844	65	1.2	9.4	8.2	9734	56	3.9	13	9.1	2081	35	5.2	10.3	5.1	378	8	8.7	8.7	0.0
31703	9-Oct-17	2854	19	1.2	7.4	6.2	7597	30	1.2	9.4	8.2	527	8	1.2	8.7	7.5	1118	20	0.8	24.9	24.1
31704	9-Oct-17	1888	24	1.2	36.1	34.9	2025	22	1.2	9.4	8.2	-	-	-	-	-	-	-	-	-	-
31705	9-Oct-17	932	5	1.2	7.4	6.2	886	10	0.6	7.4	6.8	7	1	5	5	0.0	501	5	0.8	1.9	1.1
31706	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31707	9-Oct-17	13071	31	3.8	7.4	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31708	9-Oct-17	21	5	1.2	1.2	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31709	9-Oct-17	7230	11	1.2	7.9	6.7	536	2	2.7	7.9	5.2	-	-	-	-	-	-	-	-	-	-
31710	9-Oct-17	361	14	3.8	7.4	3.6	438	8	6.5	9.4	2.9	-	-	-	-	-	-	-	-	-	-
31711	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31712	9-Oct-17	5045	43	6.5	24.7	18.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31713	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31714	9-Oct-17	77	4	3.8	3.8	0.0	1887	29	4.2	4.2	0.0	182	12	5	5	0.0	-	-	-	-	-
31715	9-Oct-17	1024	5	1.2	7.4	6.2	213	4	1.2	13	11.8	229	5	1.2	5	3.8	121	5	5.0	9.9	4.9
31716	8-Oct-17	34874	75	1.2	2.7	1.5	59102	131	1.2	1.2	0.0	37887	81	1.2	1.2	0.0	38325	126	1.2	1.2	0.0
31717	8-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31718	9-Oct-17	64	2	3.8	3.8	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A1-4: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometre (rkm) detection sites, and detection range for Lake Whitefish tagged in Stephens Lake during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), 2020 (May 1 to September 23), and 2021 (May 1 to October 10) open-water periods. Tag id highlighted yellow = lost tags. Tag id highlighted red = fish moved downstream through the Kettle GS.

Tag ID	Date tagged	2018					2019					2020					2021				
		n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)	n	# Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Range (rkm)
31719	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31720	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31721	8-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31723	10-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31724	10-Oct-17	11143	54	1.2	13	11.8	12347	71	1.2	18.6	17.4	1967	42	5	13	8.0	-	-	-	-	-
31725	10-Oct-17	62	1	7.4	7.4	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31747	10-Oct-17	249	4	1.2	4.4	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31748	10-Oct-17	8800	94	1.2	36.1	34.9	1053	24	13	40.8	27.8	-	-	-	-	-	-	-	-	-	-
31749	10-Oct-17	52	6	16.8	24.7	7.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31750	10-Oct-17	5820	21	1.2	7.9	6.7	288	5	1.2	7.4	6.2	-	-	-	-	-	144	5	5.0	8.7	3.7
31751	10-Oct-17	15	2	3.8	7.4	3.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31752	10-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31753	10-Oct-17	5106	53	3.8	6.5	2.7	1963	37	4.2	6.5	2.3	1853	29	5	13.9	8.9	2839	46	0.8	13.4	12.6
31754	10-Oct-17	4662	53	2.7	13	10.3	2666	33	1.2	18.6	17.4	605	15	7.5	13.2	5.7	5512	30	0.8	13.2	12.4
31755	10-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31756	10-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31757	10-Oct-17	404	6	6.5	10.3	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53761	10-Oct-17	1817	46	3.8	24.7	20.9	219	5	6.5	16.8	10.3	-	-	-	-	-	-	-	-	-	-
53762	9-Oct-17	61	4	20	36.1	16.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX 2:

LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC-TAGGED LAKE WHITEFISH IN GULL LAKE, OCTOBER 2017 TO OCTOBER 2021

Figure A2-1:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31722) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	66
Figure A2-2:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31726) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	67
Figure A2-3:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31727) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	68
Figure A2-4:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31728) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	69
Figure A2-5:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31729) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	70
Figure A2-6:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31730) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	71
Figure A2-7:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31731) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	72
Figure A2-8:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31732) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	73
Figure A2-9:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31733) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	74
Figure A2-10:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31734) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	75
Figure A2-11:	Position of a Lake Whitefish tagged with an acoustic transmitter (code #31735) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	76

Figure A2-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31736) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	77
Figure A2-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31737) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	78
Figure A2-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31738) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	79
Figure A2-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31739) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	80
Figure A2-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31740) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	81
Figure A2-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31741) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	82
Figure A2-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31742) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	83
Figure A2-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31743) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	84
Figure A2-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31744) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	85
Figure A2-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31745) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	86
Figure A2-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31746) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.....	87

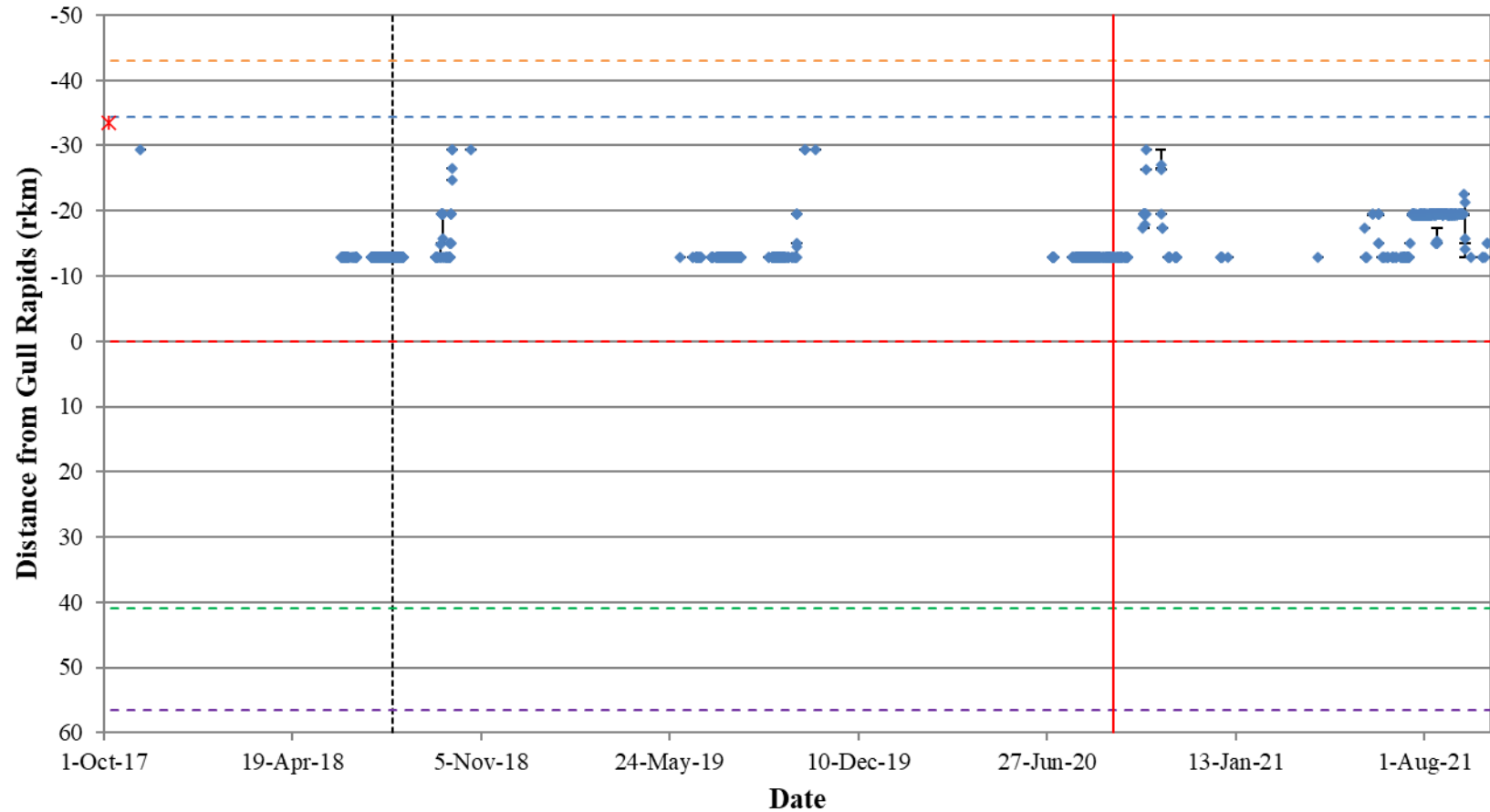


Figure A2-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31722) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

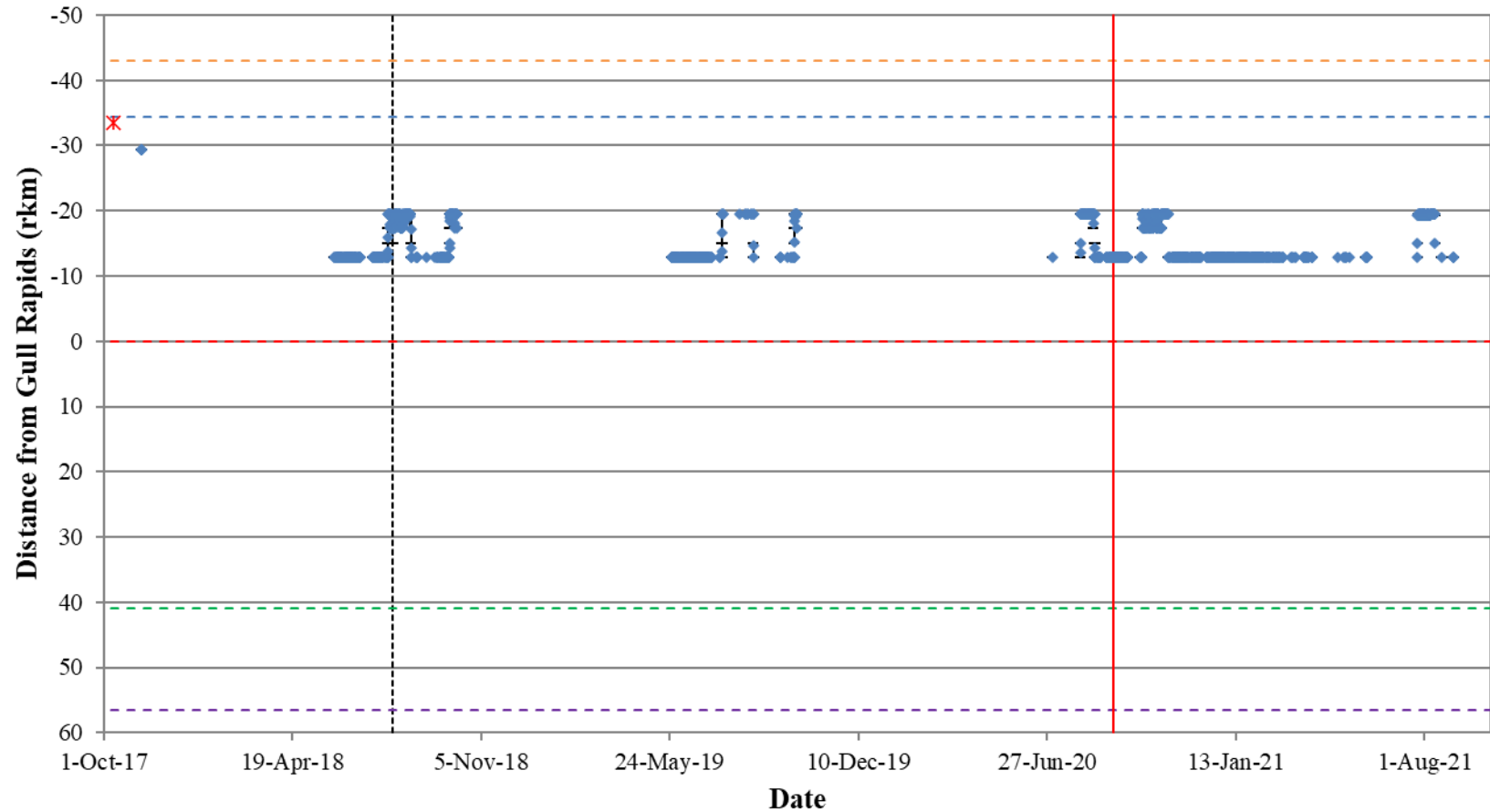


Figure A2-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31726) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

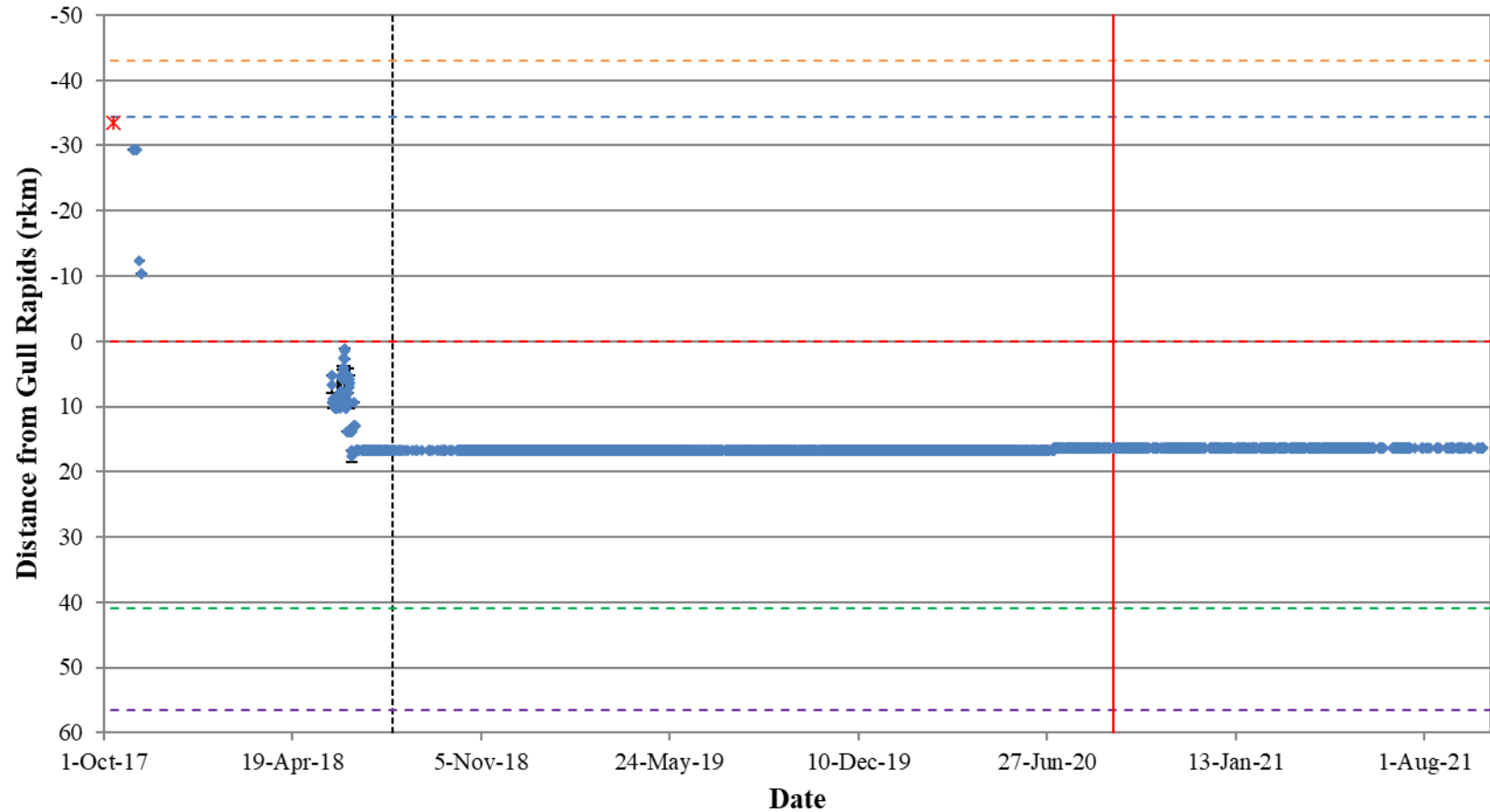


Figure A2-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31727) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

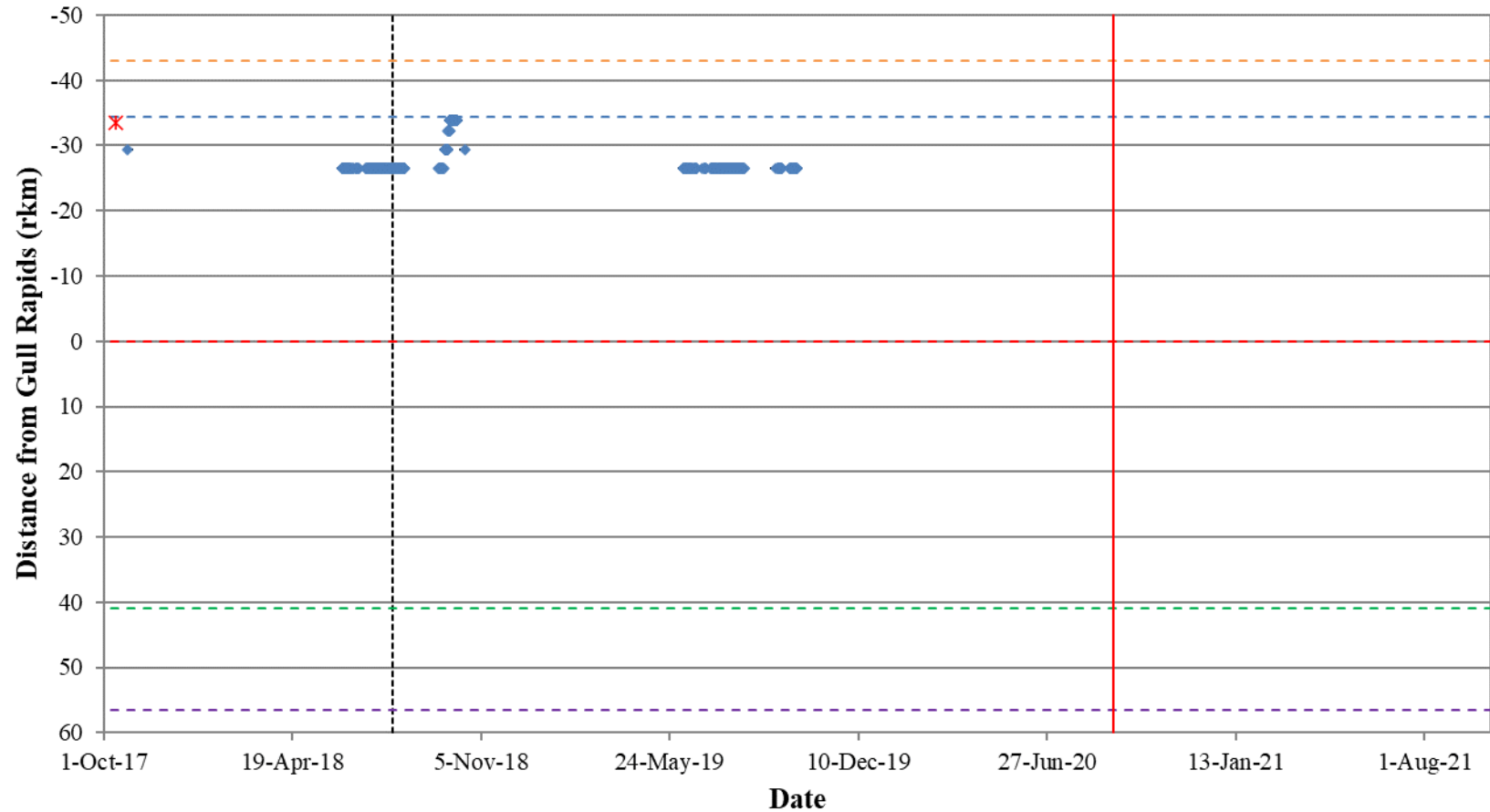


Figure A2-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31728) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

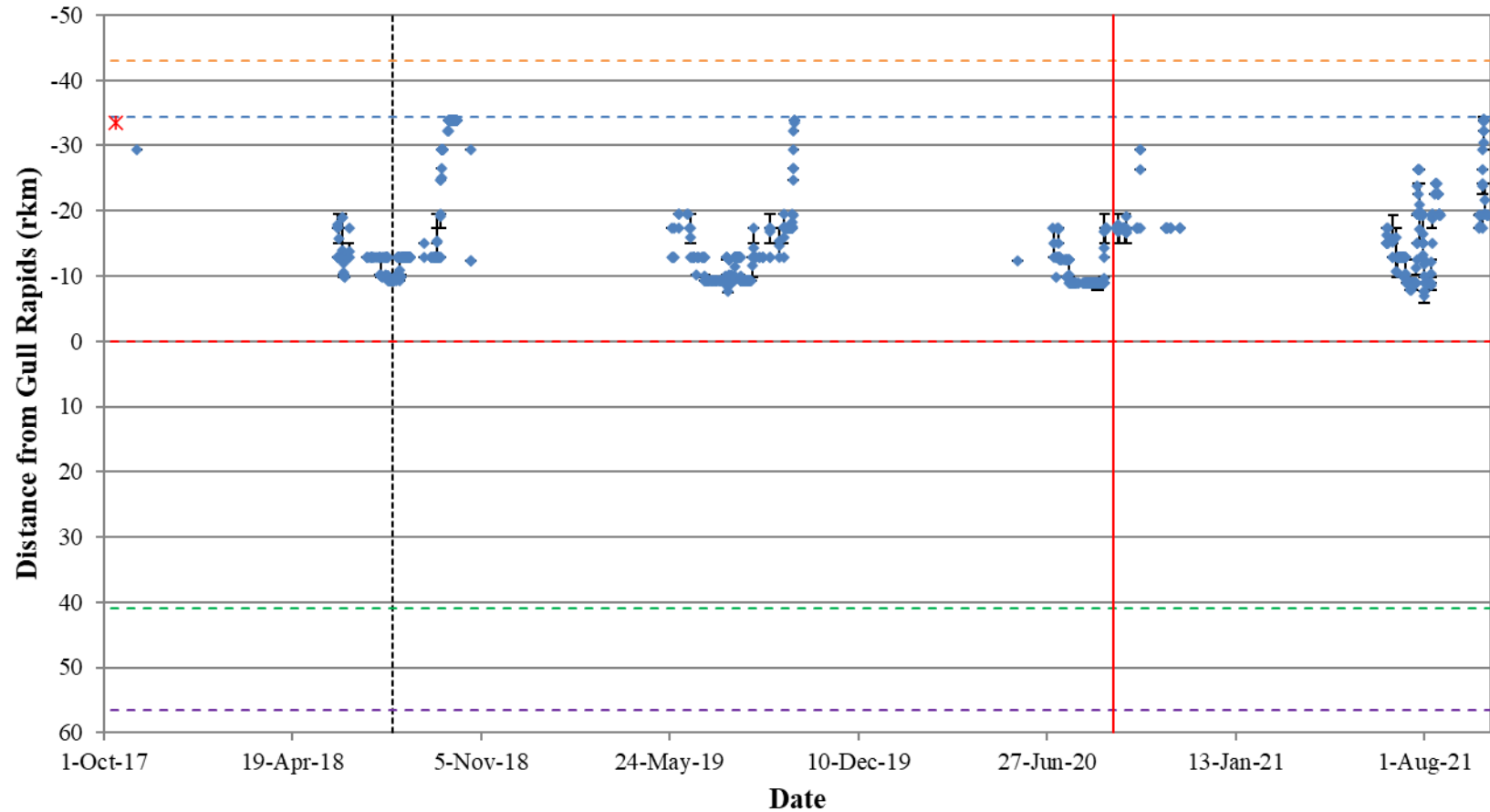


Figure A2-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31729) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

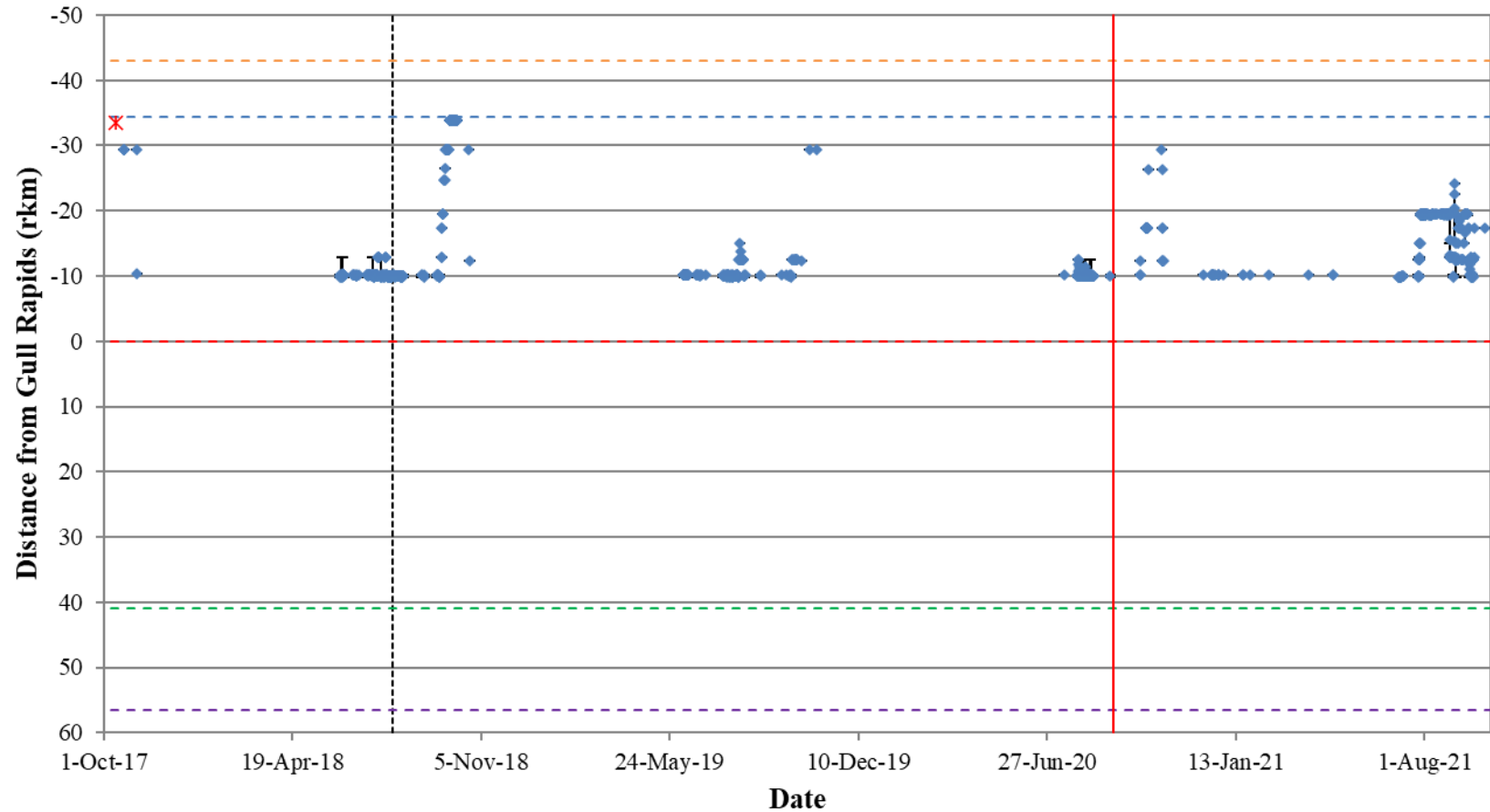


Figure A2-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31730) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

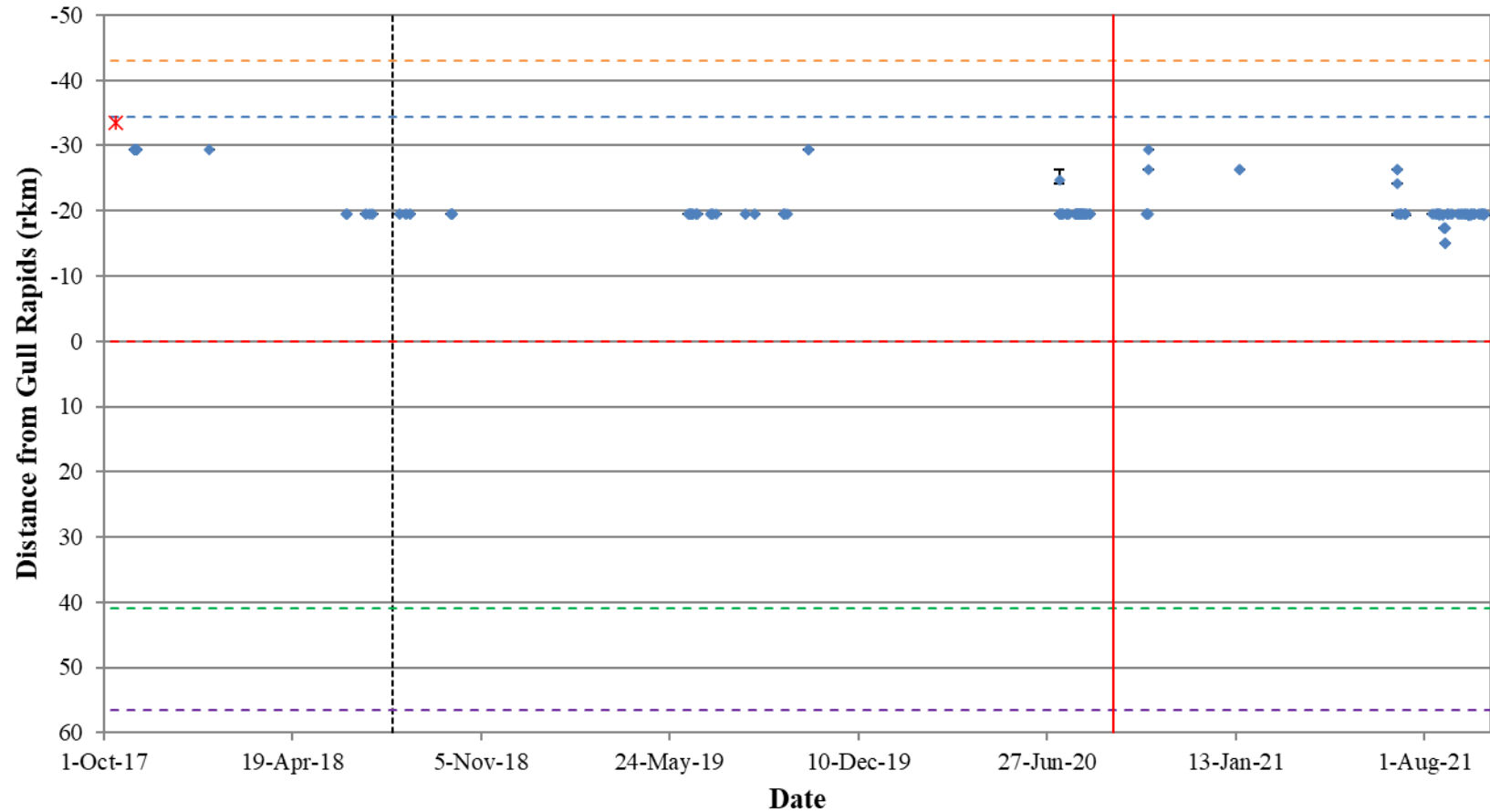


Figure A2-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31731) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

