



Keeyask Generation Project Aquatic Effects Monitoring Plan

Lake Whitefish Movement Monitoring Report AEMP-2021-03



KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

REPORT #AEMP-2021-03

LAKE WHITEFISH MOVEMENT MONITORING IN THE NELSON RIVER BETWEEN CLARK LAKE AND THE LIMESTONE GENERATING STATION, OCTOBER 2019 TO SEPTEMBER 2020: YEAR 7 CONSTRUCTION

Prepared for

Manitoba Hydro

By

C.L. Hrenchuk

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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

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SUMMARY

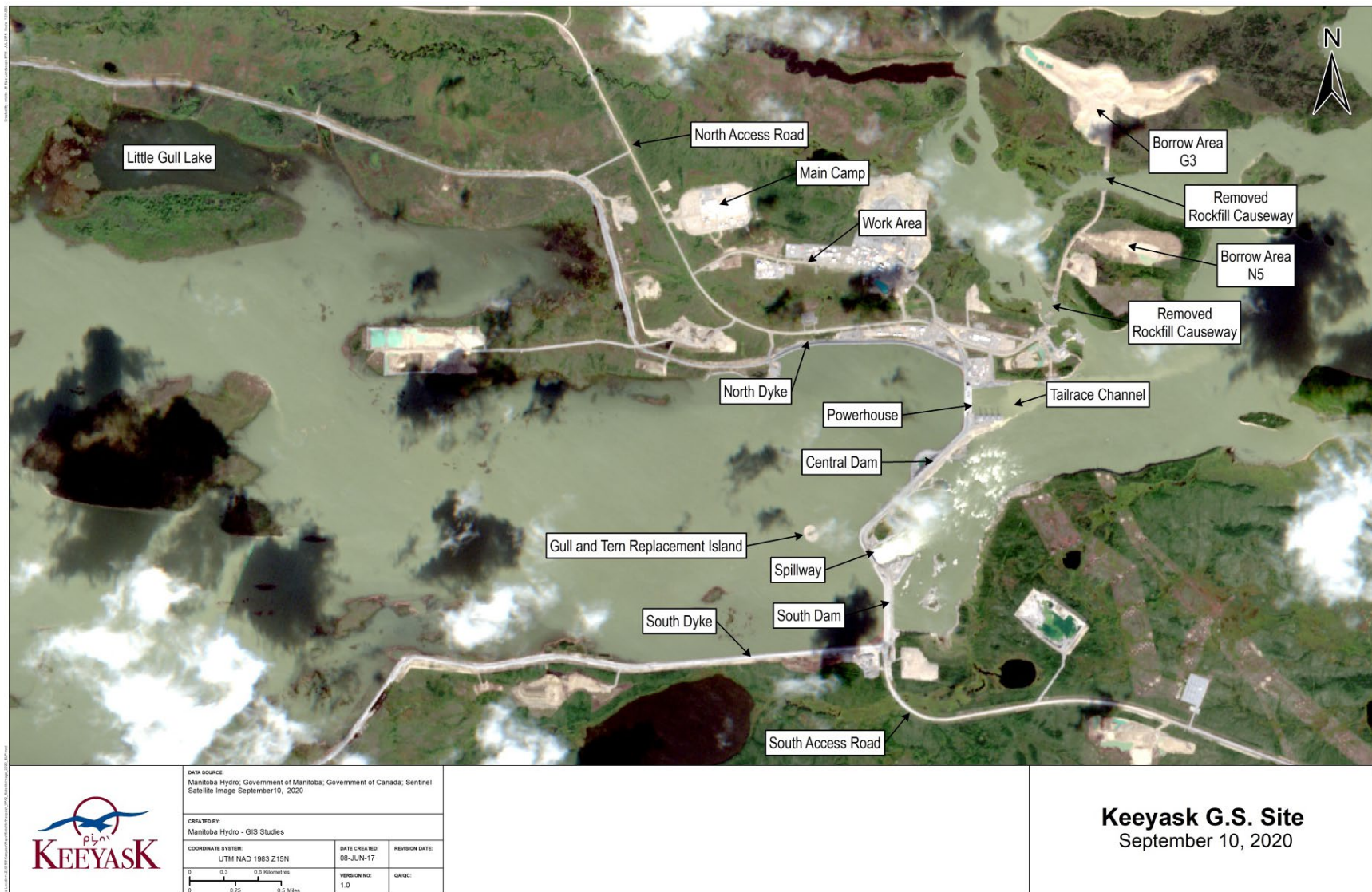
Background

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 with the construction of cofferdams in the north and central channels of Gull Rapids. These cofferdams resulted in the dewatering of the north and central channels and the diversion of all flow to the south channel. Construction of the Spillway Cofferdam (SWCD), which extends into the south channel of Gull Rapids, was completed in 2015. The rock placement for the inner and outer groins of the Tailrace Cofferdam (TRCD) started in late 2016 and the impervious fill placement was completed in fall 2017. The spillway was commissioned between August 3 and 7, 2018. Closing the south channel with the upstream South Dam Cofferdam (SDCD) commenced at the beginning of August and river closure was achieved on August 16. This closure and the work that continued to seal the cofferdam forced the entire river flow through the spillway. In 2020 water-up of the areas kept dry by cofferdams for construction occurred between the end of February and mid-April. The cofferdams upstream of Keeyask and the North Channel Rock Groin were removed and/or lowered throughout the water-up process. Excavation of the TRCD occurred from mid-April to May 14 and then resumed on July 16 and was completed in October. Impoundment of the Keeyask reservoir took place between August 31 and September 5, 2020. Commissioning of the first generator unit started on August 31, 2020 and was still underway at the end of 2020.

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 October 2019 to September 2020 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.



Map illustrating instream structures at the Keeyask Generating Station site after reservoir flooding, September 2020.

Why is the study being done?

Monitoring during construction is being done to answer two questions:

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.

How many Lake Whitefish are moving through and/or away from the Keeyask GS (formerly Gull Rapids) during construction and how far are they going?

Movement studies tell us how many whitefish are moving up or down through Gull Rapids (now the Keeyask GS), how far they travel up or downstream away from the site, whether they are leaving the Keeyask area completely and when they are making these movements. The distance they travel is monitored as far upstream as the inlet to Clark Lake and downstream as far as the Limestone reservoir.

In 2020, monitoring was conducted for 19 days after the reservoir was flooded on September 5, 2020. This means an additional AEMP key question can begin to be addressed.

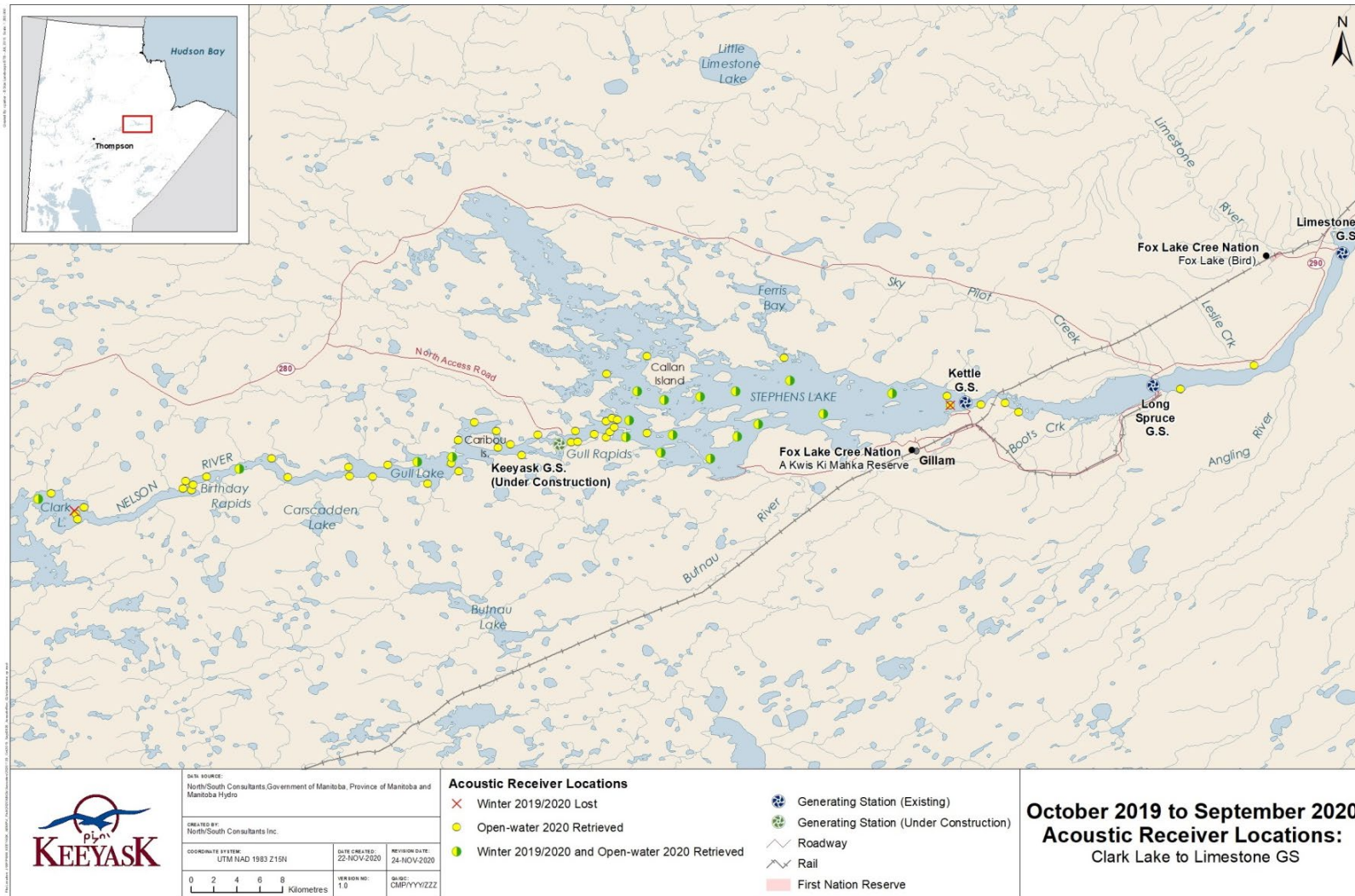
How many Lake Whitefish move upstream past Birthday and/or Long rapids?

Flooding of Gull Lake will cause changes to available habitat in the area. This may cause Lake Whitefish to move out of the newly formed reservoir.

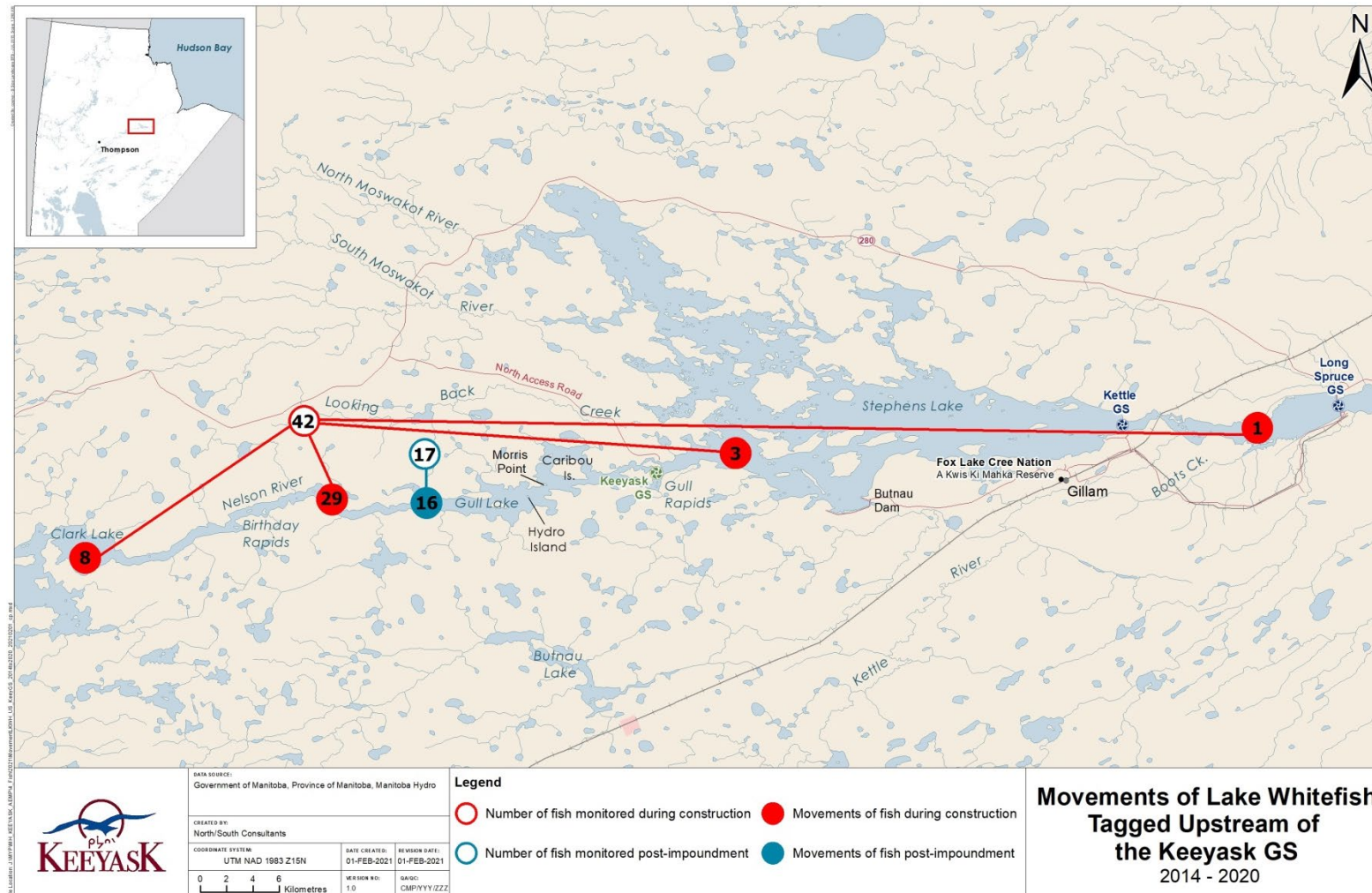
What was done?

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 life-span.

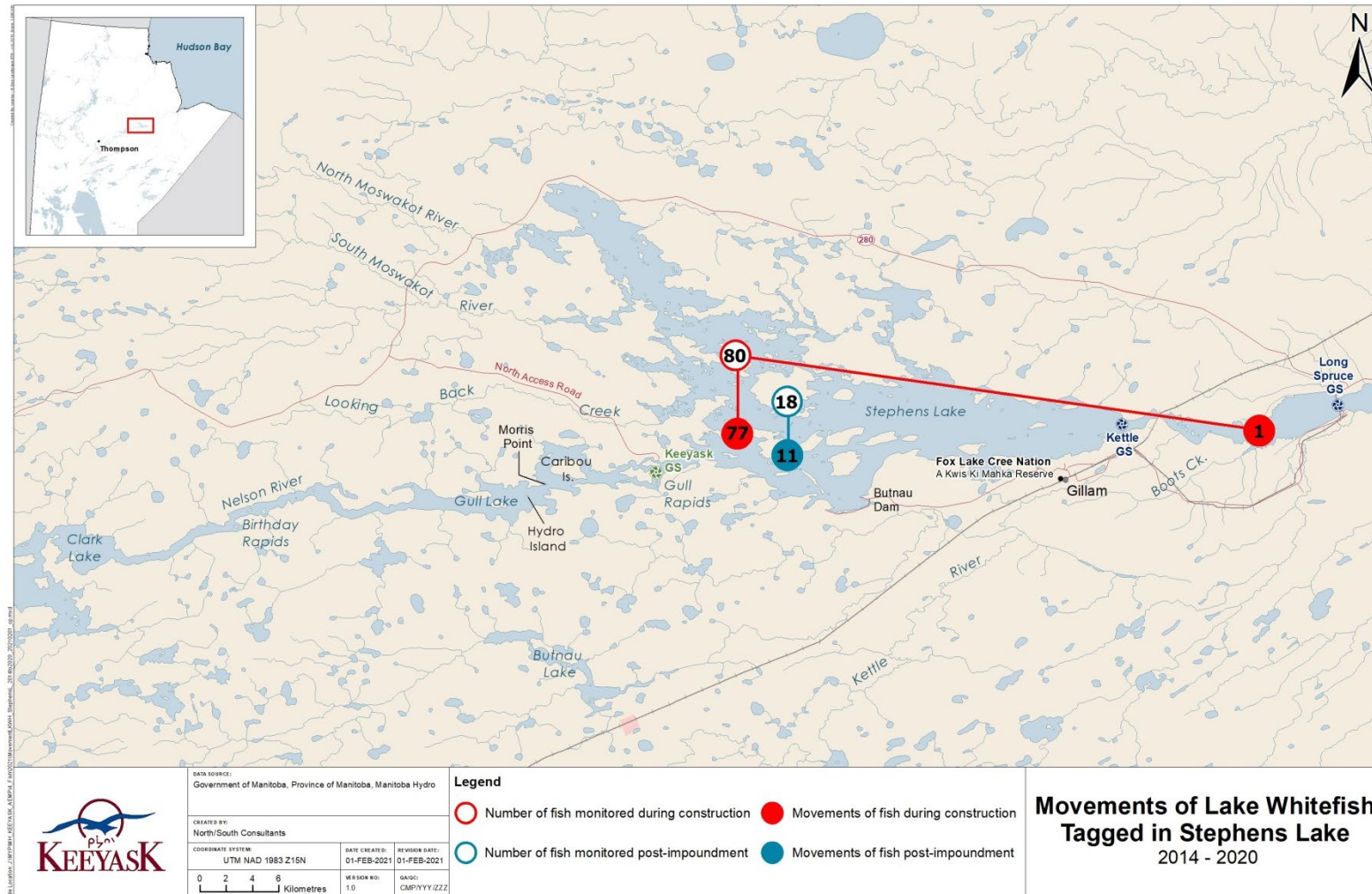
Sixty Lake Whitefish were tagged in 2014, 20 upstream and 40 downstream of Gull Rapids. Because the batteries in these transmitters expired in winter 2017, 62 additional transmitters were implanted into Lake Whitefish in October 2017. This will extend the tracking of Lake Whitefish movements until summer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



Map 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 before construction (yellow), 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 before construction (yellow), 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 six years of tracking the movements of Lake Whitefish suggest that movement through 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.

Upstream of the Keeyask GS, fish spent a large part of their time in the upper section of Gull Lake during the open-water period and do not appear to be using habitat directly upstream of the construction site. In the fall, some of the detected fish made upstream movements out of Gull Lake to the base of Birthday Rapids. These upstream movements are believed to be for spawning.

In Stephens Lake, Lake Whitefish were more evenly spread throughout the lake. Many tagged whitefish were located closer to the base of the Keeyask GS in the fall, likely because it is a spawning area. Based on detections in the north part of Stephens Lake, it is suspected that some fish spend most of their time in the north arm of Stephens Lake, and some of these fish move to the Keeyask GS in the fall to spawn.

Flooding of the Keeyask GS reservoir to the full supply level was completed during 6 days ending on September 5, 2020. Monitoring was conducted for 19 days after this date. No long-distance movements or changes to movement patterns were observed upstream or downstream of the Keeyask GS during or after impoundment. No whitefish tagged upstream of the GS left the newly formed reservoir. Continued monitoring will show if movement patterns change.

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 during the five-year study. Some of these movements may be related to tagging stress or mortality. The number of Lake Whitefish moving past the Keeyask GS or the Kettle GS does not seem to have increased during construction.

Long distance movements from fish tagged in Gull Lake have varied from year to year. For example, eight whitefish tagged in 2014 moved upstream from Gull Lake into Clark Lake, but none tagged in 2017 made this movement. No fish moved upstream or downstream out of the reservoir within 19 days of impoundment to full supply level.

What will be done next?

The additional Lake Whitefish tagged in October 2017 will allow movement data to be collected until summer 2022. Ongoing tracking of fish through GS construction, and the initial years

following impoundment will provide additional information about where the fish are moving, what kinds of habitats these fish need to use over several years, when and where they are spawning, and where they are feeding.

ACKNOWLEDGEMENTS

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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 #10-20.

STUDY TEAM

Data Collection

Jesse Bell

Regan Caskey

Grant Connell

Leslie Flett

Brett Funk

Claire Hrenchuk

Reid Minary

Eric Mullen

Data Analysis, Report Preparation, and Report Review

Cameron Barth

Claire Hrenchuk

Candace Parker

Friederike Schneider-Vieira

Dirk Schmidt

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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). Results from October 8, 2019 to September 23, 2020 are presented in this report.

Lake Whitefish movements in the main flow of the Nelson River near the construction site may be affected by the installation of cofferdams 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).

The key questions (presented in the AEMP) related to Lake Whitefish movement monitoring during construction of the Keeyask GS are:

- What number (or proportion) of tagged Lake Whitefish move past the construction site?
- Are whitefish utilizing habitat in the vicinity of the construction site (particularly during spawning)?

Reservoir impoundment occurred over six days ending on September 5. Monitoring was conducted for 19 days after impoundment, which made it possible to begin to address another key question:

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

This report provides results from October 2019 to September 2020, which is the fifth winter and sixth open-water period of monitoring conducted since construction of the Keeyask GS began in July 2014. This report includes data collected during the first 19 days (September 5 to September 23, 2020) 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. Water velocities were classified as low (0.2–0.5 metres per second [m/s]), moderate (0.5–1.5 m/s), or high (greater than 1.5 m/s), as described in the Keeyask AE SV.

Clark Lake is located immediately downstream of Split Lake, and approximately 42 km upstream of the Keeyask GS (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.

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of the Keeyask GS (Maps 1 and 3). The drop in elevation from the upstream to downstream side of Birthday Rapids is approximately 2 m. The 14 km reach of the Nelson River between Birthday Rapids and Gull Lake is characterized as a large and somewhat uniform channel with medium to high water velocities. There are a few large bays with reduced water velocity and a number of small tributaries that drain into the Nelson River.

Gull Lake is a section of the Nelson River where the river widens, with moderate to low water velocity. Gull Lake is herein defined as the reach of the Nelson River beginning approximately 19.5 km upstream of the Keeyask GS and 14 km downstream of Birthday Rapids, where the river widens to the north into a bay around a large point of land (Maps 1 and 3), and extending to the downstream end of Caribou Island, approximately 3 km upstream of the Keeyask GS. Gull Lake has three distinct basins, the first extending from the upstream end of the lake downstream approximately 6 km to a large island; the second extending from the large island to Morris Point (a constriction in the river immediately upstream of Caribou Island); and the third extending from Morris Point to the downstream end of Caribou Island (Map 3).

In fall 2020, Gull Lake was impounded by the Keeyask GS and became part of the Keeyask reservoir, which will operate at a full supply level (FSL) of 159 m above sea level (ASL) on a permanent basis. The Keeyask reservoir is comprised of the mainstem of the original Nelson River from the outlet of Clark Lake as far as the Keeyask GS, plus 45 km² of adjacent, flooded terrestrial area. Reservoir impoundment formed relatively shallow bays due to flooding of terrestrial areas, which generally have low water velocities and limited mixing with the mainstem flow. Over time the total area of the reservoir will increase as the terrestrial (peat) areas erode.

Gull Rapids, now the site of the Keeyask GS, was located approximately 3 km downstream of Caribou Island on the Nelson River (Map 1). Prior to construction, the rapids were approximately 2 km in length, and the river elevation dropped approximately 11 m along the 2 km length. Two large islands and several small islands occurred within the rapids, prior to the

river narrowing; these features are within the Project footprint and have now been either dewatered, incorporated into the GS or were flooded after impoundment (Map 2). A summary of construction activities is provided in Section 2.1.

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 4). 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.