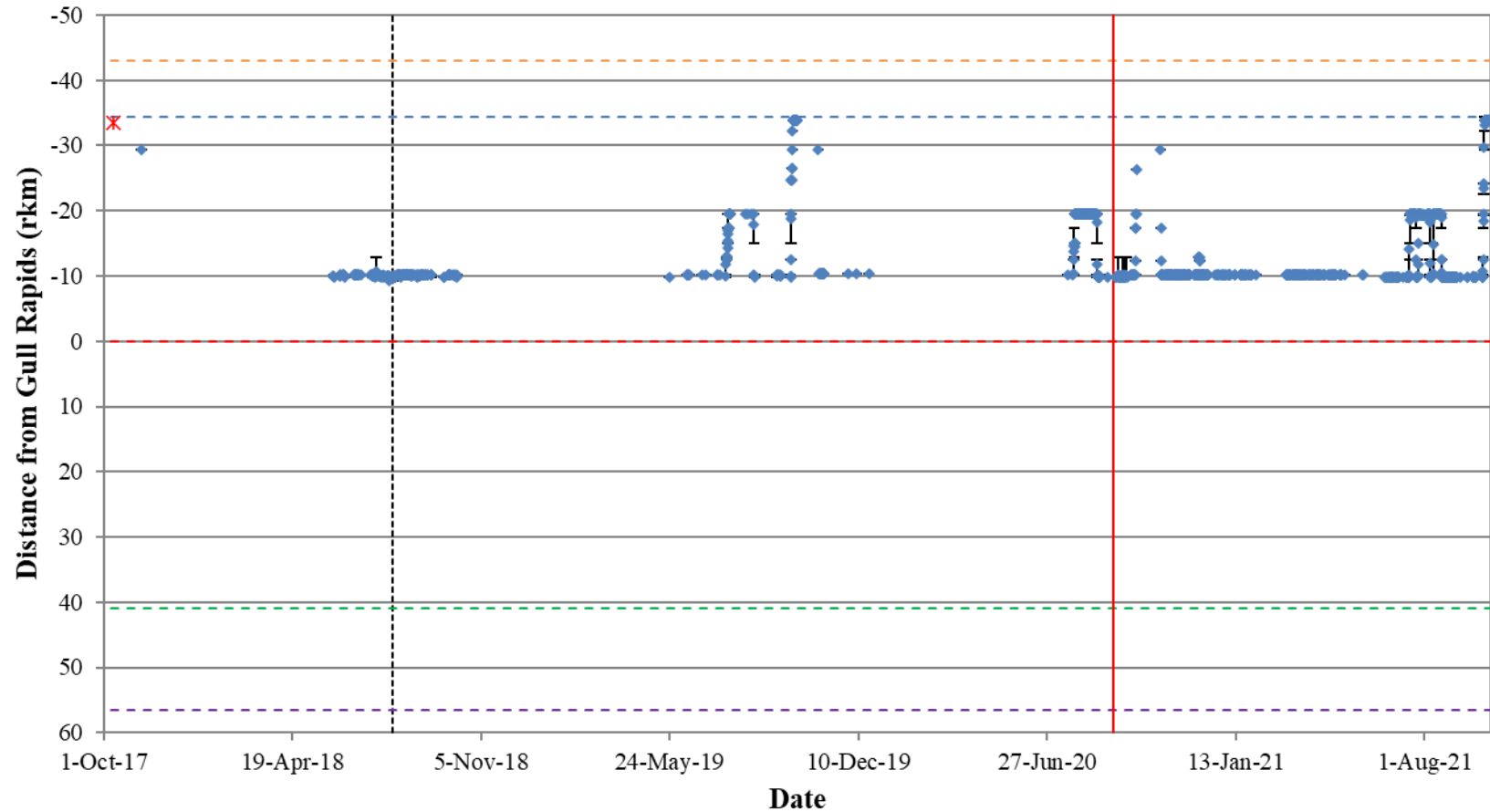


Figure A2-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31732) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

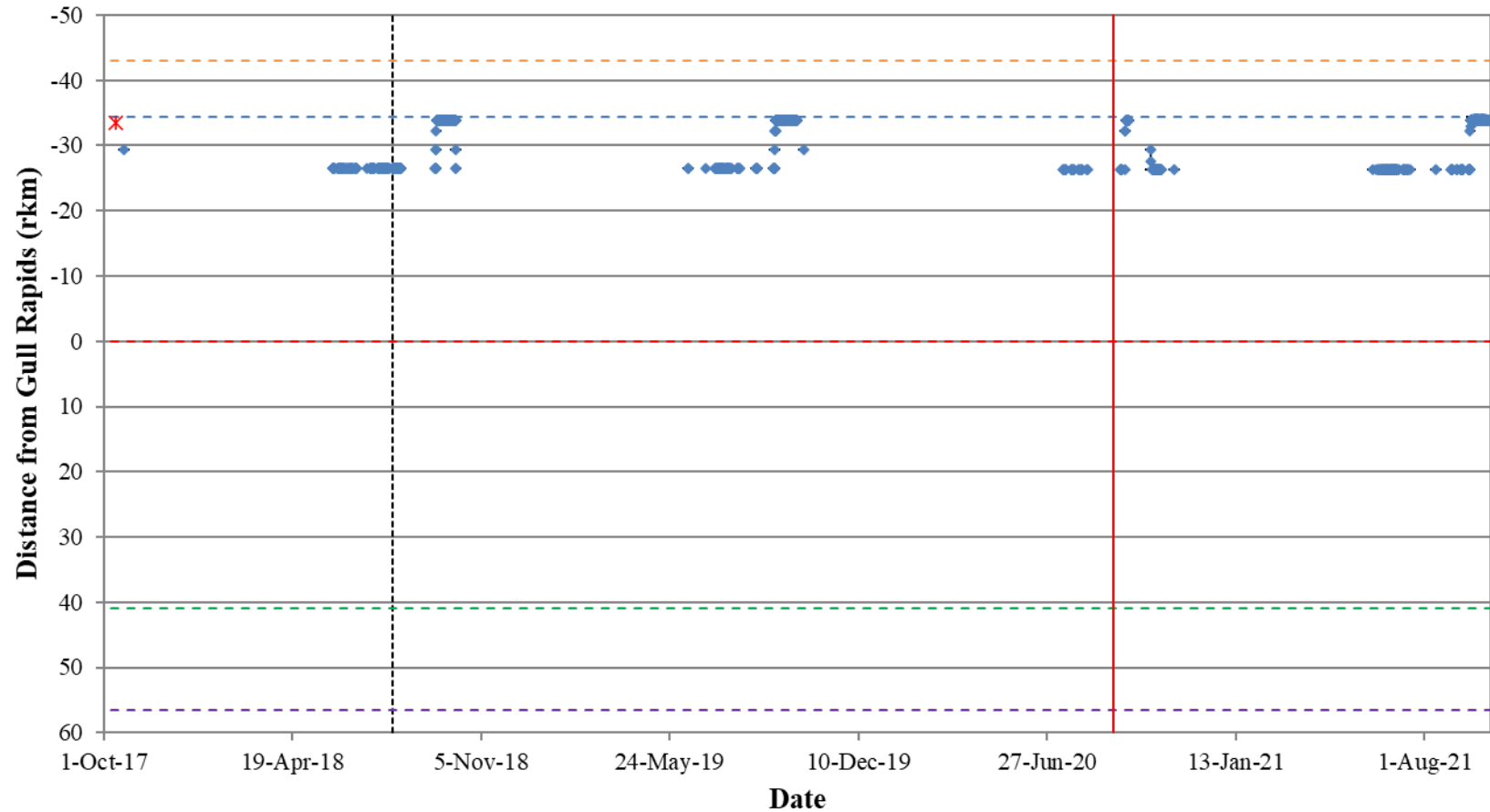


Figure A2-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31733) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

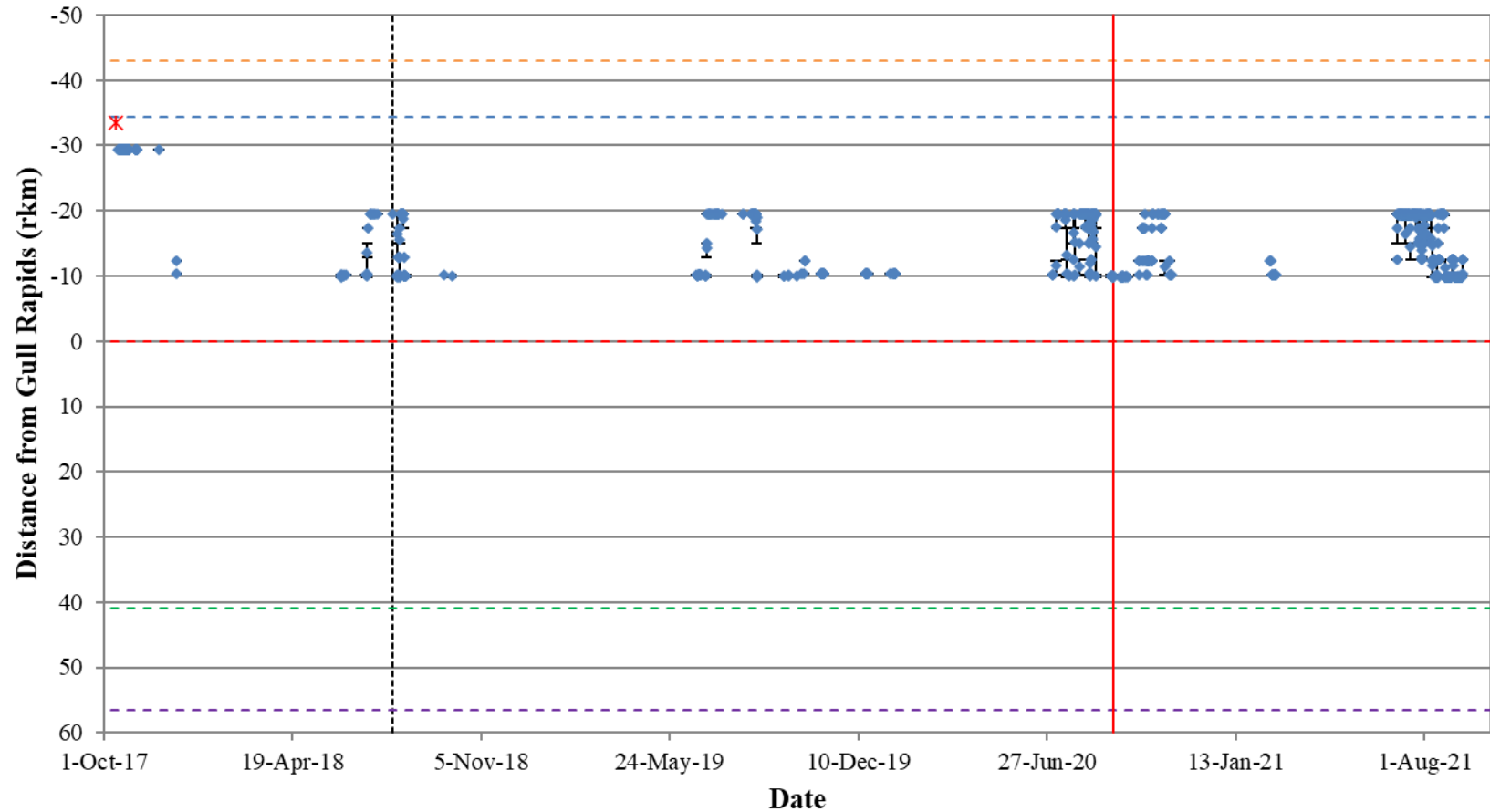


Figure A2-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31734) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

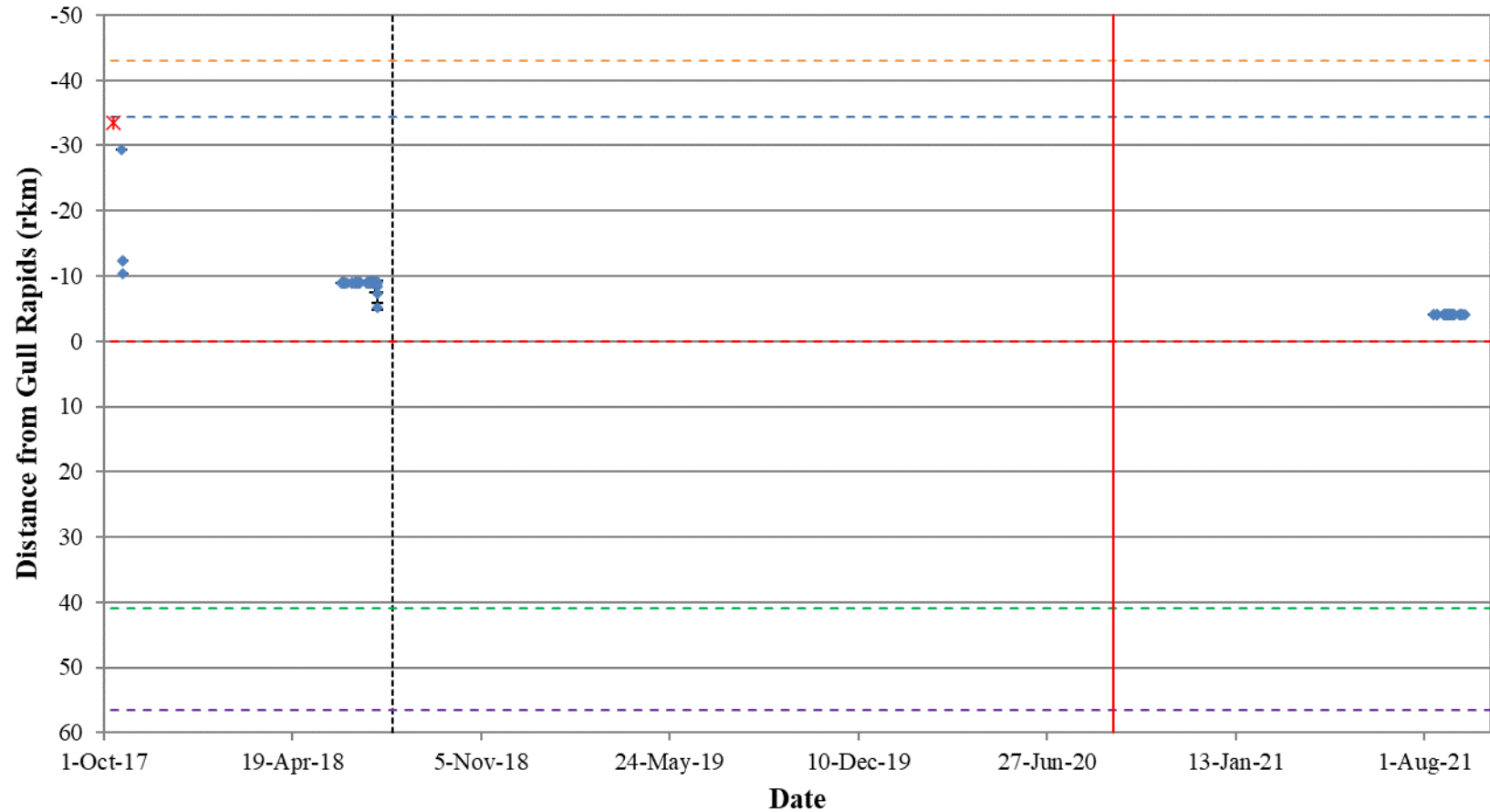


Figure A2-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31735) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

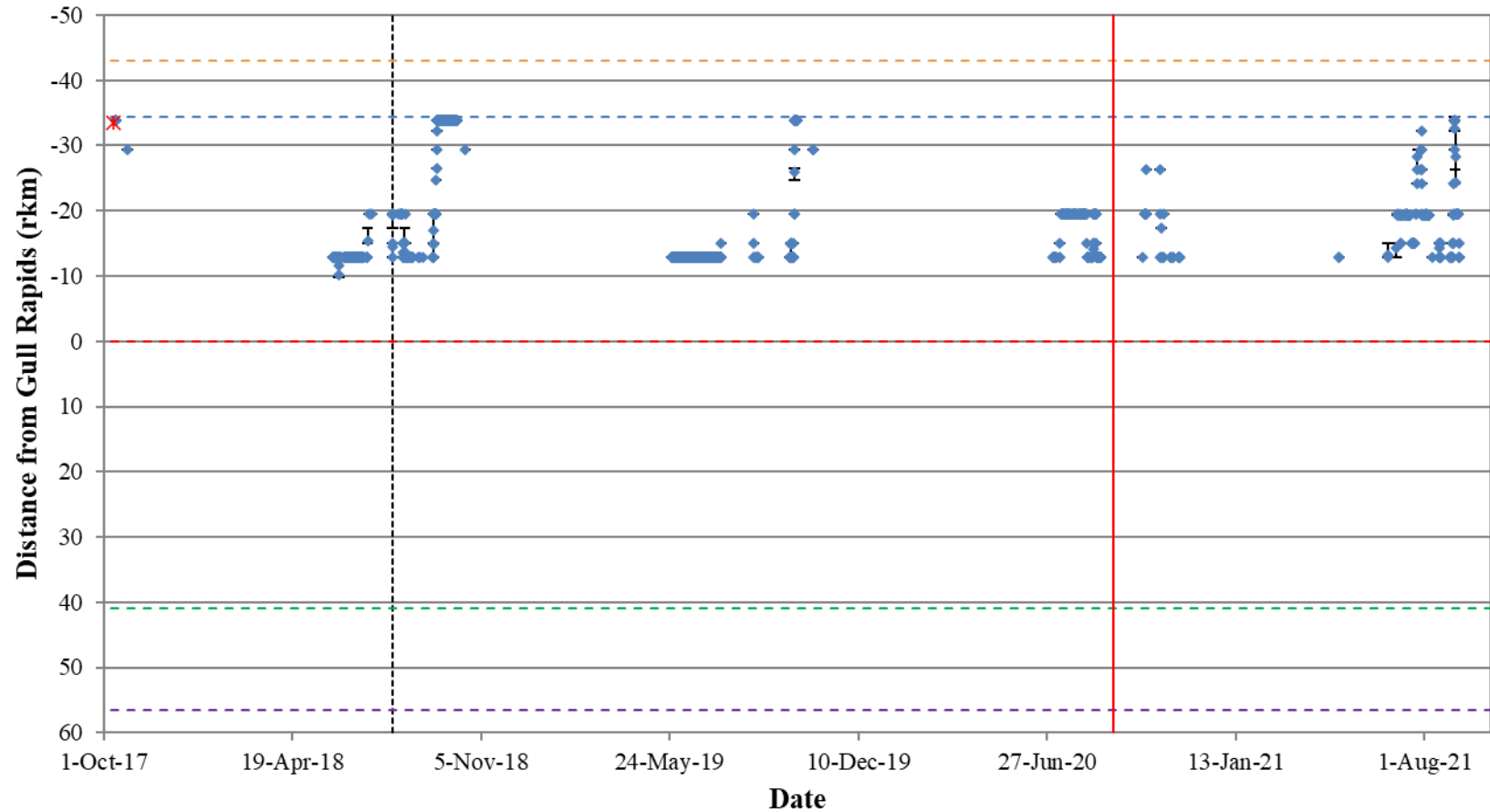


Figure A2-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31736) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

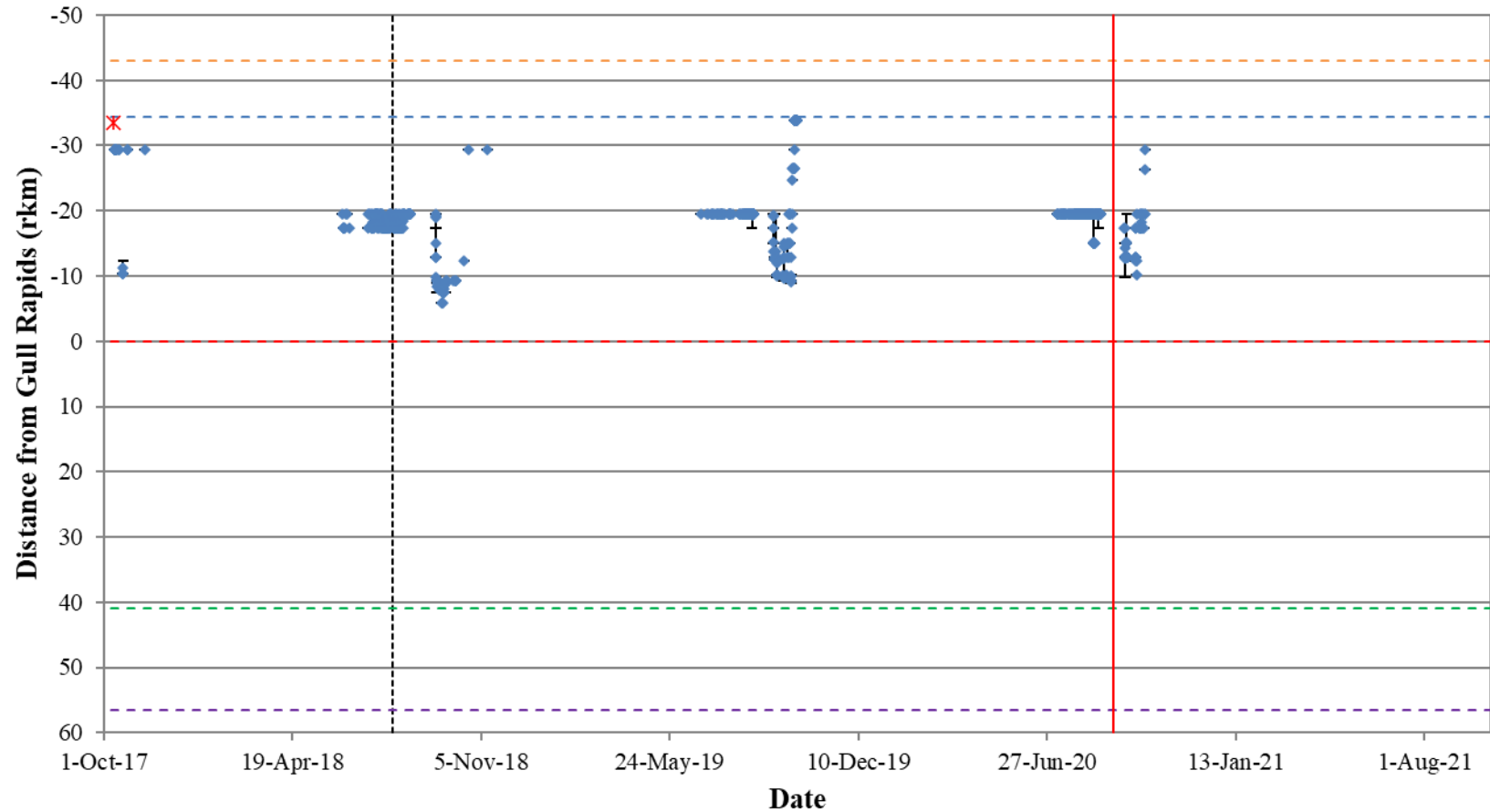


Figure A2-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31737) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

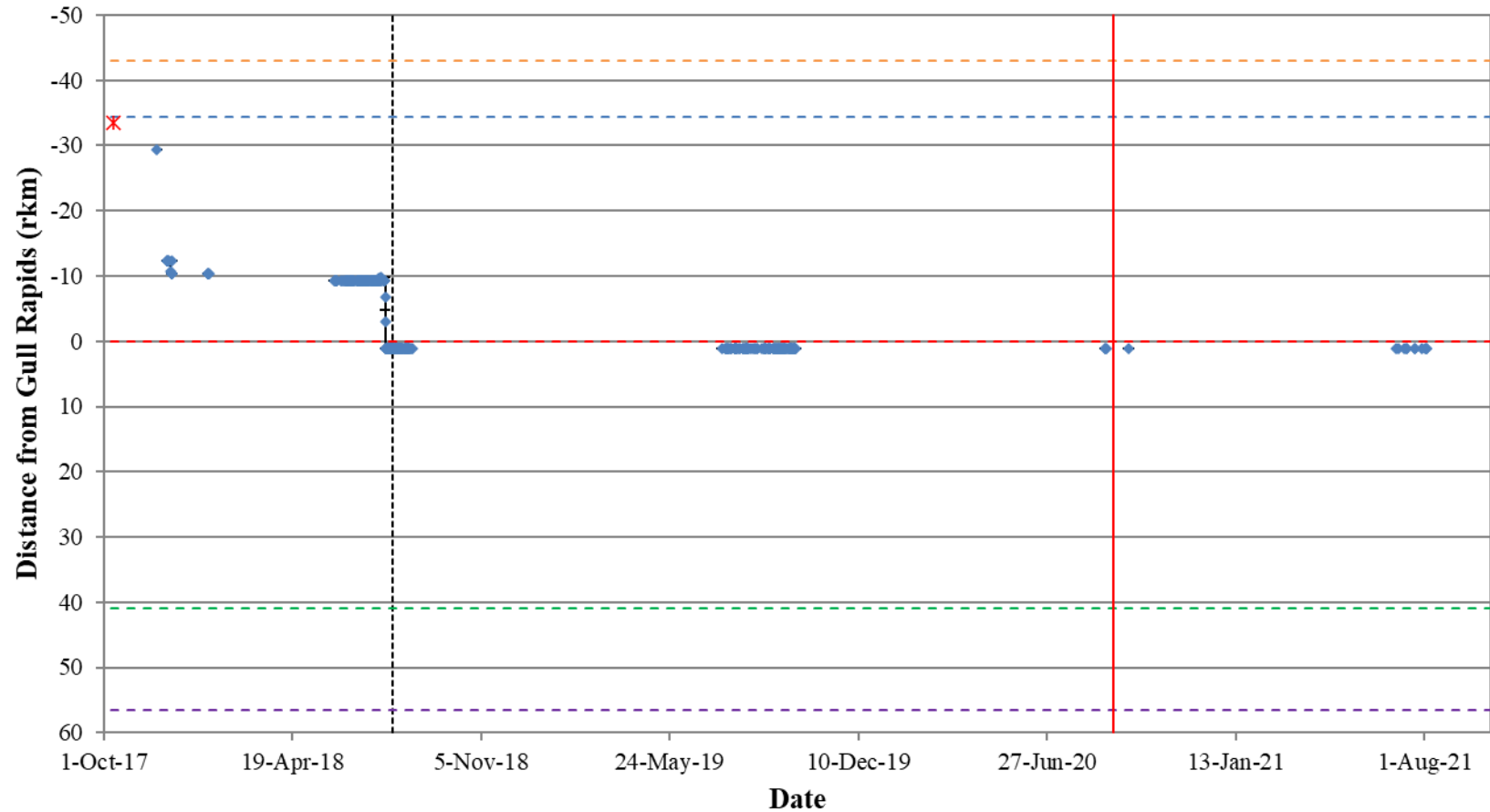


Figure A2-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31738) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

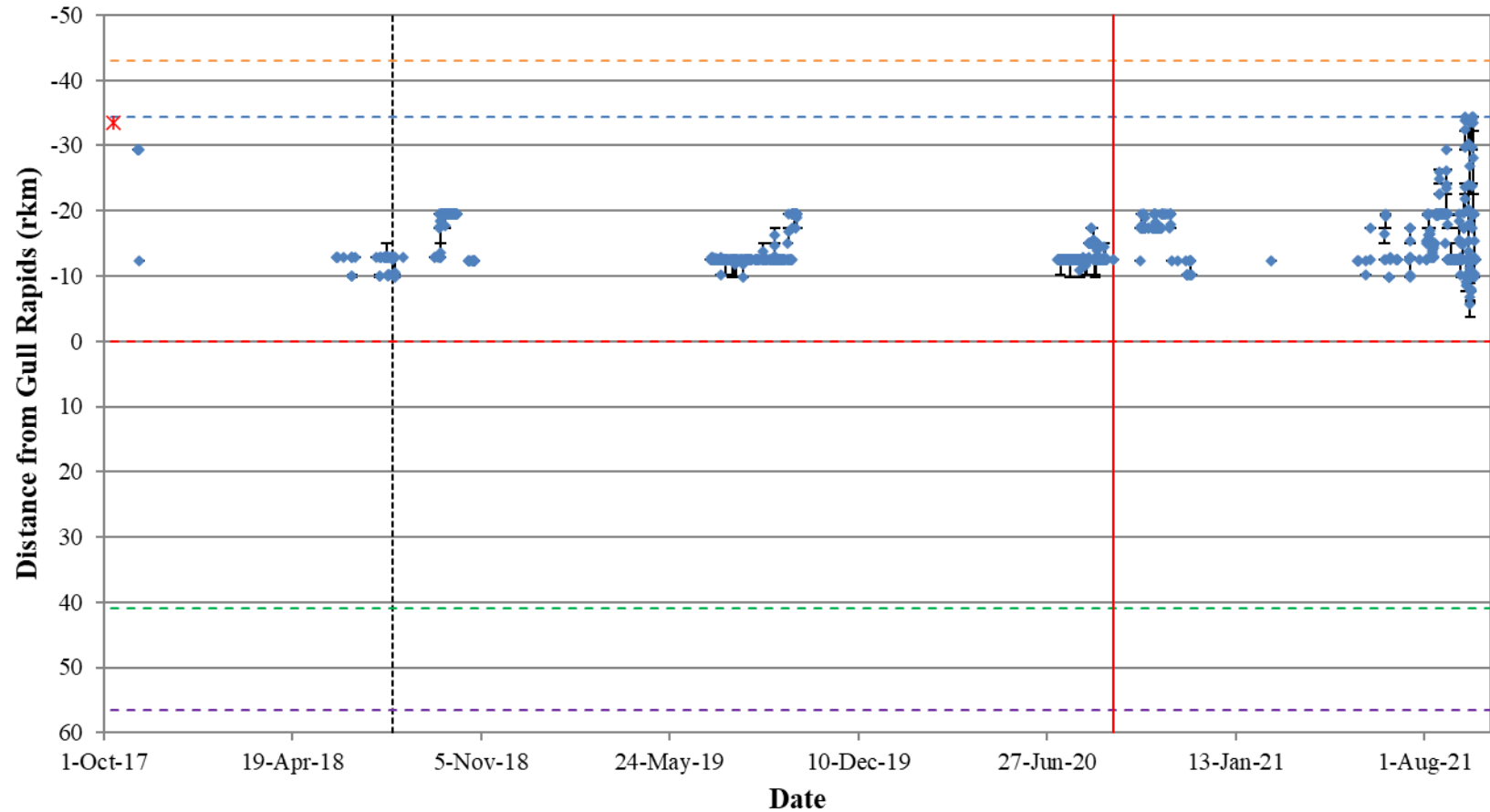


Figure A2-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31739) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

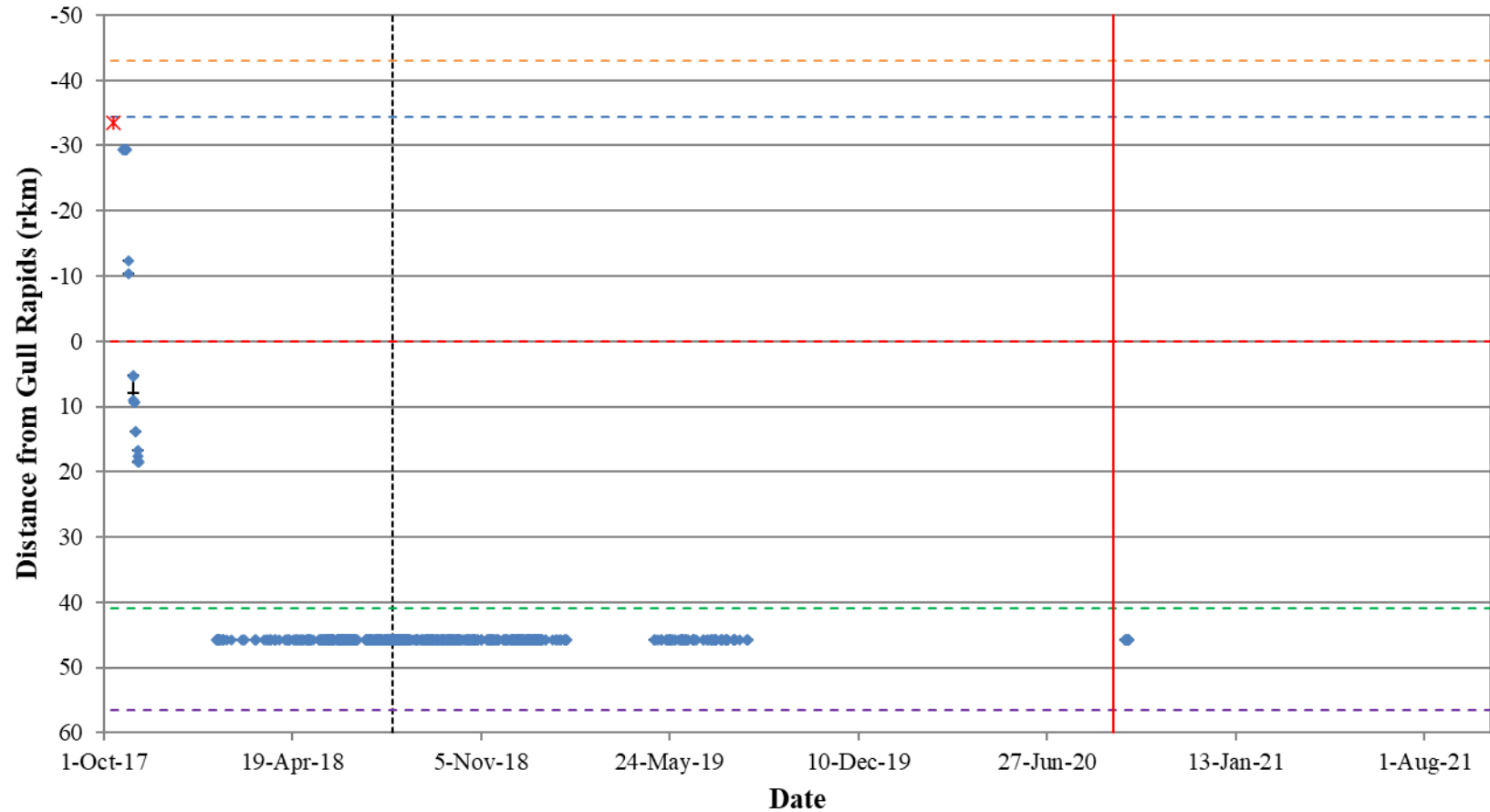


Figure A2-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31740) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

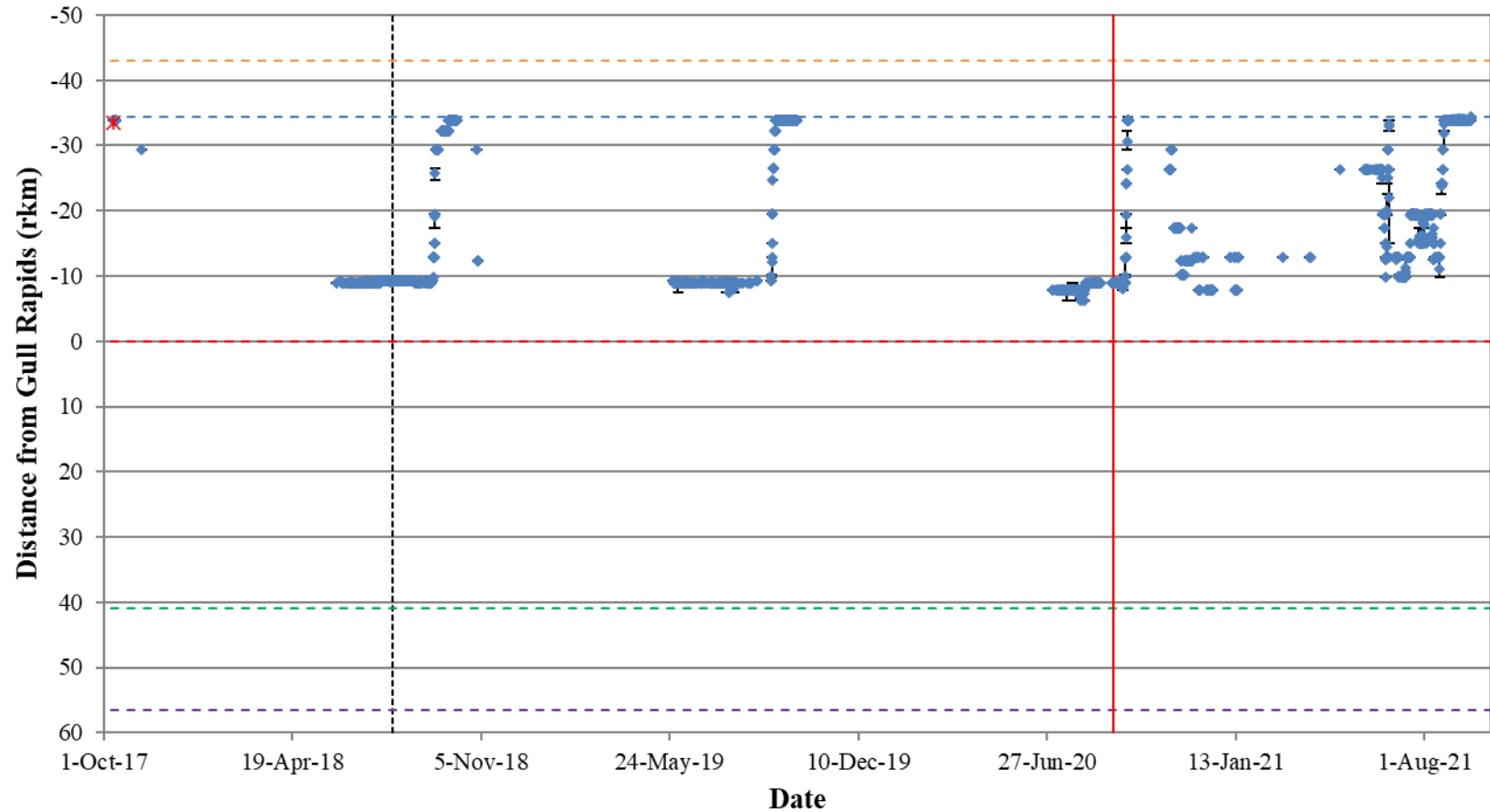


Figure A2-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31741) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

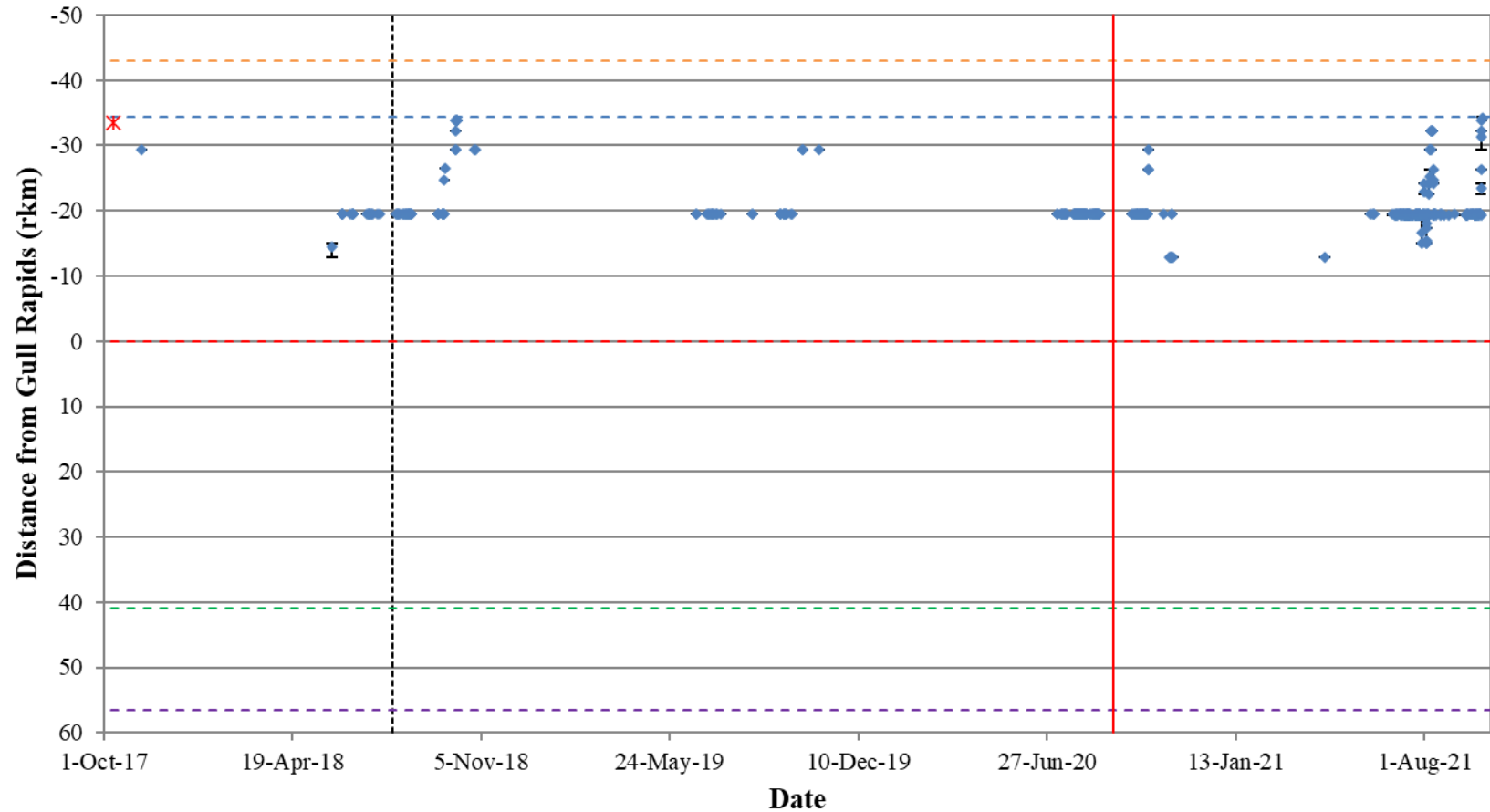


Figure A2-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31742) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

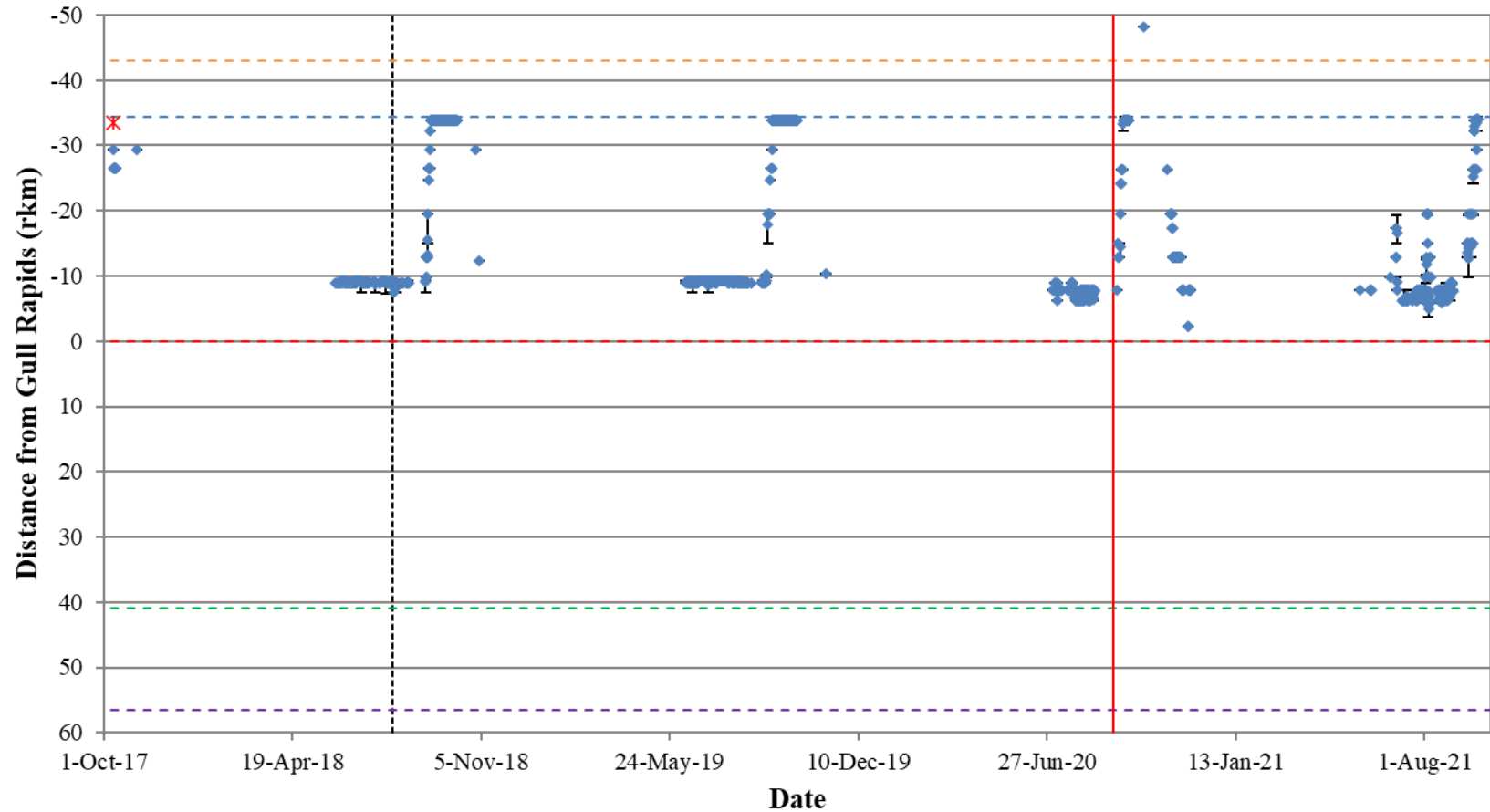


Figure A2-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31743) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

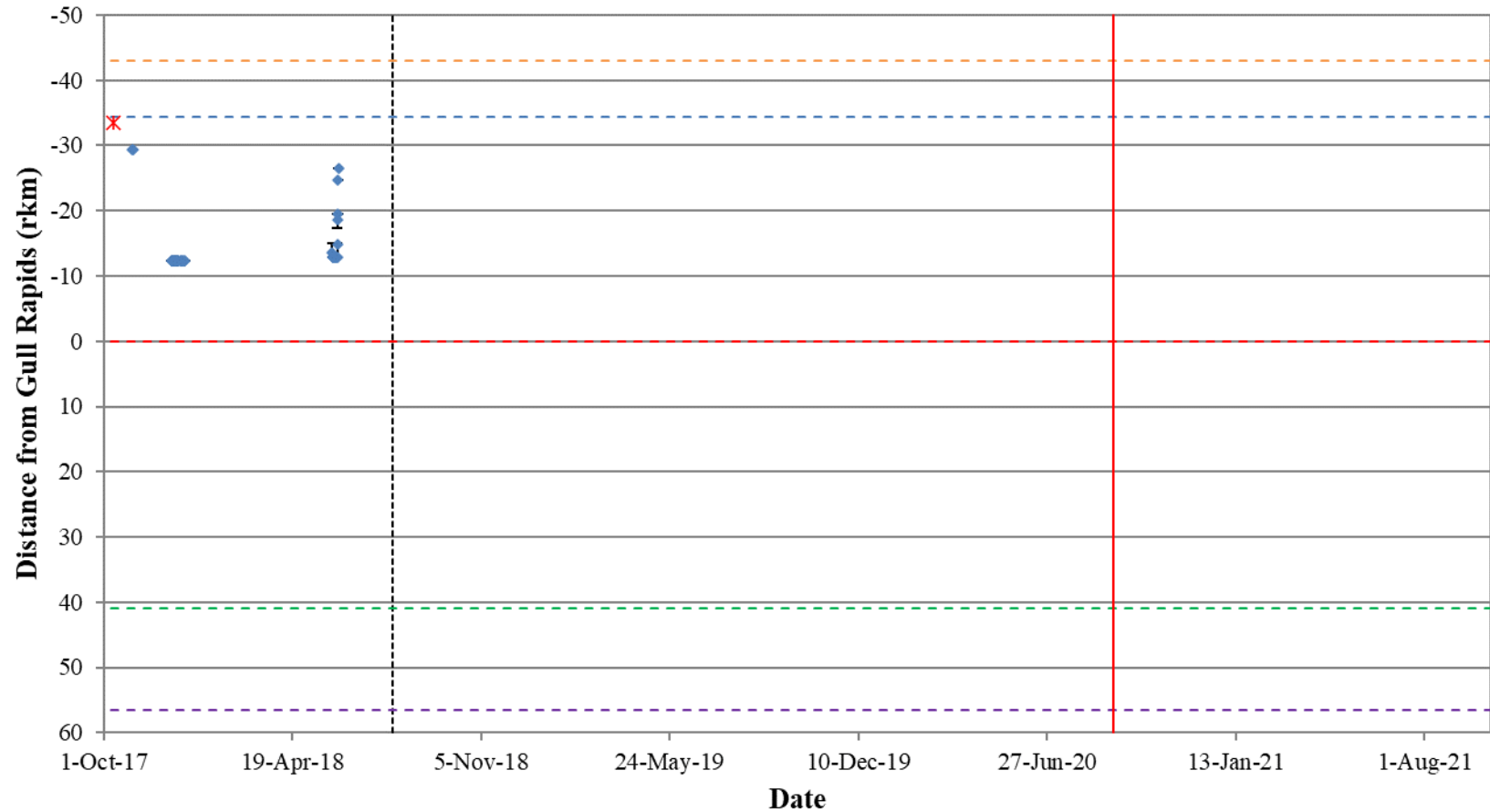


Figure A2-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31744) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

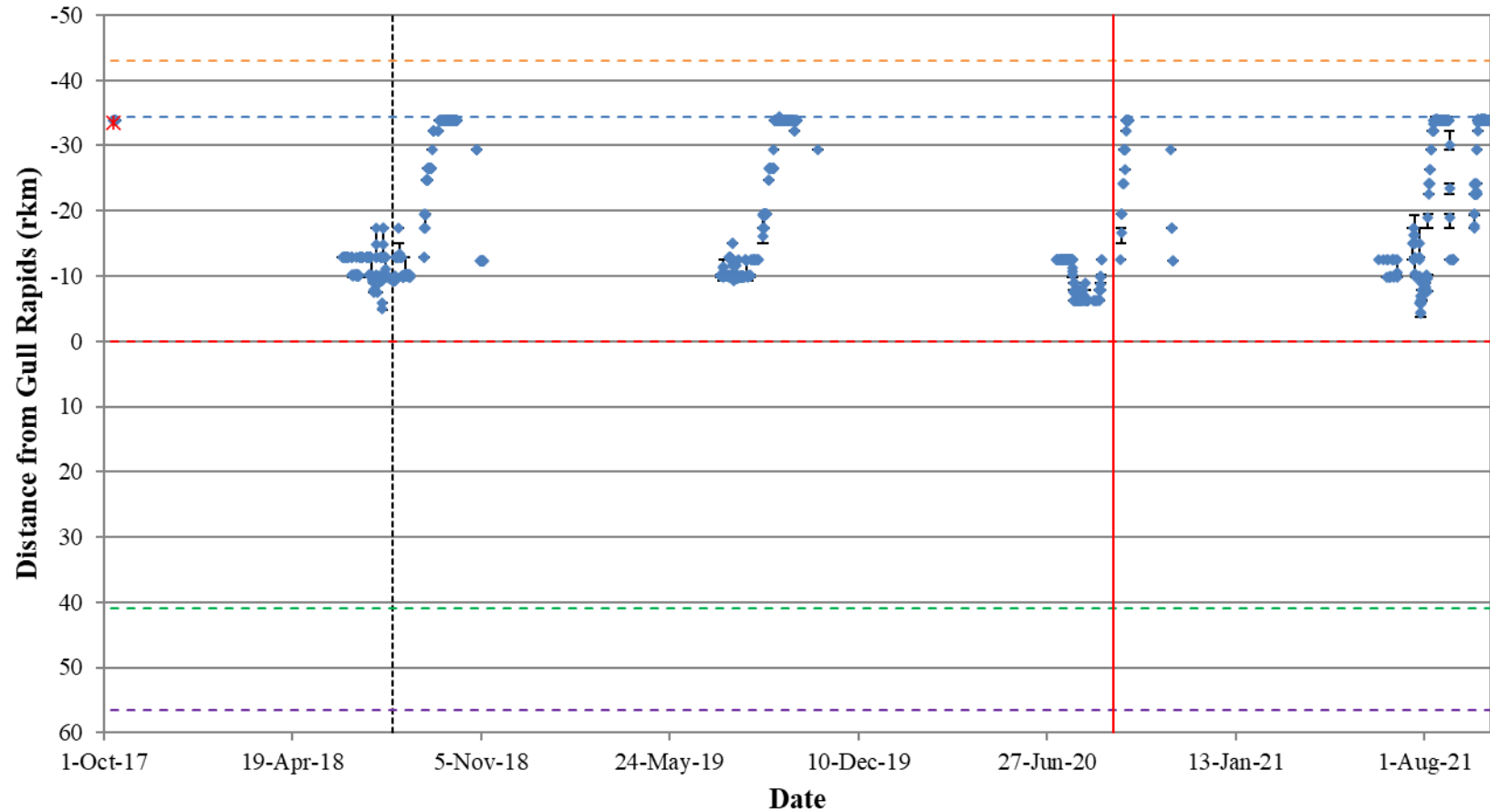


Figure A2-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31745) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

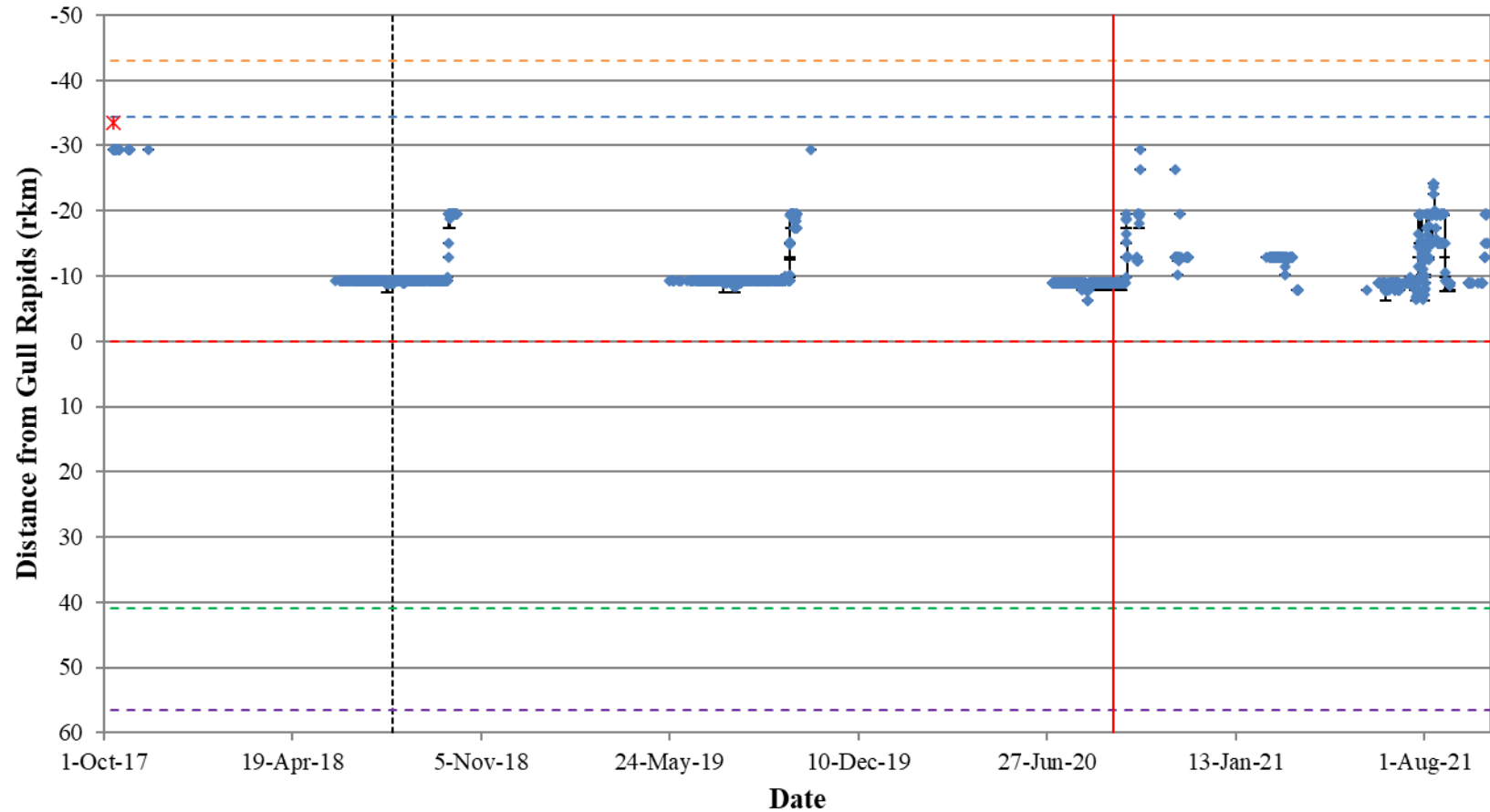


Figure A2-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31746) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

APPENDIX 3:

LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC-TAGGED LAKE WHITEFISH IN STEPHENS LAKE, OCTOBER 2017 TO OCTOBER 2021

Figure A3-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31698) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	92
Figure A3-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31699) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	93
Figure A3-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31700) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	94
Figure A3-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31701) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	95
Figure A3-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31702) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	96
Figure A3-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31703) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	97
Figure A3-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31704) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	98
Figure A3-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31705) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	99
Figure A3-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31706) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	100
Figure A3-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31707) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	101
Figure A3-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31708) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	102

Figure A3-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31709) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	103
Figure A3-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31710) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	104
Figure A3-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31711) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	105
Figure A3-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31712) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	106
Figure A3-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31713) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	107
Figure A3-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31714) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	108
Figure A3-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31715) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	109
Figure A3-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31716) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	110
Figure A3-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31717) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	111
Figure A3-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31718) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	112
Figure A3-22: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31719) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	113
Figure A3-23: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31720) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	114
Figure A3-24: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31721) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	115

Figure A3-25: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31723) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	116
Figure A3-26: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31724) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	117
Figure A3-27: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31725) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	118
Figure A3-28: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31747) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	119
Figure A3-29: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31748) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	120
Figure A3-30: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31749) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	121
Figure A3-31: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31750) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	122
Figure A3-32: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31751) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	123
Figure A3-33: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31752) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	124
Figure A3-34: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31753) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	125
Figure A3-35: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31754) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	126
Figure A3-36: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31755) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	127
The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).	127

Figure A3-37: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31756) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	128
Figure A3-38: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31757) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	129
Figure A3-39: Position of a Lake Whitefish tagged with an acoustic transmitter (code #53761) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	130
Figure A3-40: Position of a Lake Whitefish tagged with an acoustic transmitter (code #53762) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021.	131