The Long Spruce reservoir was formed in 1979 by the construction of the Long Spruce GS. It is a 16 km reach of the Nelson River extending from Long Spruce GS upstream to Kettle GS (Manitoba Hydro Public Affairs 1999). Kettle River and Boots Creek are the only major tributaries flowing into Long Spruce reservoir, with both tributaries entering the reservoir on the south shore (Maps 1 and 6).

The Limestone Reservoir was formed in 1990 by the construction of the Limestone GS. It is a 23 km reach of the Nelson River extending from Limestone GS upstream to Long Spruce GS. Four tributaries of the Nelson River enter the reservoir; Wilson Creek and Brooks Creek enter from the south, and Sky Pilot Creek and Leslie Creek enter from the north. Aquatic habitat within the reservoir ranges from a riverine environment in the upper reach, to more lacustrine conditions just upstream of the Limestone GS.

2.1 CONSTRUCTION SUMMARY

Construction of the Keeyask GS began in mid-July 2014 with the construction of cofferdams in the north and central channels of Gull Rapids. These cofferdams resulted in the dewatering of the north and central channels and the diversion of all flow to the south channel. Construction of the Spillway Cofferdam (SWCD), which extends into the south channel of Gull Rapids, was completed in 2015. The rock placement for the inner and outer groins of the Tailrace Cofferdam (TRCD) started in late 2016 and the impervious fill placement was completed in fall 2017. The spillway was commissioned between August 3 and 7, 2018. Closing the south channel with the upstream South Dam Cofferdam (SDCD) commenced at the beginning of August and river closure was achieved on August 16. This closure and the work that continued to seal the cofferdam forced the entire river flow through the spillway. In 2020 water-up of the areas kept dry by cofferdams for construction occurred between the end of February and mid-April. The cofferdams upstream of Keeyask and the North Channel Rock Groin were removed and/or lowered throughout the water-up process. Excavation of the TRCD occurred from mid-April to May 14 and then resumed on July 16 and was completed in October. Impoundment of the Keeyask reservoir took place between August 31 and September 5, 2020. Commissioning of the first generator unit started on August 31, 2020 and was still underway at the end of 2020.

2.2 FLOWS AND WATER LEVELS

From October 2019 to October 2020 the calculated Split Lake outflow ranged between 2,600 m³/s in October 2019 and 5,900 m³/s in May 2020. Flows increased from about 2,600 m³/s in October 2019 to about 4,000 m³/s in December 2019 and remained fairly steady between 4,000–4,400 m³/s until the end of April 2020. In summer the flows were high and ranged between 5,000–6,000 m³/s from May through August before dropping in September through October until it reached 3,500 m³/s, slightly above the existing environment average flow.

Water levels on Gull Lake generally varied with flow and ice conditions between October 2019 and February 2020. Levels on Gull Lake rose from a low of about 153.5 m to 156 m from October to December and remained near that level until February while upstream levels varied with flow and ice conditions. From February to April, water-up activities at the construction site caused Gull Lake levels to rise about 0.3 m. After water-up, the spillway gates were used to keep levels relatively steady between about 156.3–156.8 m until the end of August prior to impoundment. The Keeyask reservoir was impounded to its operating level (158 to 159 m) from August 31 to September 5. During this period, Gull Lake was raised about 2 m to a maximum level of 158.9 m, 0.1 m below the full supply level. Upstream of Gull Lake the water level increase diminished with distance, with increases of about 0.8 m and 0.2 m immediately below and above Birthday Rapids while no increases occurred at the water level gauges immediately below and on Clark Lake. Gull Lake has since been held near 158.8 m while upstream levels vary with flow. With impoundment the Keeyask reservoir has entered its operating condition. Water levels on Gull Lake and upstream areas within the project's open water hydraulic zone of influence, which extends to about 3 km below Clark Lake, will now be permanently elevated relative to pre-project conditions.

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 2021a); however, the same array is also used to monitor juvenile Lake Sturgeon (Hrenchuk 2021b), Walleye (Hrenchuk 2021c), 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 Gull Lake.

3.1.2.1 WINTER 2019/2020

The stationary acoustic receiver array for the winter 2019/2020 (October 8, 2019, to April 30, 2020) period consisted of 21 receivers. Five were set upstream of the Keeyask GS and 16 throughout Stephens Lake (Maps 3 and 4). Low water levels prevented boat access to the river section between Kettle GS and Long Spruce GS, and therefore, an acoustic receiver could not be set downstream of the Kettle GS during winter 2019/2020. The 2019/2020 winter array differed slightly from the array used in 2018/2019. An additional receiver (#107999) was set near the outlet of Clark Lake at rkm -45.0 (Map 3). One receiver (#122776) was set immediately upstream of the Kettle GS, at rkm 40.0 (Map 4).

3.1.2.2 OPEN-WATER 2020

An array of 64 acoustic receivers was used during the 2020 open-water period (defined as May 1 to September 23, 2020). Twenty-nine were set upstream of the Keeyask GS and 30 were set in Stephens Lake (Maps 5 and 6). The 2020 open-water array differed slightly from the array used in 2019. Two additional receivers were set upstream of the GS, one close to the spillway (#127091 at rkm -3.8) and one close to the powerhouse (#127100 at rkm -2.2) (Map 6).

Water levels were higher in 2020 than in previous sampling years, and receivers were set in the Long Spruce ($n = 3$) and Limestone ($n = 2$) reservoirs (Map 7). A single receiver deployed in the Long Spruce reservoir prior to winter 2017/2018 was retrieved. The battery was no longer active, but data was recorded from October 13, 2017, to August 15, 2019.

Due to complications associated with conducting field work during the COVID-19 pandemic, the open-water receiver array was deployed later than in previous years. The open-water array was completely deployed by July 3, 2020, whereas in previous years, the array was deployed in late May or early June.

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 October 8, 2019 to September 23, 2020. 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 when water temperature measured less than 12°C (when movements to spawning areas may be occurring) were considered as the “spawning period”.

Between August 31 and September 5, 2020, the Keeyask GS reservoir was impounded to full-supply level. Prior to impoundment, all acoustic receivers set within the reservoir (*i.e.*, between Birthday Rapids and the Keeyask GS) were sunk as is done prior to the winter study period. This was done to minimize the potential for losing receivers due to increased water levels and potential debris. All receivers were retrieved prior to the end of the open-water period.

By September 23, 2020, the majority of receivers were removed and a subset ($n = 26$) were redeployed to monitor movements during winter 2020/2021.

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 2019/20 winter and 2020 open-water periods. Figure 3 provides water temperatures in the Nelson River mainstem between October 2019 and September 2020. 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 2017-2019 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 2019/2020, 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).

Two fish are missing (*i.e.*, have not been detected for more than a year).

- #31735 was last detected in lower Gull Lake on July 18, 2018 (Appendix A2-11).
- #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 two fish that are missing, 17 Lake Whitefish were available to be detected upstream of the Keeyask GS at the beginning of the 2019/2020 winter period.

4.1.2 STEPHENS LAKE

Forty Lake Whitefish were tagged in Stephens Lake in October 2017. Twenty-two fish were only detected briefly after tagging and/or have not been detected for more than one year. They are currently missing and are not discussed for the remainder of the report.

- #31698 was tagged on October 9, 2017, at rkm 0.4. It was last detected in the upstream portion of Stephens Lake on October 15, 2017 (Appendix A3-1).
- #31700 was tagged on October 10, 2017, at rkm 0.4. It was last detected on September 15, 2018 2.7 km downstream of the GS (Appendix A3-3).
- #31701 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was never detected after tagging (Appendix A3-4).
- #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).
- #31708 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was last detected on September 15, 2018 in upper Stephens Lake (Appendix A3-11).
- #31711 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was detected for a single day in 2017 and over four days in September 2018 1.2 km downstream of the GS (Appendix A3-14).
- #31712 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was last detected on July 1, 2018 16.8 km downstream of the GS (Appendix A3-15).
- #31713 was tagged on October 9, 2017 immediately downstream of the GS construction site. It moved between upper and lower Stephens Lake and was last detected on October 14, 2017 (Appendix A3-16).
- #31717 was tagged on October 9, 2017 immediately downstream of the GS construction site. It displayed upstream and downstream movements and 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 tagged on October 9, 2017 immediately downstream of the GS construction site. It was detected in upper Stephens Lake until October 15, 2017 (Appendix A3-23).
- #31721 was tagged on October 8, 2017 immediately downstream of the GS construction site. It was last detected on October 15, 2017 in upper Stephens Lake (Appendix A3-24).
- #31723 was tagged on October 9, 2017 immediately downstream of the GS construction site. It moved between upper and lower Stephens Lake and was last detected on October 22, 2017 (Appendix A3-25).
- #31725 was tagged on October 10, 2017 immediately downstream of the GS construction site. It was last detected on July 7, 2018 in lower Stephens Lake (Appendix A3-27).
- #31747 was tagged on October 10, 2017 immediately downstream of the GS construction site. It was last detected in upper Stephens Lake in September 2018 (Appendix A3-28).
- #31749 was tagged on October 10, 2017 immediately downstream of the GS construction site. It was last detected in lower Stephens Lake in June 2018 (Appendix A3-30).
- #31751 was tagged on October 10, 2017 immediately downstream of the GS construction site. It was last detected on August 10, 2018 in lower Stephens Lake (Appendix A3-32).
- #31752 was tagged on October 10, 2017 immediately downstream of the GS construction site. It was detected regularly, displaying upstream and downstream movements until November 30, 2017 (Appendix A3-33).
- #31755 was tagged on October 9, 2017 immediately downstream of the GS construction site. It moved throughout upper Stephens Lake and was last detected on October 14, 2017 (Appendix A3-36).
- #31757 was tagged on October 9, 2017 immediately downstream of the GS construction site. It was last detected on September, 2018 in lower Stephens Lake (Appendix A3-38).
- #53762 was tagged on October 9, 2017 immediately downstream of the GS construction site. It 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, 22 of which are missing, and one of which moved downstream through the Kettle GS. Three fish moved downstream from Gull Lake, one of which continues to be detected (section 4.1.1). Therefore, 18 fish were available to be detected in Stephens Lake during winter 2019/2020.

4.2 WINTER 2019/2020

4.2.1 UPSTREAM OF THE KEEYASK GS

The 2019/2020 winter array consisted of five receivers deployed in the Nelson River between Clark Lake and the Keeyask GS at rkms -48.2, -45.0, -29.4, -12.4, and -10.3 (Figure 1). Four of the five acoustic receivers were retrieved; the receiver near the outlet of Clark Lake (rkm -45.0) could not be located (Map 3).

Eleven of 17 (65%) whitefish were located a total of 366 times (range: 1–114 detections per individual) (Figure 4; Appendix A1-1). Fish were detected on one to 11 days of the 206 day winter period. No fish were detected in Clark Lake, while near equal number of detections occurred downstream of Birthday Rapids (rkm -29.4; $n = 140$) and in Gull Lake (rkm -10.3; $n = 205$) (Figure 5). No detections were logged by any receiver after January 18, 2020.

Individual movement graphs can be found in Appendix 2.

4.2.2 STEPHENS LAKE

Fifteen of the 16 receivers were deployed in Stephens Lake during the 2019/2020 winter period were retrieved. The receiver located immediately upstream of the Kettle GS (at rkm 40.0) was lost.

Eight of 18 (44%) Lake Whitefish were located a total of 41,205 times (range: 9–26,940 detections per individual) (Figure 6; Appendix A1-2). Fish were detected on one to 153 days of the 206 day winter period (0.5–74% of the time) for an average of 29 days, or 14% of the study period (StDev = 52 days). The farthest upstream detections occurred at rkm 5.2 (by three fish; 38%), while the farthest downstream occurred at rkm 18.6 (by one fish; 13%) (Figure 6; Appendix A1-2). The average total movement range was 4.8 rkm (range: 0.0–13.4 rkm).

As in previous years, the majority of detections ($n = 21,911$; 53%) were logged in the southern portion of Stephens Lake at rkm 13.9 (Figure 7). A large proportion of detections were also logged at the most northern receiver at rkm 6.5 ($n = 11,701$; 28%).

Individual movement graphs can be found in Appendix 3.

4.3 OPEN-WATER 2020

4.3.1 ACOUSTIC RECEIVER RETRIEVAL

All stationary acoustic receivers deployed upstream of the Keeyask GS ($n = 29$), in Stephens Lake ($n = 30$), and the Long Spruce ($n = 3$) and Limestone ($n = 2$) reservoirs during the 2020 open-water period were successfully retrieved (Maps 5 and 6).

Water temperature reached 12°C on September 12, 2020, and measured 10°C by the end of the study period on September 23 (Figure 3). Based on these water temperatures, the time between September 12 and 23 is referred to as the spawning period.

4.3.2 UPSTREAM OF THE KEEYASK GS

Sixteen of 17 (94%) Lake Whitefish were detected upstream of the Keeyask GS during the 2020 open-water period. Fish were detected 334–15,247 times for 19–81 days of the 146 day open-water period (13–55% of the time) (Appendix A1-3). The average movement range was 10.3 rkm (StDev = 9.3 rkm; range: 0.0–28.1 rkm). The farthest upstream detections occurred just upstream of Birthday Rapids at rkm -34.3 (by two fish; 13%), while the farthest downstream detections occurred in lower Gull Lake at rkm -6.2 (by four fish; 25%) (Figure 8; Map 5). No fish moved downstream through the Keeyask GS. The majority of detections were logged in lower Gull Lake east of Caribou Island (rkm -8.9; $n = 20,776$; 23%; Map 5). No detections were logged at the four receivers located closest to the Keeyask GS construction site (between rkms -5.8 and -2.2) (Figure 11). The one fish (#31728) that was not detected was last located in the riverine portion of the Nelson River downstream of Birthday Rapids (rkm-26.5) on October 6, 2019 (Appendix A2-4).

Several Lake Whitefish continued to move to Birthday Rapids during the spawning period. During this time, 30% of all detections were logged immediately downstream of Birthday Rapids (rkm -33.8; $n = 3,445$) (Figure 12).

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 = 43%, range: 0–100%) (Table 3; Figure 9 and 10). Lake Whitefish were detected for an average of 9% of the study period in Zone 3 (river reach from Birthday Rapids to Gull Lake; StDev = 25%; range: 0–100%) and 22% in Zone 5 (lower basin of Gull Lake; StDev = 37%, range: 0–93%).

Relative to previous years of study, there was no obvious change in proportional distribution of tagged Lake Whitefish after reservoir impoundment was completed on September 5. 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 2020 open-water period:

- Eleven remained exclusively in Gull Lake.
 - Two (#31729 and #31746) moved between the upper and lower basins of Gull Lake (Zones 4 and 5).
 - Nine were only detected in Zone 4 (upper basin of Gull Lake), moving as far upstream as the inlet to the Lake (rkm -19.5).
- Four remained in Gull Lake for the majority of the open-water period:
 - #31731 overwintered in the riverine area upstream of Gull Lake (in Zone 3) and moved downstream in July 2020.
 - Three (#31741, #31743, and #31745) made distinct upstream movements to Birthday Rapids (rkm -33.8) in fall. These fish displayed the same pattern in both 2018 and 2019.
- One (#31733) remained exclusively in the riverine area between Birthday Rapids and Gull Lake (Zone 3). The same fish remained in this riverine area during open-water 2018 and 2019.

No obvious changes in movement patterns were observed in the 19 days of monitoring after the reservoir reached full supply level on September 5. No Lake Whitefish were observed moving upstream out of the newly-formed reservoir.

4.3.3 STEPHENS LAKE

Eleven of 18 fish (61%) were detected in Stephens Lake during the 2020 open-water period. These fish were detected between 7 and 37,887 times over one to 86 days of the 146 day open-water period (1–59% of the time) (Appendix A1-4). The average total movement range was 4.9 rkm (StDev = 4.8 rkm; range: 0.0–14.9 rkm) (Figure 13). The farthest upstream detections occurred at the receiver closest to the Keeyask GS tailrace at rkm 1.2 (by four fish; 36%), while the farthest downstream detections were in lower Stephens Lake at rkm 18.8 (by one fish; 9%). As in previous years, the highest number of detections ($n = 38,366$; 69%) were recorded just below the Keeyask GS, near the North shore at rkm 1.2 (Figure 15). During the spawning period, 88% of detections were logged at this receiver (Figure 16).

Of the seven fish that were not detected:

- One (#31707) was last detected during the winter 2018/2019 period at rkm 6.5 on February 2, 2019 (Appendix A3-10).

- Four were detected regularly during the 2019 open-water season.
 - #31704 was last detected in upper Stephens Lake at rkm 4.1 on October 4, 2019 (Appendix A3-7).
 - #31710 was last detected in upper Stephens Lake at rkm 4.2 on September 10, 2019 (Appendix A3-13).
 - #31748 was last detected immediately upstream of the Kettle GS at rkm 40.8 on June 14, 2019. (Appendix A3-29).
 - #53761 was last detected in lower Stephens Lake at rkm 16.8 on July 28, 2019 (Appendix A3-39).
- Two were last detected in lower Stephens Lake during the winter 2019/2020 period
 - #31709 was last detected at rkm 13.0 on November 15, 2019 (Appendix A3-12).
 - #31750 was last detected at rkm 8.4 on November 2, 2019 (Appendix A3-31).

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 2020 open-water period (Figures 9 and 14; Table 3). On average, fish spent 80% of the time in Zone 7 (StDev = 44%; range: 0–100%) and 20% in Zone 6 (StDev = 38%, range: 0–100%).

There was no obvious change in proportional distribution of tagged Lake Whitefish in the 19 days of monitoring after reservoir impoundment. As in previous years, the use of Zone 6 (closest to the GS) increased near the end of the study period (Figure 9).

4.3.3.2 MOVEMENT PATTERNS

Of the 11 Lake Whitefish detected in Stephens Lake during the 2020 open-water period:

- Three remained exclusively in the southern portion of the lake.
 - Two (#31716 and #31738) were detected exclusively at the receiver located closest to the GS tailrace (rkm 1.2).
 - #31699 moved more extensively within the southern portion of Stephens Lake (between rkms 3.9 and 18.8).
- Three remained exclusively in the northern portion of Stephens Lake
 - Two (#31705 and #31714) were detected exclusively at rkm 5.0.
 - #31754 moved within the northern portion of Stephens Lake between rkms 7.5 and 13.5
- Five (#31702, #31703, #31715, #31724, and #31753) moved throughout Stephens Lake, using both the northern and southern portions.

No obvious changes in movement patterns were observed in the 19 days of monitoring after reservoir impoundment. No Lake Whitefish were observed moving downstream out of Stephens Lake.

4.3.4 LONG SPRUCE RESERVOIR

Due to low water levels that prevented boat access downstream of the Kettle GS, no acoustic receivers were set in the Long Spruce reservoir between October 2017 and August 2020. Water levels were higher in 2020 than in previous sampling years, and receivers were set in the Long Spruce ($n = 3$) and Limestone ($n = 2$) reservoirs (Map 7). A single receiver deployed in the Long Spruce reservoir prior to winter 2017/2018 was retrieved. The battery was no longer active, but data was recorded from October 13, 2017, to August 15, 2019.

The movements of two fish through the Kettle GS were confirmed with the retrieval of this receiver.

- #31740 was tagged on October 11, 2017 in Gull Lake. It was detected in Stephens Lake 20 days post-tagging where it continued to move downstream. It moved through the Kettle GS and was first detected in the Long Spruce reservoir on January 29, 2018 (Appendix A2-16).
 - It was detected within the reservoir over four days in September 2020.
- #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 for a single day (November 1, 2017; Appendix A3-37).

No additional Lake Whitefish were detected within the Long Spruce reservoir in 2020.

5.0 DISCUSSION

Lake Whitefish movement monitoring was initiated in 2014 to describe movements during the construction (2014–September 5), and post-reservoir impoundment/operation phases 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 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 2020) provide 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.

As in previous study years, a large proportion of Lake Whitefish in Stephens Lake (39% of those available to be detected) were not located during open-water 2020. This is not unexpected based on previous monitoring. Of the Lake Whitefish originally tagged in 2014, 23% went undetected for the entirety of the three-year study, and only 33% were detected during all three open-water periods. It is reasoned that at least some of the missing fish have not suffered mortality. For example, one Lake Whitefish that was tagged near Birthday Rapids in 2014 went undetected for two years until being detected during the open-water season of 2017. Lake Whitefish frequently use shallow water habitat outside the detection range of receivers. It is likely that the fish missing in 2020 occupy areas outside of the detection range of the receiver array.

5.2 WINTER MOVEMENT

A limited amount of winter movement data has been collected from Lake Whitefish upstream of the Keeyask GS since the study commenced in 2014. During the winter period, tracking is limited by the reduced number of receivers, as only four receivers are left in during the winter (ice conditions prevent leaving additional receivers in). During the 2019/2020 winter period, 65% of fish were located; however, they were only detected for an average of three days of the entire winter period. Similarly, in previous years, the average number of detection days were low in the winter (four days in 2014/15, seven days in 2015/16, six days in 2016/17, four days in 2017/18, and two days in 2018/19). In all study years, the majority of detections have occurred during October and November downstream of Birthday Rapids (rkm -33.8). These detections are likely related to spawning and post-spawning movements.

The winter receiver array in Stephens Lake is more extensive, and thus more fish can be tracked for a greater proportion of the period. As in all previous study years, the majority of detections during the 2019/2020 winter period occurred at rkm 13.9, in the southern part of Stephens Lake. Lake Whitefish tagged in 2014 were also detected in this area during all previous years. It is suspected that Lake Whitefish may also overwinter in the north arm of Stephens Lake, out of the detection range of the receiver array. During winter 2019/2020, 63% of fish were detected within the northern portion of the lake, and a large number of detections were logged at the northern-most receiver at rkm 6.5.

5.3 OPEN-WATER MOVEMENT

The proportion of Lake Whitefish detected during the 2020 open-water period continued to be high. In 2018, all fish tagged upstream of the Keeyask GS were detected, while 89% were detected during open-water 2019, and 94% in 2020. This was higher than the 47–80% detection rates observed in previous years. In Stephens Lake, 61% of fish were detected, which is similar to the 49%–68% in previous years (Lavergne and Hrenchuk 2016; Burnett and Hrenchuk 2017; Lacho and Hrenchuk 2018; Lacho and Hrenchuk 2019; Hrenchuk 2020).

As in previous years, Lake Whitefish continued to spend most of the open-water period in Gull Lake, with some fish staying in the lake for the entire open-water period and some making upstream movements to Birthday Rapids during the fall. Similar to those tagged in 2014, Lake Whitefish tagged in 2017 were 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 just prior to the spawning period (*i.e.*, on September 5). Despite this, three fish made distinct upstream movements to Birthday Rapids during the spawning period. All three fish had shown this pattern of movement in previous years.

Movements of fish tagged in 2017 continued to differ from those tagged in 2014 in one respect: no fish from Gull Lake moved upstream to Clark Lake in 2018, 2019, or 2020. In the three previous study years, fish were detected as far upstream as Clark Lake during the open-water

season. The EIS predicted that fish may move upstream out of the study area following reservoir impoundment. In the 19 days that monitoring was conducted following impoundment, no Lake Whitefish were observed moving upstream out of the reservoir.

Lake Whitefish in Stephens Lake continued to display movement patterns similar to those observed in 2018 and 2019, 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. The majority of Lake Whitefish were detected within the northern portion of Stephens Lake, some of which likely moved into the north arm outside of the receiver array.

5.4 KEY QUESTIONS

The AEMP identified key questions for Lake Whitefish movement monitoring, two of which are relevant to the construction period and one relevant to the time immediately following impoundment. Keeyask reservoir impoundment was completed near the end of the open-water monitoring period, reaching full supply level on September 5. Thus, monitoring was conducted for 19 days after impoundment was complete. An additional key question is relevant to this period. Key questions are addressed in the discussion below.

What is the number (or proportion) of tagged Lake Whitefish that move past the construction site?

Monitoring the movement of Lake Whitefish for six 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 17). 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 have moved upstream over Gull Rapids since the study was initiated in 2014 (Figure 18). The Keeyask GS spillway was commissioned in August 2018, after which upstream movements were no longer possible.

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

Upstream of the Keeyask GS, Lake Whitefish do not frequently use habitat in the vicinity of the construction site. No Lake Whitefish were detected closer than -5.8 rkm to the GS in either 2019 or 2020. In previous years, only one to two fish per year have been located here during the open-water period.

In contrast, Lake Whitefish in Stephens Lake have been frequently detected in the vicinity of the construction site since the study began. Although no fish were detected at a receiver placed 0.6 rkm downstream of the Keeyask GS spillway in 2020, four fish (36%) were located by the

receiver located 1.2 rkm downstream of the Keeyask GS near the tailrace (receiver #129194; Map 6).

Immediately prior to the 2020 spawning period, the first unit of the powerhouse was commissioned, causing flow alterations downstream of the GS. This coincided with the Lake Whitefish spawning period and 88% of all detections logged during this period occurred within 1.2 rkm of the Keeyask GS. These detections were logged by four fish, or 44% of fish detected during this time. Lake Whitefish have been detected in this area during all spawning periods since 2015.

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 were observed moving upstream into Clark Lake. Of the 20 fish tagged in 2014, eight fish (40%) moved upstream through Birthday Rapids and into Clark Lake (Figure 17). One fish made two upstream movements in both 2016 and 2017. No upstream movements of fish tagged in 2017 have been observed. No tagged Lake Whitefish moved upstream out of the Keeyask reservoir after impoundment in 2020. It should be noted that the reported period of post-impoundment monitoring was very brief and movements associated with impoundment may be observed during 2020/2021. An array of acoustic receivers was deployed at the end of the open-water period to continue monitoring movements during the first winter following impoundment. Monitoring of Lake Whitefish with acoustic telemetry will continue until tags expire in 2022. Continued monitoring will determine if movements change during the initial years post-impoundment.

6.0 SUMMARY AND CONCLUSIONS

- Although Lake Whitefish may go undetected for long periods of time and the number of detections are low compared to Lake Sturgeon, acoustic monitoring provides enough data to meet the objectives of the AEMP.
- In open-water 2020, as in previous years, Lake Whitefish upstream of Gull Rapids spent the majority of time in Gull Lake, with some fish making upstream movements out of the lake during the fall, likely related to spawning. As in all previous years of the study, Lake Whitefish were detected at Birthday Rapids during the spawning period. No fish tagged in 2017 have been detected upstream of Birthday Rapids since tagging; in contrast, fish tagged in 2014 were detected as far upstream as Clark Lake during all three open-water seasons that they were monitored.
- In Stephens Lake, movement patterns were similar to those observed in previous years, with fish spending more time closer to Gull Rapids during the fall and a large proportion of detections occurring near Gull Rapids during the spawning period. As in previous years, Lake Whitefish were detected frequently in the northern portion of the lake.
- The key questions as described in the AEMP for Lake Whitefish movement monitoring during construction and impoundment of the Keeyask GS are:

- *What is the number (or the proportion) of tagged Lake Whitefish that move past the construction site?*

Results of four years of monitoring suggest that a small proportion of Lake Whitefish tagged in Gull Lake move downstream into Stephens Lake. Of the fish tagged upstream of the Keeyask GS, two of 20 (10%) tagged in 2014 and three of 22 (14%) tagged in 2017 moved downstream into Stephens Lake. At least one of the movements in 2017 may have been related to tagging stress. Prior to spillway commissioning in 2018, there were no upstream movements through Gull Rapids.

- *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 directly upstream of the construction site. 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.

- *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 were observed moving upstream into Clark Lake. Of the 20 fish tagged in Gull Lake in 2014, eight fish (40%) moved upstream through Birthday Rapids and into Clark

Lake. No tagged Lake Whitefish moved upstream out of the Keeyask reservoir in the 19 days of monitoring after impoundment in 2020.

- Reservoir impoundment for the Keeyask GS was completed by September 5, 2020. Movement monitoring was conducted for 19 days after this date. Although no changes in movements were observed during this time, future monitoring will determine whether changes to movement patterns occur. Monitoring of Lake Whitefish movements will continue until tags expire in 2022.

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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), and 2020 (July 3 to September 23) 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

FIGURES

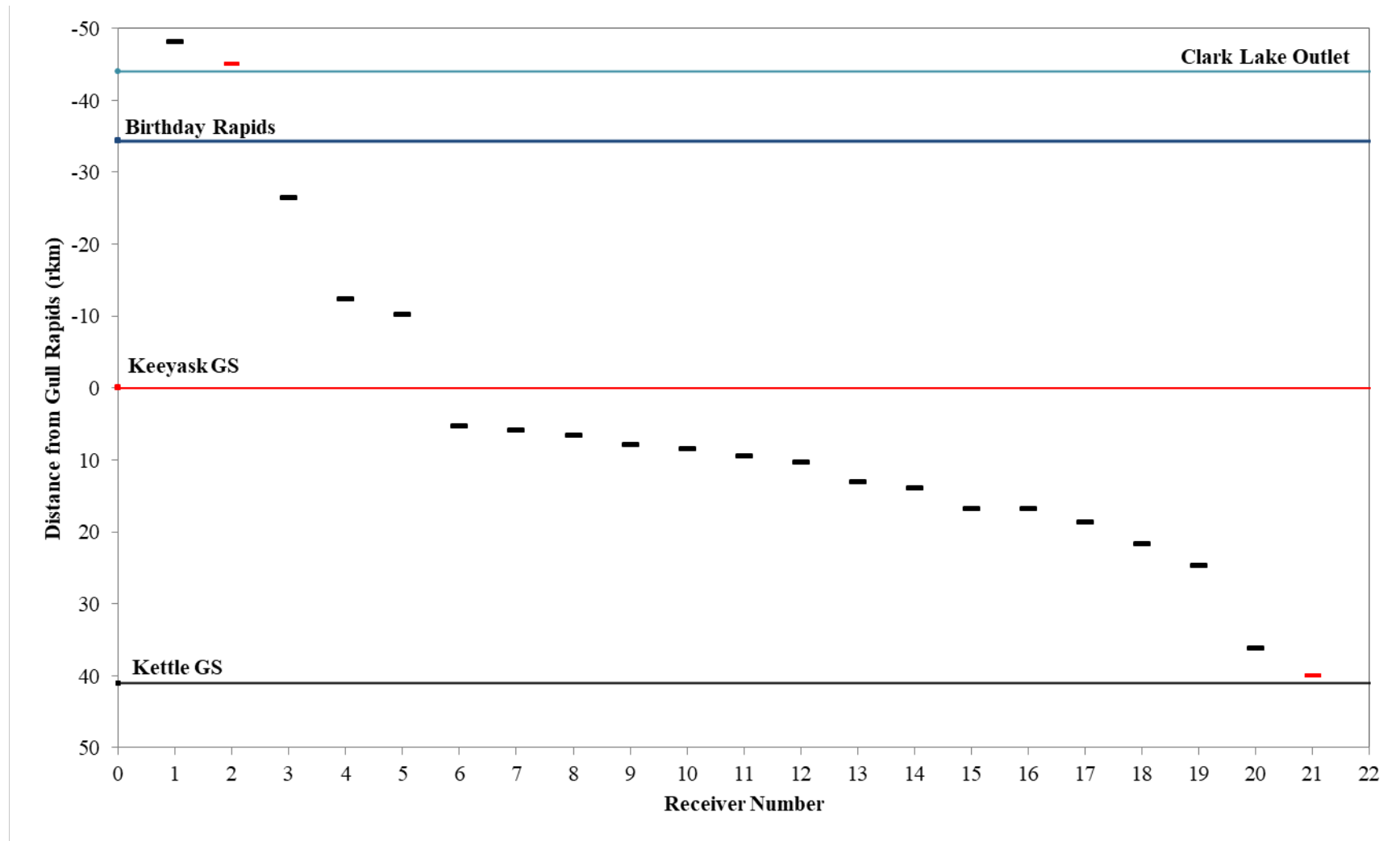


Figure 1: Locations of stationary acoustic receivers (dashes) in relation to the base of the Keeyask GS (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Limestone GS between October, 2019 and July, 2020. A red dash indicates a receiver that was lost.

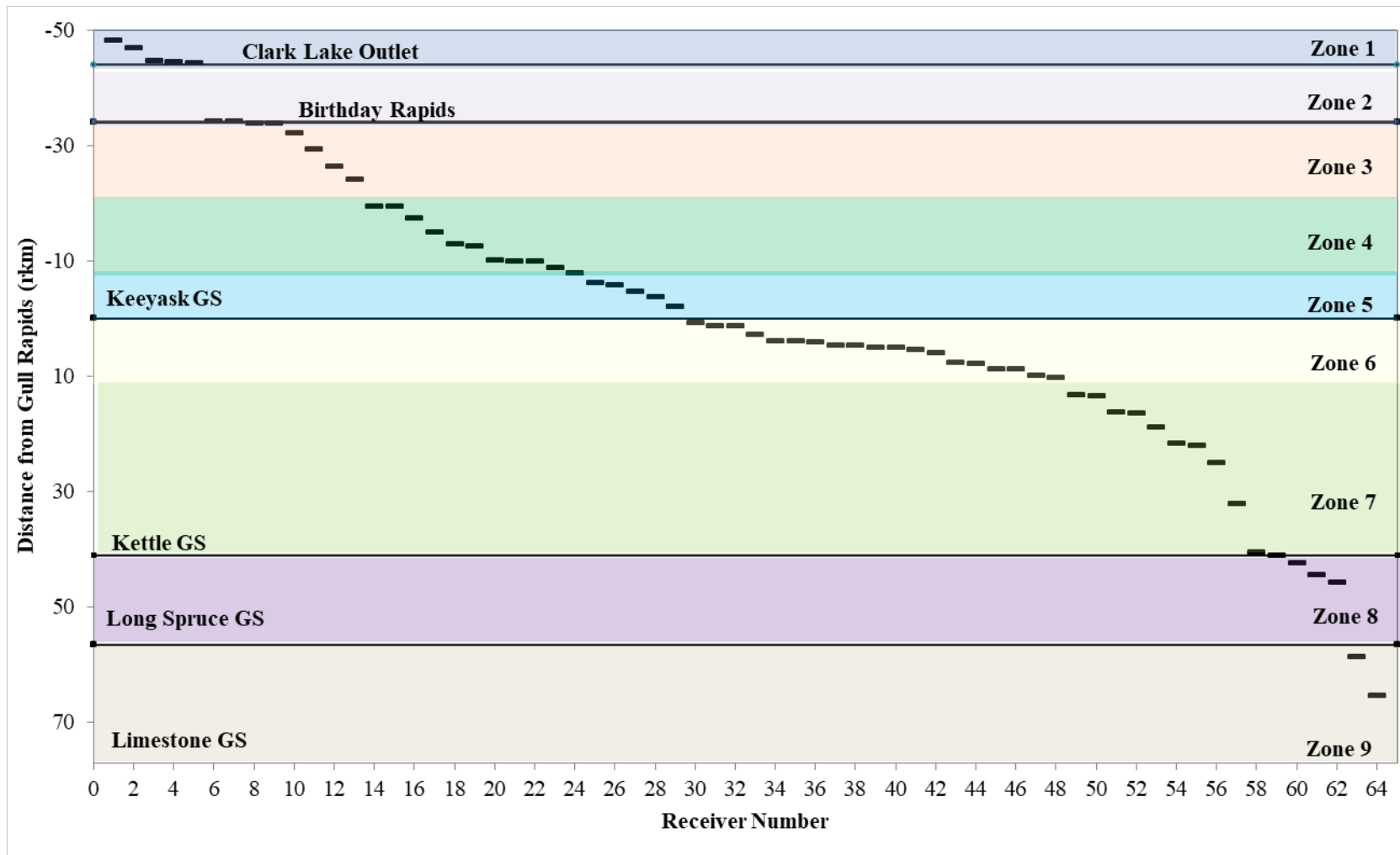


Figure 2: Locations of stationary acoustic receivers (dashes) in relation to the base of the Keeyask GS (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake (Zone 1) and the Limestone GS (Zone 9) between July and September, 2020. River zones upstream and downstream of Gull Rapids are indicated by shading.

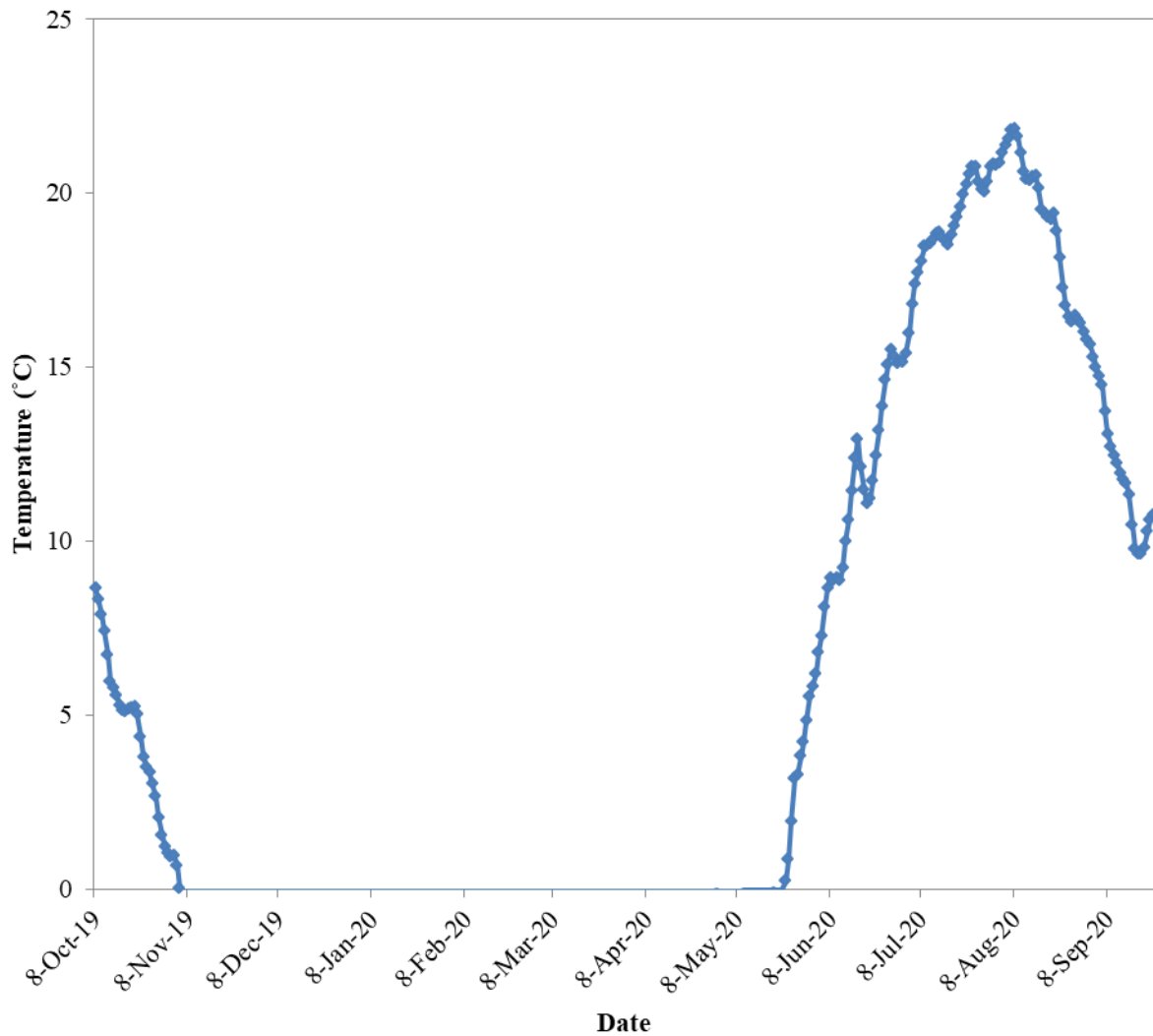


Figure 3: Water temperature in the Nelson River mainstem from October 8, 2019, to September 23, 2020.

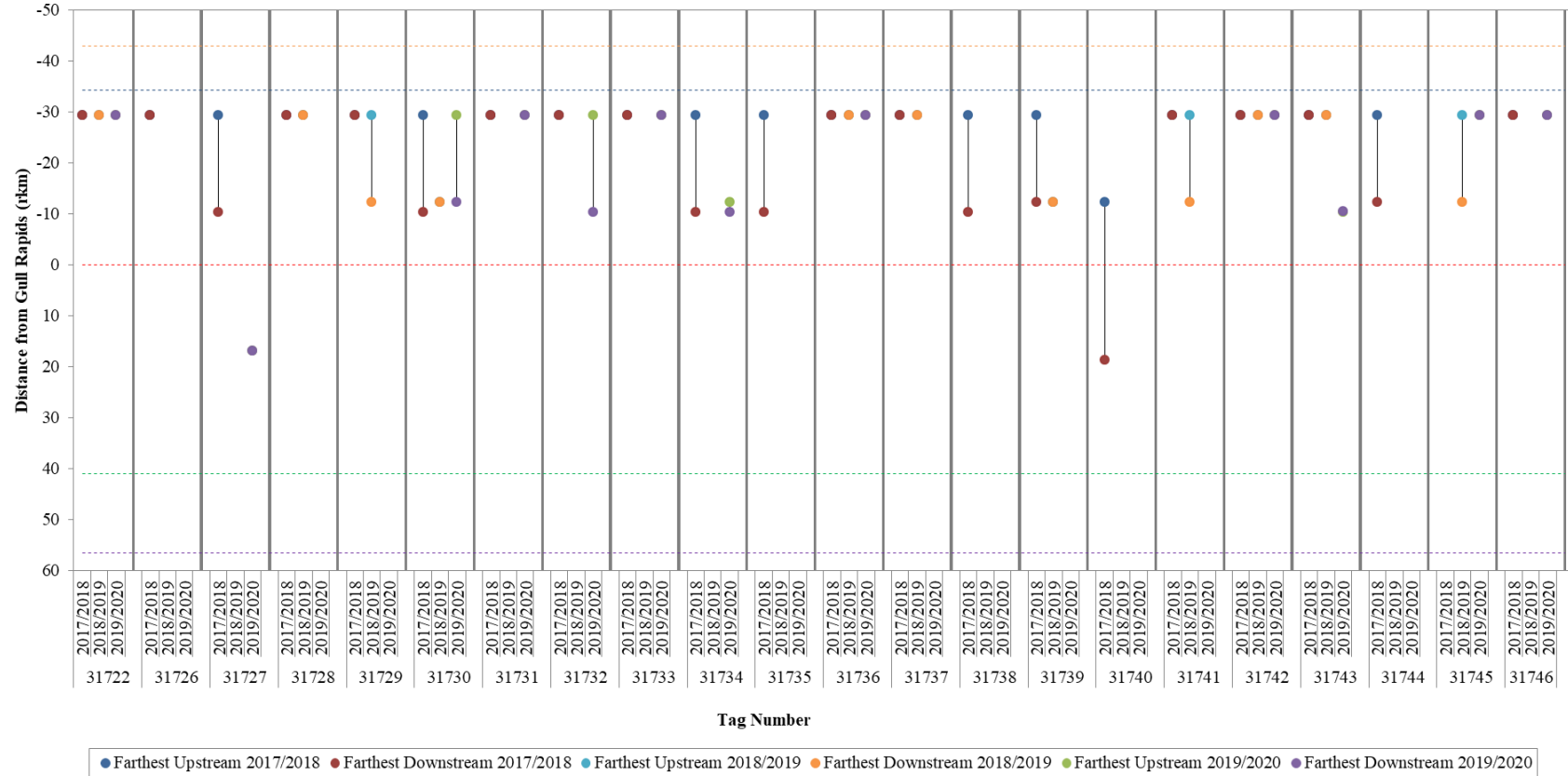


Figure 4: Detection ranges for individual Lake Whitefish ($n = 22$) tagged with acoustic transmitters upstream of the Keeyask GS during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), and 2019/2020 (October 8, 2019 to April 30, 2020) winter periods.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

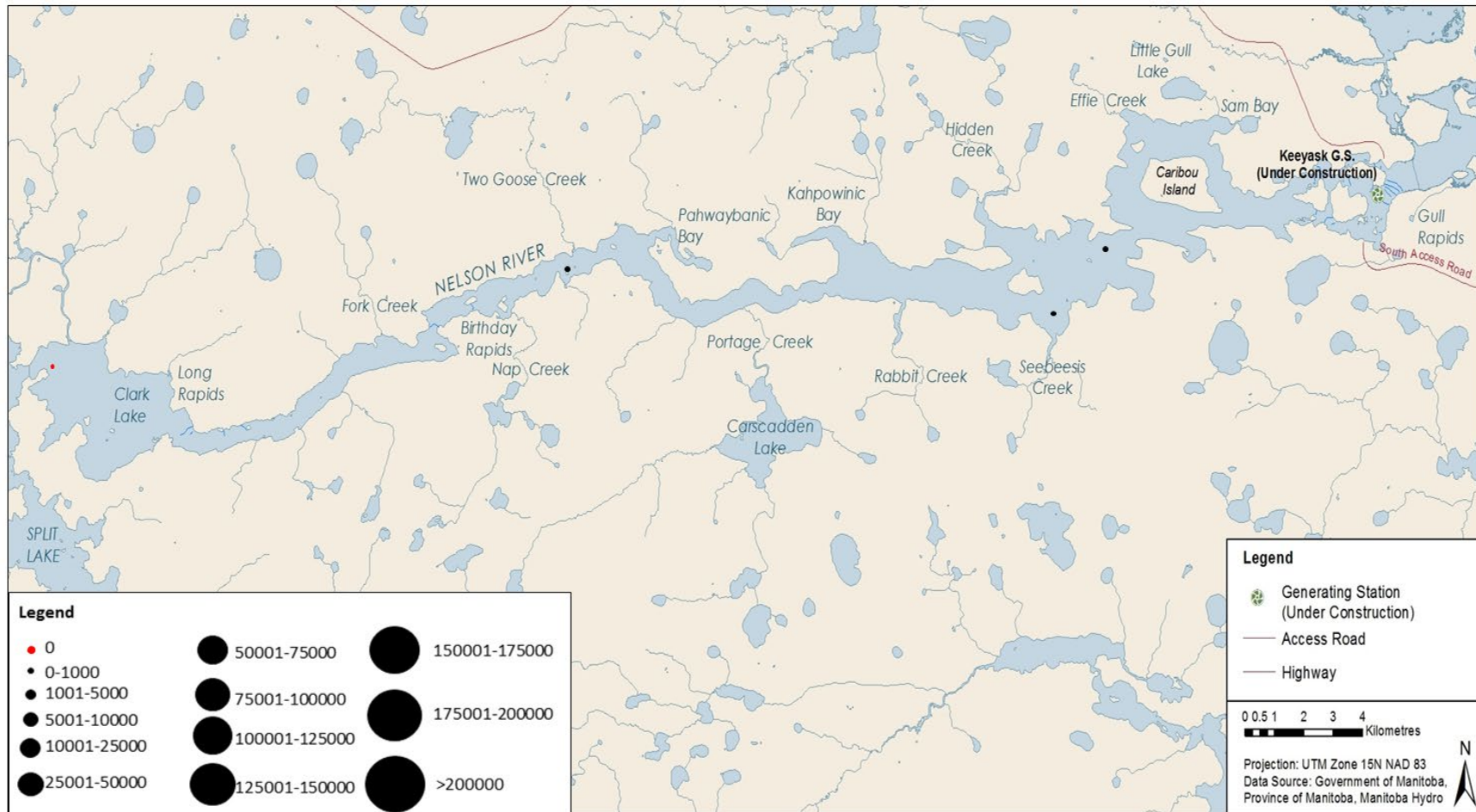


Figure 5: Relative number of detections at each acoustic receiver set between Clark Lake and the Keeyask GS during winter 2019/2020 (October 18, 2019, to April 30, 2020). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