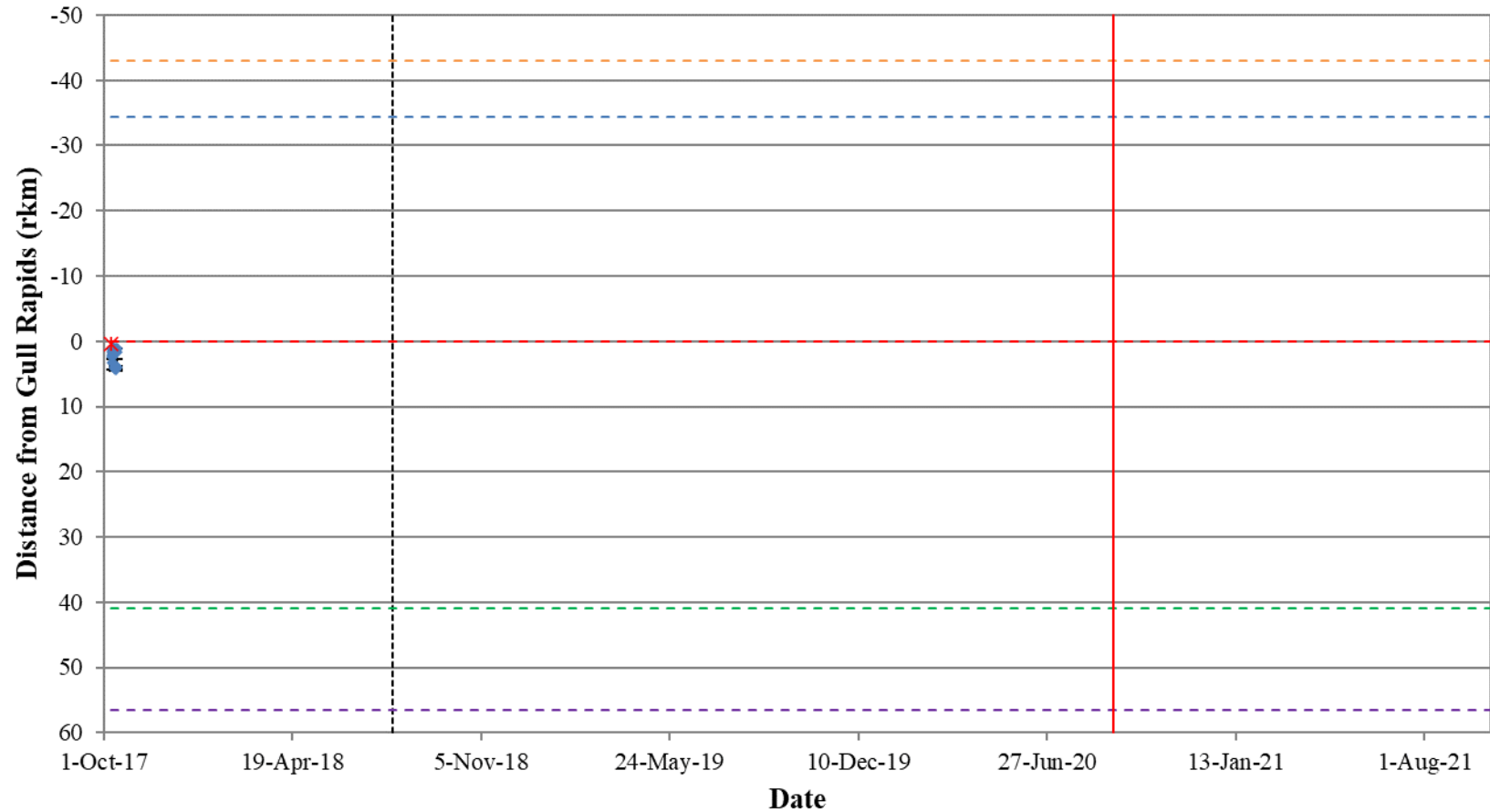


Figure A3-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31698) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

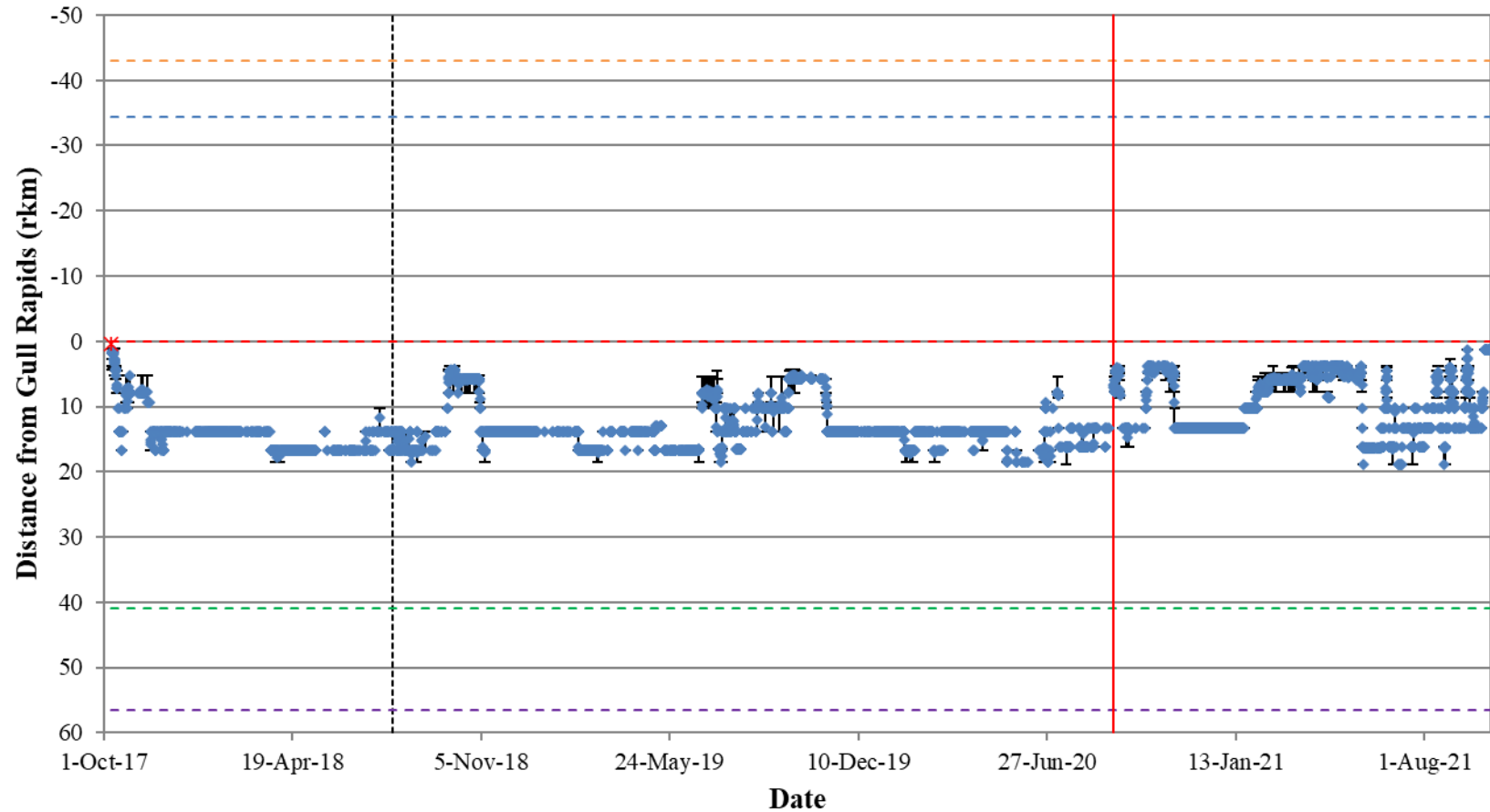


Figure A3-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31699) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

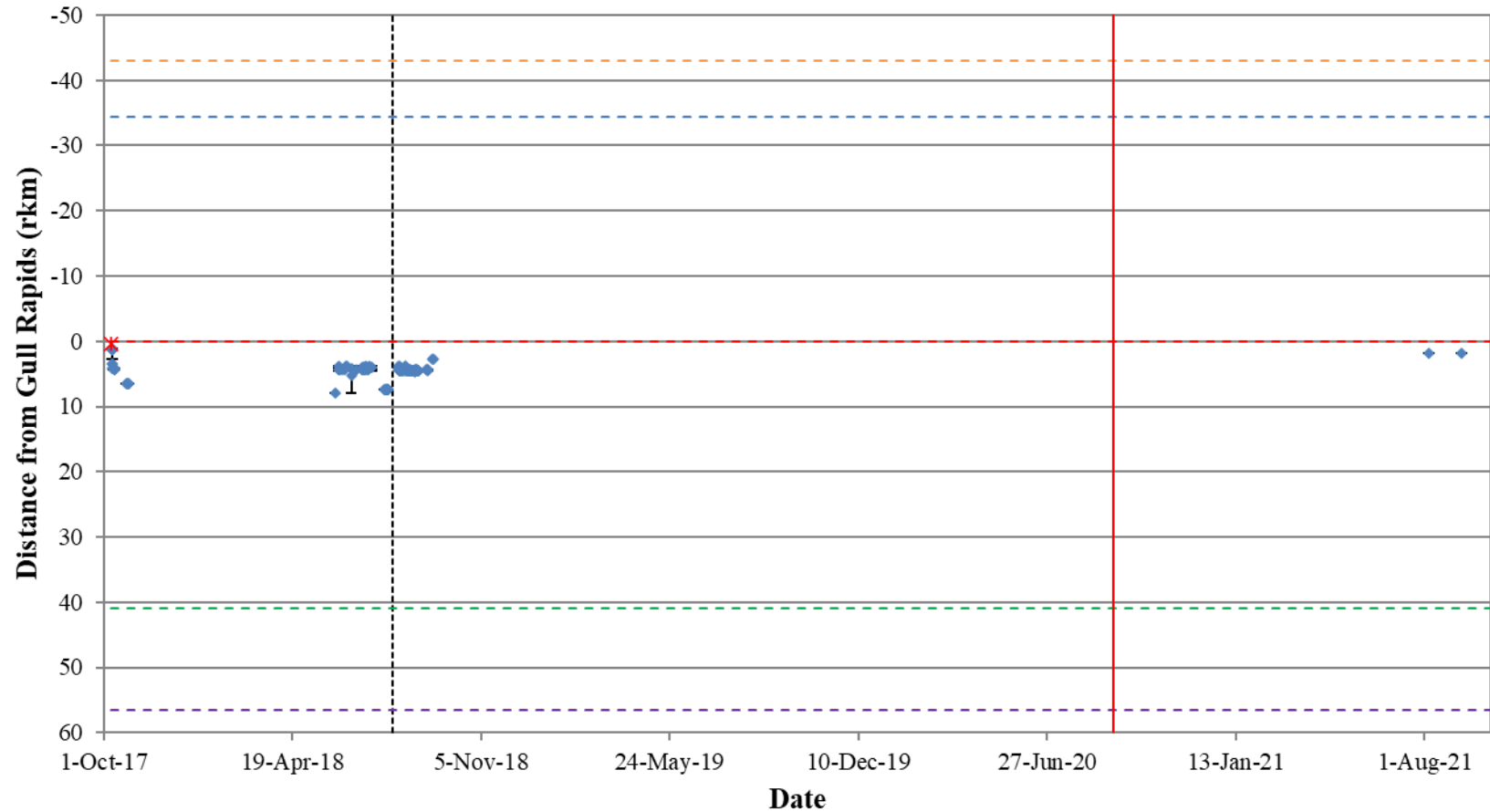


Figure A3-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31700) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

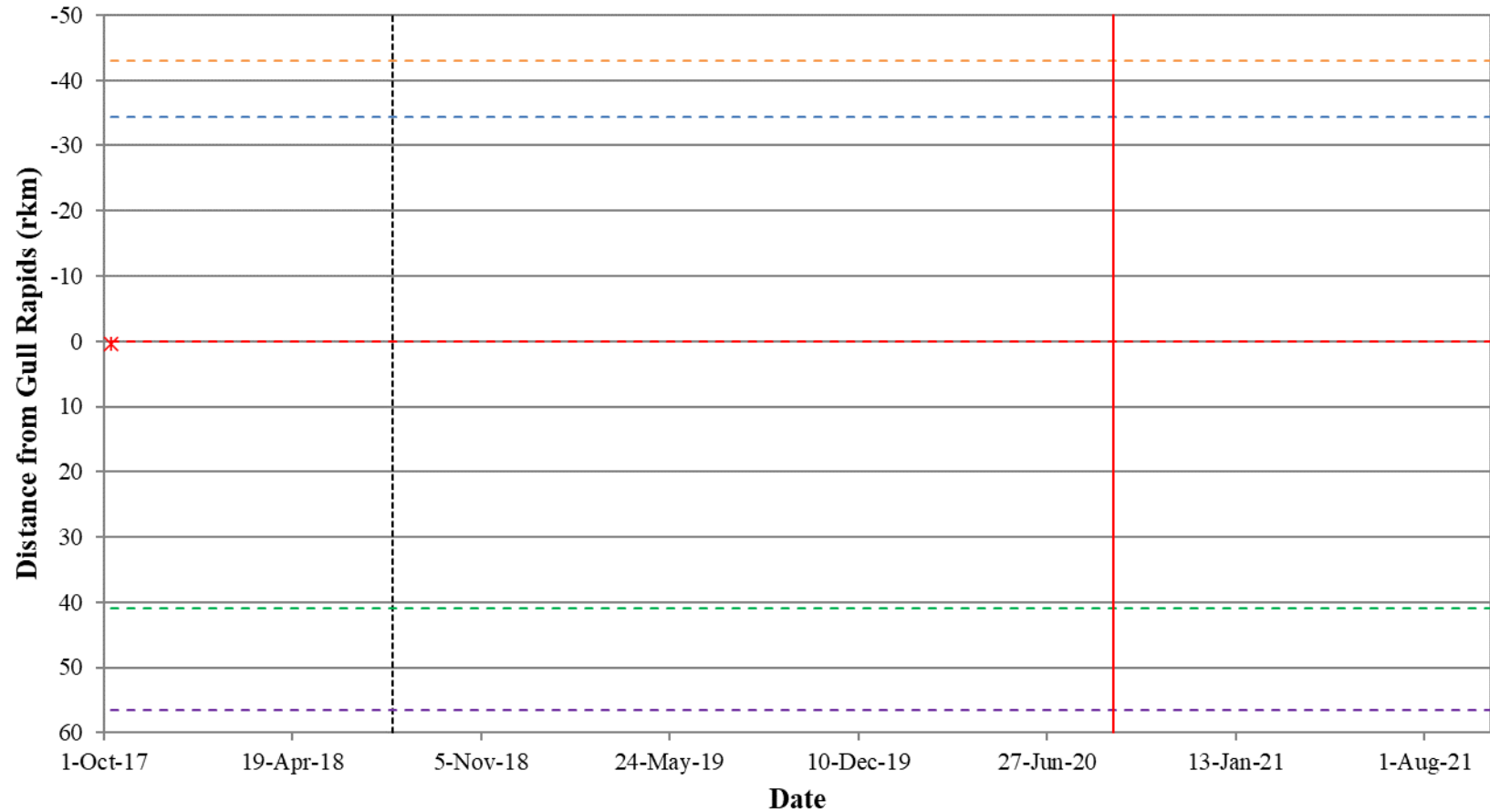


Figure A3-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31701) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

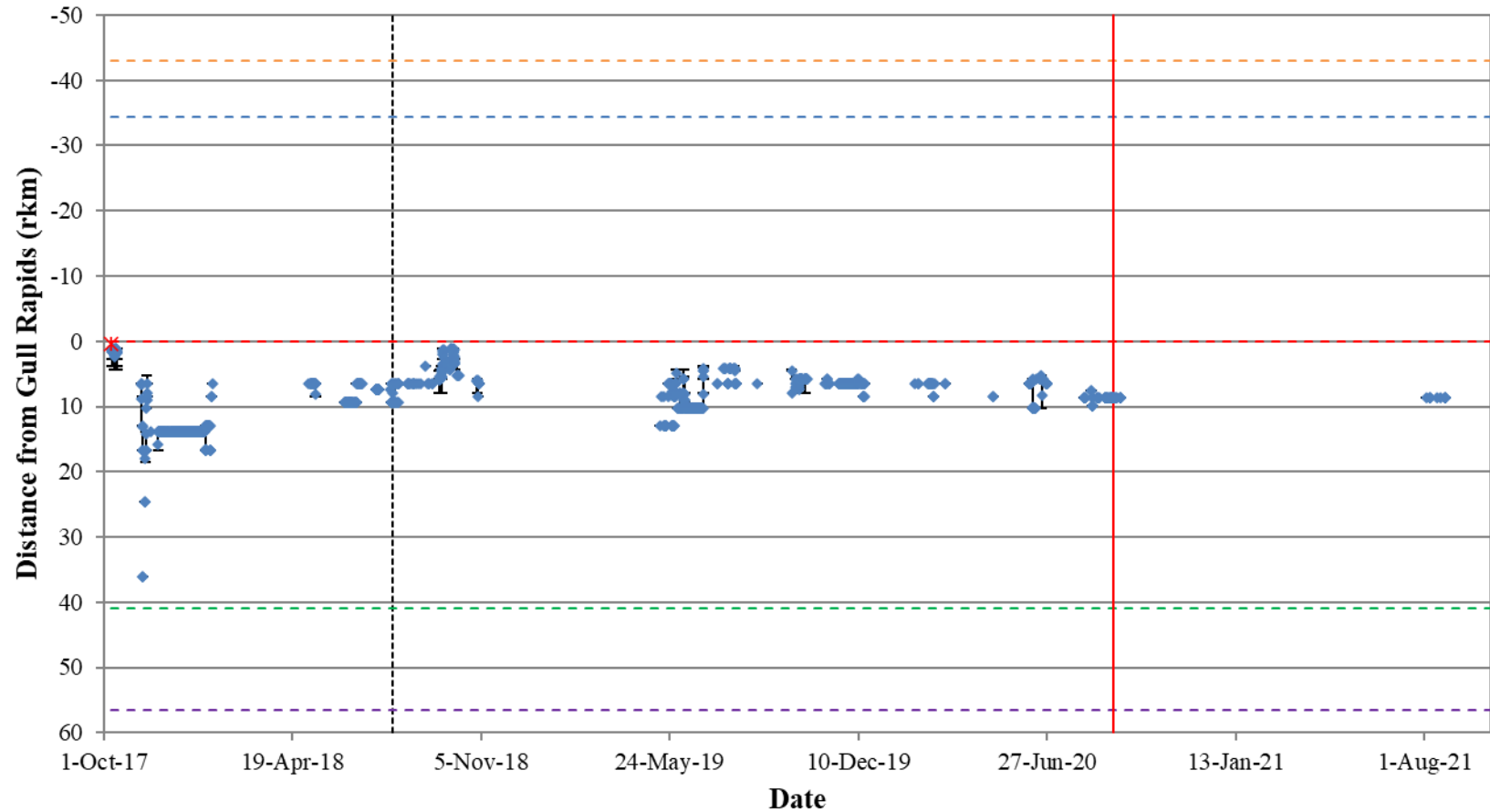


Figure A3-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31702) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

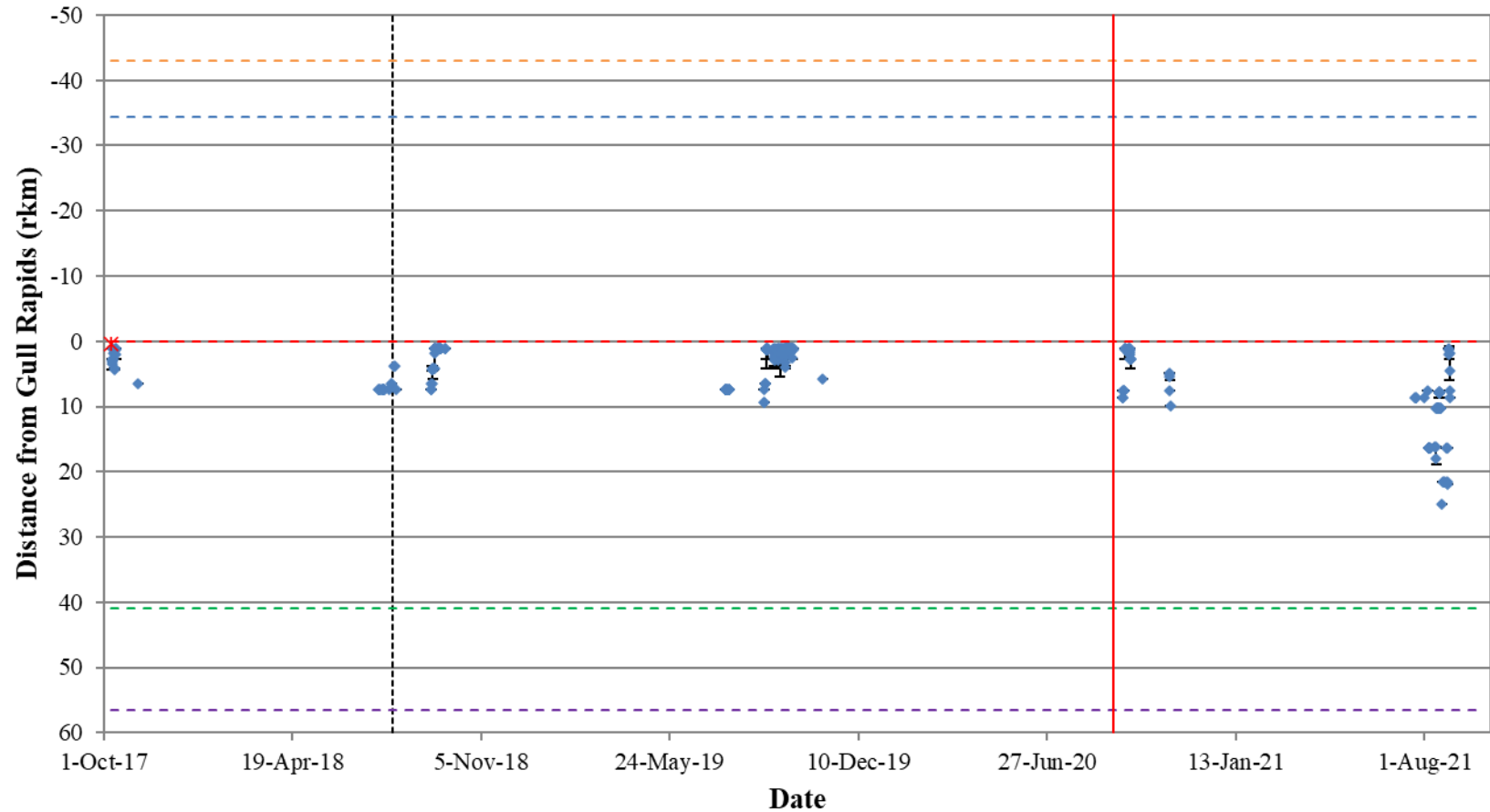


Figure A3-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31703) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

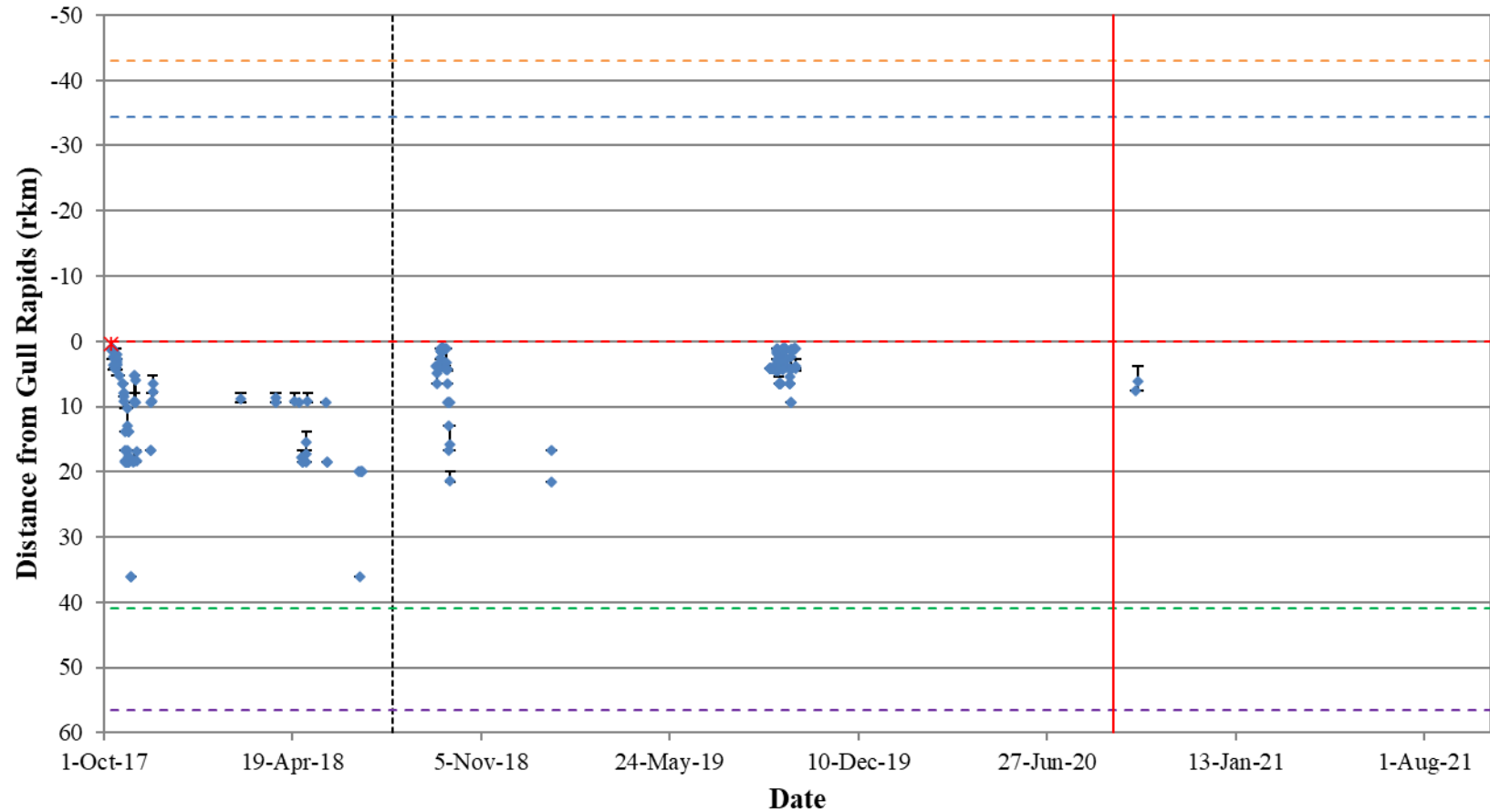


Figure A3-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31704) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

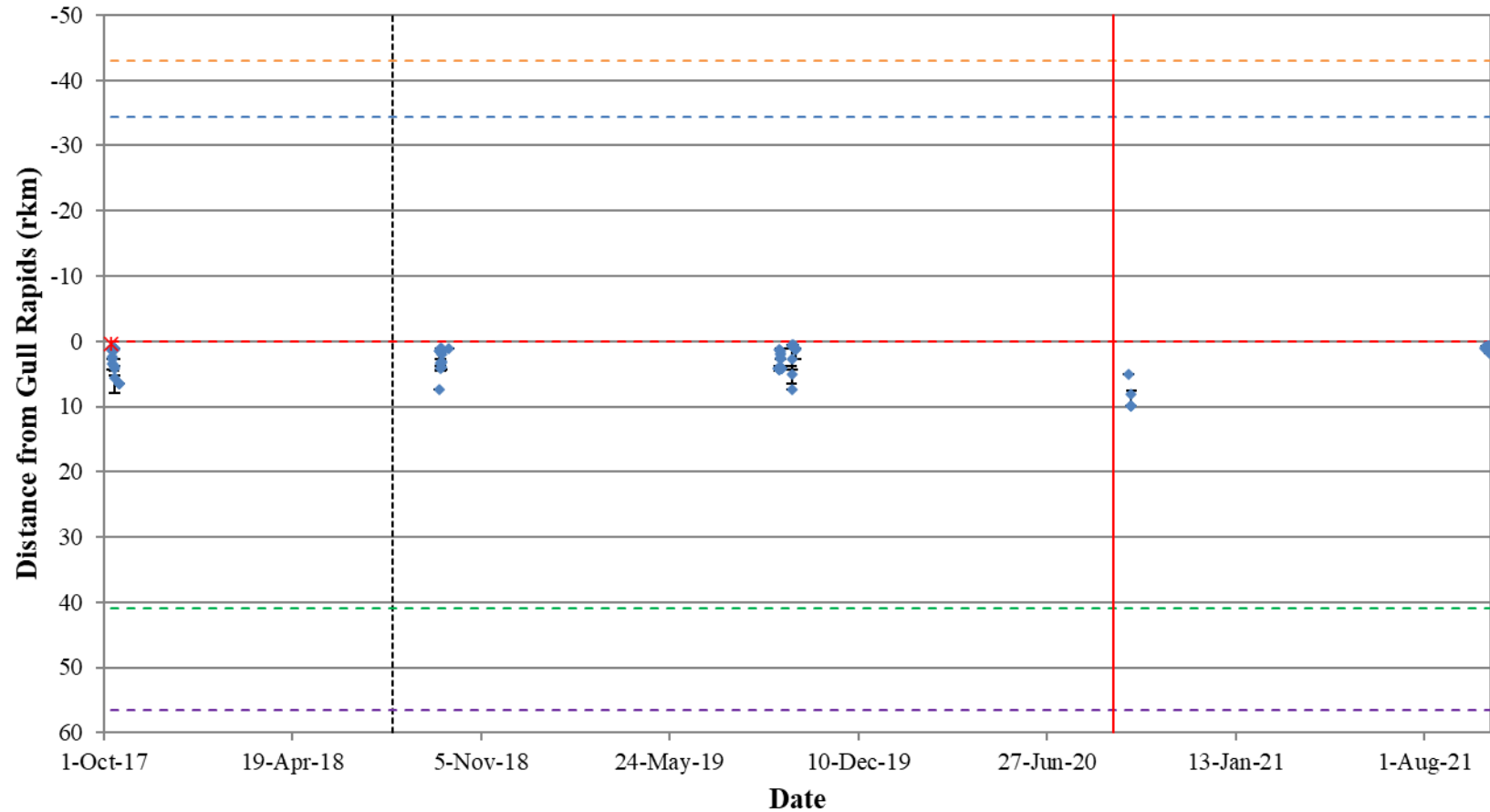


Figure A3-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31705) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

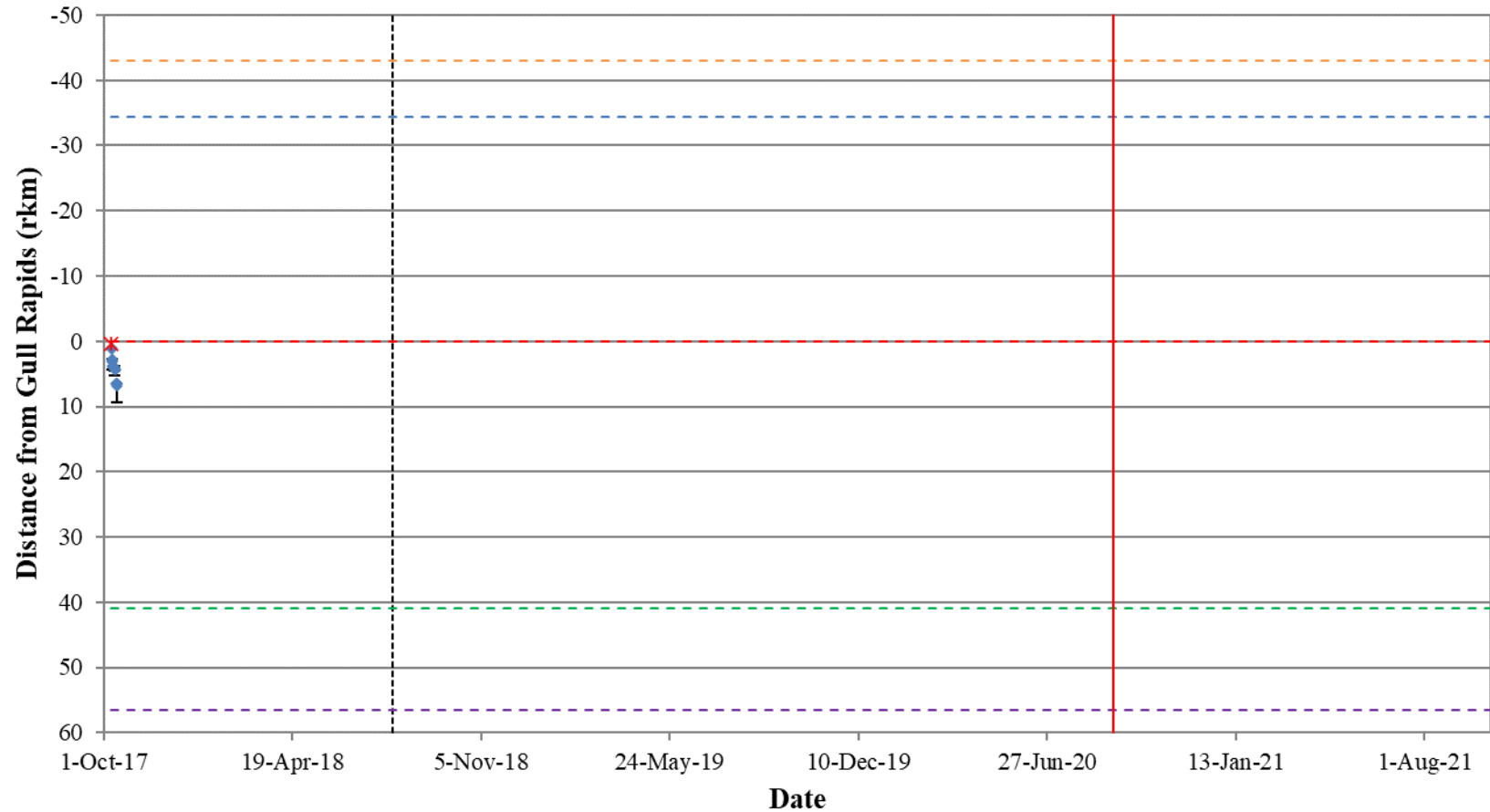


Figure A3-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31706) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

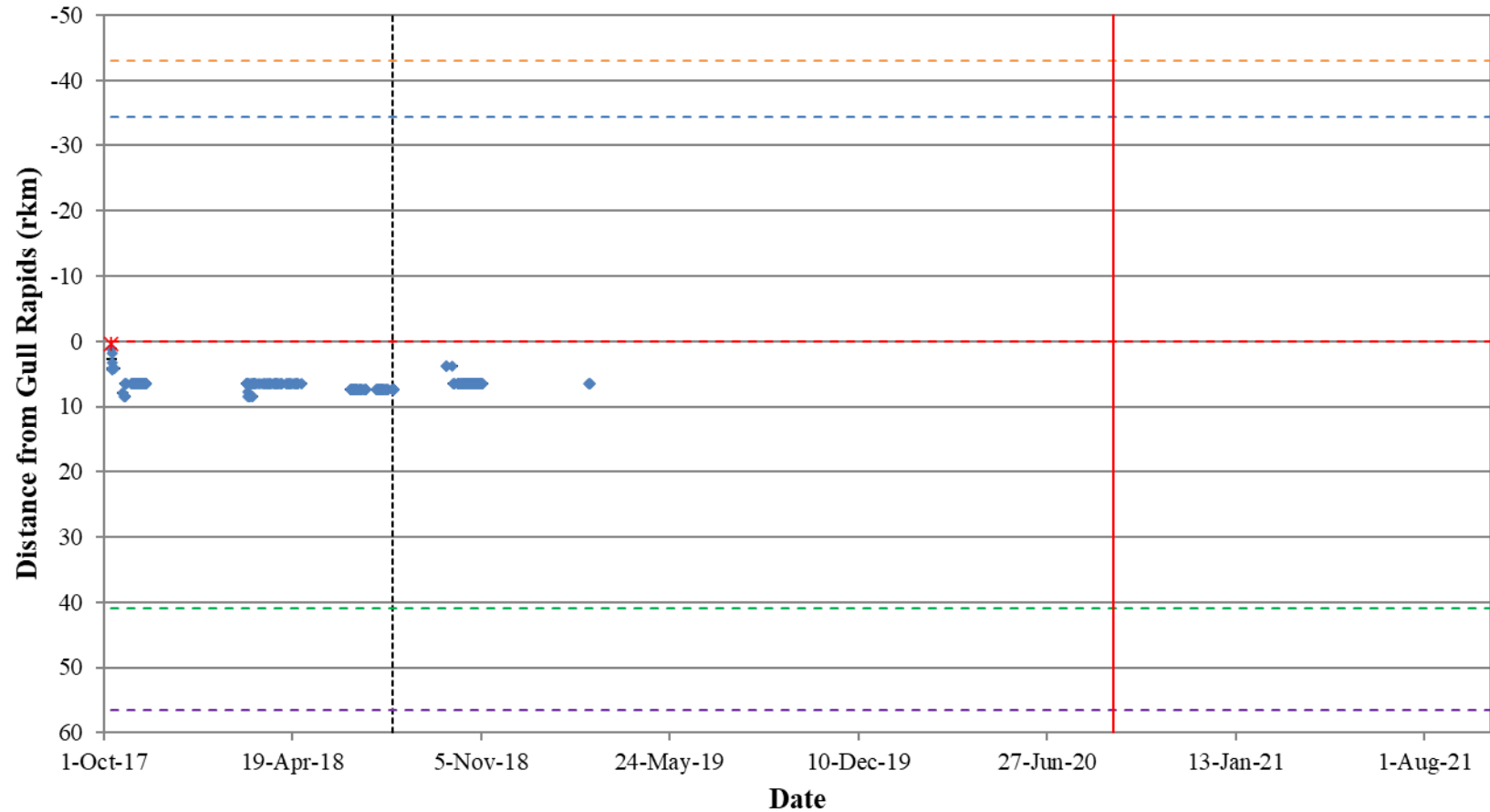


Figure A3-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31707) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

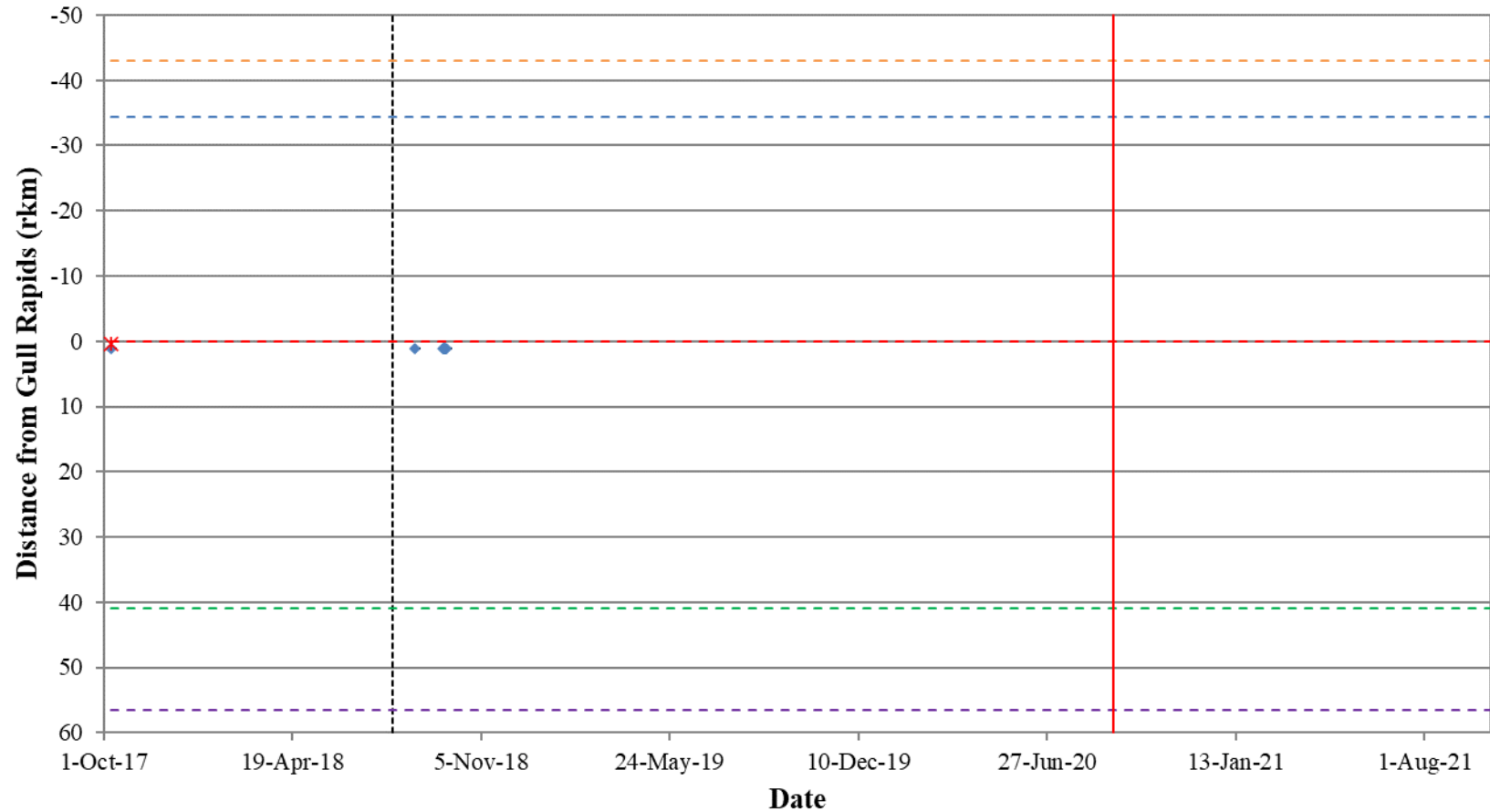


Figure A3-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31708) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

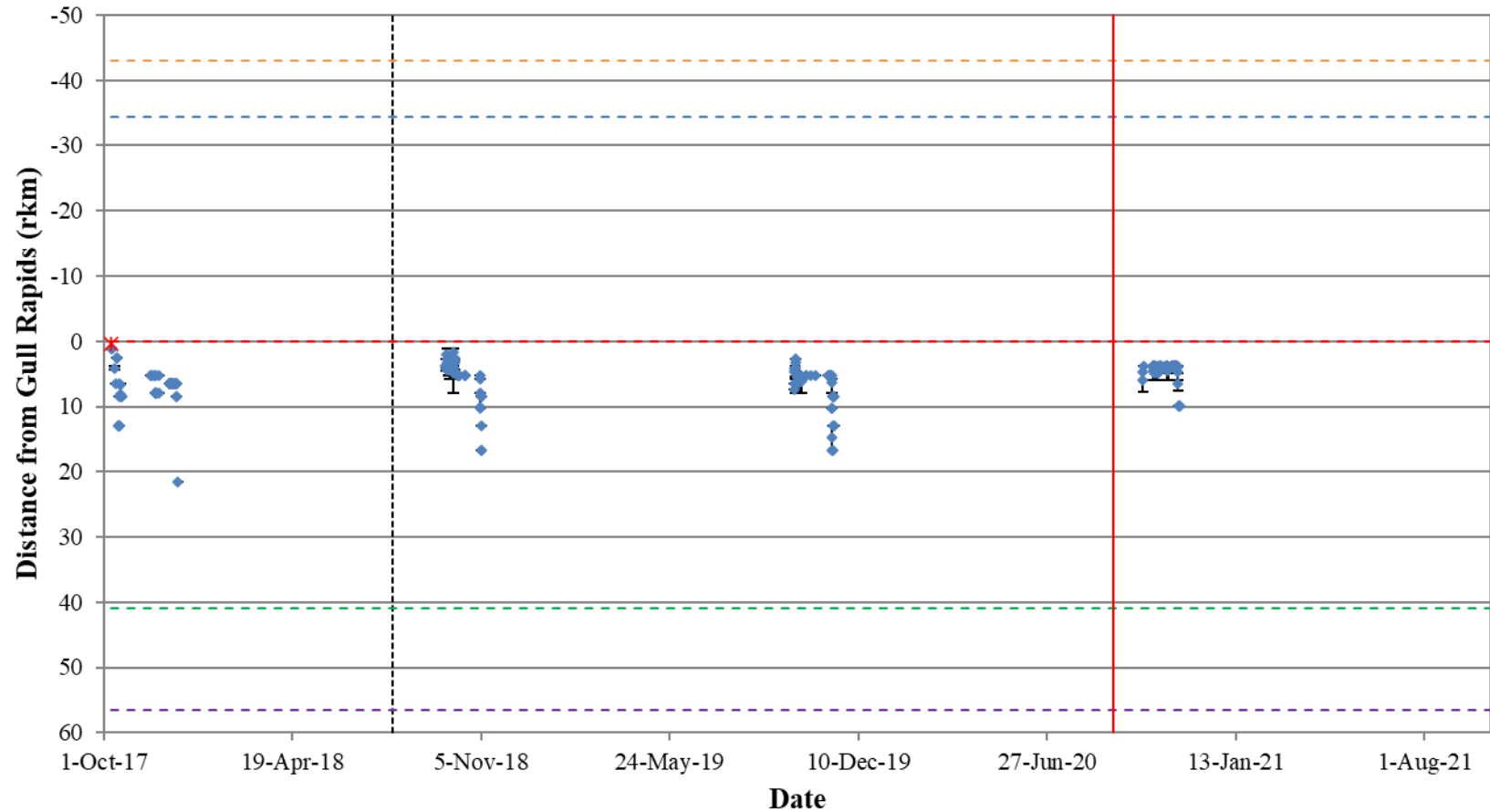


Figure A3-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31709) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

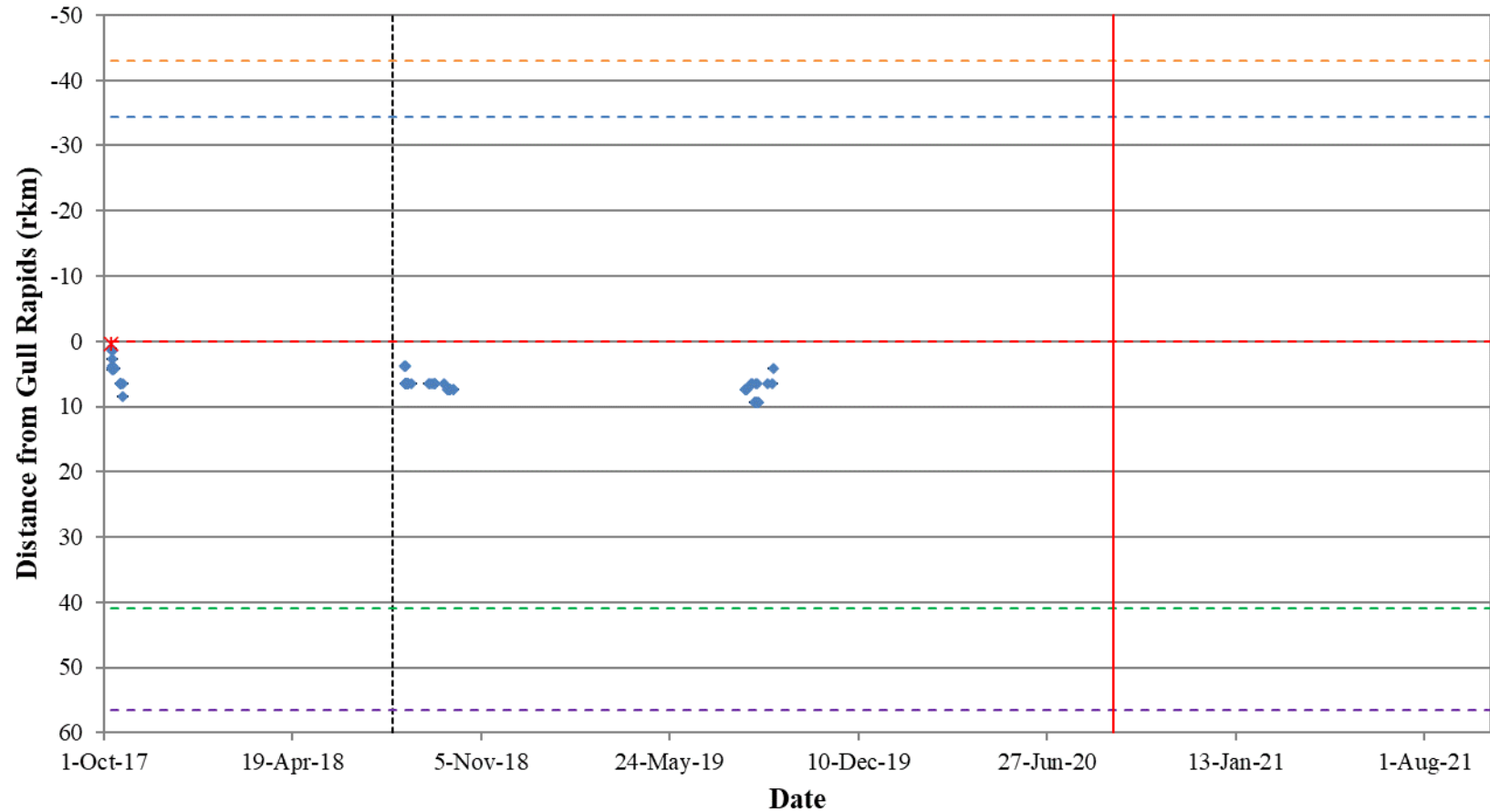


Figure A3-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31710) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

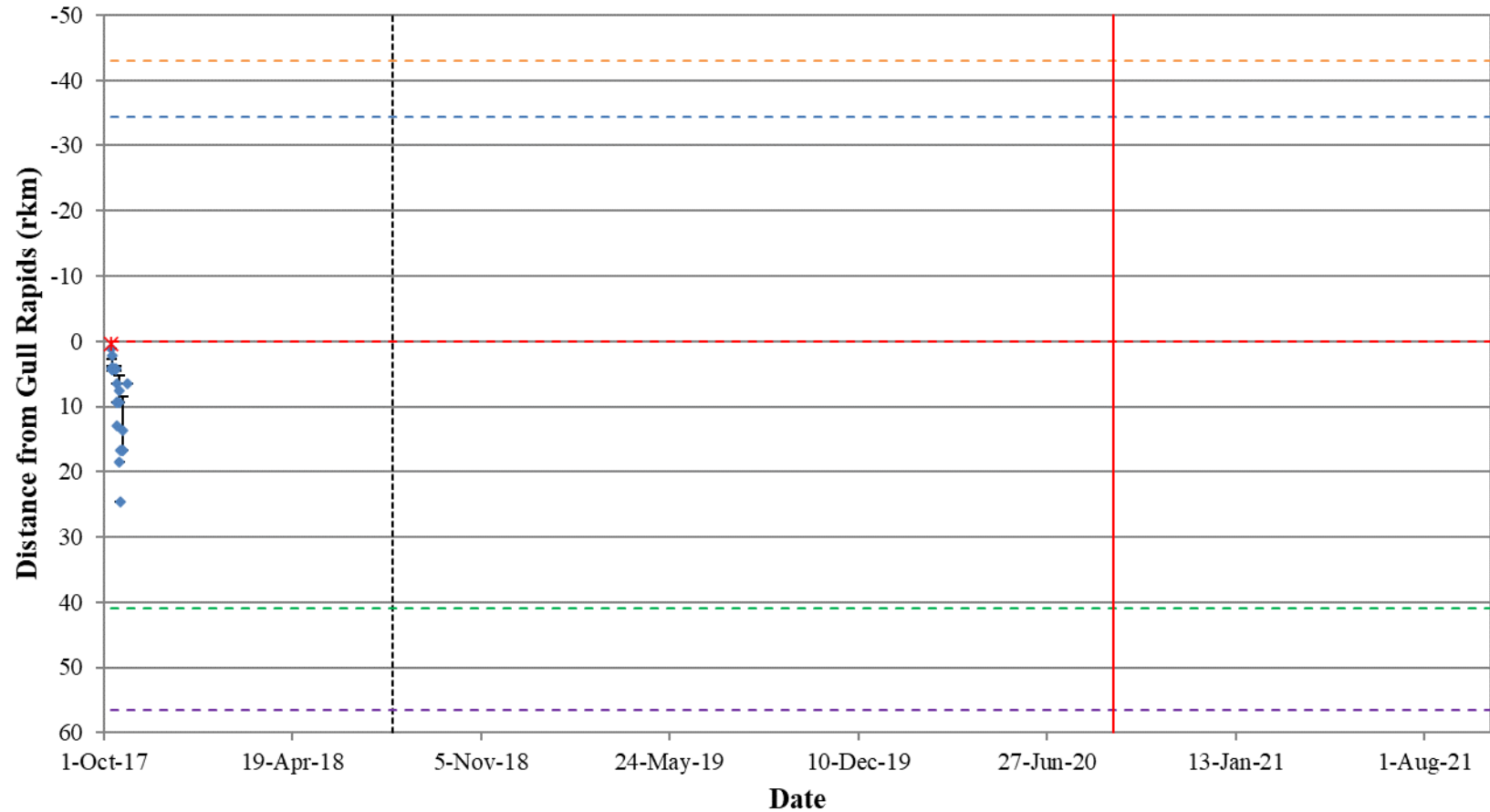


Figure A3-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31711) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

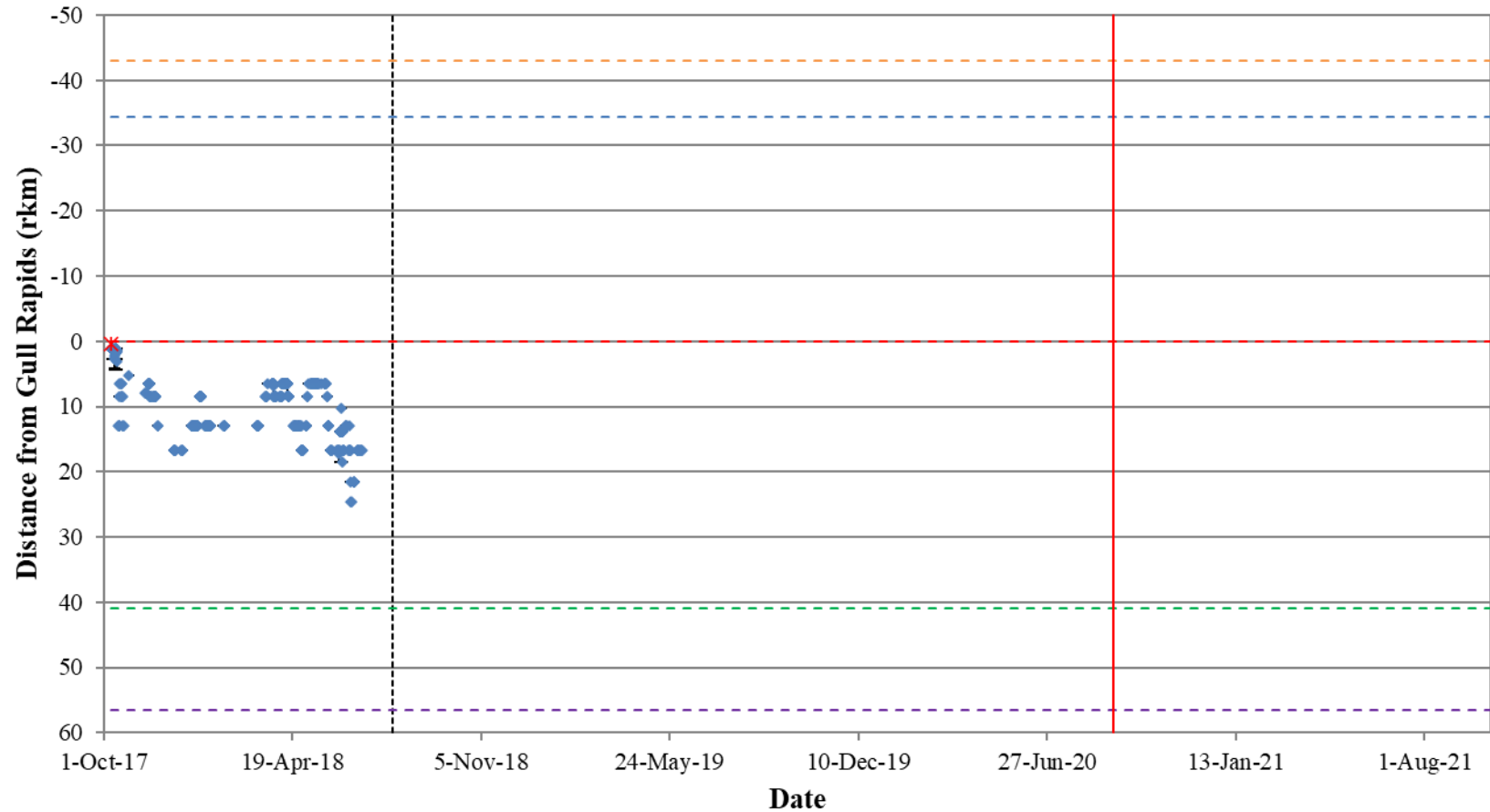


Figure A3-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31712) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

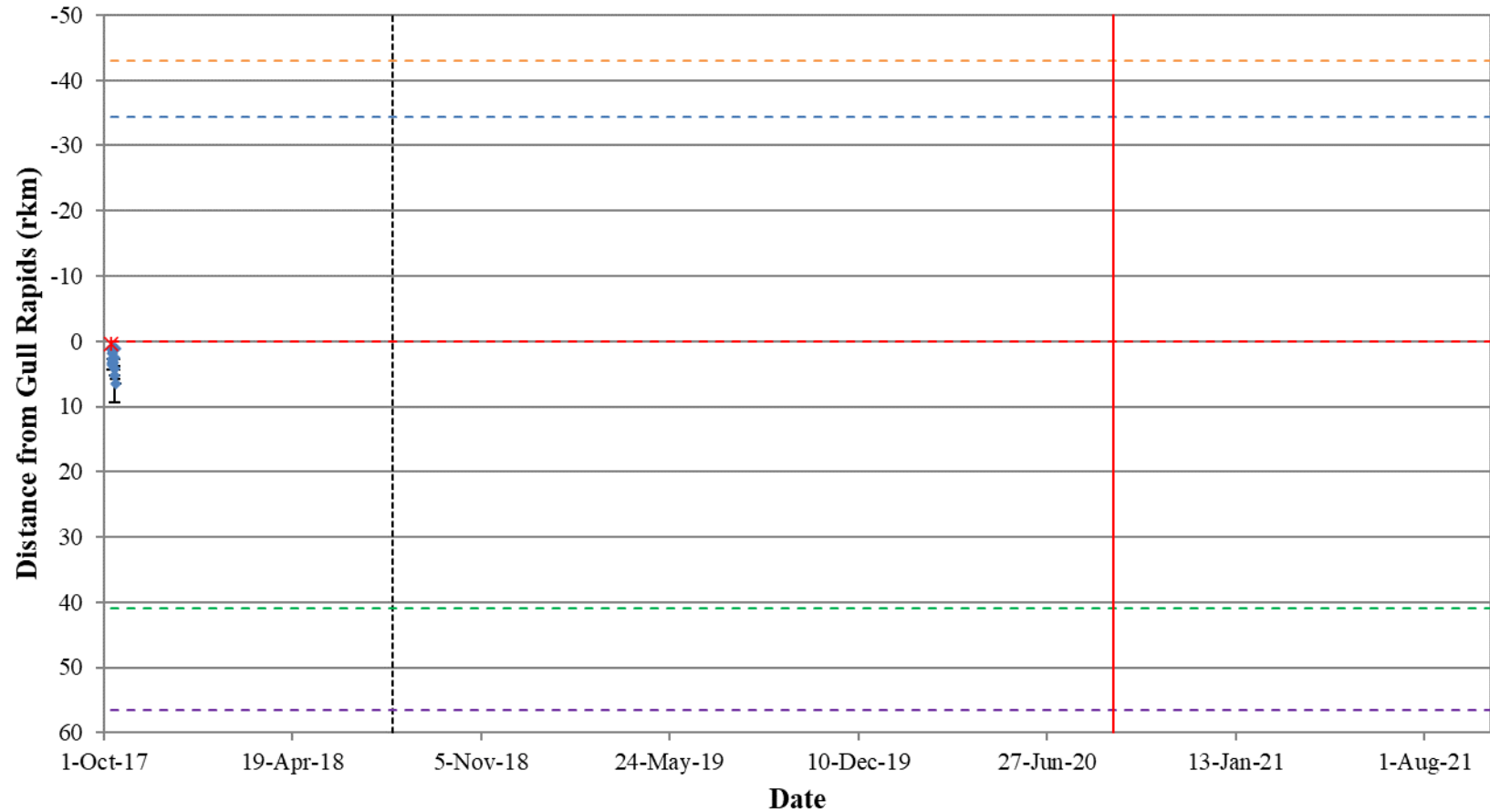


Figure A3-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31713) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