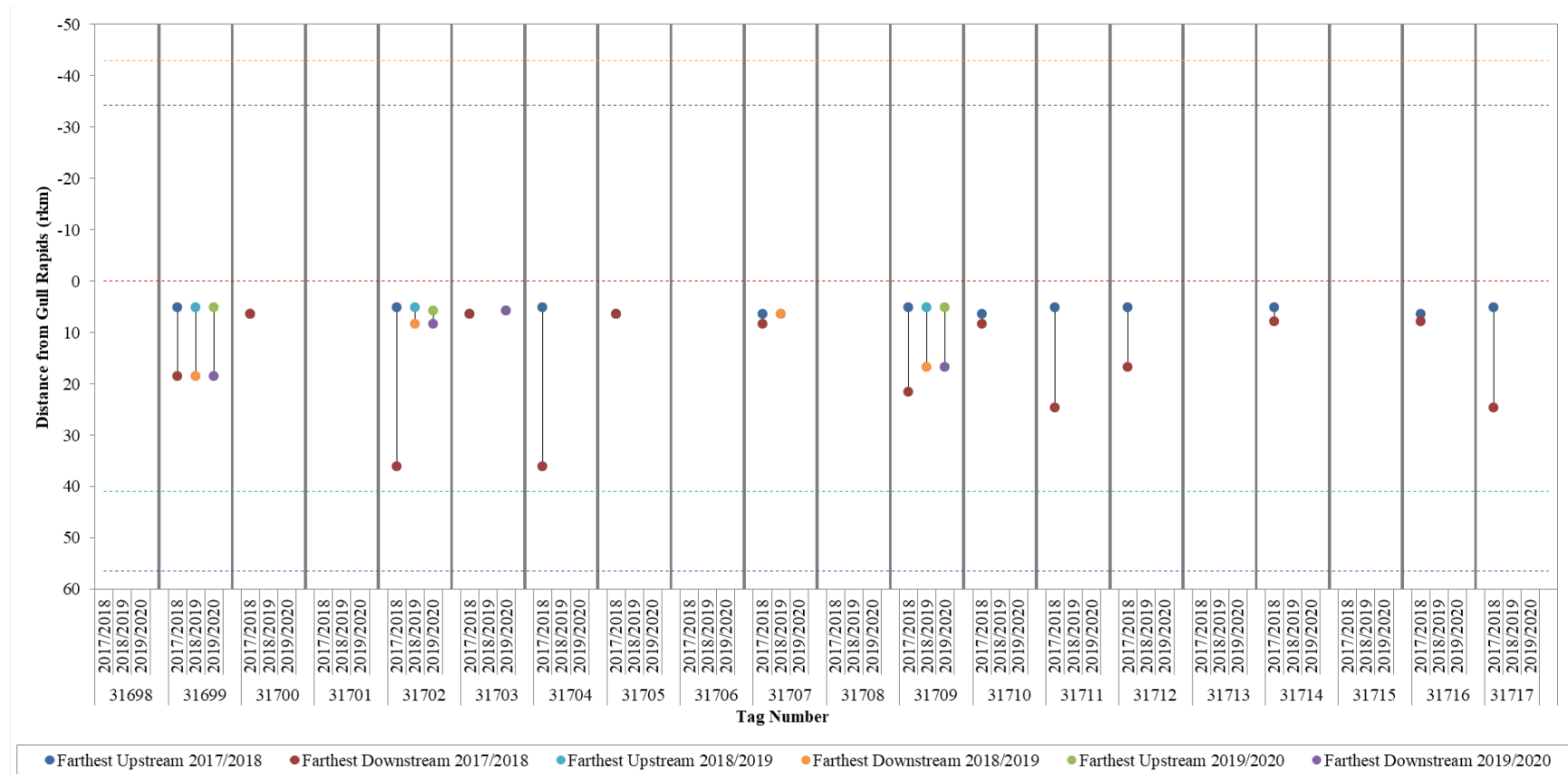


Figure 6: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), and 2019/2020 (October 8, 2019 to April 30, 2020) winter periods. Horizontal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

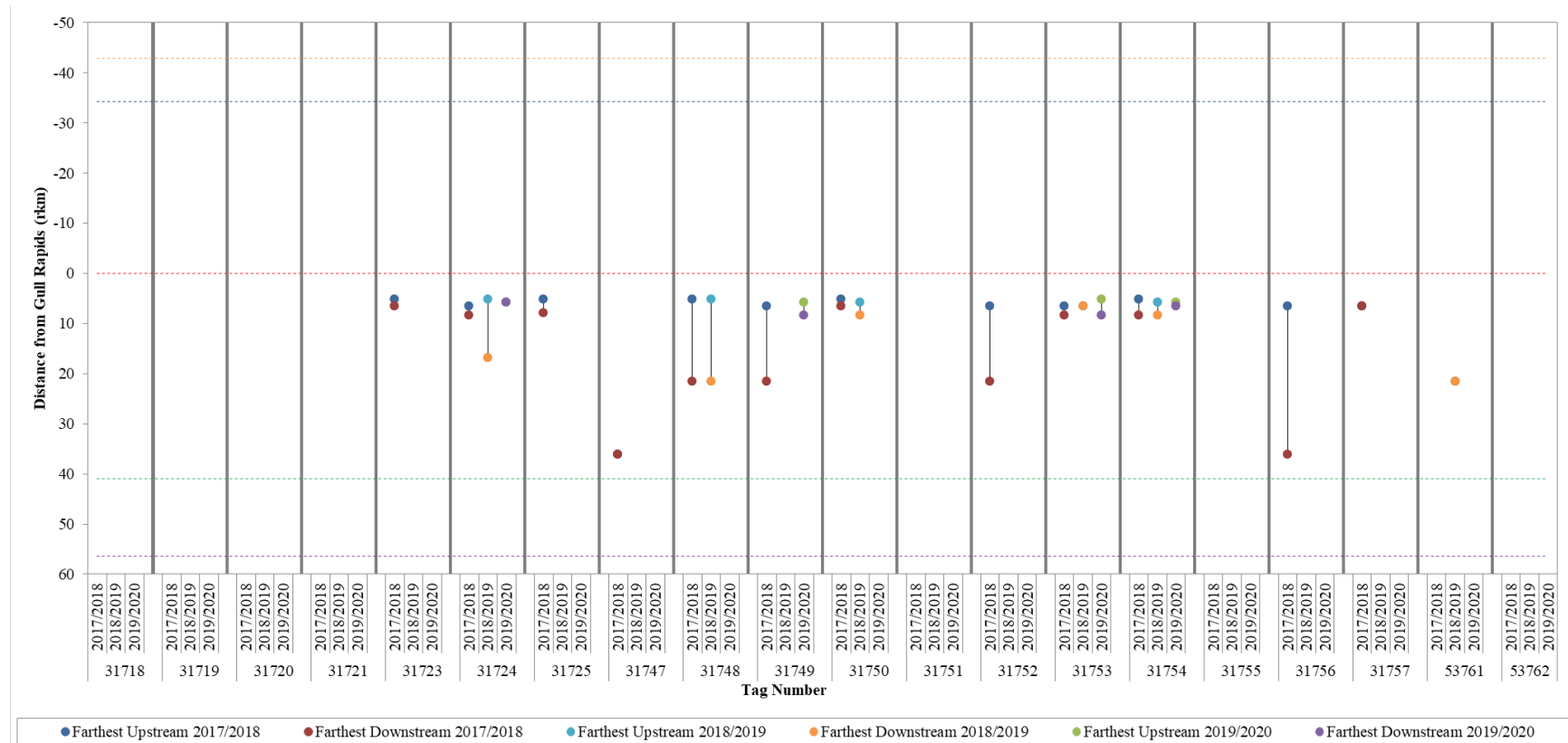


Figure 6: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2017/2018 (October 17, 2017 to April 30, 2018), 2018/2019 (October 11, 2018 to April 30, 2019), and 2019/2020 (October 8, 2019 to April 30, 2020) winter periods. Horizontal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

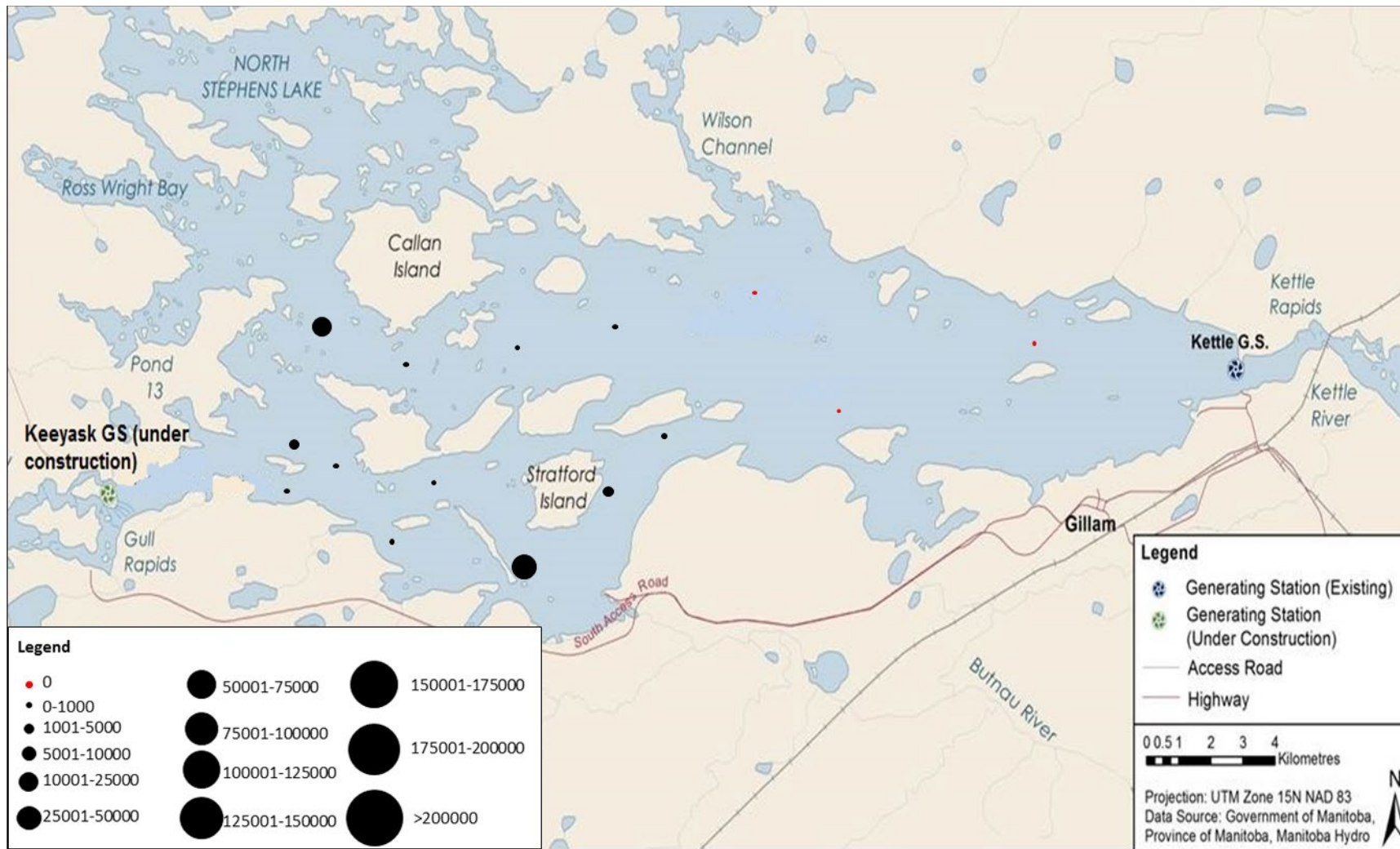


Figure 7: Relative number of detections at each acoustic receiver set in Stephens Lake during winter 2019/2020 (October 8, 2019 to April 30, 2020). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

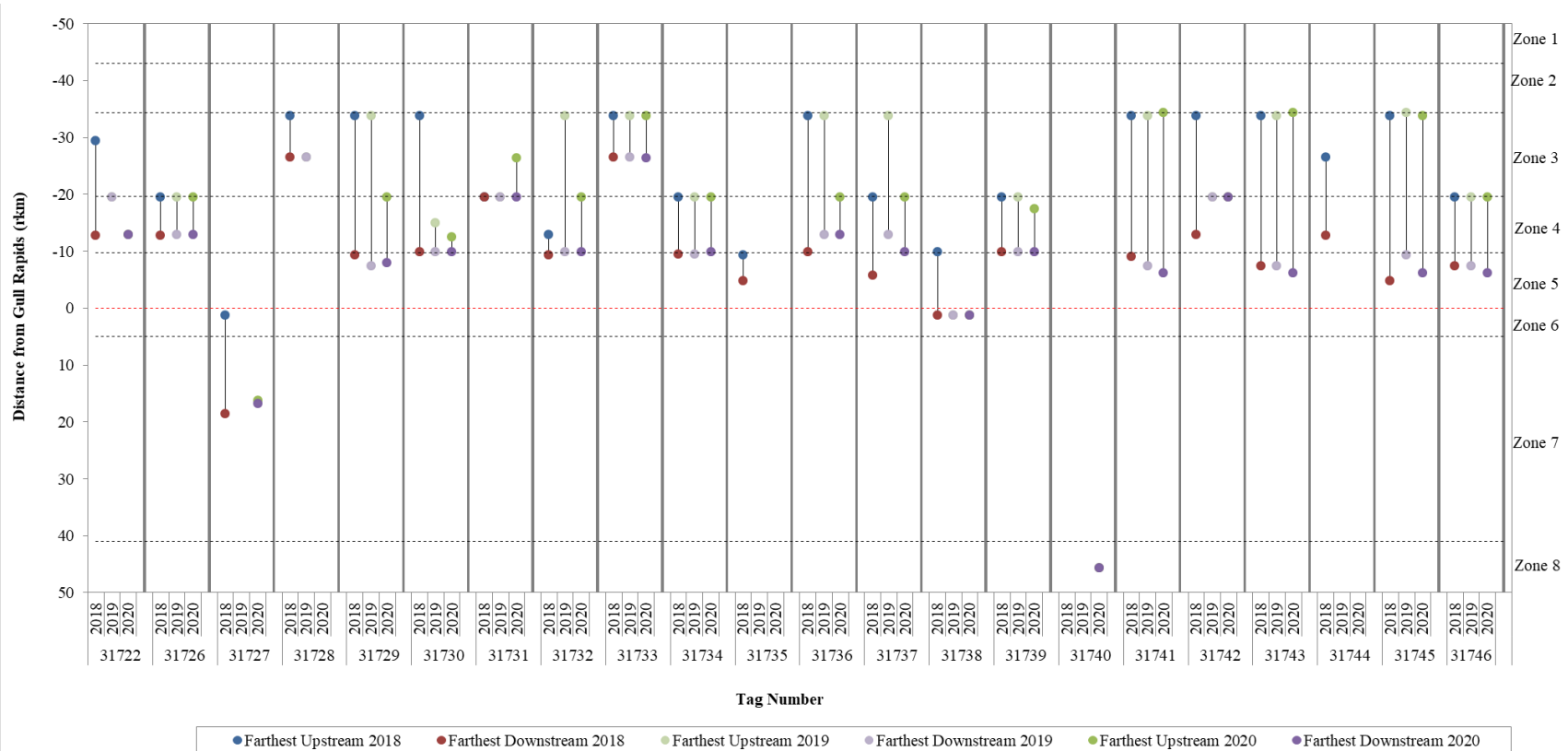


Figure 8: Detection ranges for individual Lake Whitefish (n = 22) tagged with acoustic transmitters upstream of the Keeyask GS during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), and 2020 (May 1 to September 23) open-water periods. Horizontal dotted lines demarcate zones with the red line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

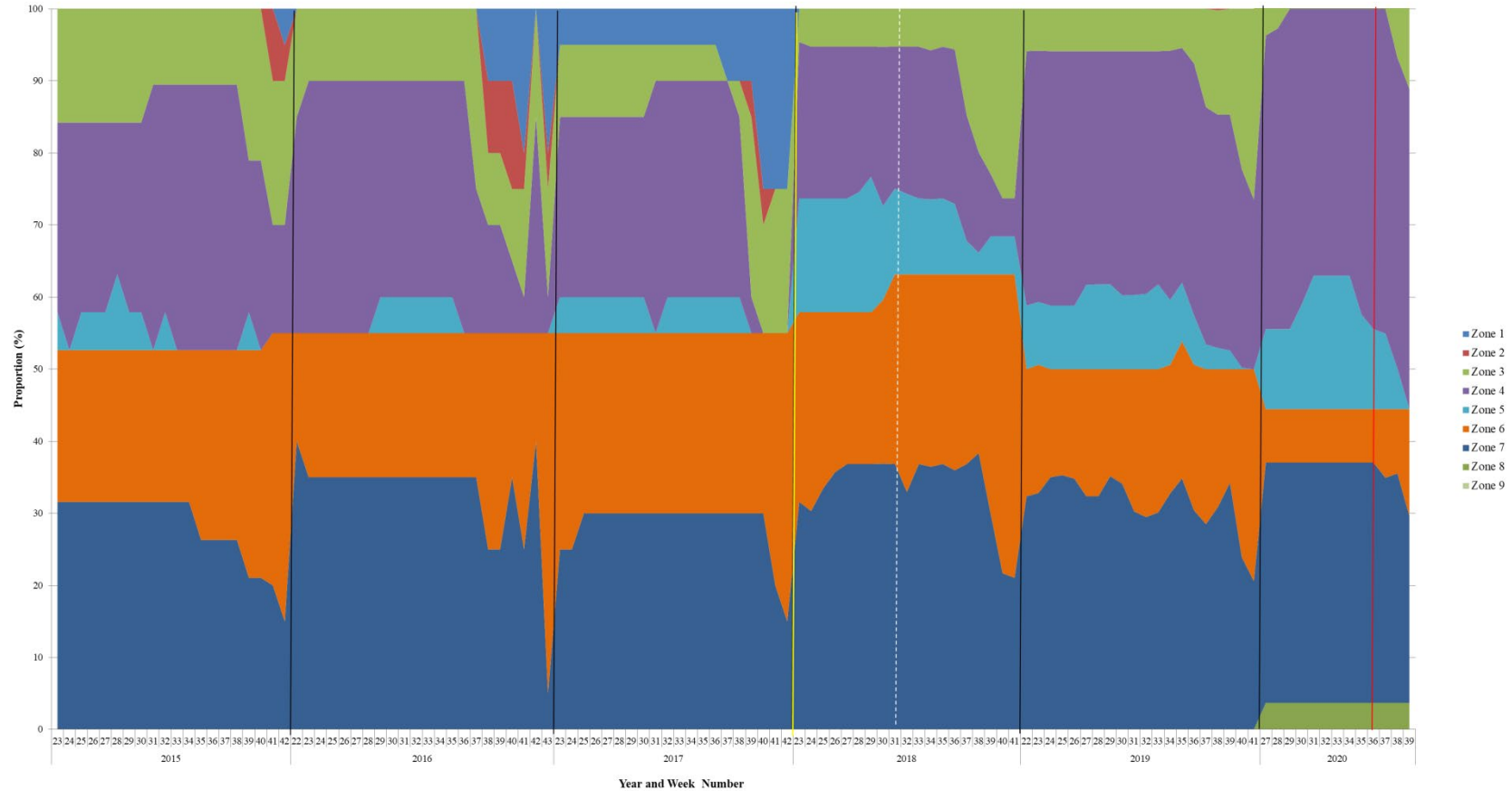


Figure 9: Proportional distribution of Lake Whitefish with acoustic transmitters tagged in 2014 and 2017 within seven river zones between Clark Lake and the Kettle GS during a portion of the 2015 (June 4 to October 11), 2016 (June 25 to October 19), 2017 (June 7 to October 16), 2018 (June 6 to October 10), 2019 (June 2 to October 7), and 2020 (July 3 to September 23) 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.

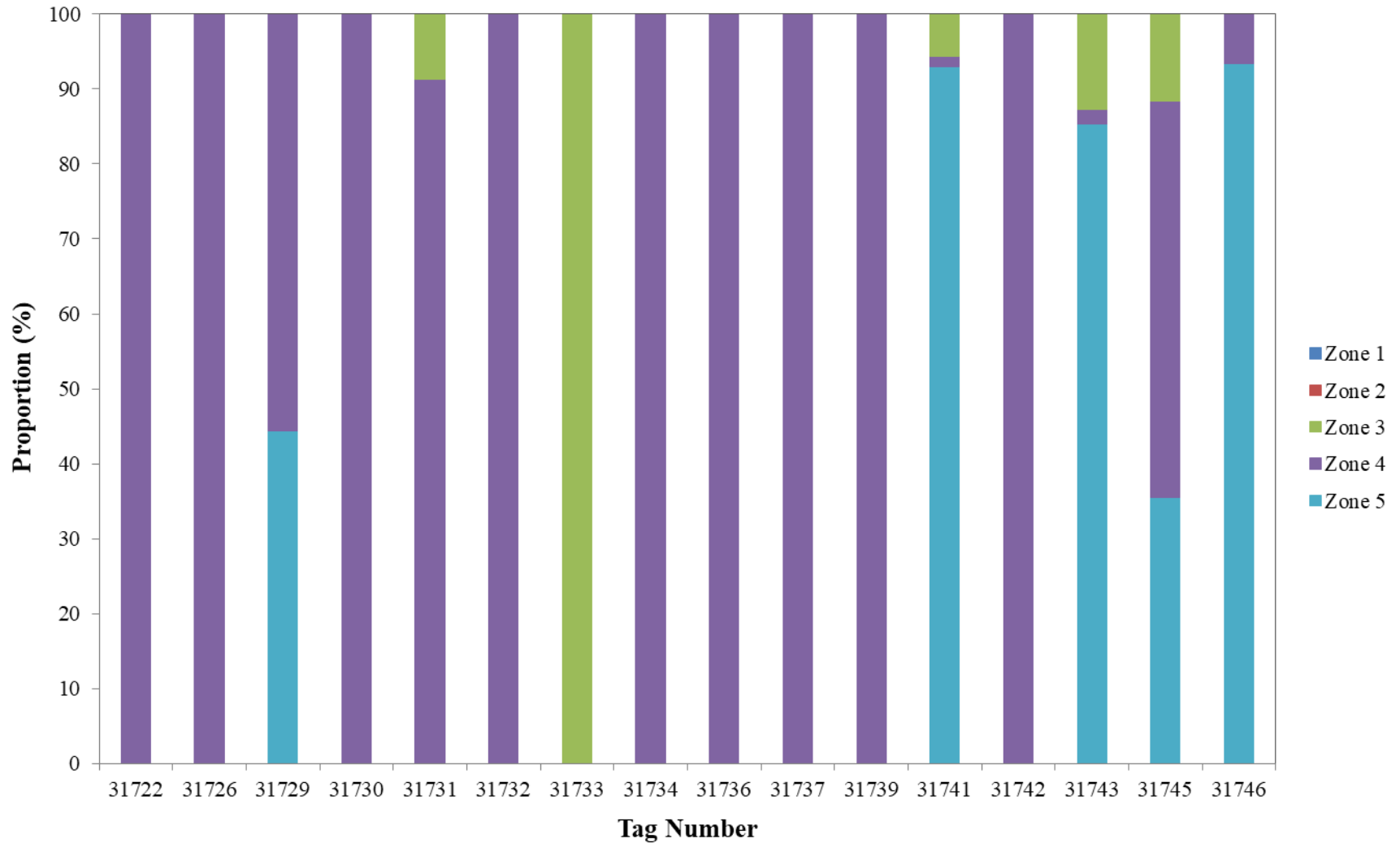


Figure 10: Proportion of time spent within five river zones between Clark Lake and the Keeyask GS by individual acoustic-tagged Lake Whitefish during a portion of the 2020 open-water period (July 3 to September 23).