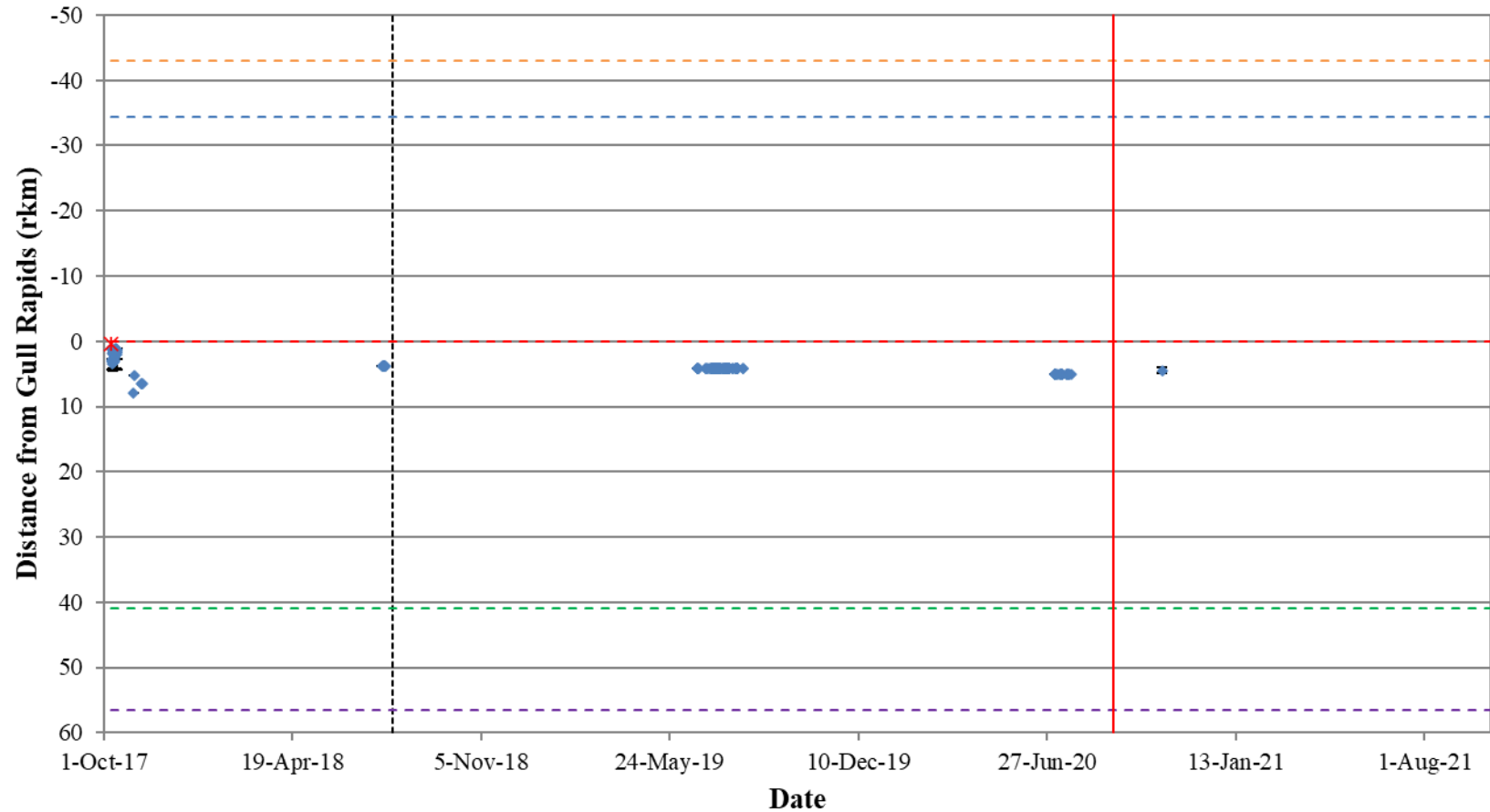


Figure A3-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31714) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

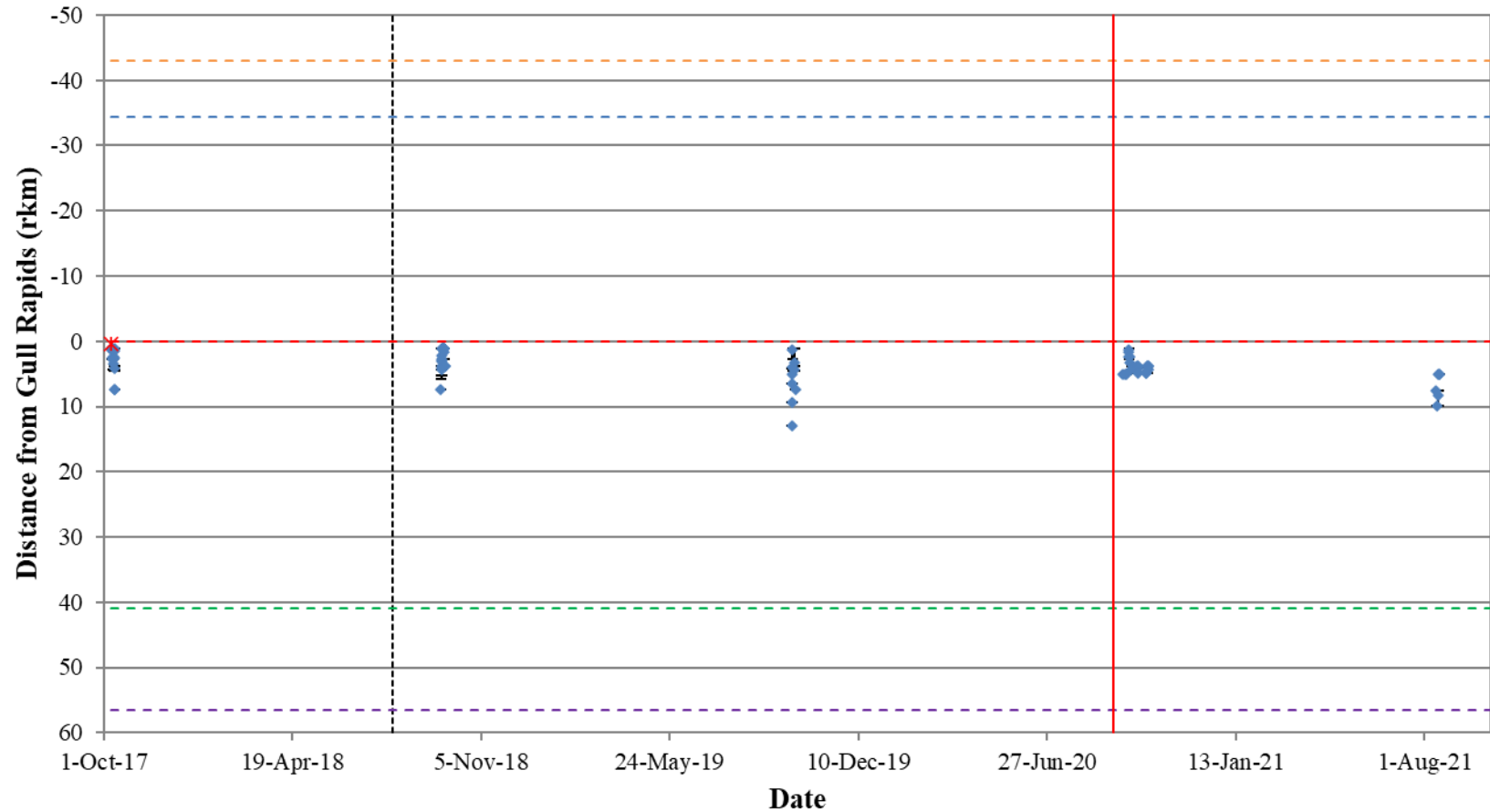


Figure A3-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31715) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

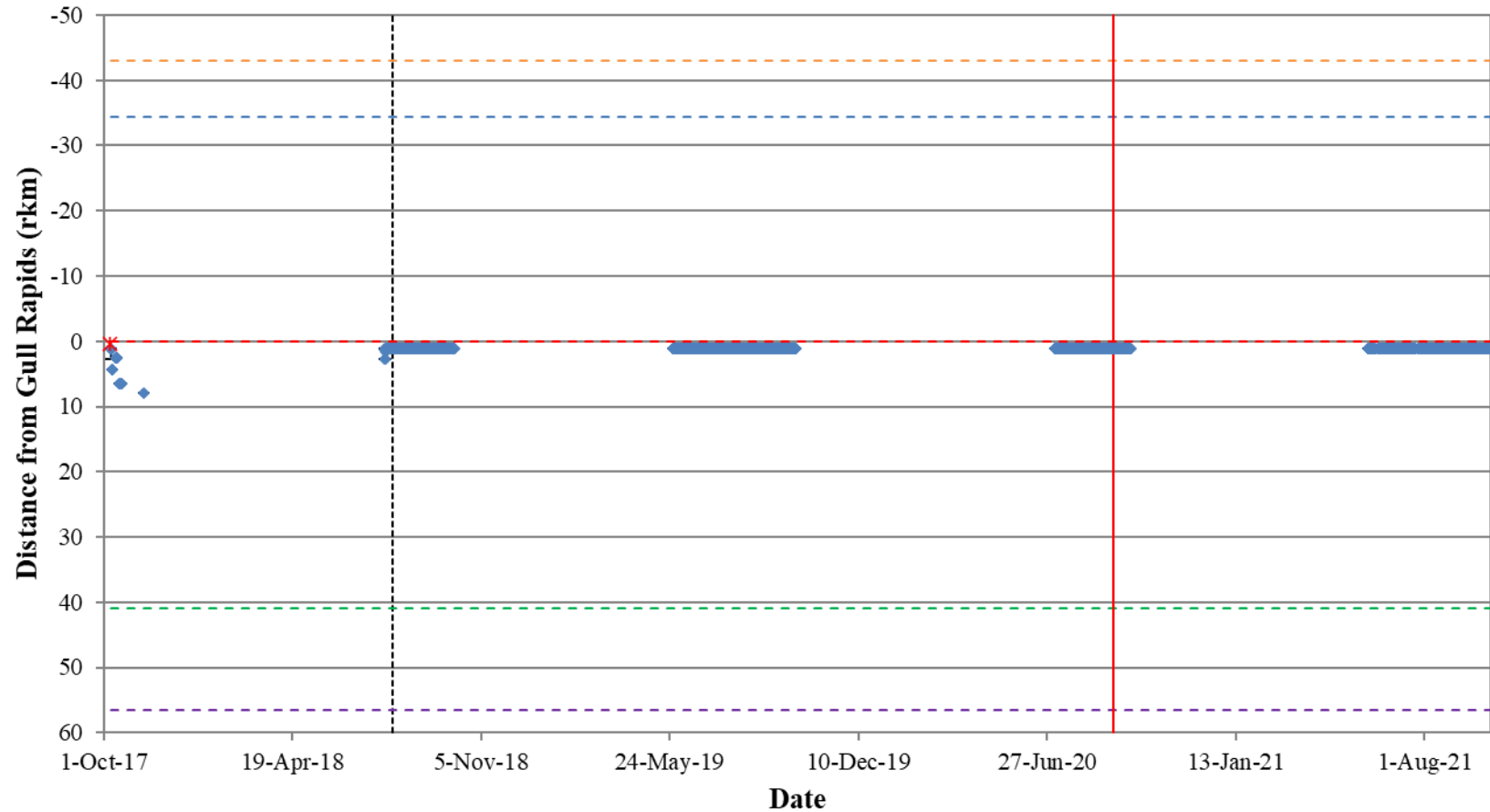


Figure A3-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31716) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

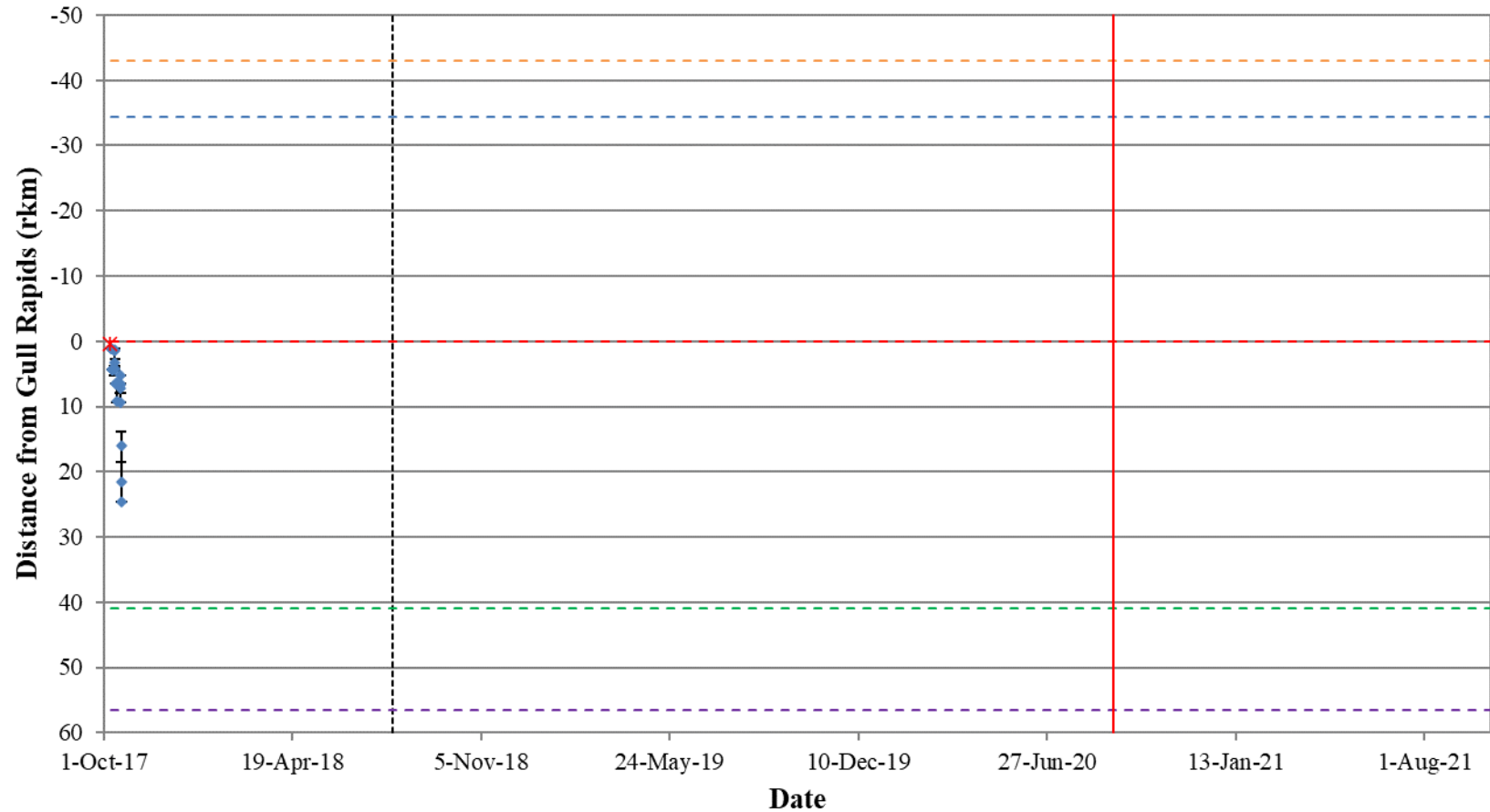


Figure A3-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31717) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

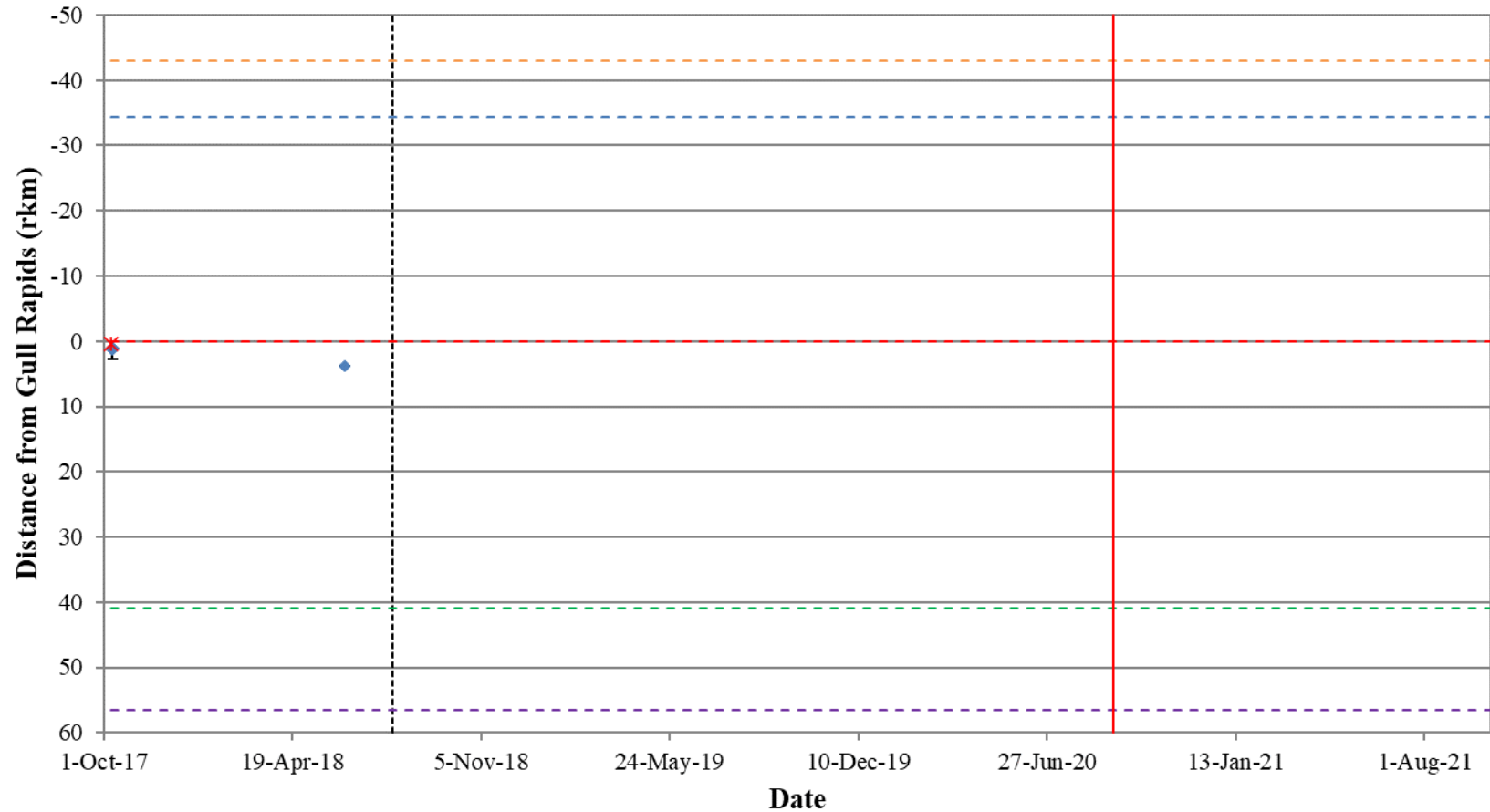


Figure A3-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31718) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

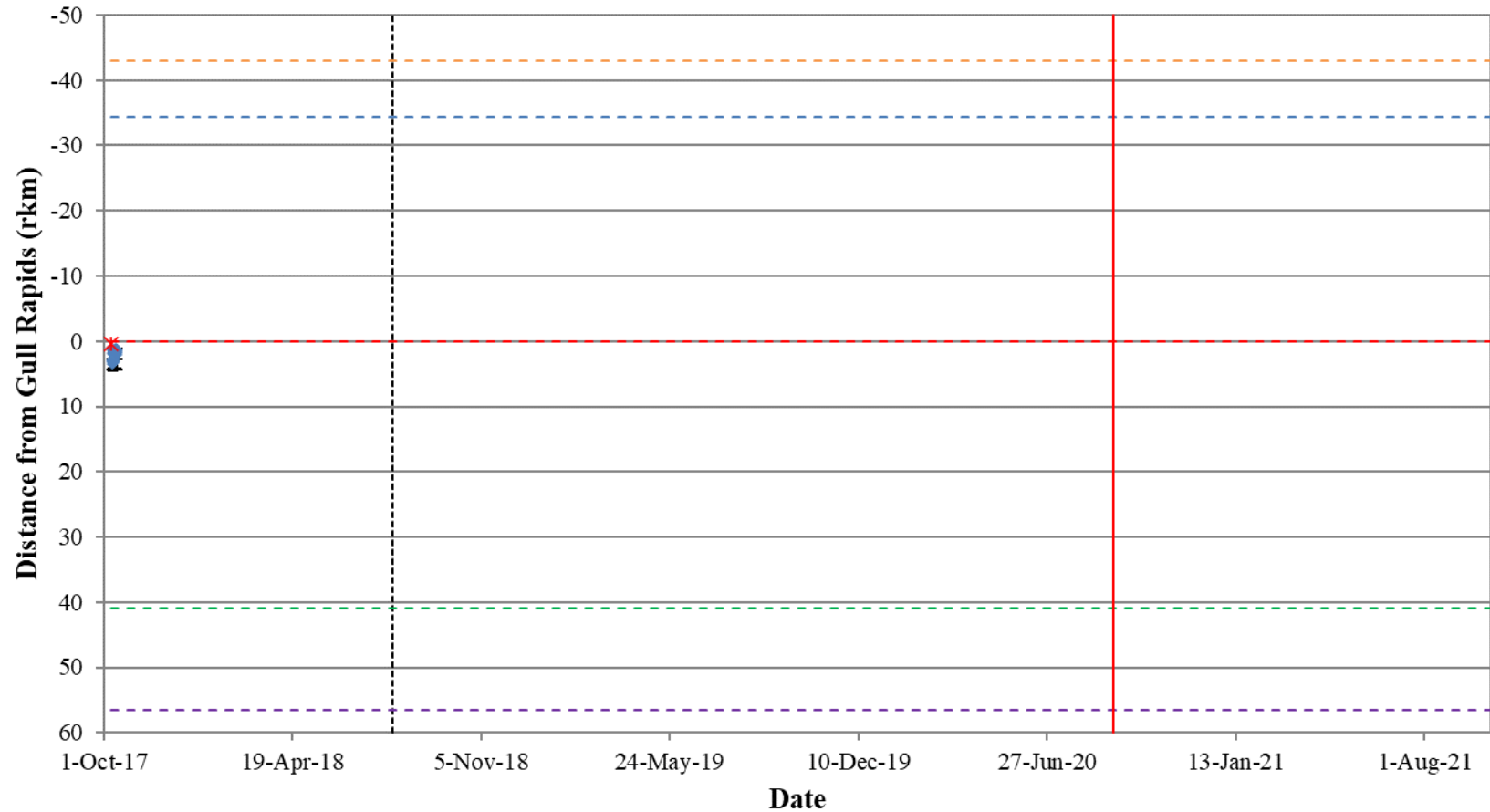


Figure A3-22: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31719) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

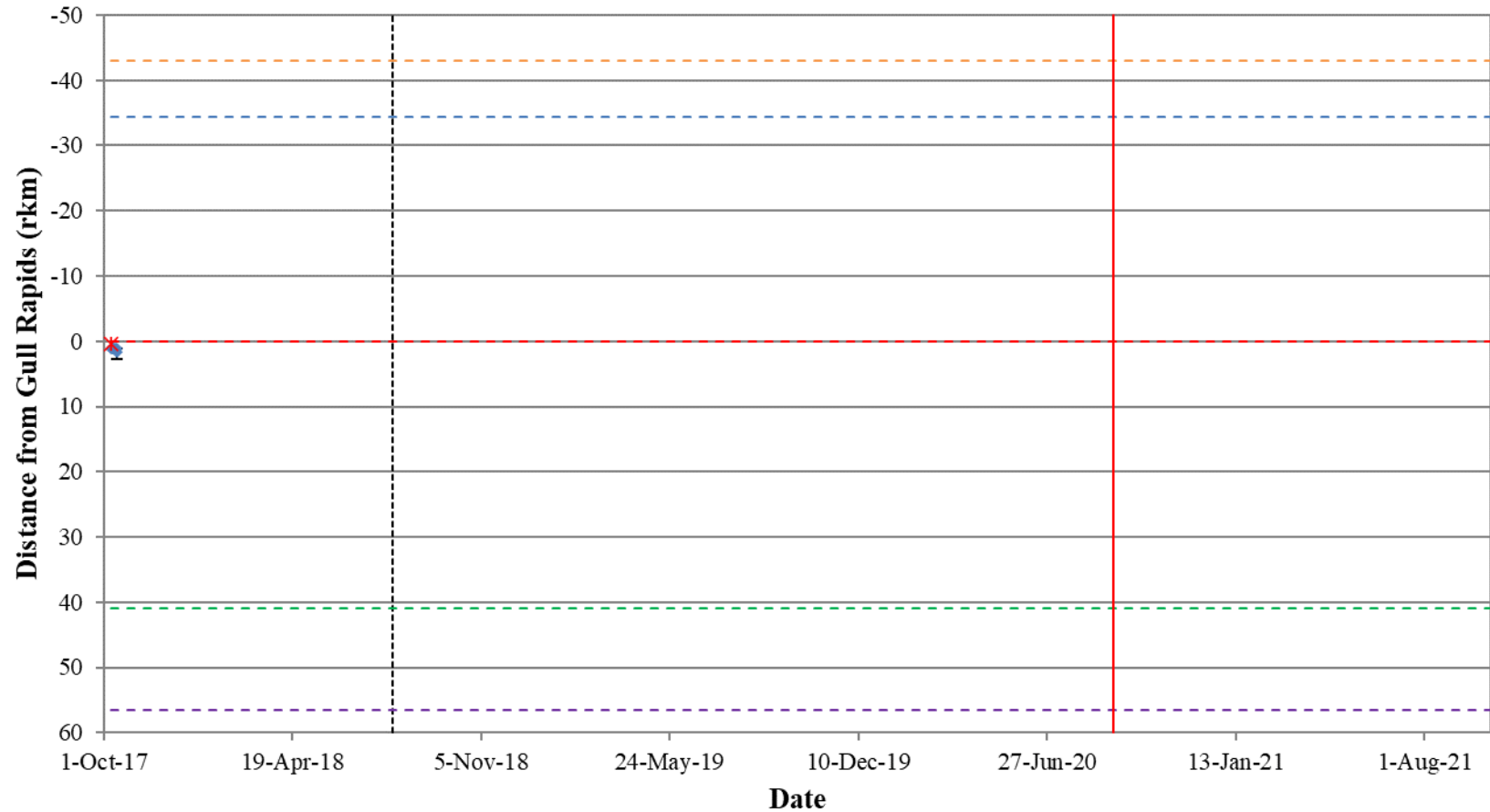


Figure A3-23: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31720) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

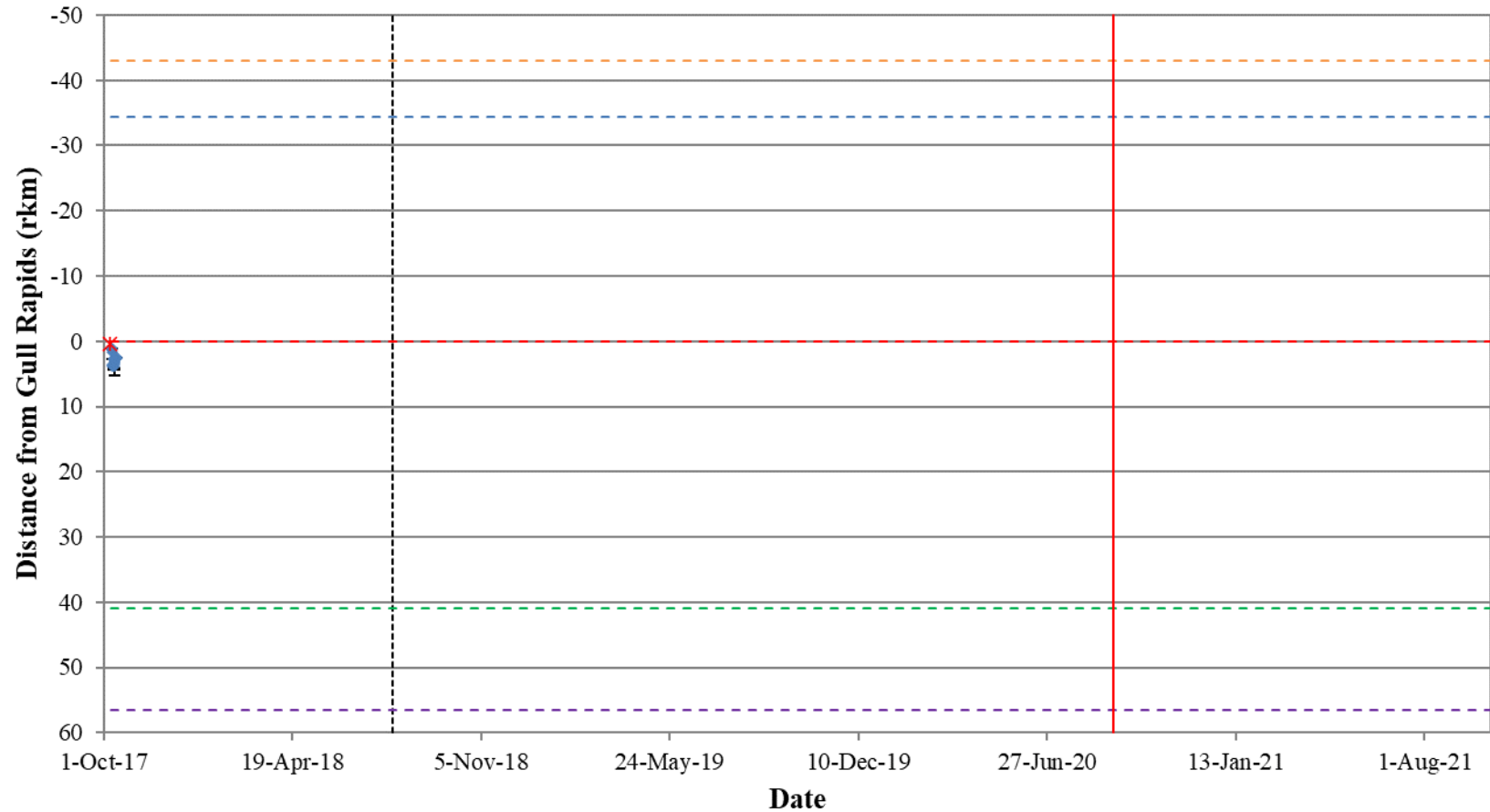


Figure A3-24: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31721) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