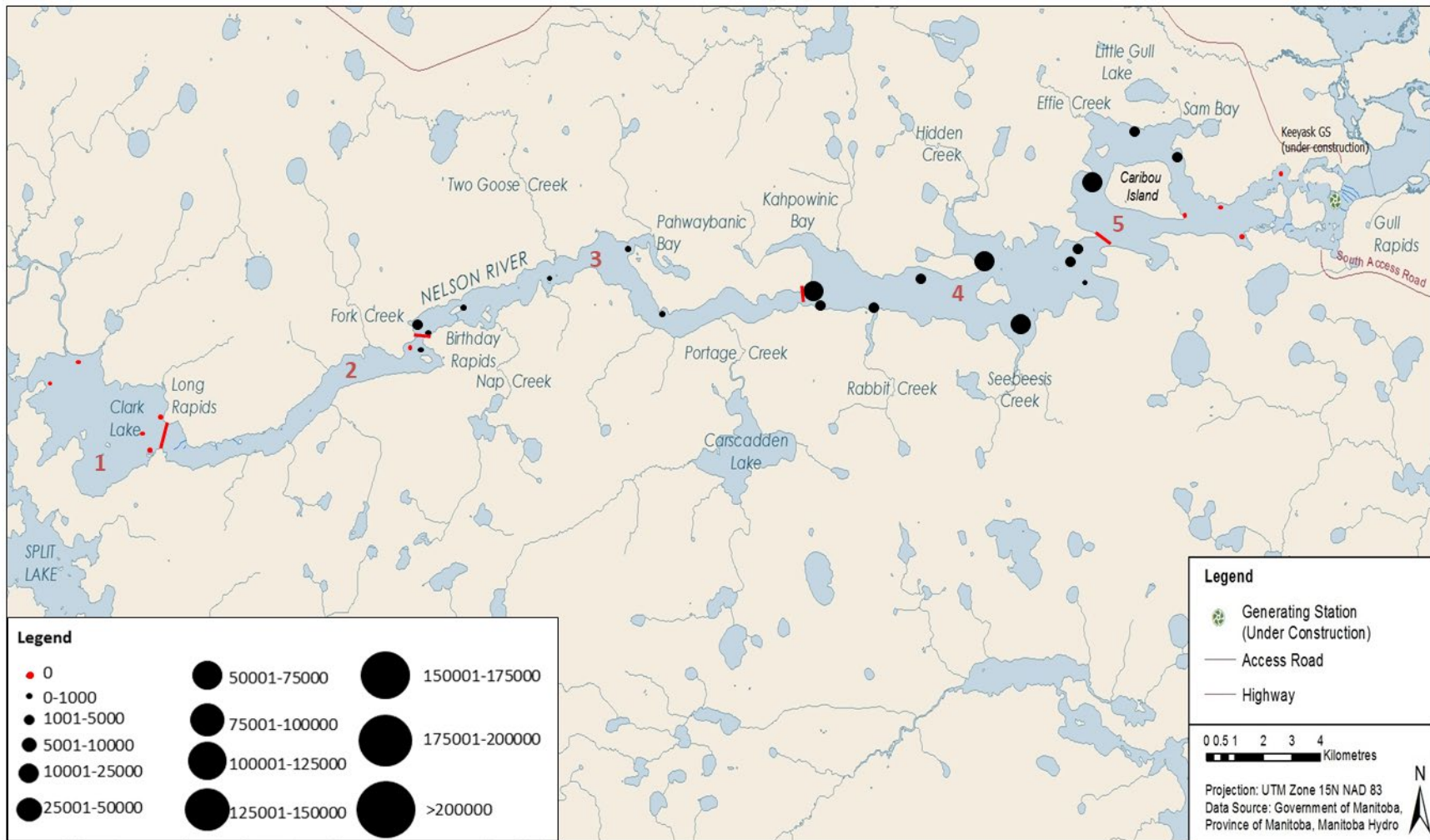


Figure 11: Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and the Keeyask GS during the 2020 open-water period (May 1 to September 23). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot. The river is divided into five "zones" based on placement of receiver "gates."

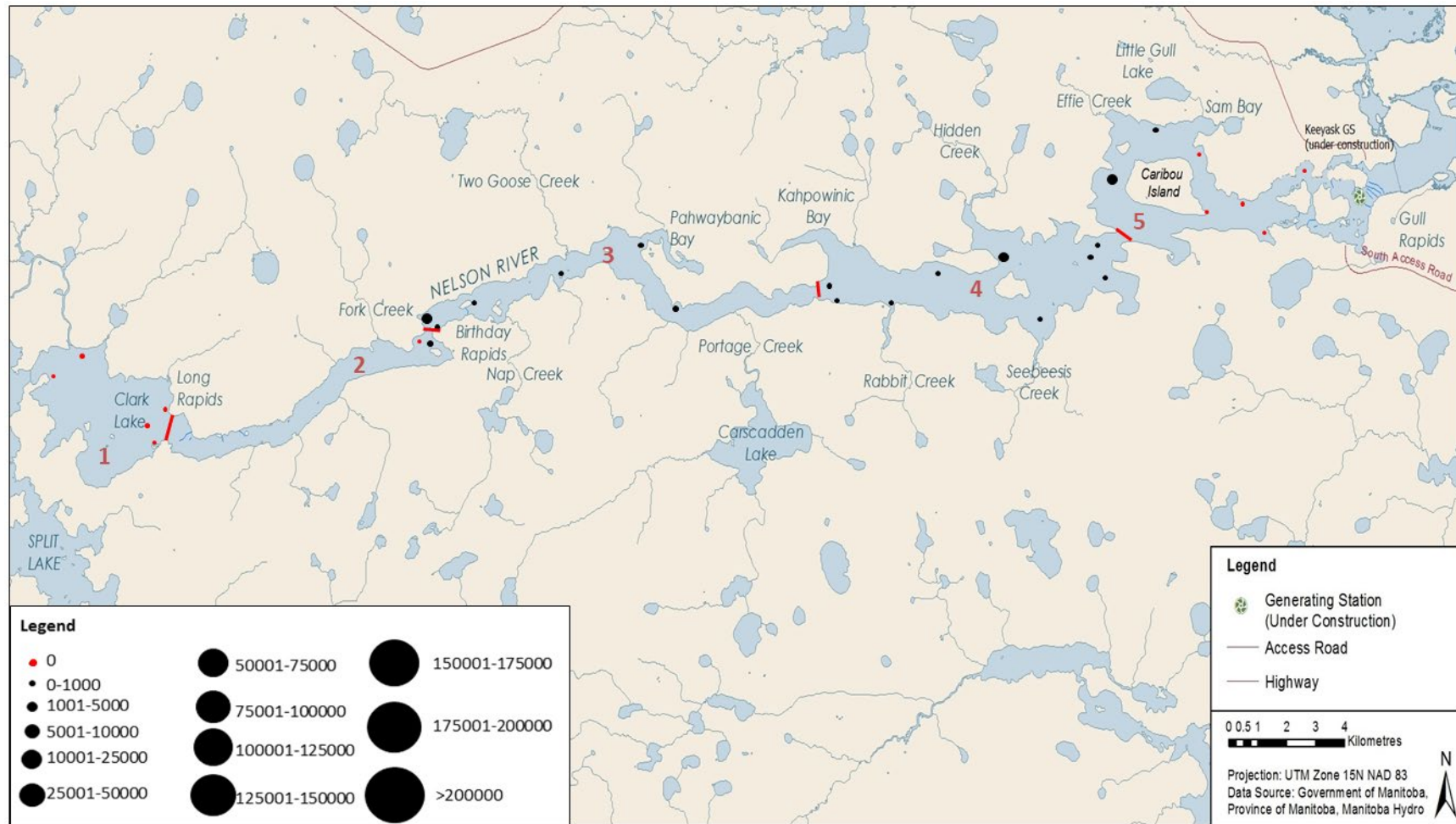


Figure 12: Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and the Keeyask GS during the 2020 spawning period (September 12 to 23). Spawning period was defined as the time when water temperature fell below 12°C (in order to capture movement of Lake Whitefish to spawning sites) to the end of the study period. Relative number of detections indicated by size of bubble. Receivers with no detections indicated with red dot. The river is divided into five "zones" based on placement of receiver "gates."

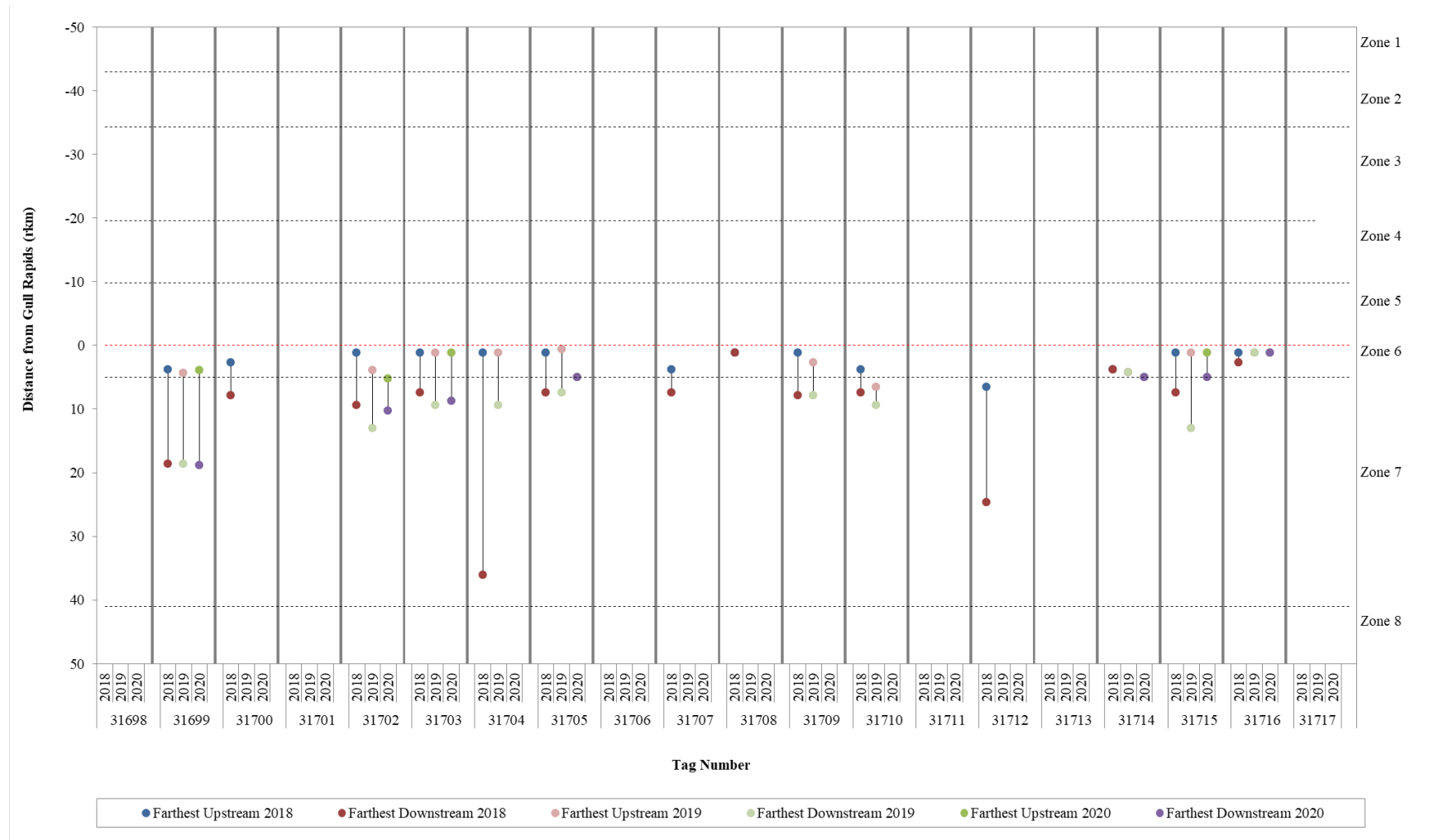


Figure 13: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), and 2020 (July 3 to September 23) open-water periods. Horizontal dotted lines demarcate zones with the red line representing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

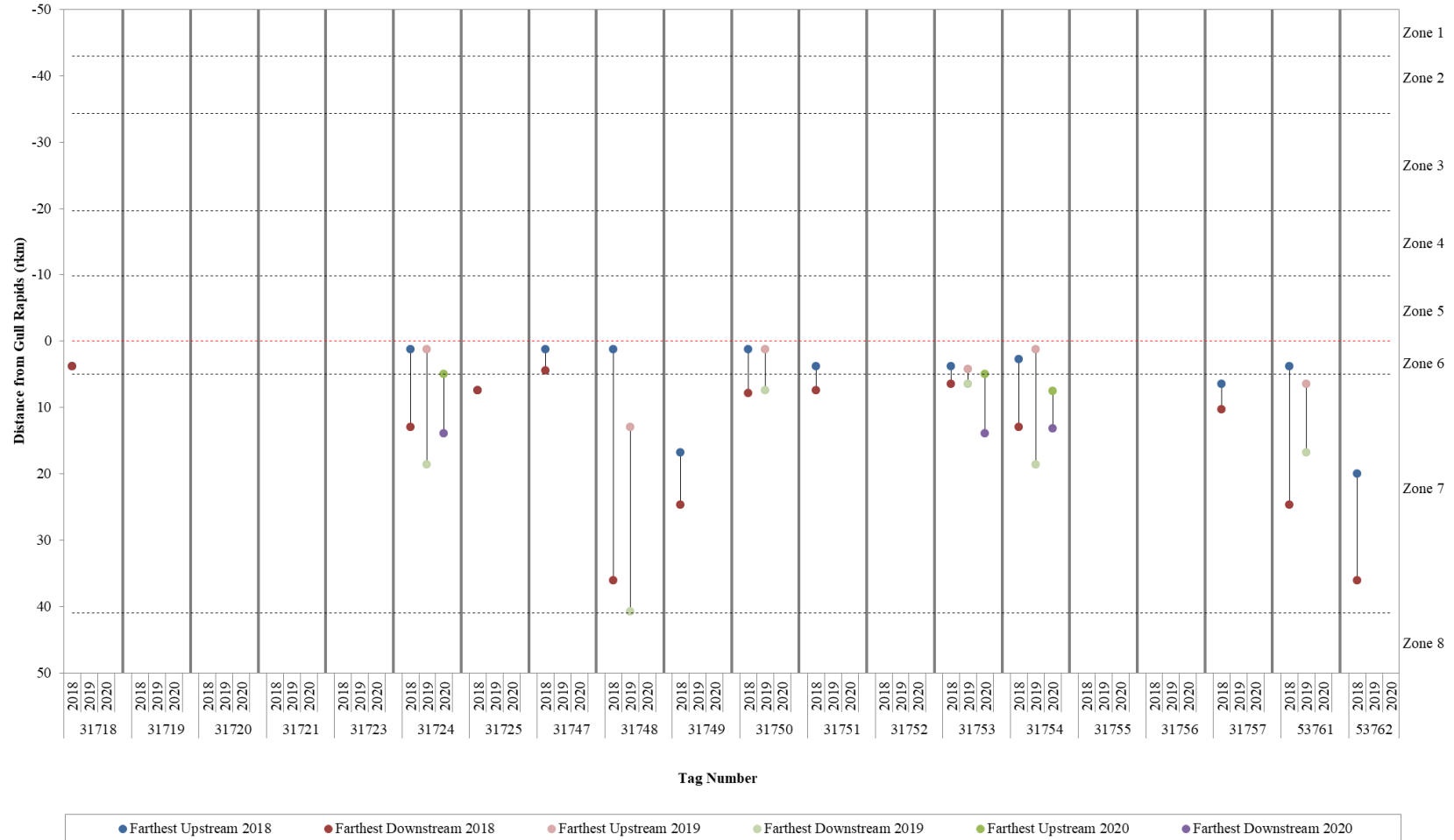


Figure 13: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens during the 2018 (May 1 to October 10), 2019 (May 1 to October 7), and 2020 (July 3 to September 23) open-water periods. Horizontal dotted lines demarcate zones with the red line representing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

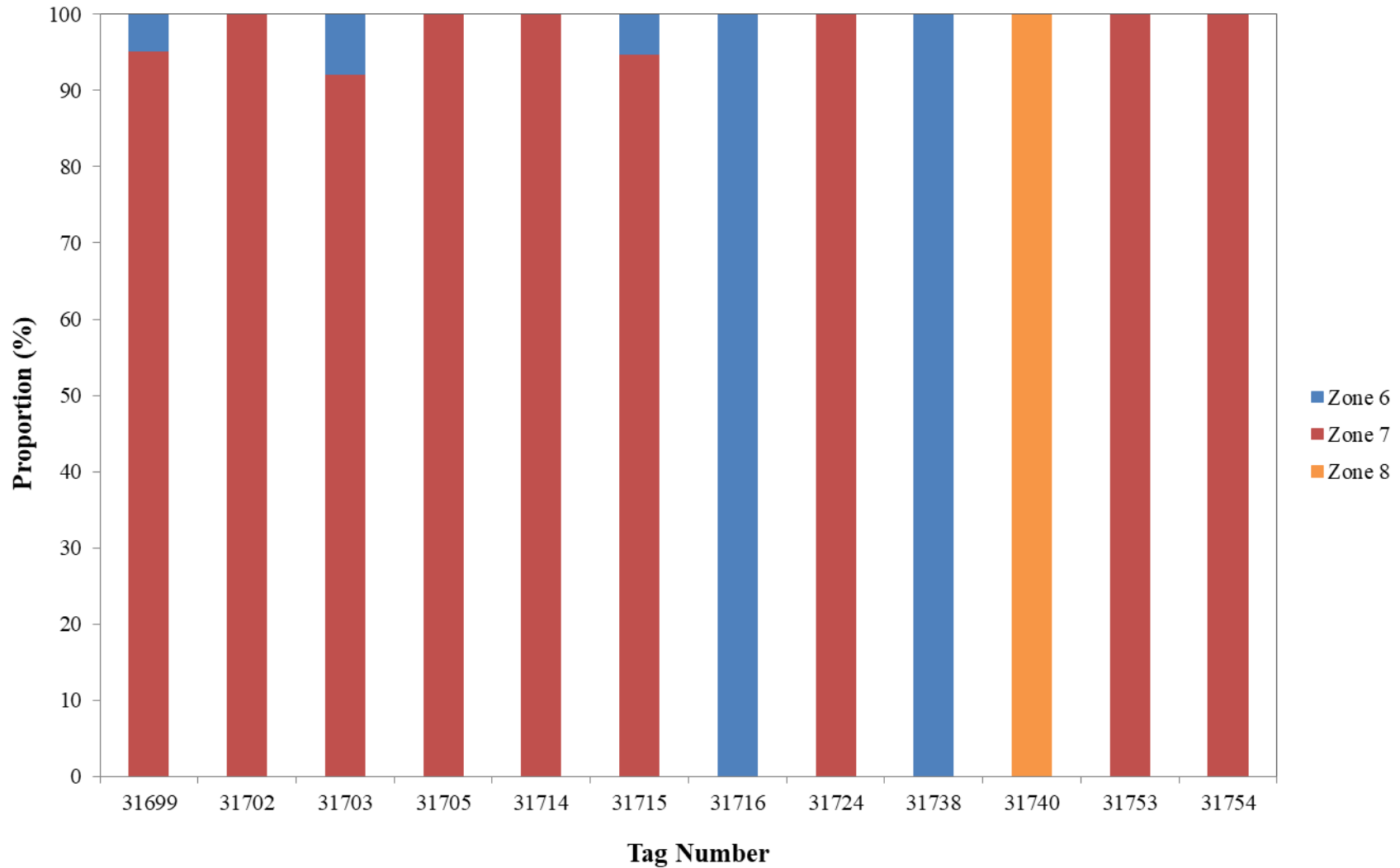


Figure 14: Proportion of time spent in Stephens Lake between the Keeyask GS and the Long Spruce GS by individual acoustic-tagged Lake Whitefish during a portion of the 2020 open-water period (July 3 to September 23).

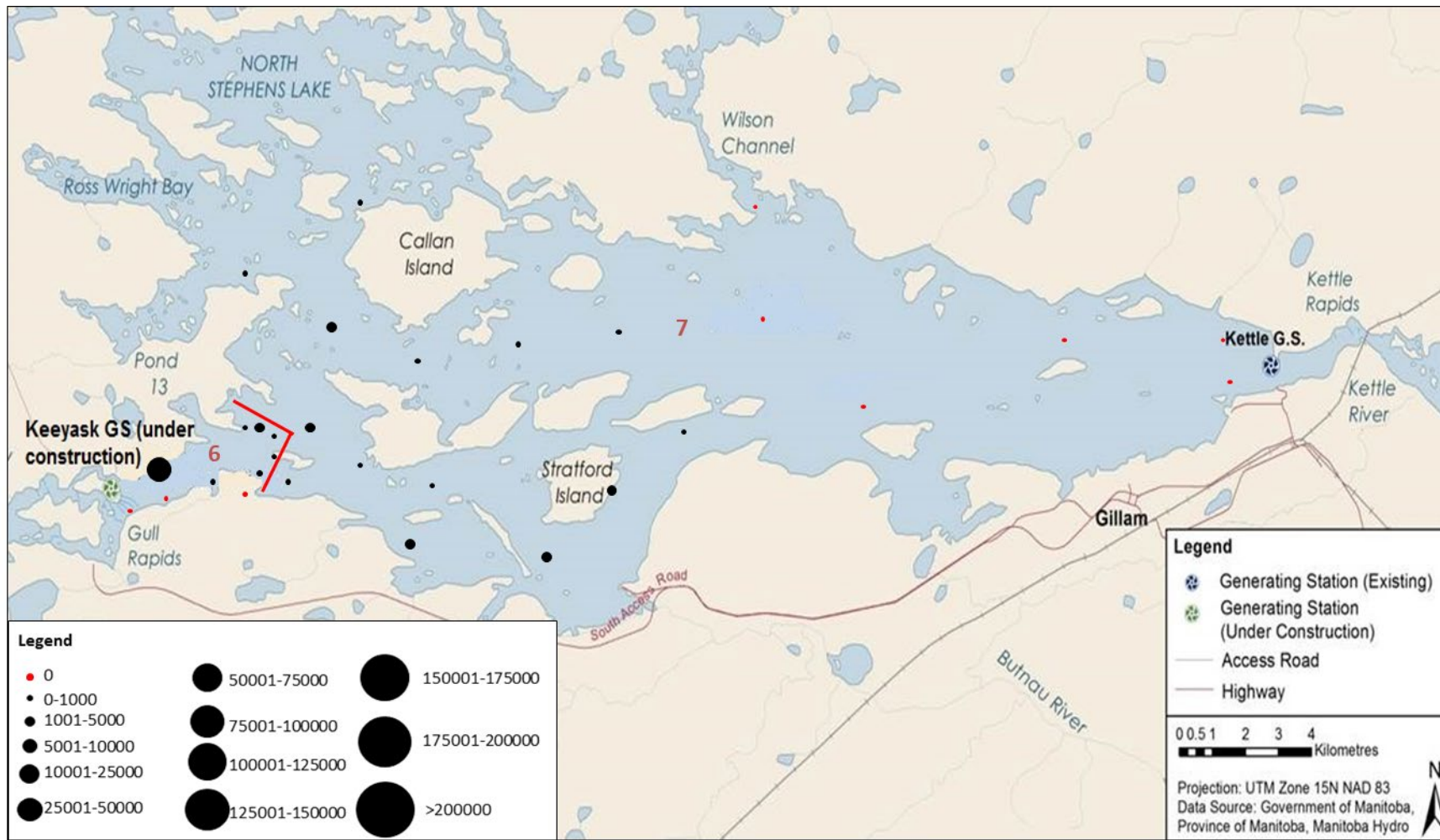


Figure 15: Relative number of detections at each acoustic receiver set in Stephens Lake during the 2020 open-water period (July 3 to September 23). Relative number of detections indicated by size of bubble. Receivers with no detections indicated with red dot. The river is divided into two "zones" based on placement of receiver "gates."

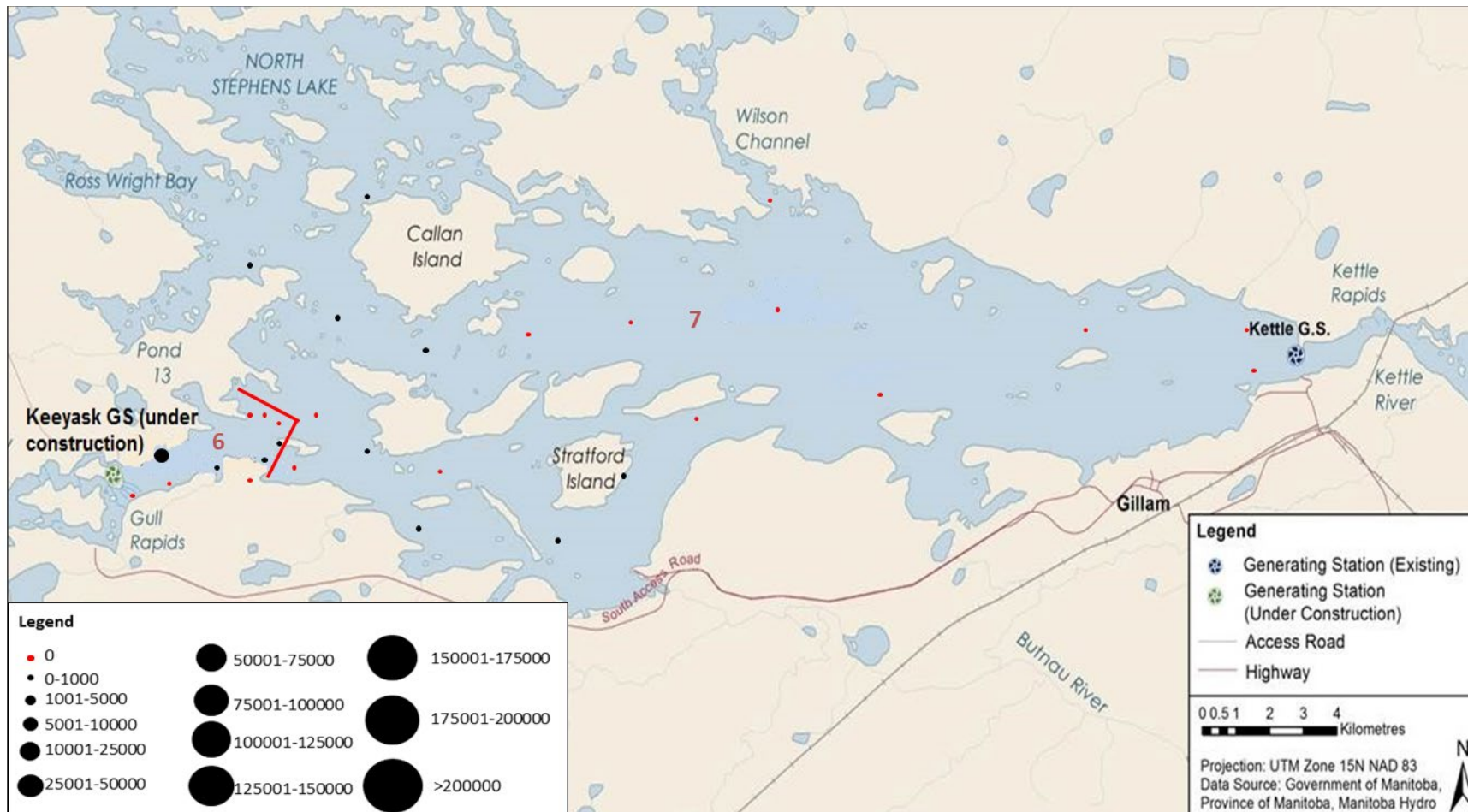


Figure 16: Relative number of detections at each acoustic receiver set in Stephens Lake during the 2020 spawning period (September 12 to 23). Spawning period was defined as the period when water temperature fell below 12°C (in order to capture movement of Lake Whitefish to spawning sites) to the end of the study period. 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."

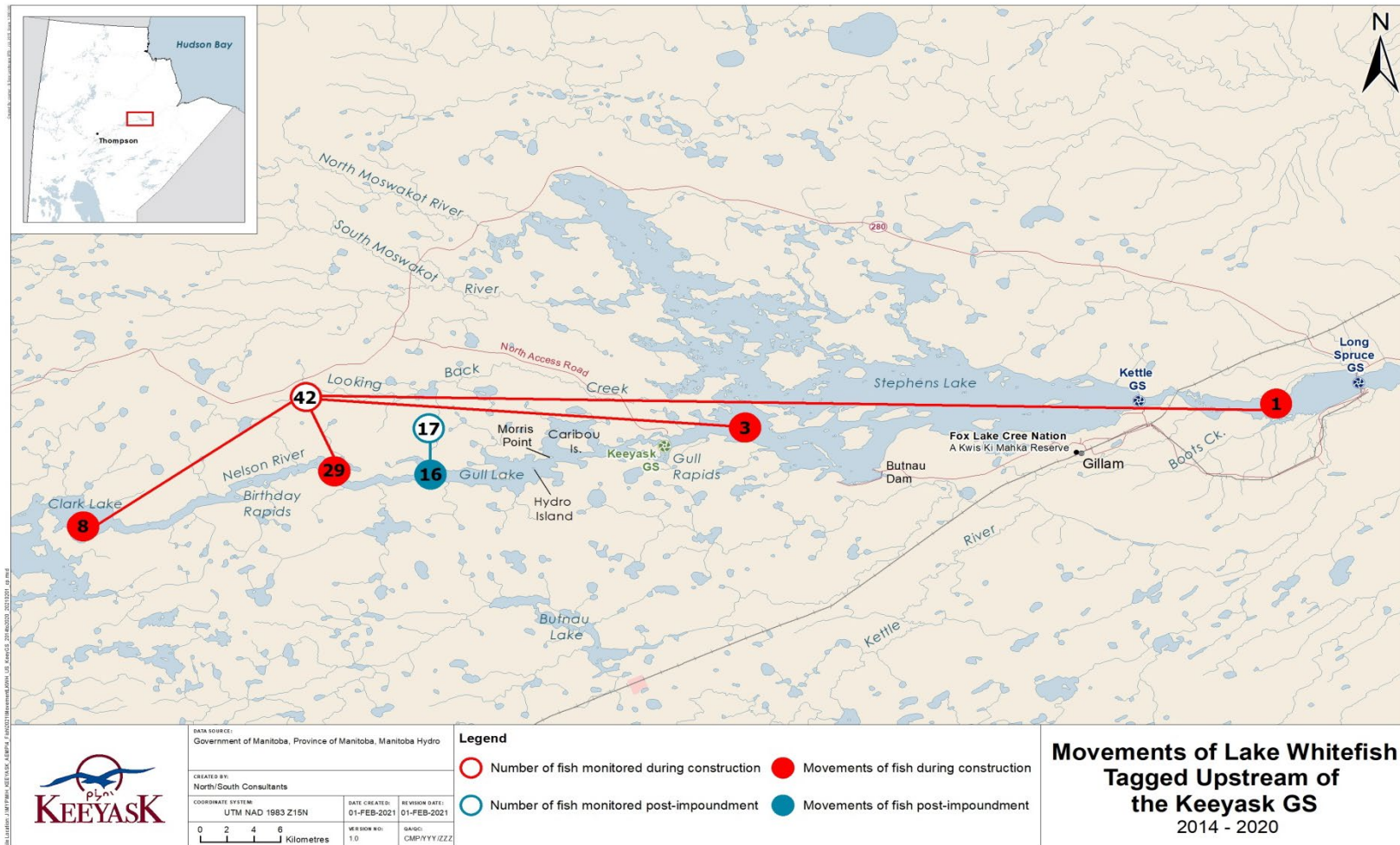
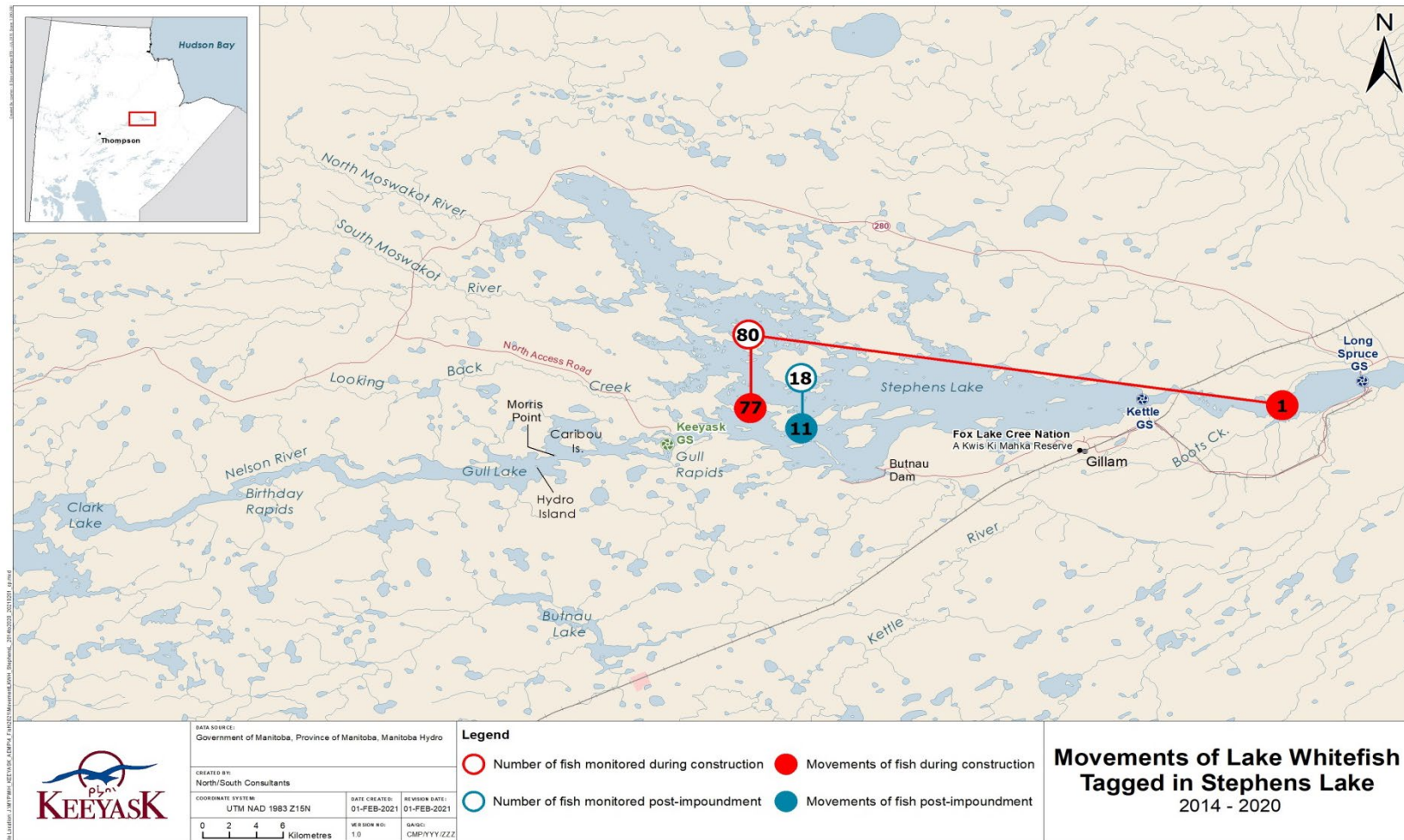
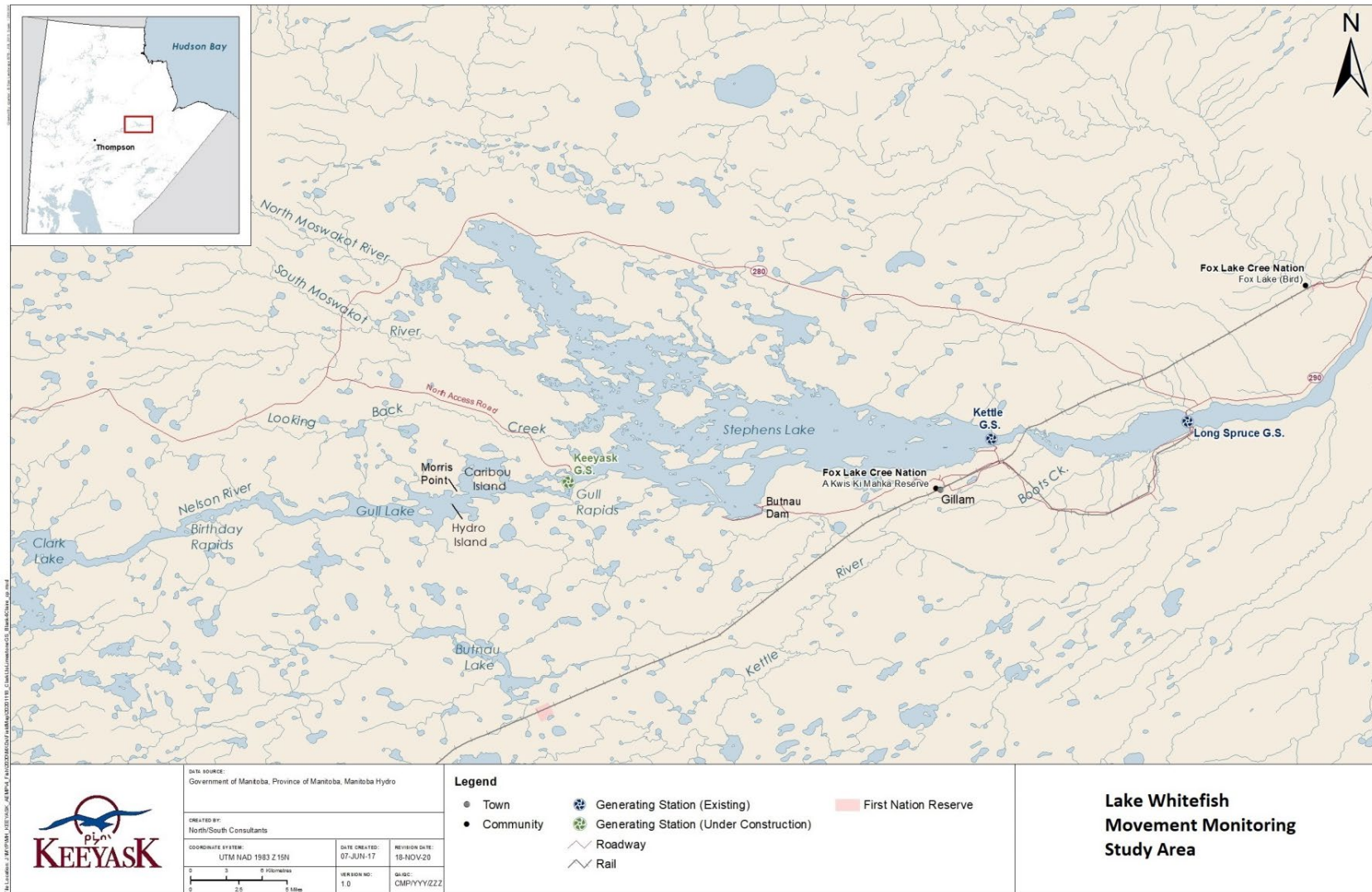


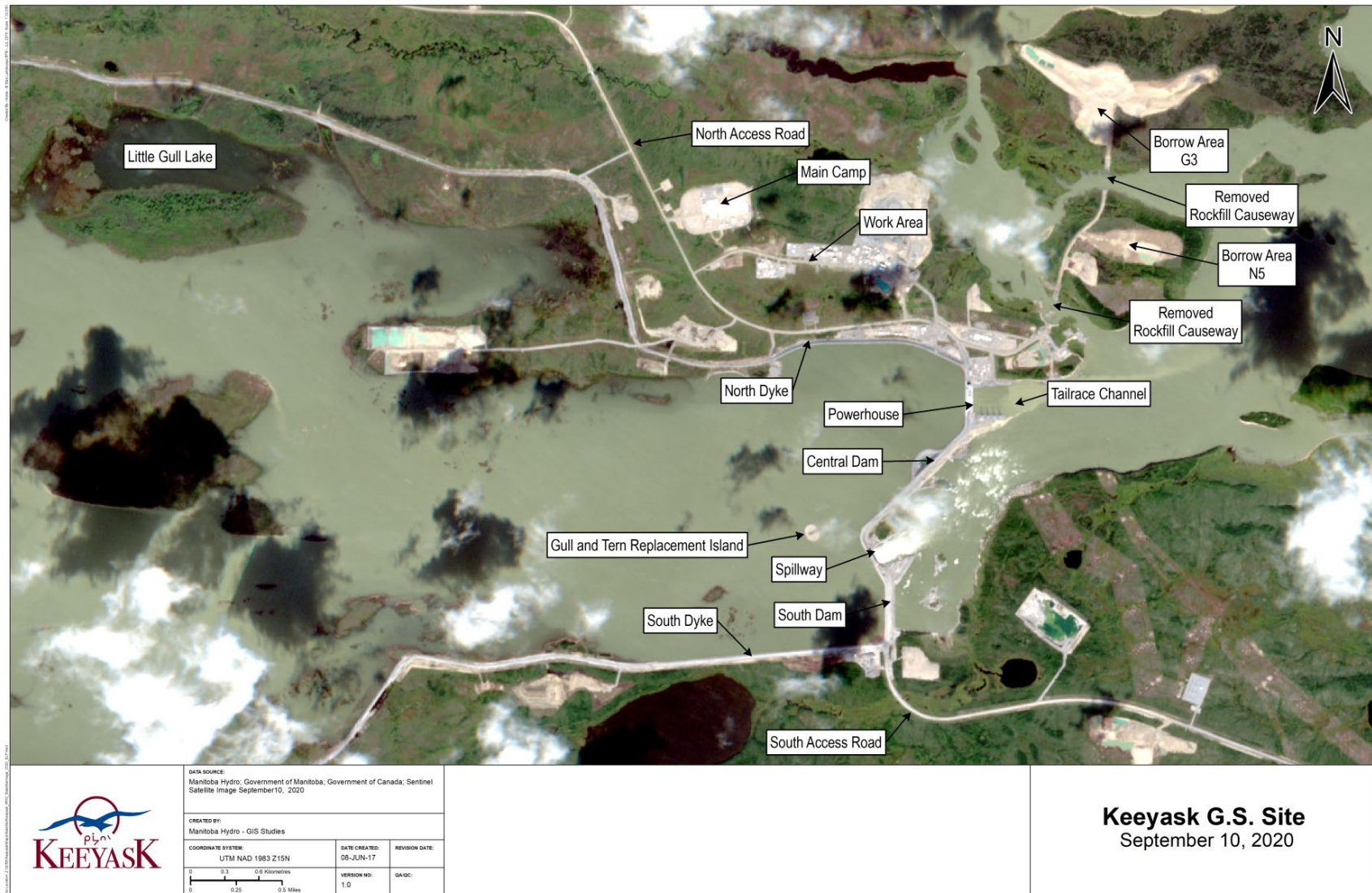
Figure 17: Map showing how many Lake Whitefish moved upstream to Clark Lake, stayed in Gull Lake, moved into Stephens Lake, and moved downstream through the Kettle GS during construction (red) and after reservoir impoundment (blue). Movements of fish due to tagging stress or mortality were not included. 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.



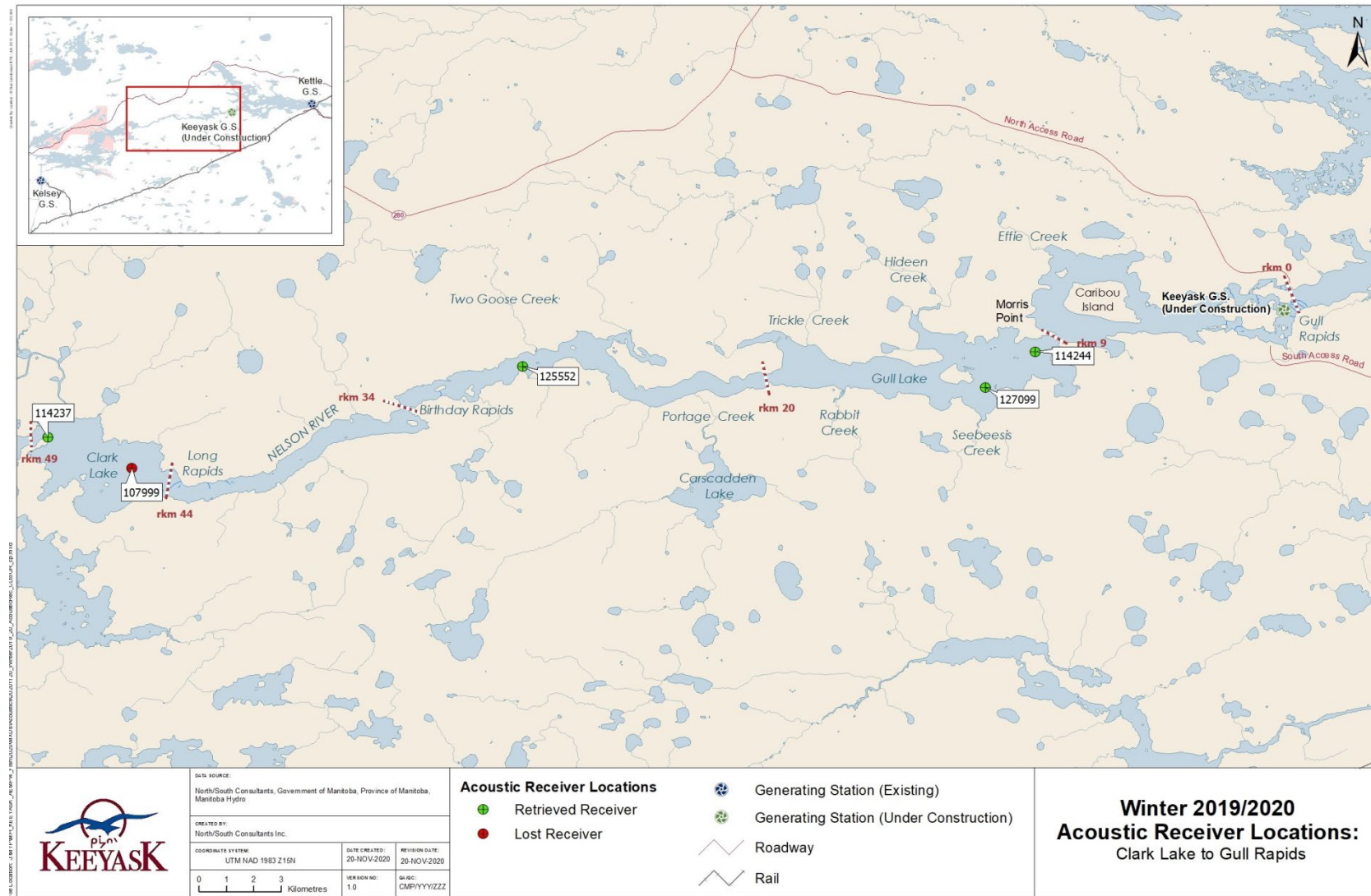
MAPS



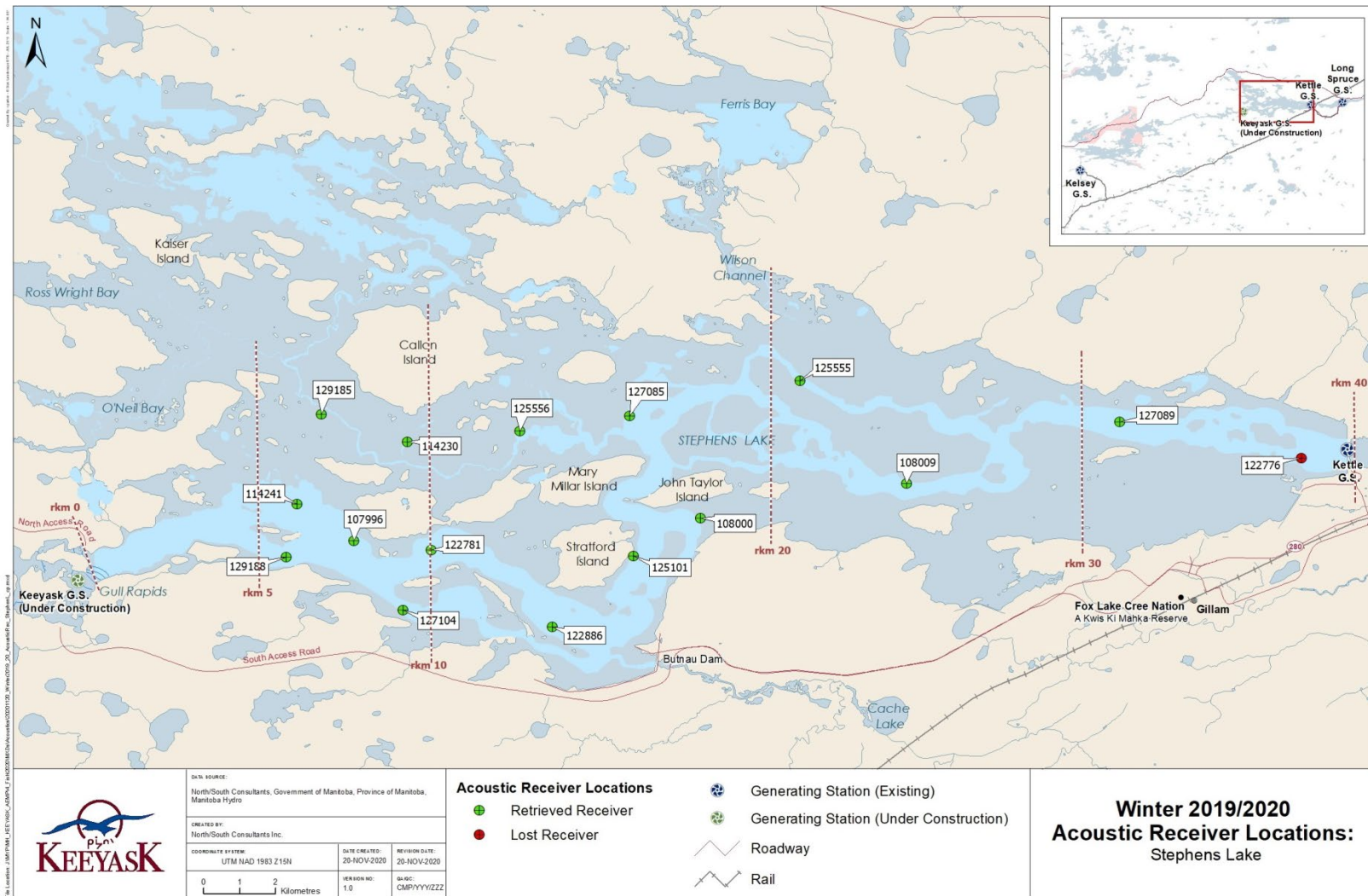
Map 1: Map of the Nelson River showing the site of the Keeyask Generating Station and the Lake Whitefish movement monitoring study setting.