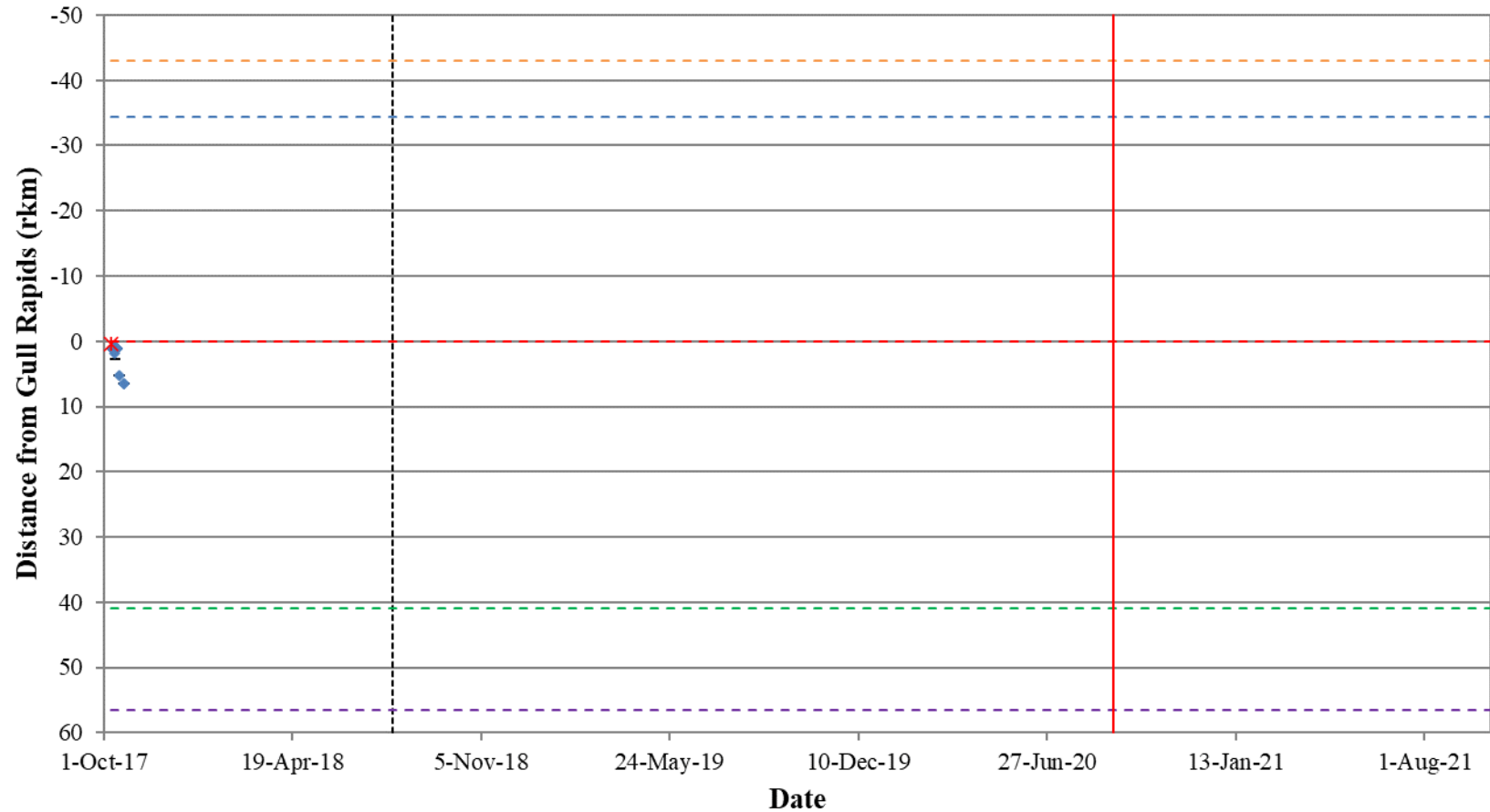


Figure A3-25: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31723) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

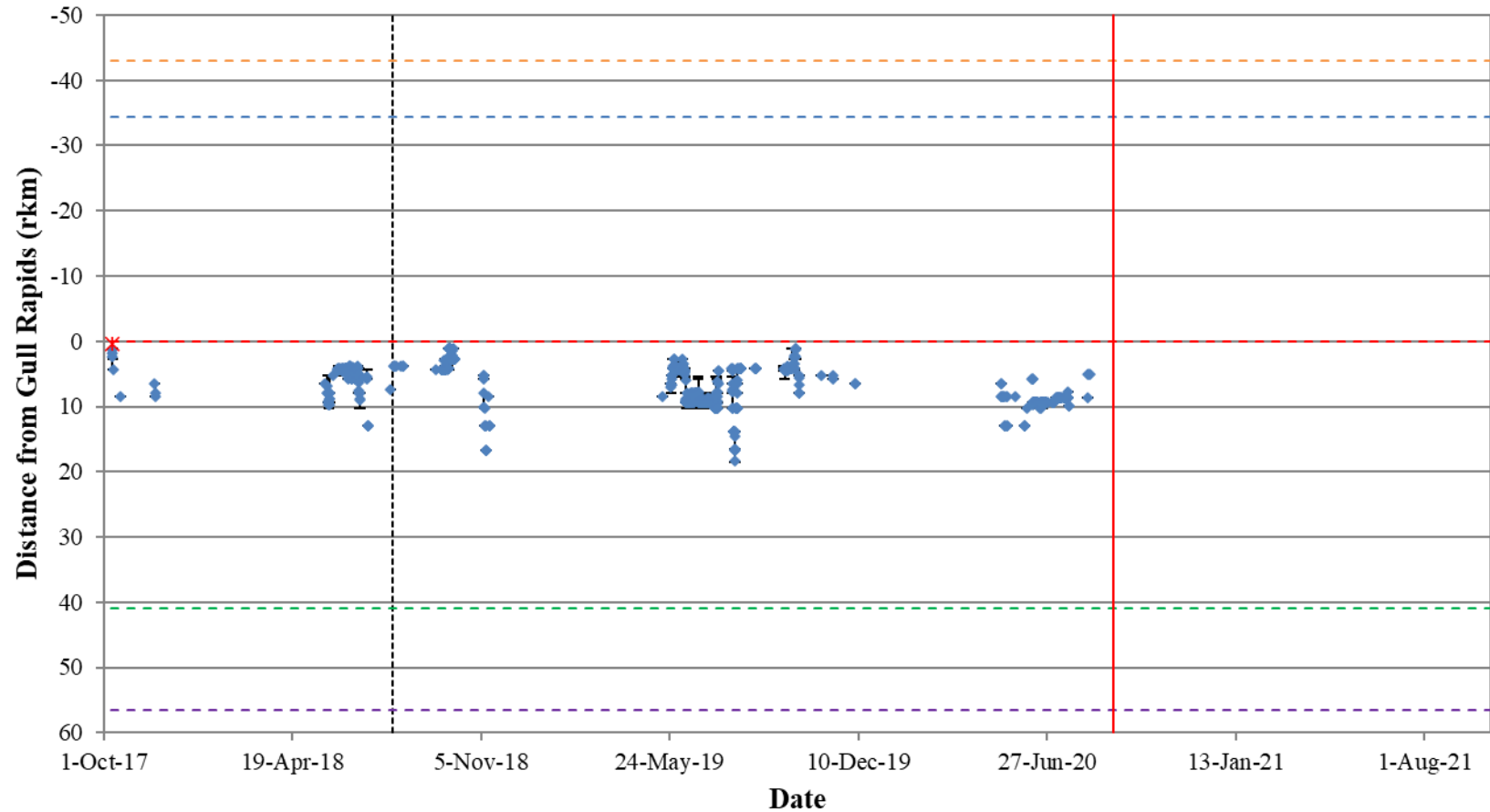


Figure A3-26: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31724) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

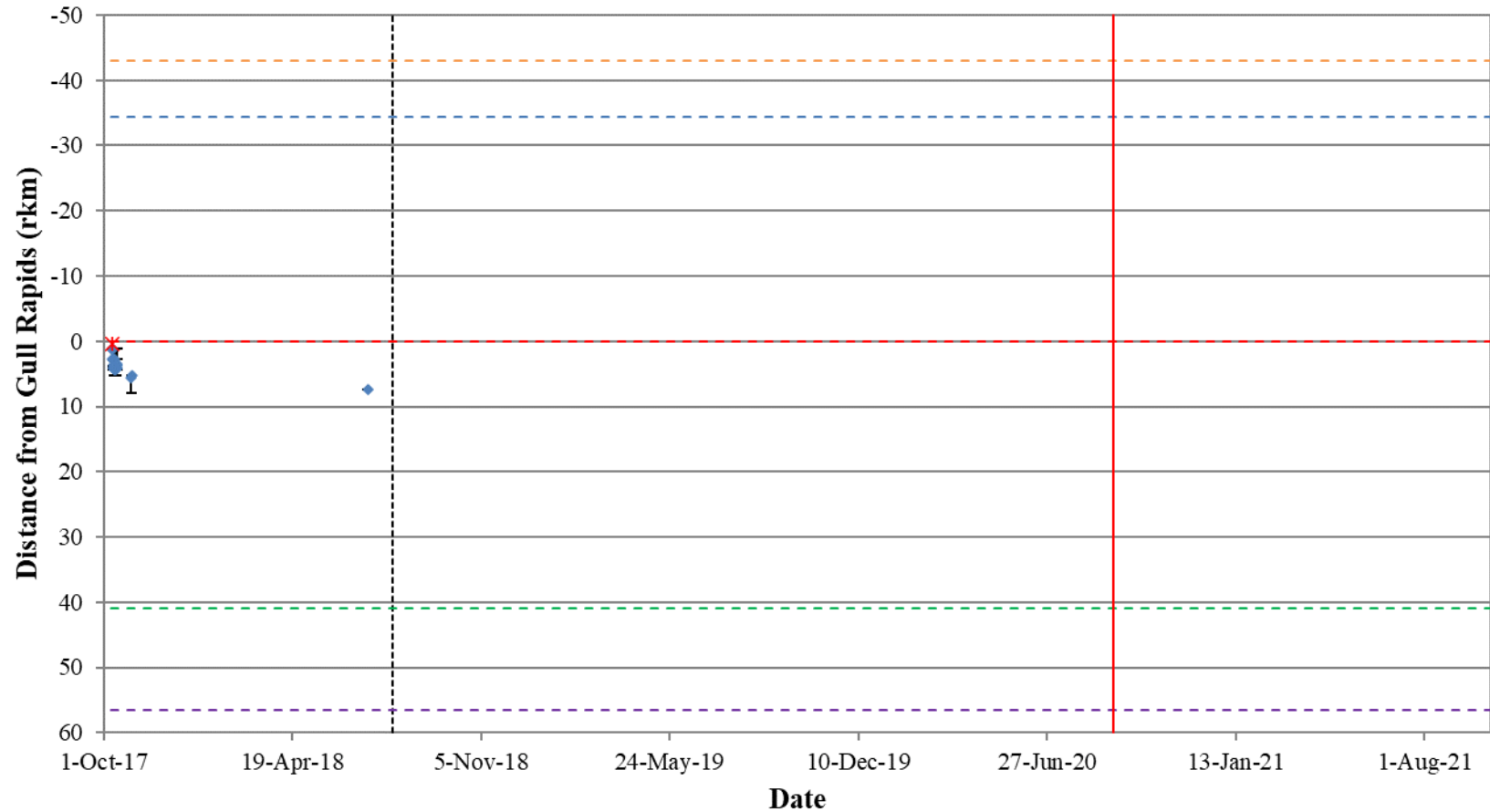


Figure A3-27: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31725) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

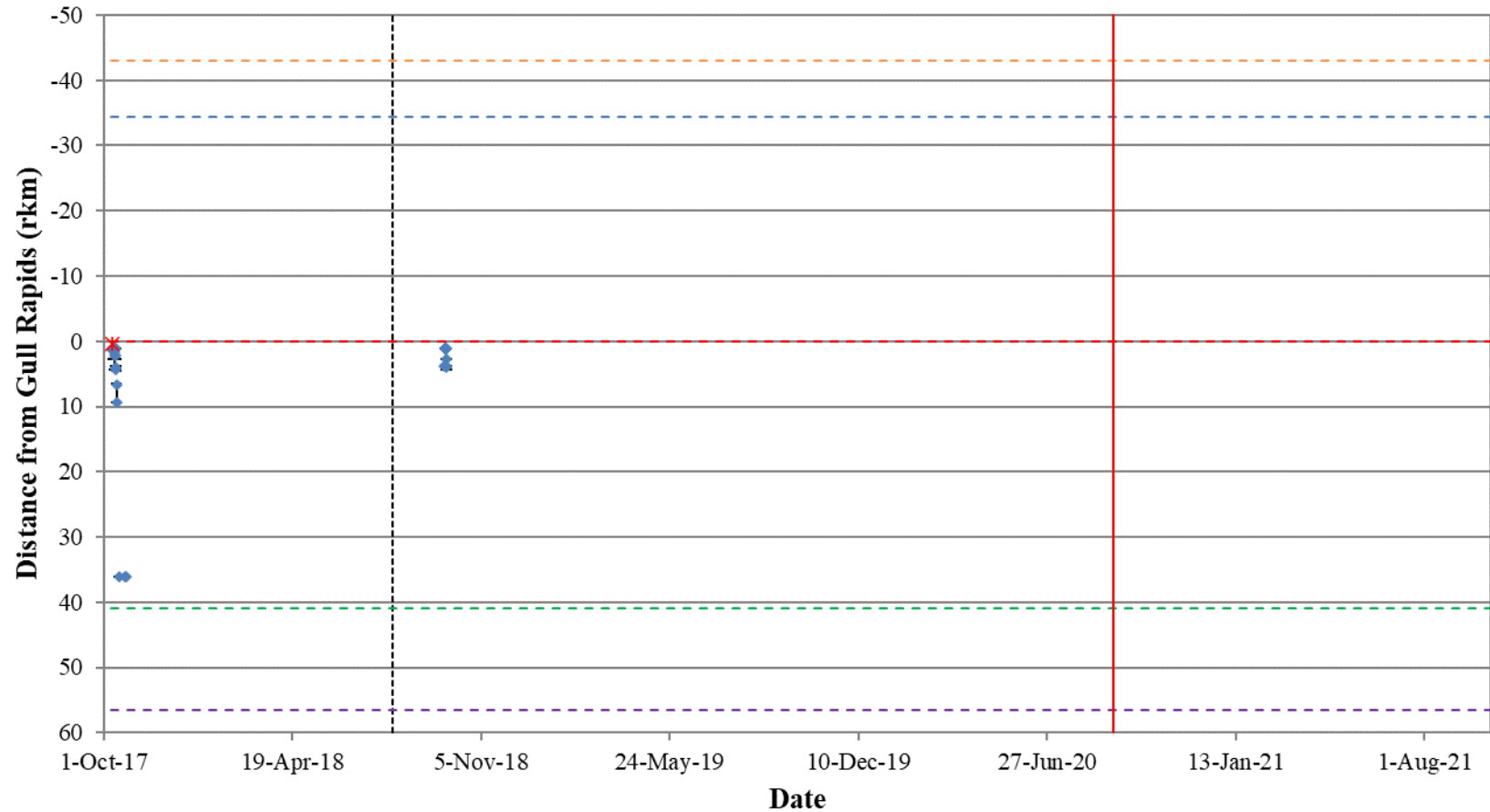


Figure A3-28: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31747) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

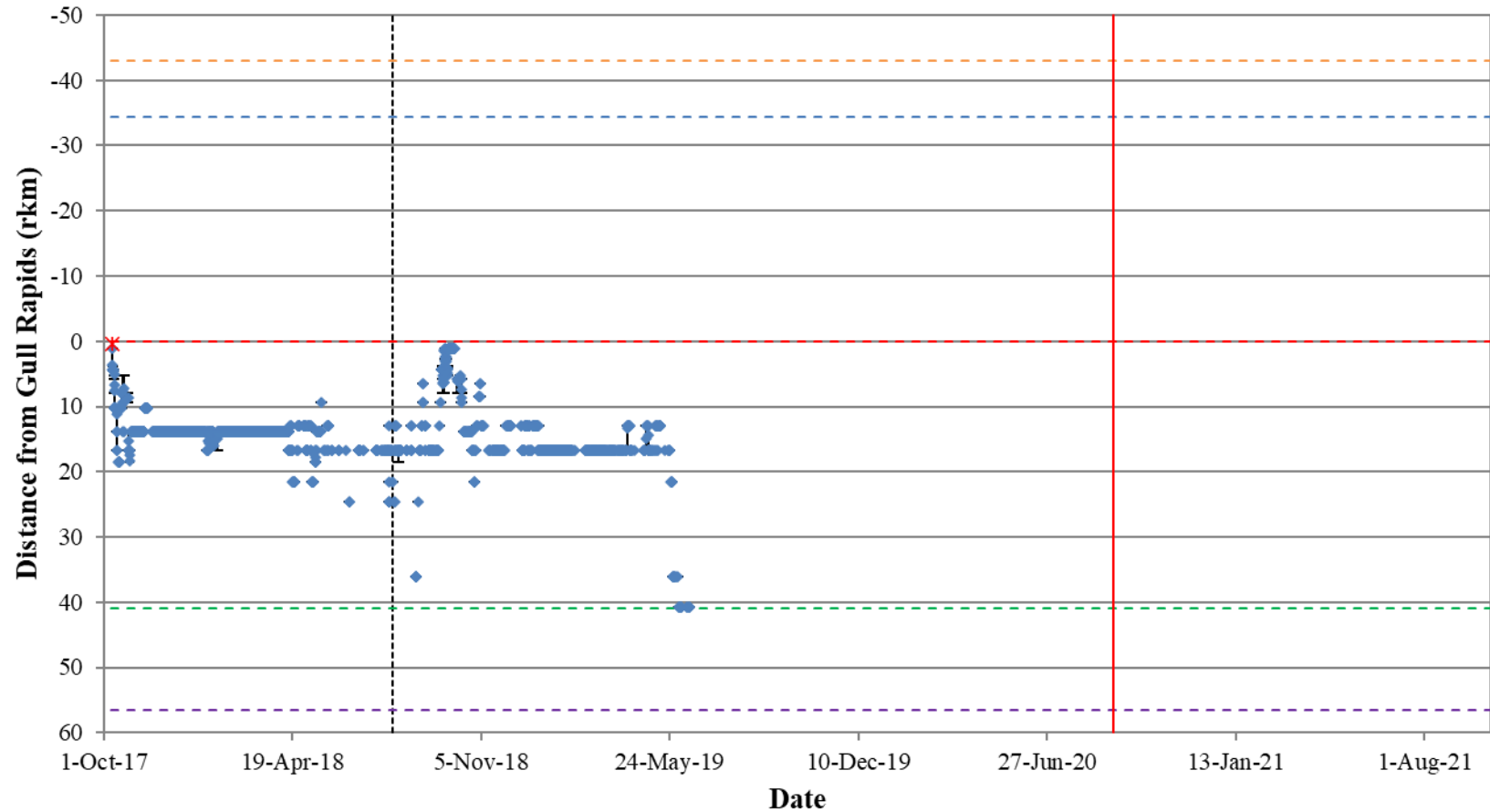


Figure A3-29: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31748) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

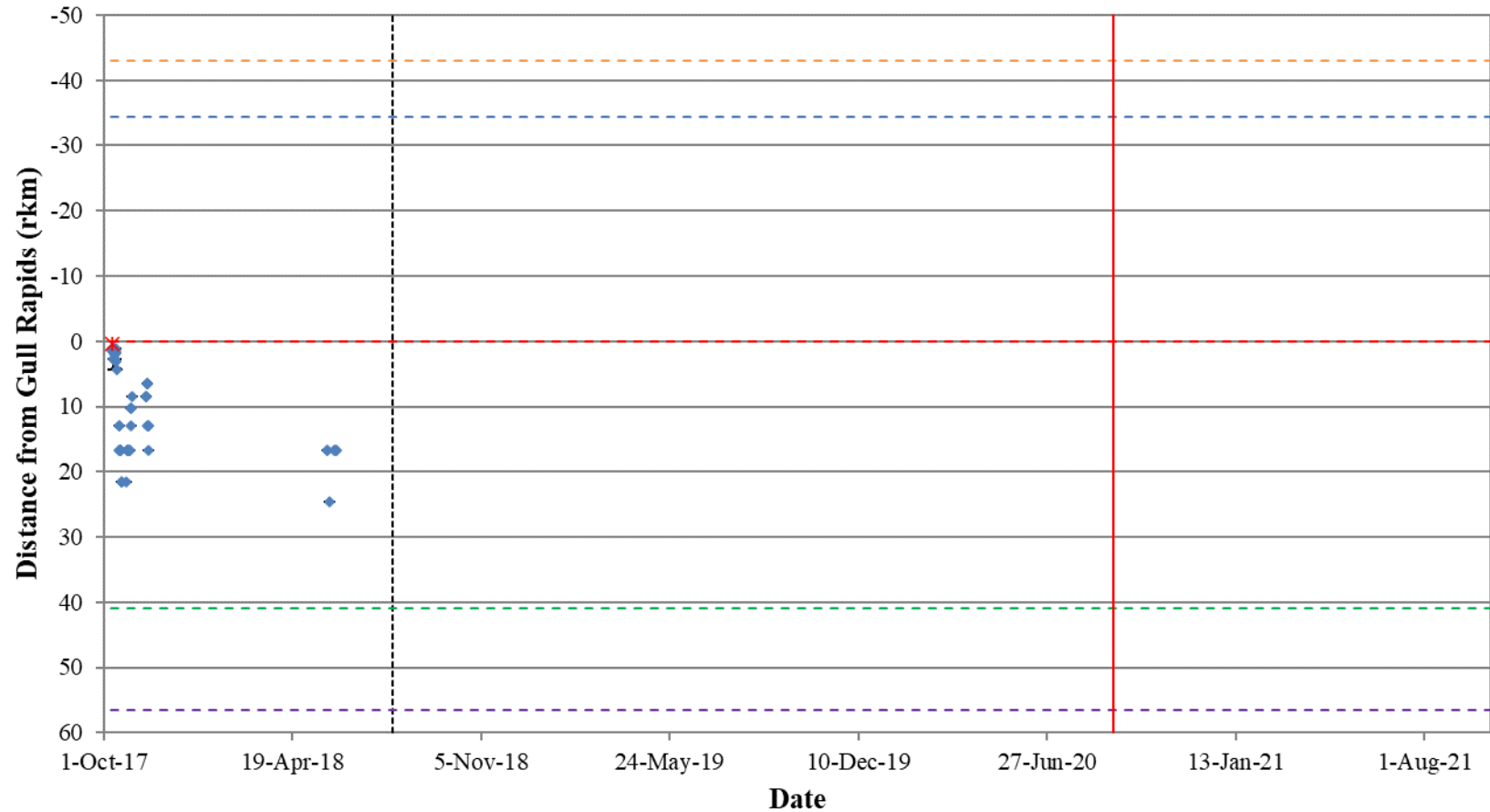


Figure A3-30: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31749) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

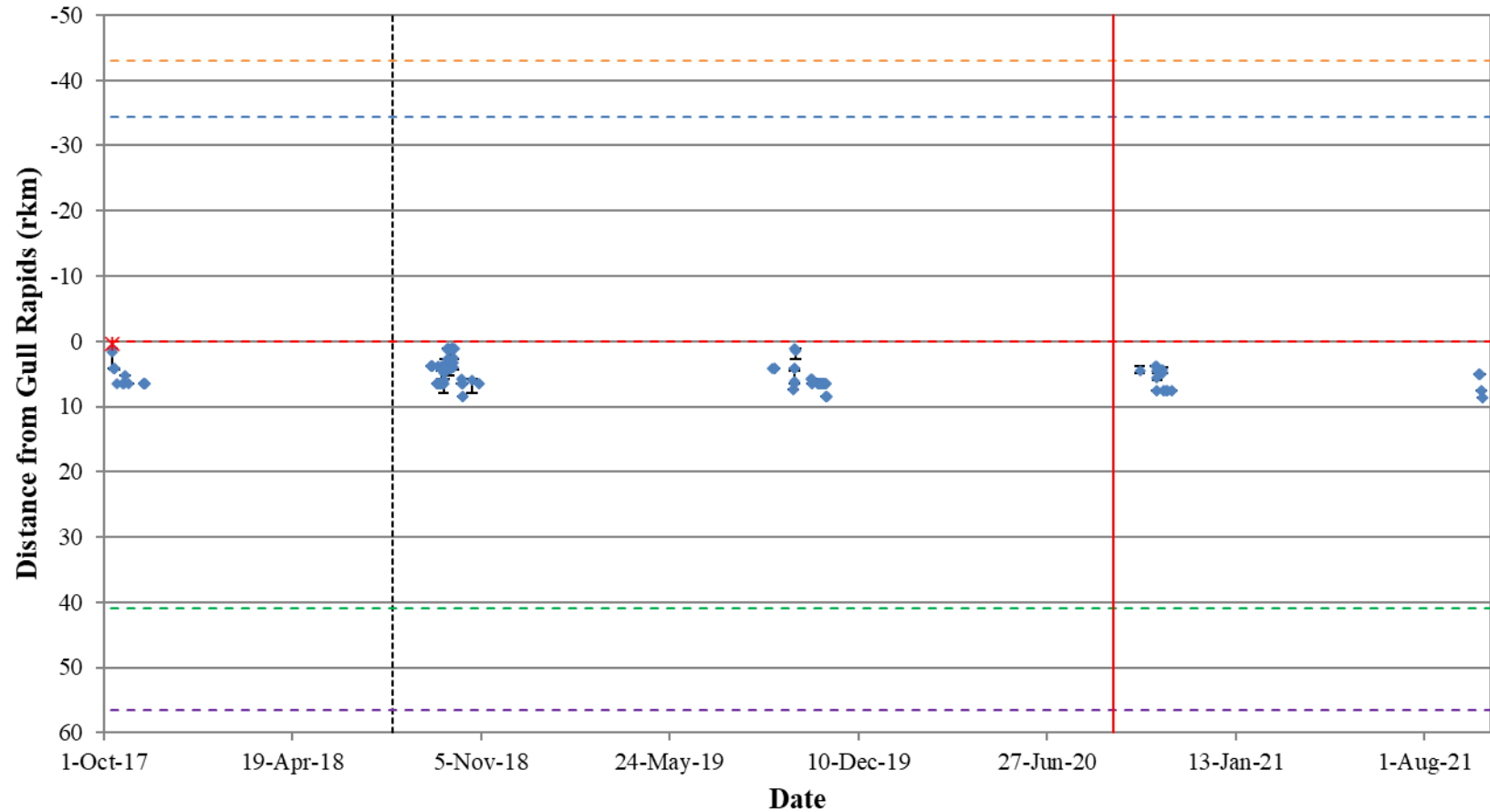


Figure A3-31: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31750) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

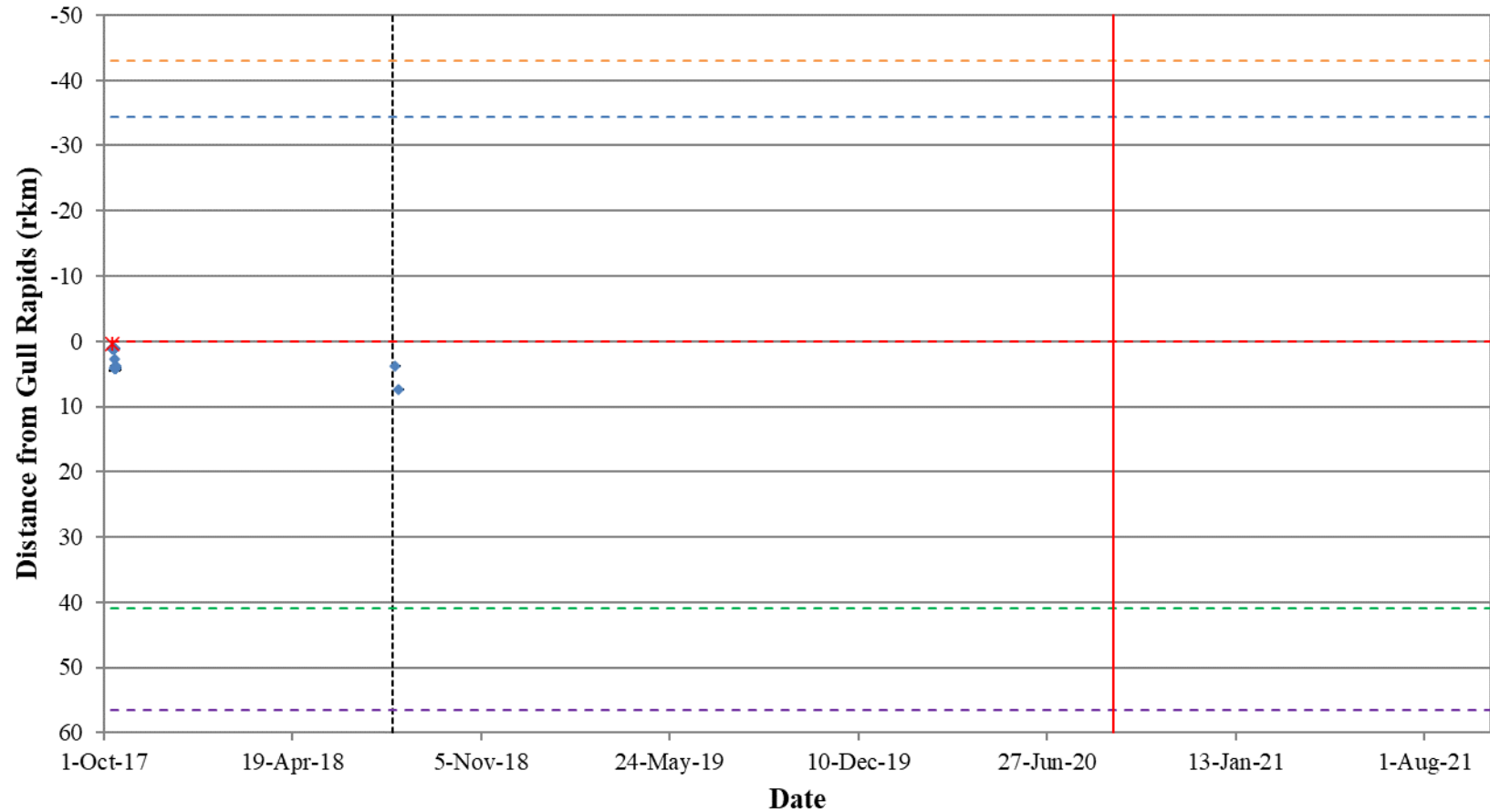


Figure A3-32: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31751) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