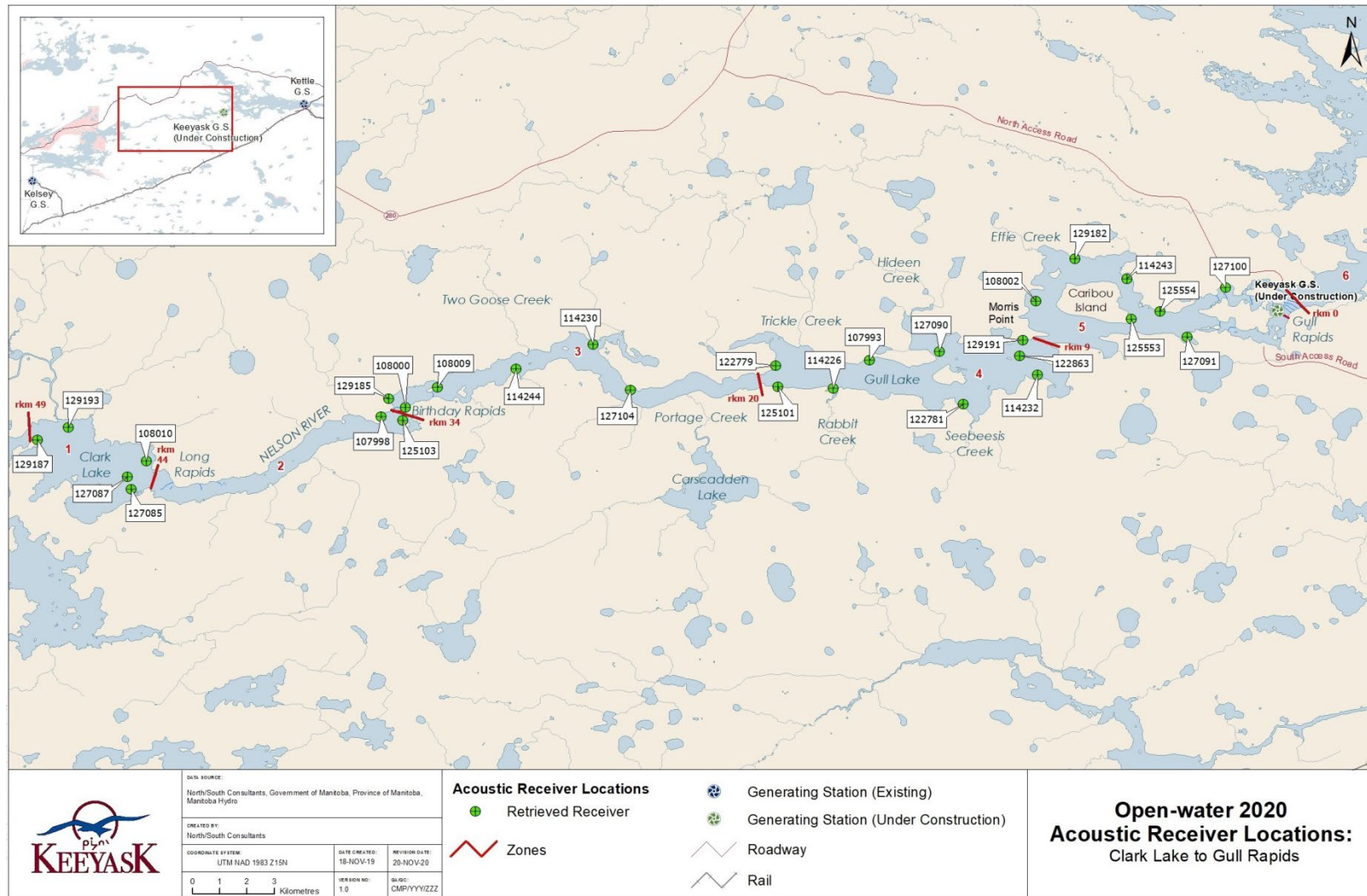
Map 2: Map of instream structures at the Keeyask Generating Station site after reservoir flooding, September 2020.



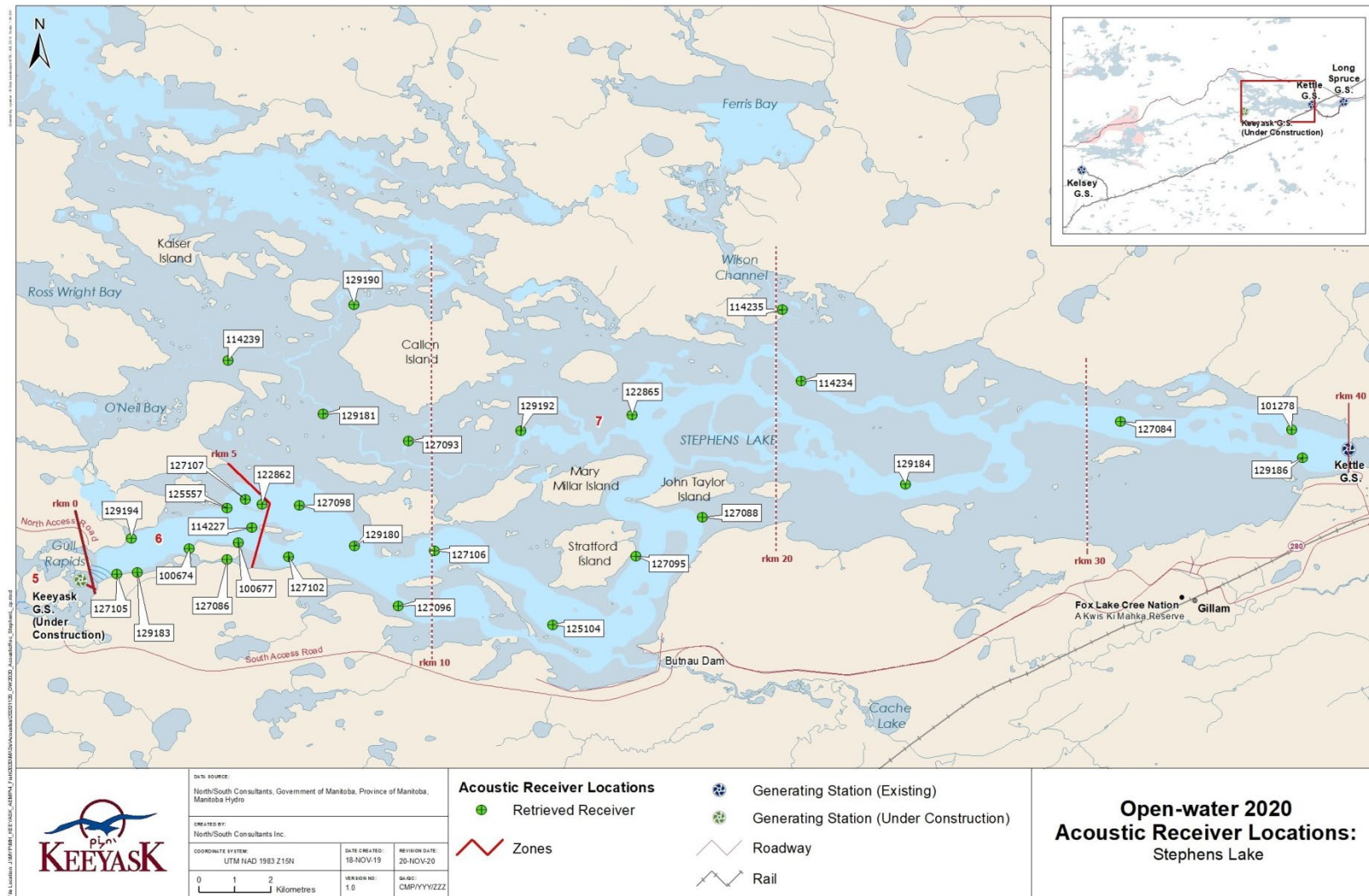
Map 3: Locations of stationary receivers set in the Nelson River from Clark Lake to the Keeyask GS between October 2019 and July 2020. River kilometer (rkm) distances are indicated with a red dotted line.



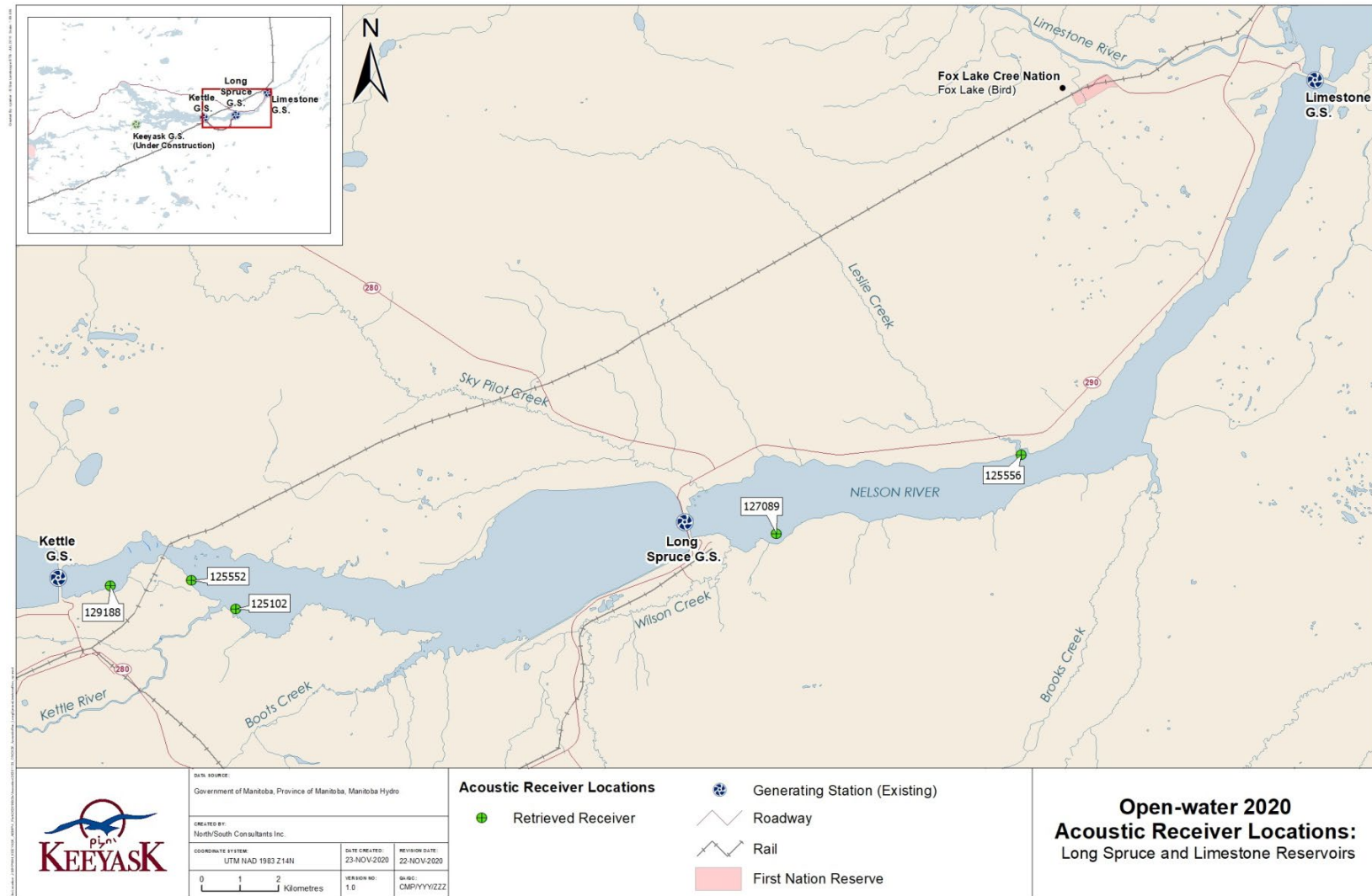
Map 4: Locations of stationary receivers set in Stephens Lake from the Keeyask GS to Kettle GS between October 2019 and July 2020. The former (pre-impoundment) river channel is shown in light blue. River kilometer (rkm) distances are indicated with a dotted red line.



Map 5: Locations of stationary receivers set in the Nelson River from Clark Lake to the Keeyask GS between July and September 2020. The river is divided into five "zones" based on placement of receiver "gates." River kilometer (rkm) distances at zone divisions are indicated in red.



Map 6: Locations of stationary receivers set in Stephens Lake between July and September 2020. 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 red line.



Map 7: Locations of stationary receivers set between the Kettle and Limestone Generating Stations, August to September 2020.

APPENDICES

APPENDIX 1:

DETECTION SUMMARIES FOR LAKE WHITEFISH

TAGGED AND MONITORED IN THE KEEYASK STUDY

AREA BETWEEN 2017 AND 2020.

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) and 2019/2020 (October 8, 2019 to April 30, 2020) winter periods.	62
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), and 2019/2020 (October 8, 2019 to April 30, 2020) winter periods.	63
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), and 2020 (May 1 to September 23) open-water periods.	65
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), and 2020 (May 1 to September 23) open-water periods.	66

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) and 2019/2020 (October 8, 2019 to April 30, 2020) 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	Date tagged	2017/2018					2018/2019					2019/2020				
		n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)
31722	7-Oct-17	3	1	-29.4	-29.4	0.0	8	1	-29.4	-29.4	0.0	20	2	-29.4	-29.4	0.0
31726	12-Oct-17	13	2	-29.4	-29.4	0.0	-	-	-	-	-	-	-	-	-	-
31727	12-Oct-17	132	5	-29.4	-10.3	19.1	92461	202	16.8	16.8	0.0	90685	201	16.8	16.8	0.0
31728	14-Oct-17	8	1	-29.4	-29.4	0.0	15	1	-29.4	-29.4	0.0	-	-	-	-	-
31729	14-Oct-17	5	1	-29.4	-29.4	0.0	26	2	-29.4	-12.4	17.0	-	-	-	-	-
31730	14-Oct-17	106	3	-29.4	-10.3	19.1	6	1	-12.4	-12.4	0.0	10	3	-29.4	-12.4	17.0
31731	14-Oct-17	153	5	-29.4	-29.4	0.0	-	-	-	-	-	33	1	-29.4	-29.4	0.0
31732	12-Oct-17	14	1	-29.4	-29.4	0.0	-	-	-	-	-	114	7	-29.4	-10.3	19.1
31733	14-Oct-17	9	1	-29.4	-29.4	0.0	-	-	-	-	-	4	1	-29.4	-29.4	0.0
31734	14-Oct-17	5914	16	-29.4	-10.3	19.1	-	-	-	-	-	111	11	-12.4	-10.3	2.1
31735	12-Oct-17	50	2	-29.4	-10.3	19.1	-	-	-	-	-	-	-	-	-	-
31736	12-Oct-17	26	1	-29.4	-29.4	0.0	6	1	-29.4	-29.4	0.0	3	1	-29.4	-29.4	0.0
31737	12-Oct-17	138	4	-29.4	-10.3	19.1	39	3	-29.4	-12.4	17.0	-	-	-	-	-
31738	11-Oct-17	227	7	-29.4	-10.3	19.1	-	-	-	-	-	-	-	-	-	-
31739	11-Oct-17	145	3	-29.4	-12.4	17.0	76	4	-12.4	-12.4	0.0	-	-	-	-	-
31740	11-Oct-17	948	11	-29.4	18.6	48.0	-	-	-	-	-	-	-	-	-	-
31741	11-Oct-17	9	1	-29.4	-29.4	0.0	22	2	-29.4	-12.4	17.0	-	-	-	-	-
31742	11-Oct-17	3	1	-29.4	-29.4	0.0	9	1	-29.4	-29.4	0.0	45	1	-29.4	-29.4	0.0
31743	11-Oct-17	4	1	-29.4	-29.4	0.0	10	1	-29.4	-29.4	0.0	2	1	-10.3	-10.3	0.0
31744	11-Oct-17	280	14	-29.4	-12.4	17.0	-	-	-	-	-	-	-	-	-	-
31745	11-Oct-17	-	-	-	-	-	170	5	-29.4	-12.4	17.0	7	1	-29.4	-29.4	0.0
31746	11-Oct-17	434	5	-29.4	-29.4	0.0	-	-	-	-	-	17	1	-29.4	-29.4	0.0

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), and 2019/2020 (October 8, 2019 to April 30, 2020) 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					2018/2019				
		n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest 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
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
31704	9-Oct-17	1111	22	5.2	36.1	30.9	-	-	-	-	-	-	-	-	-	-
31705	9-Oct-17	44	1	6.5	6.5	0.0	-	-	-	-	-	-	-	-	-	-
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
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	-	-	-	-	-	-	-	-	-	-
31715	9-Oct-17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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), and 2019/2020 (October 8, 2019 to April 30, 2020) 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					2018/2019				
		n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest 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
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
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	
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), and 2020 (May 1 to September 23) 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				
		n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest 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
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
31727	12-Oct-17	6891	86	1.2	18.6	17.4	-	-	-	-	-	21964	123	16.3	16.8	0.5
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
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
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
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
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
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
31735	12-Oct-17	2746	25	-9.3	-4.8	4.5	-	-	-	-	-	-	-	-	-	-
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
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
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
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
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
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
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
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

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), and 2020 (May 1 to September 23) 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				
		n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest 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
31700	9-Oct-17	1789	46	2.7	7.9	5.2	-	-	-	-	-	-	-	-	-	-
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
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
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
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
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
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), and 2020 (May 1 to September 23) 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				
		n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Range (rkm)	n	# Days	Furthest U/S (rkm)	Furthest 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	-	-	-	-	-
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
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
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 2020

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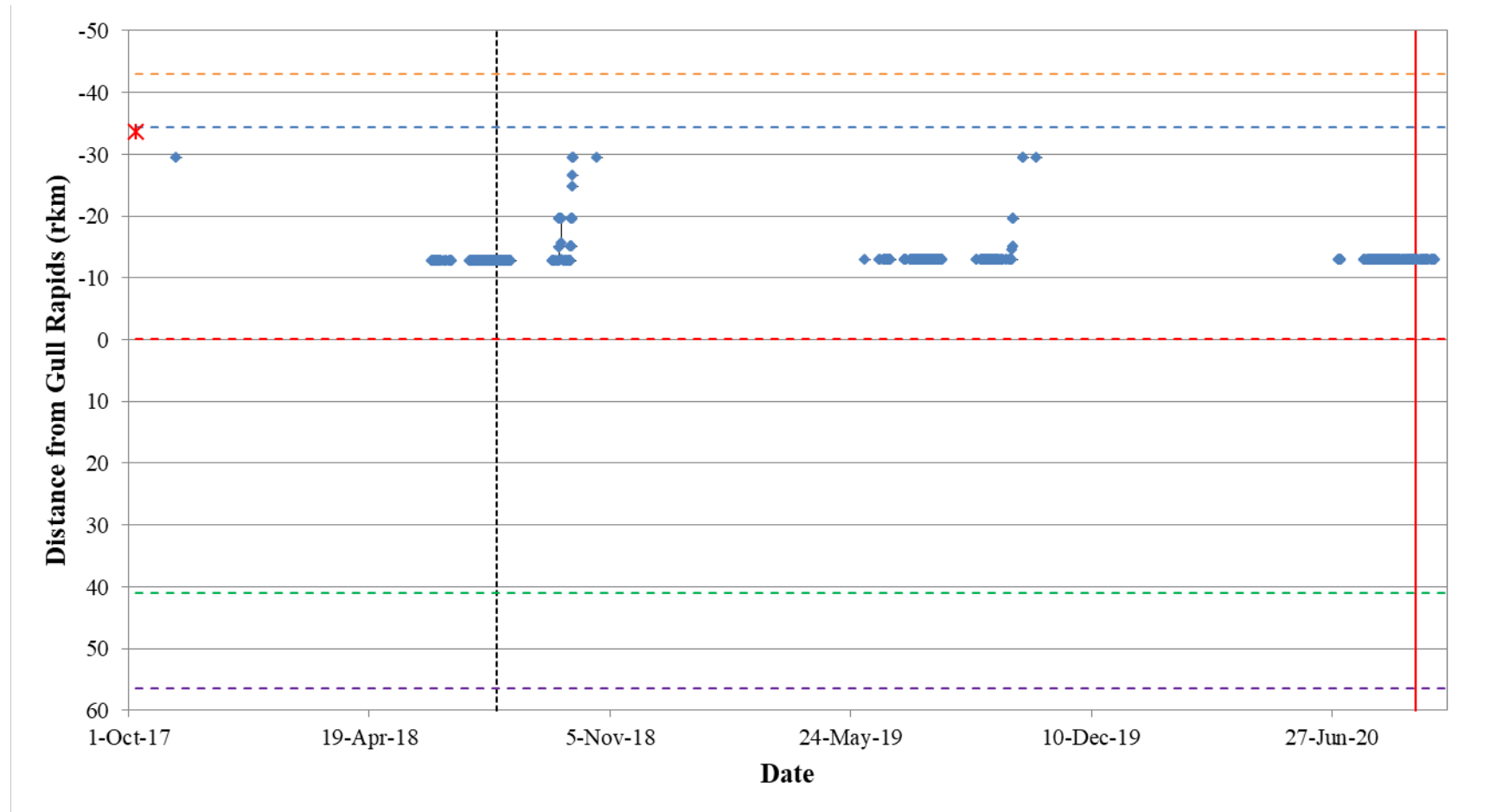