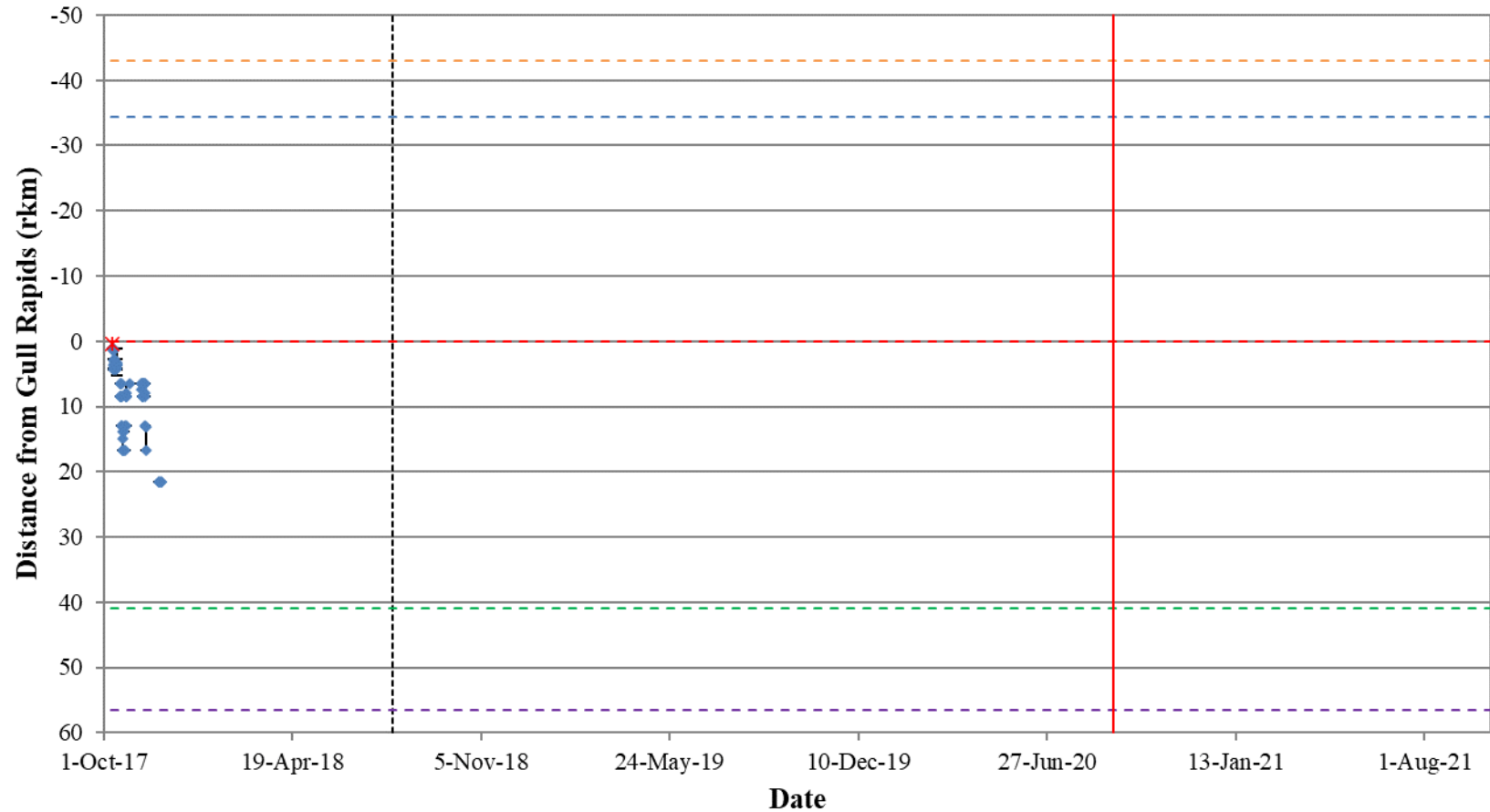


Figure A3-33: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31752) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

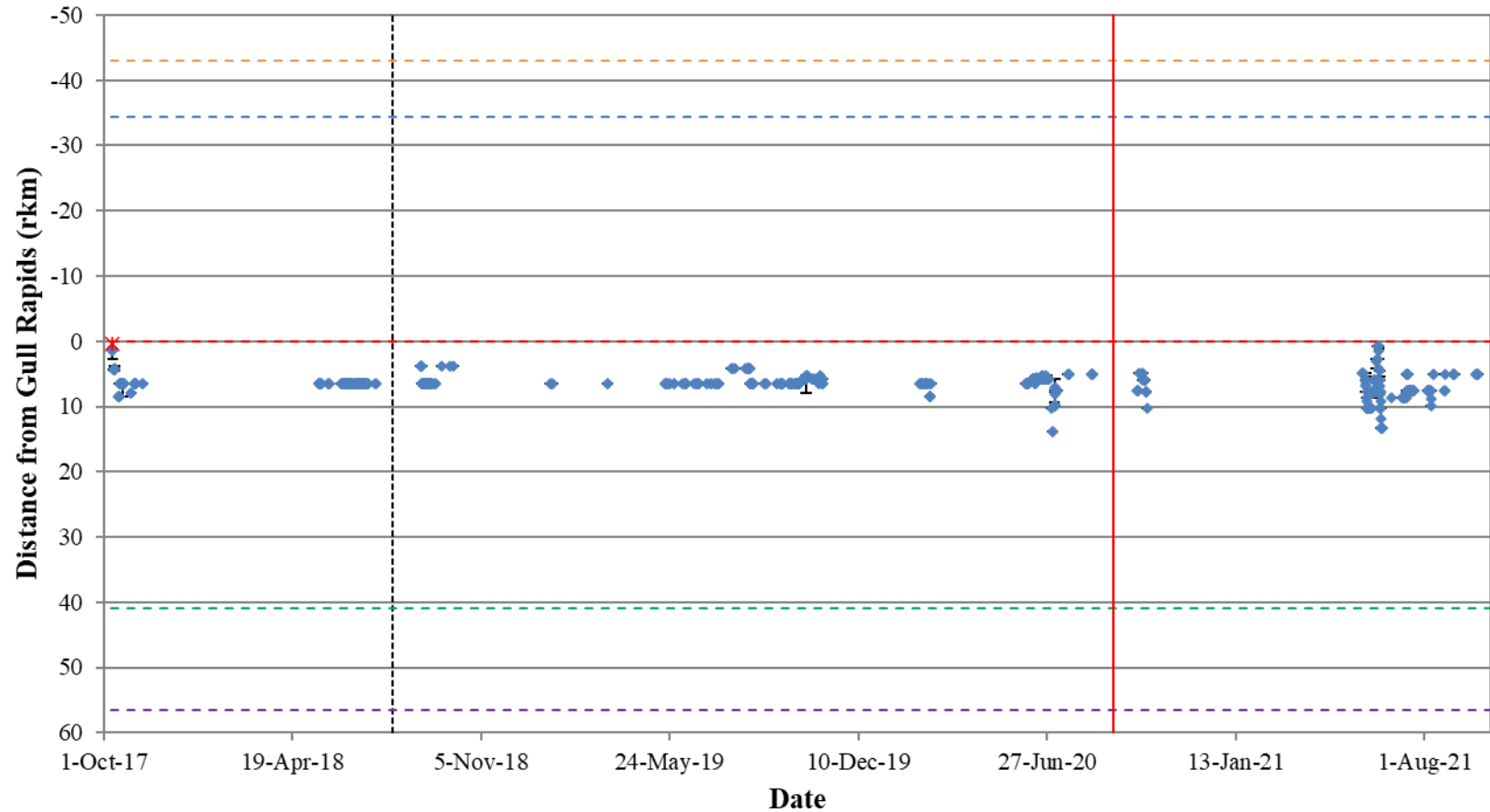


Figure A3-34: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31753) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

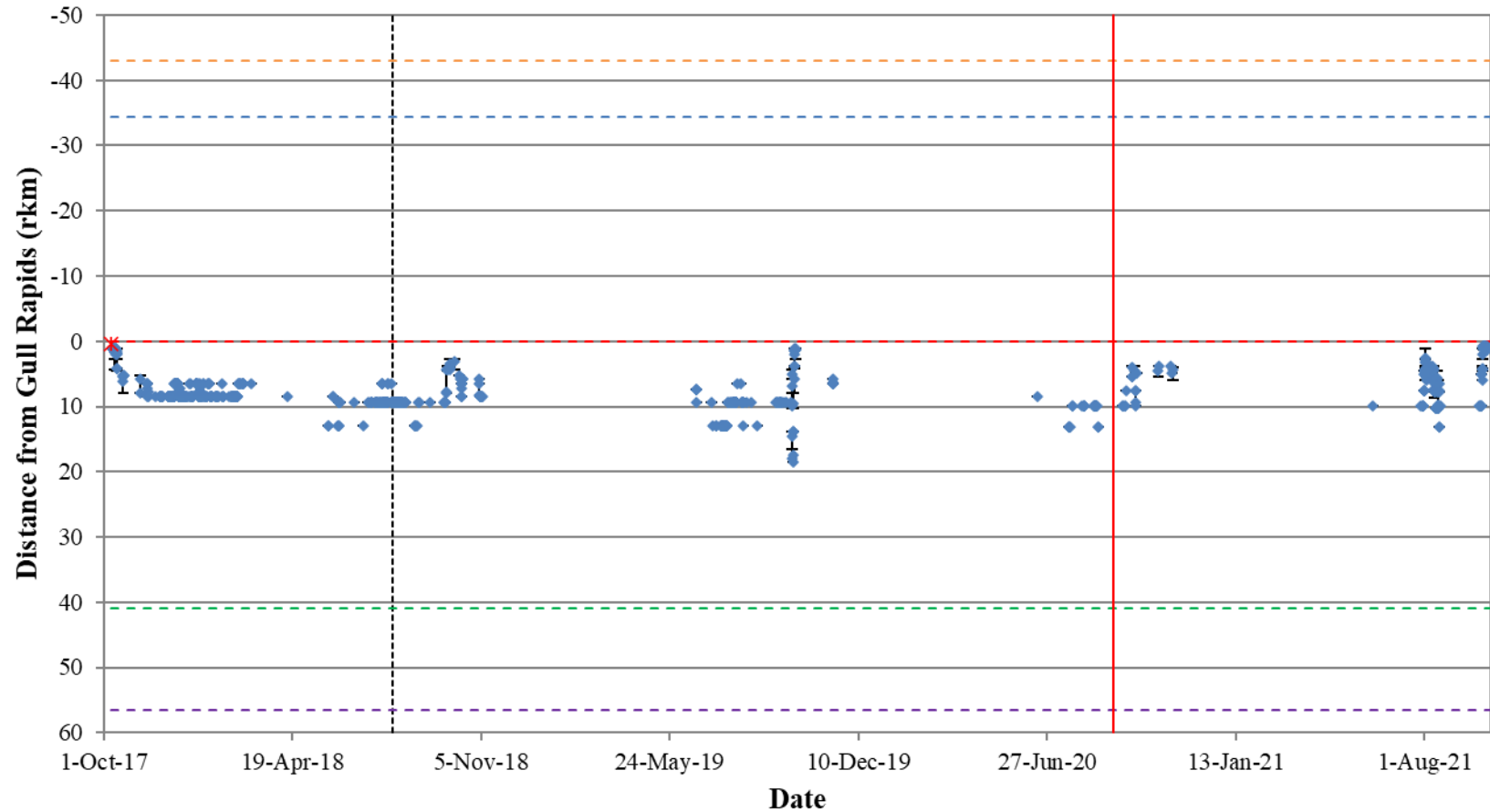


Figure A3-35: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31754) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

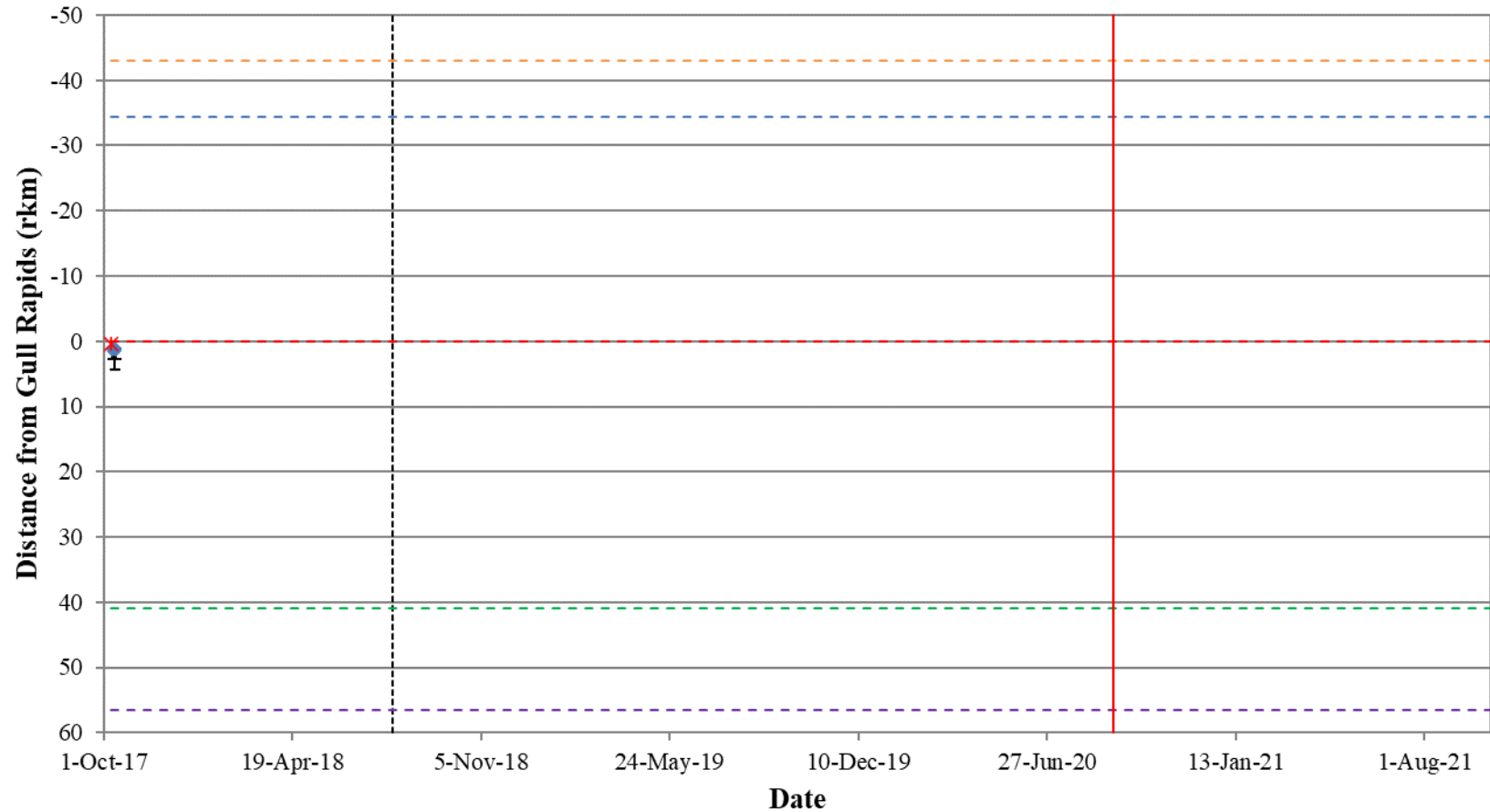


Figure A3-36: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31755) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

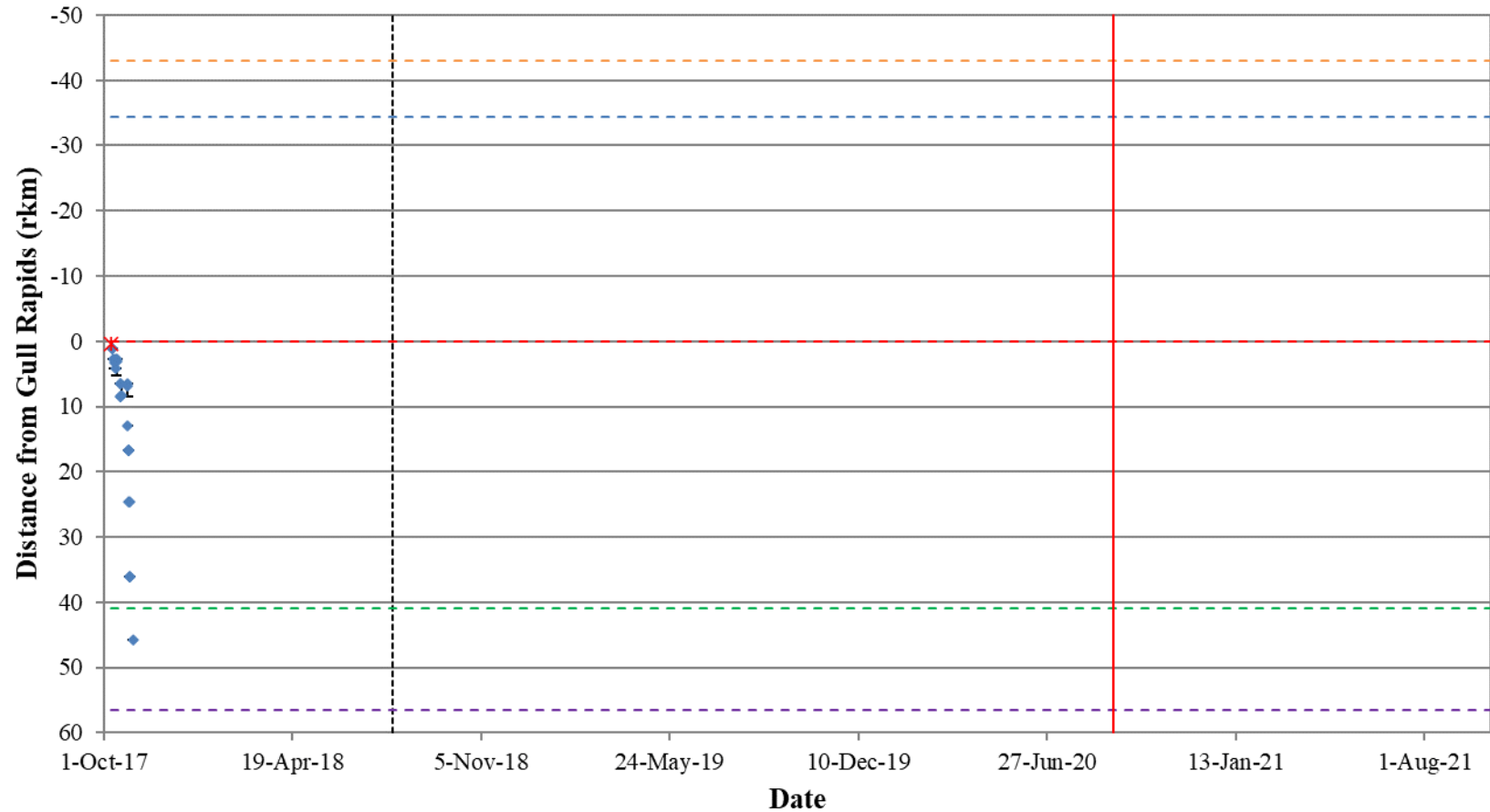


Figure A3-37: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31756) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

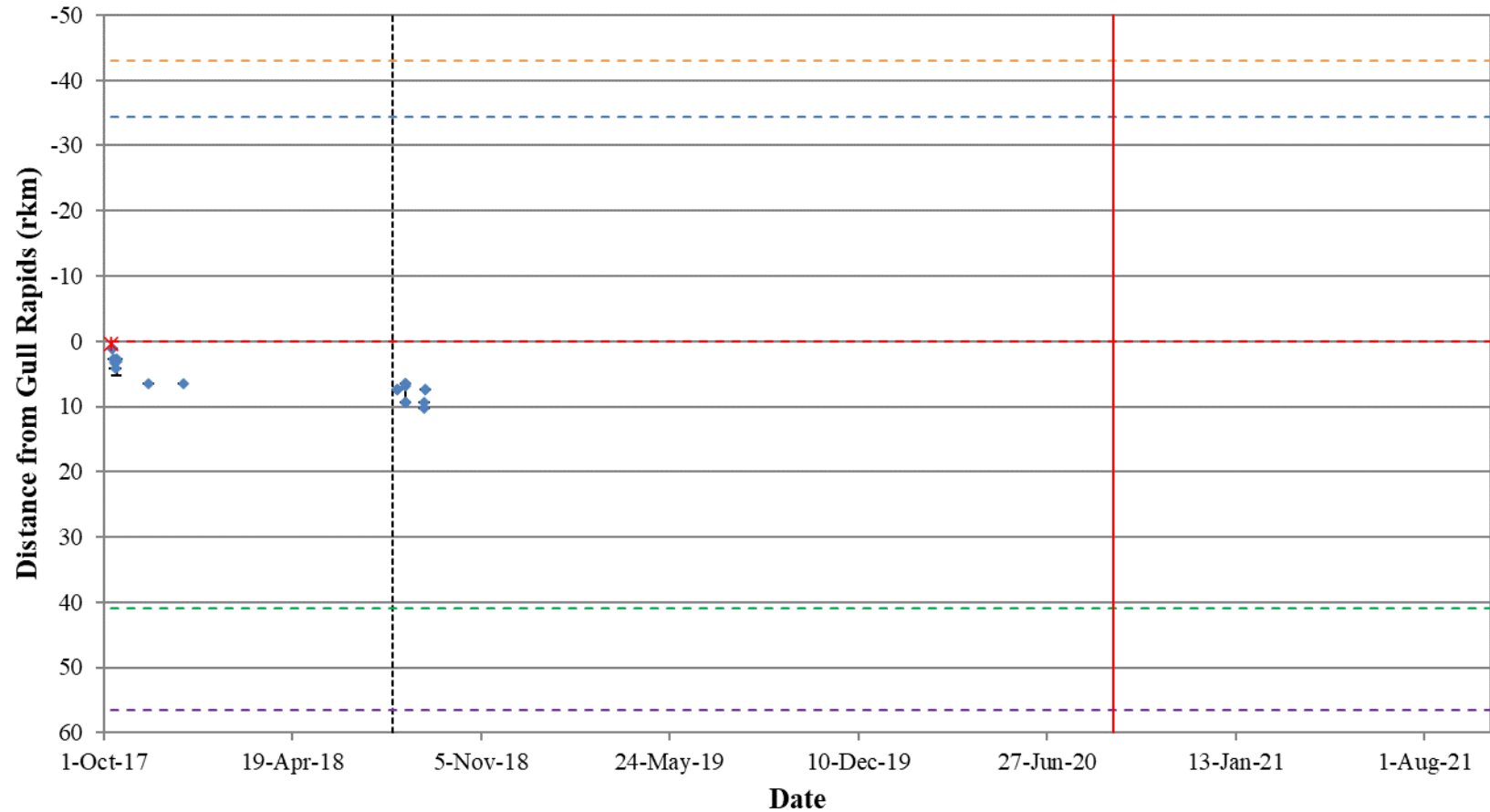


Figure A3-38: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31757) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

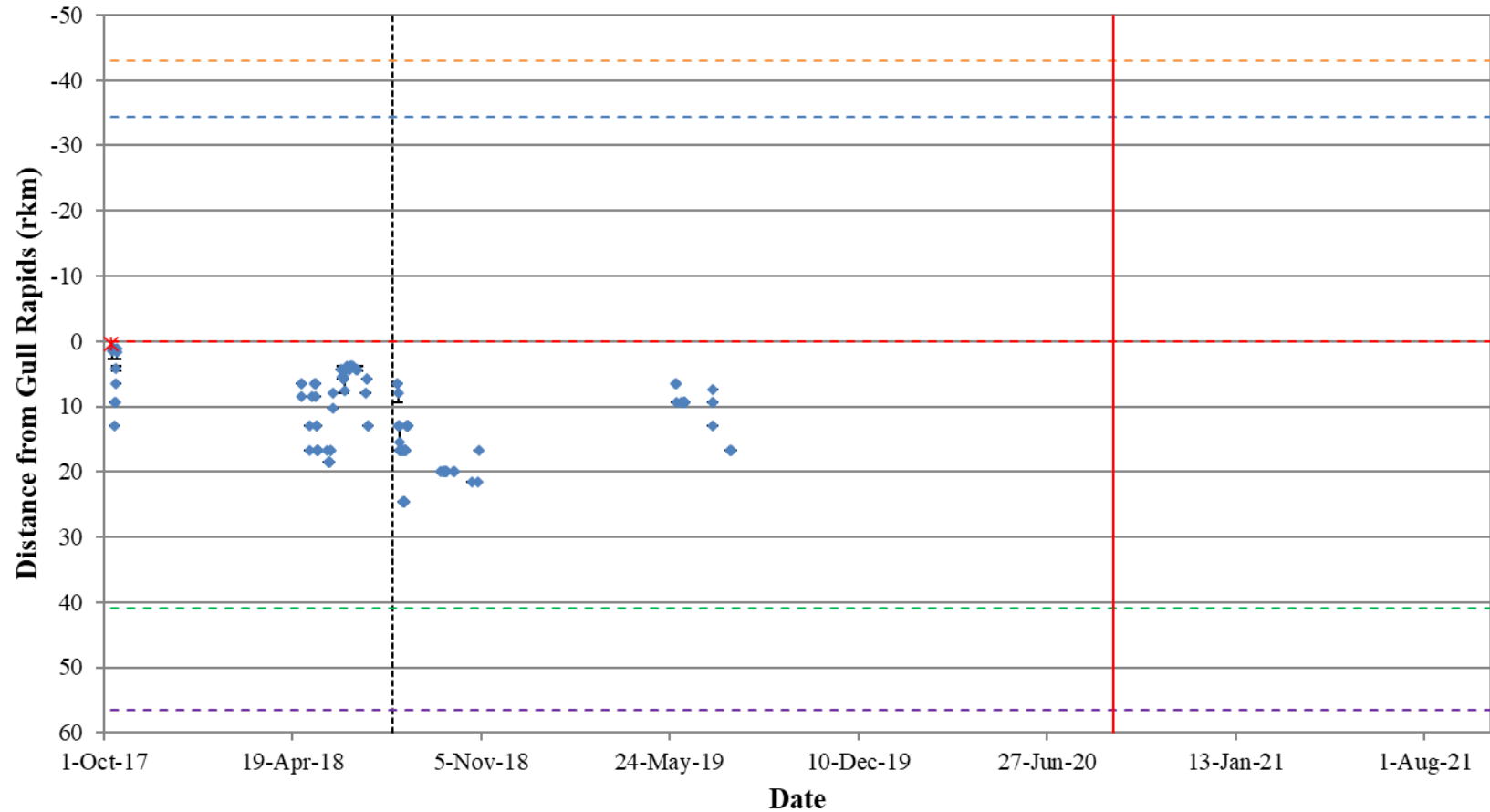


Figure A3-39: Position of a Lake Whitefish tagged with an acoustic transmitter (code #53761) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).

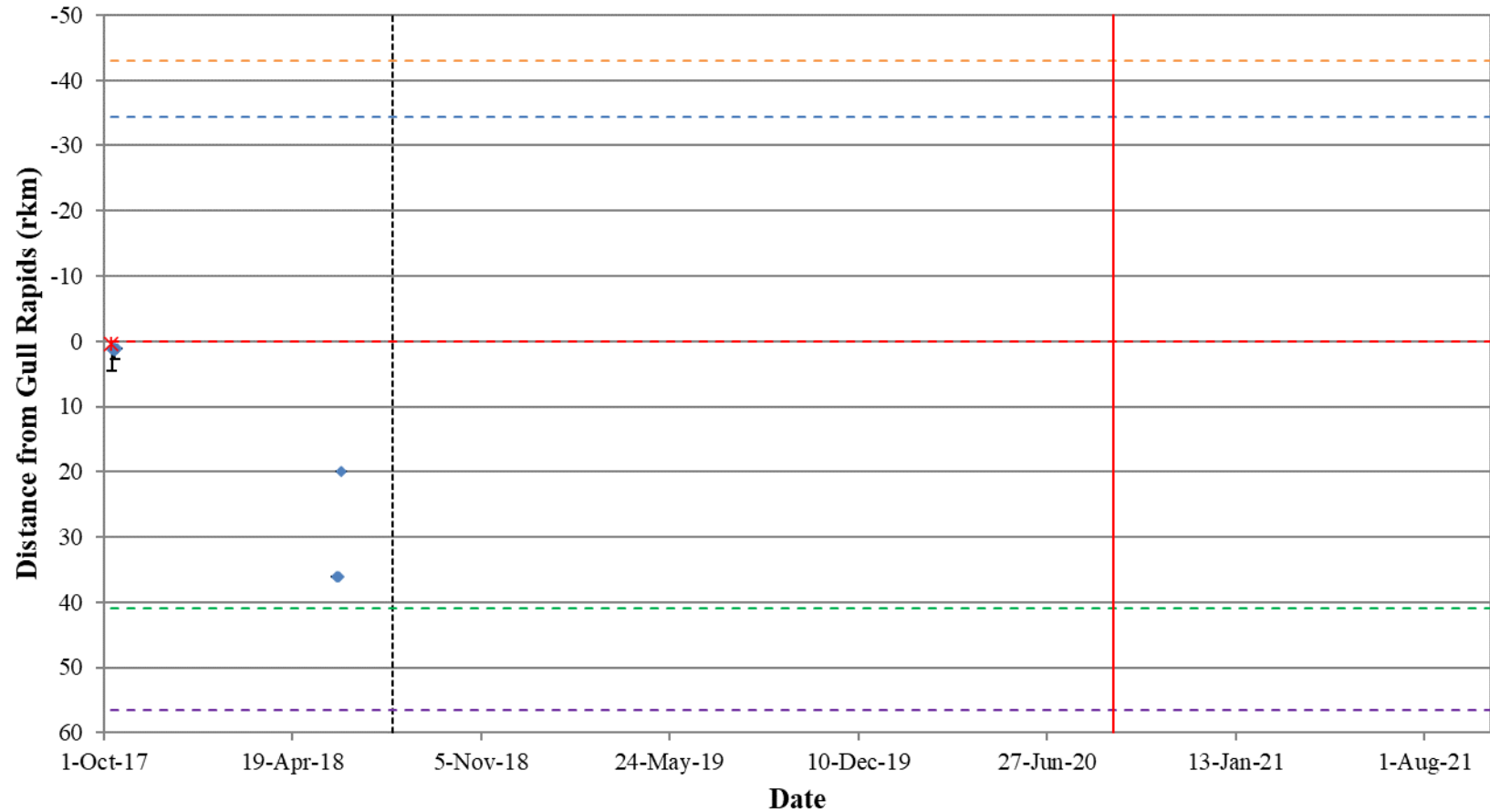


Figure A3-40: Position of a Lake Whitefish tagged with an acoustic transmitter (code #53762) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to October 2021. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Keeyask GS; green = Kettle GS, purple = Long Spruce GS). Vertical black dotted line indicates start of spillway operation (August 3, 2018). Vertical solid red line indicates the completion of reservoir impoundment (September 5, 2020).