Figure A2-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31722) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

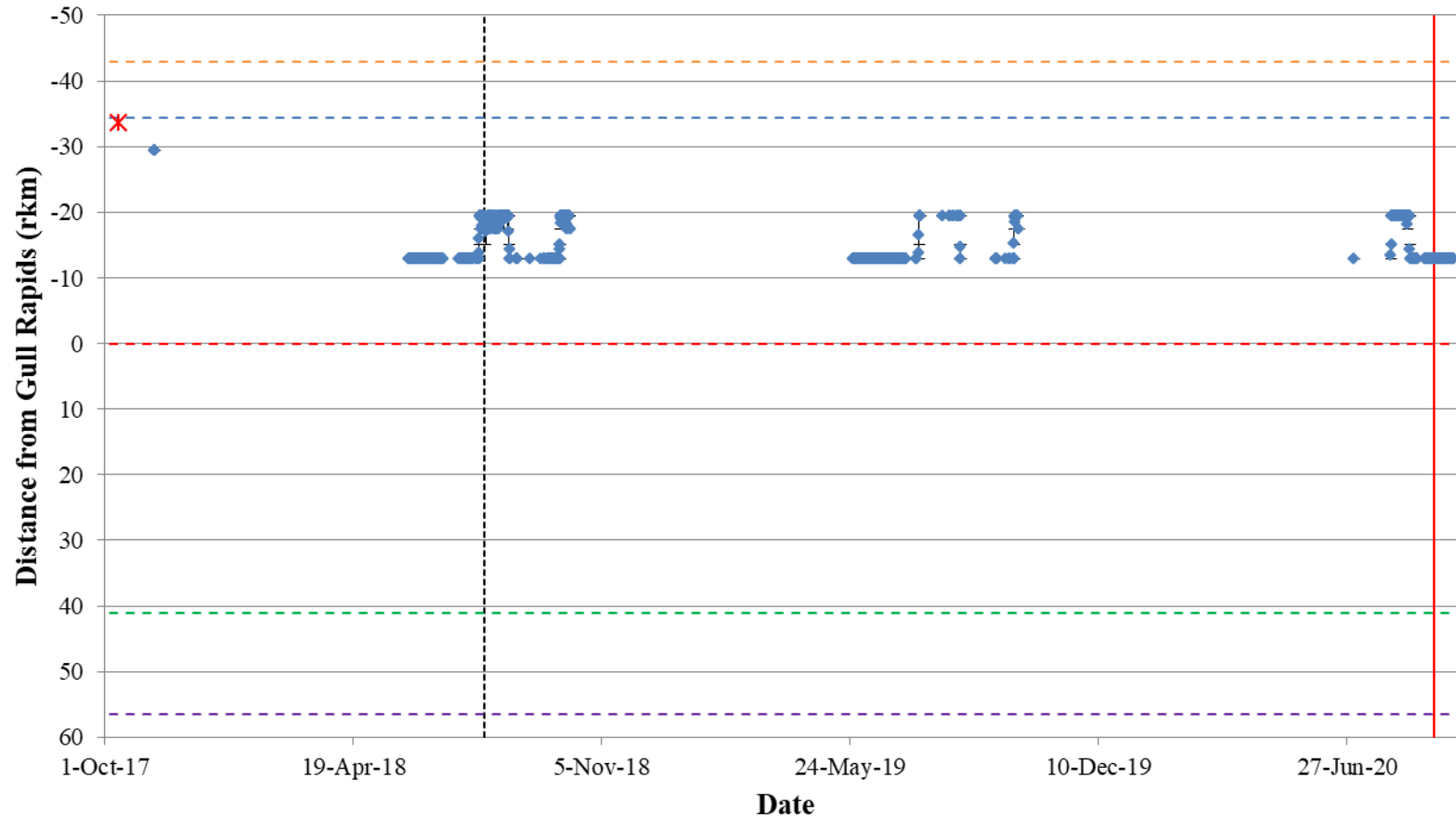


Figure A2-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31726) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

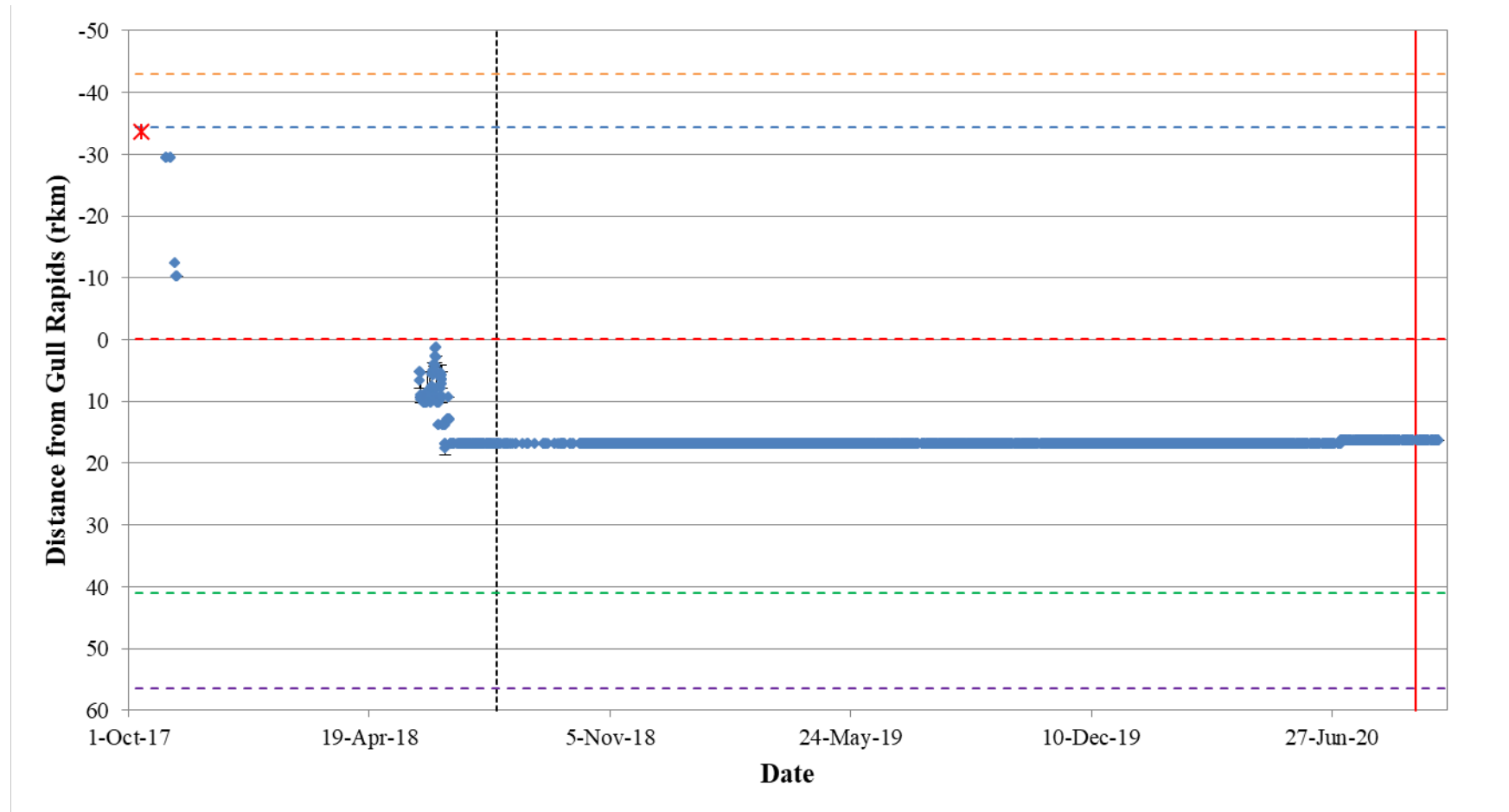


Figure A2-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31727) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

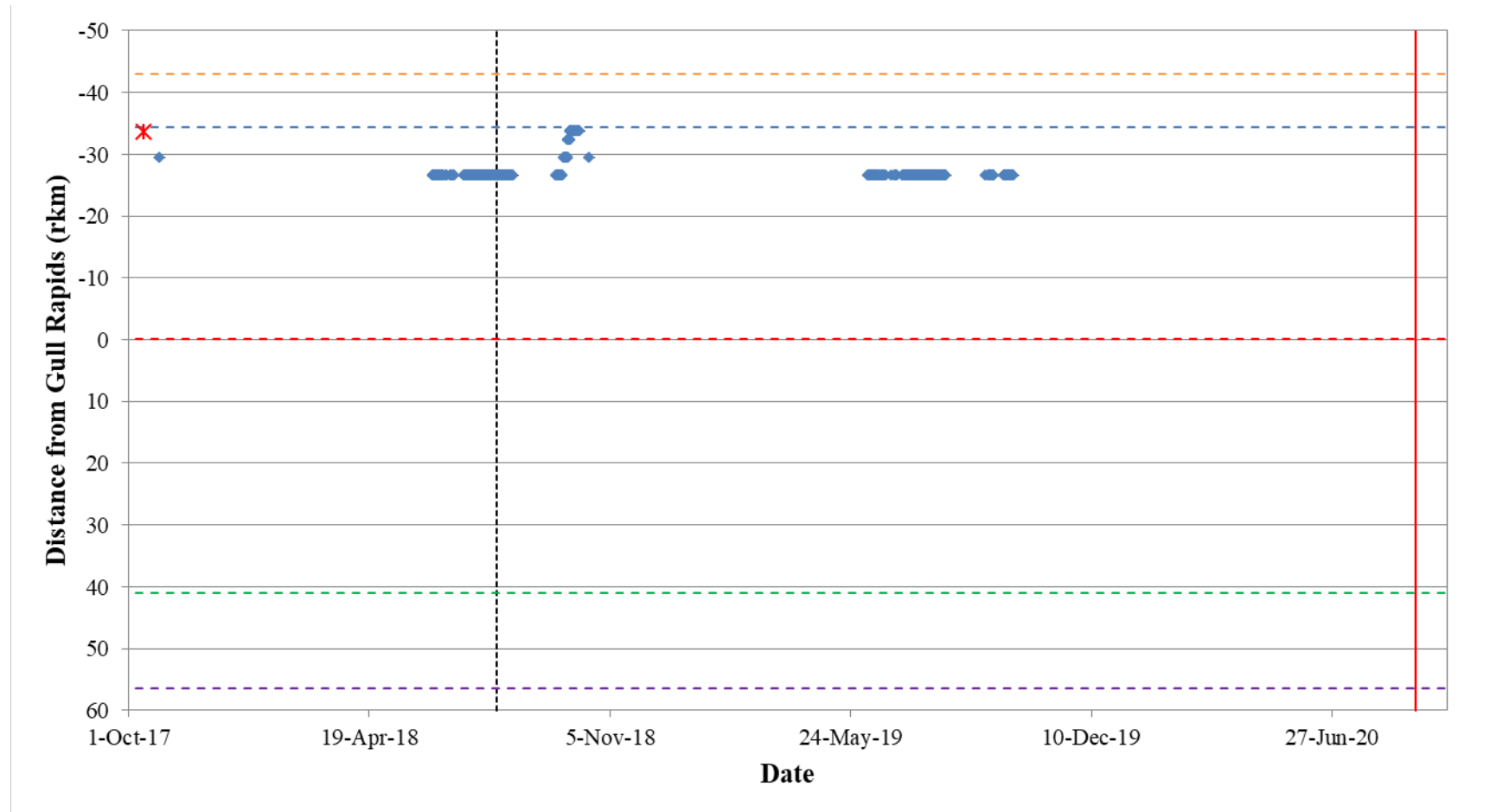


Figure A2-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31728) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

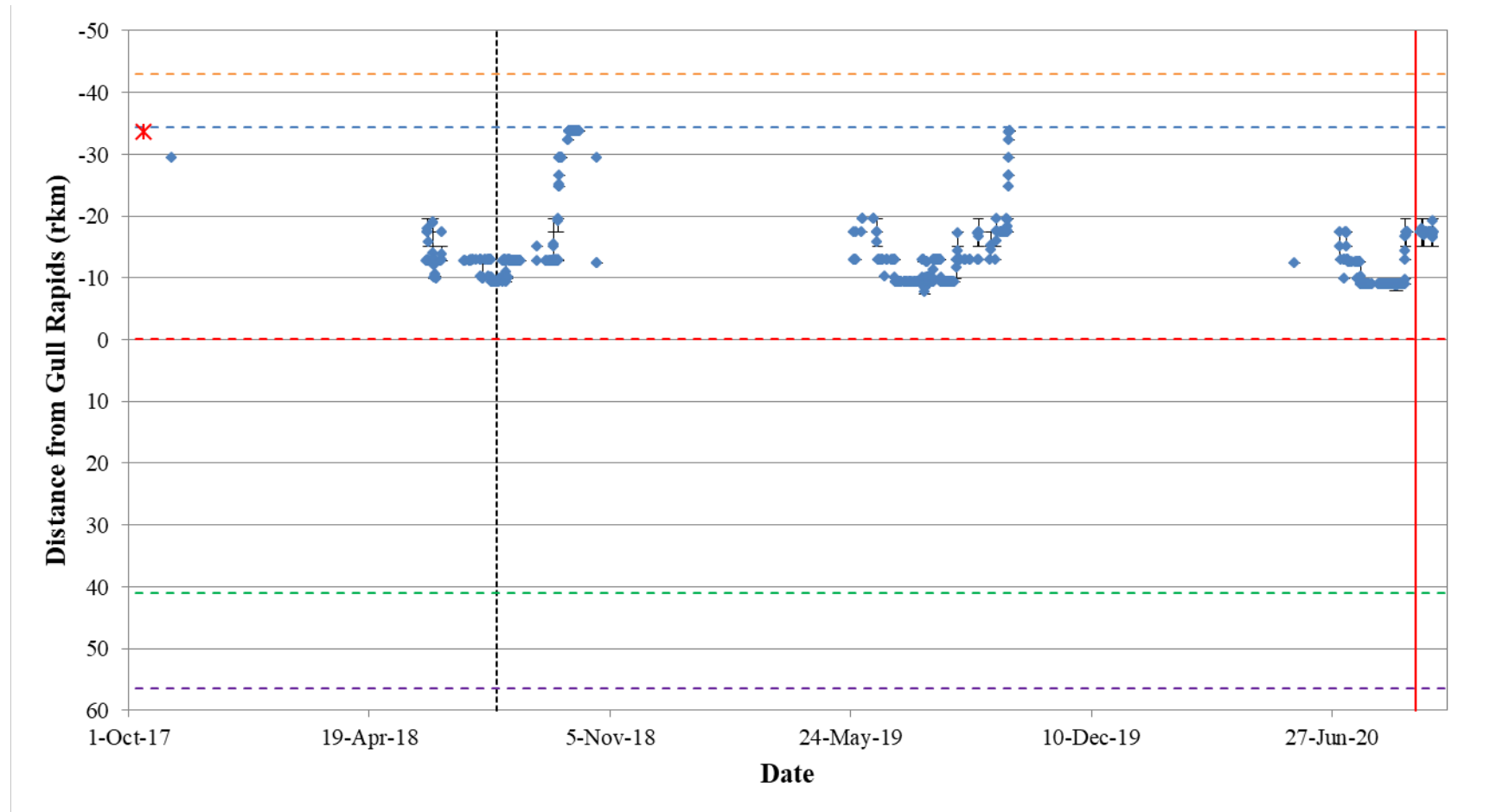


Figure A2-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31729) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

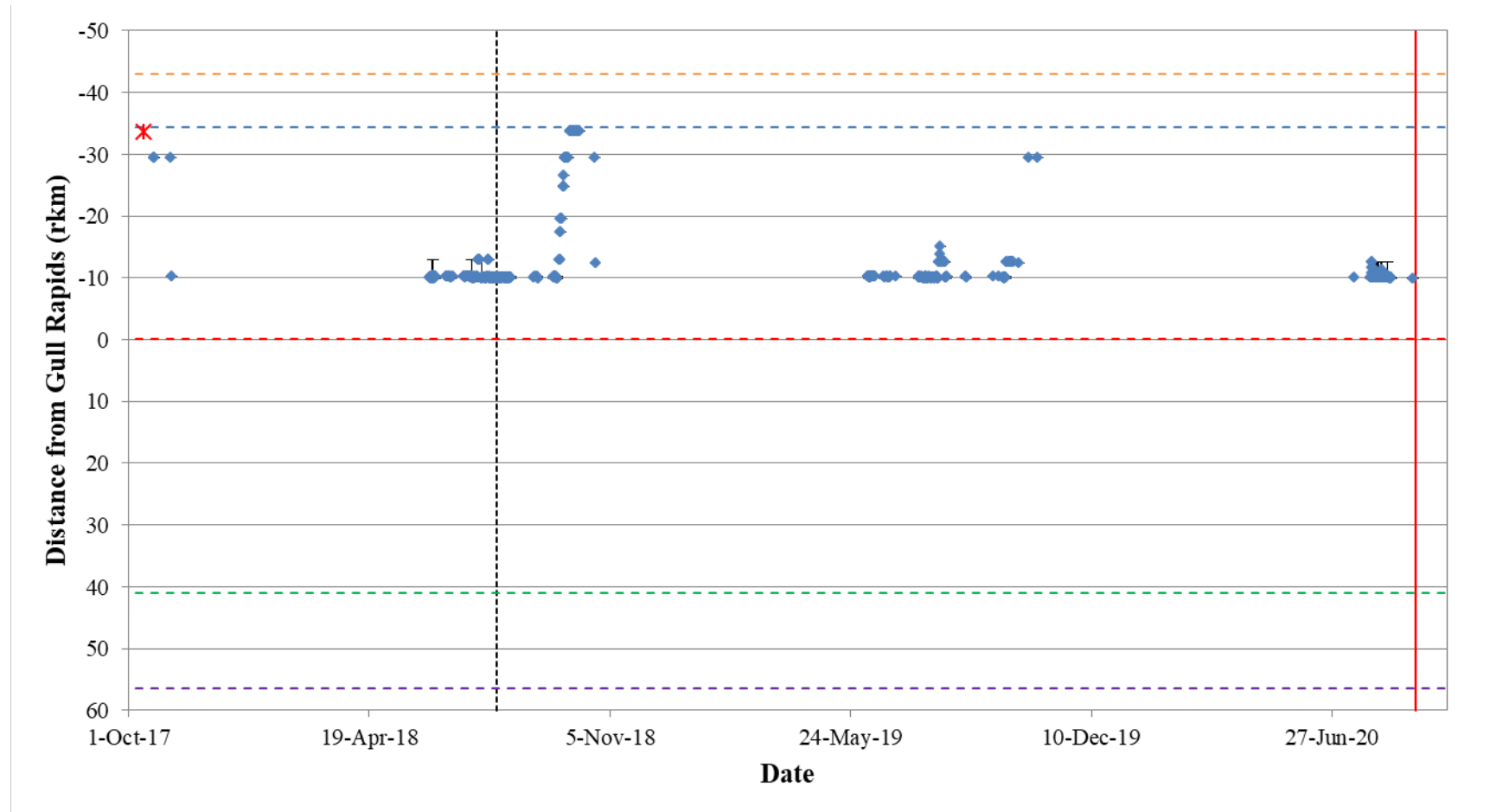


Figure A2-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31730) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

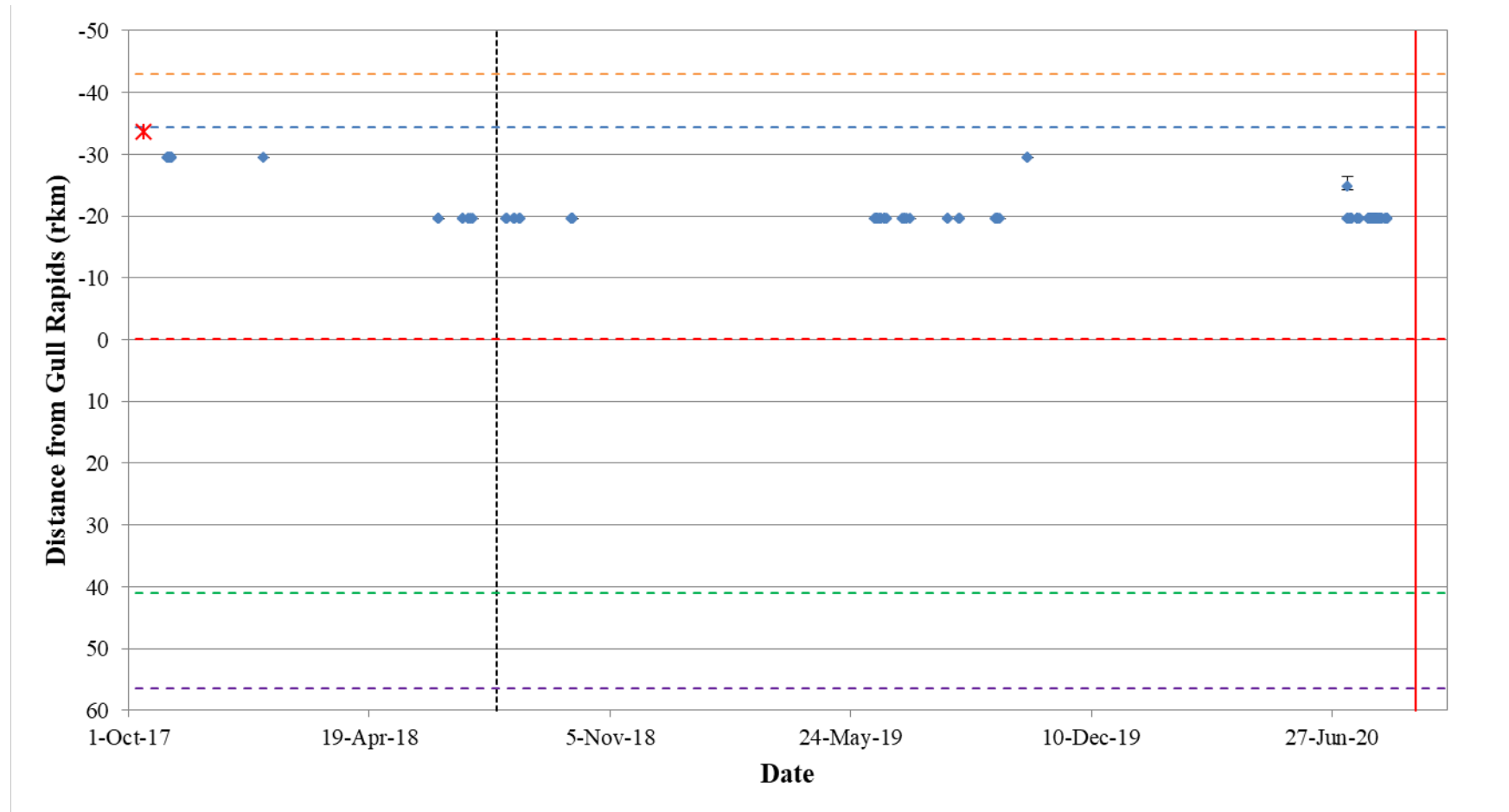


Figure A2-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31731) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

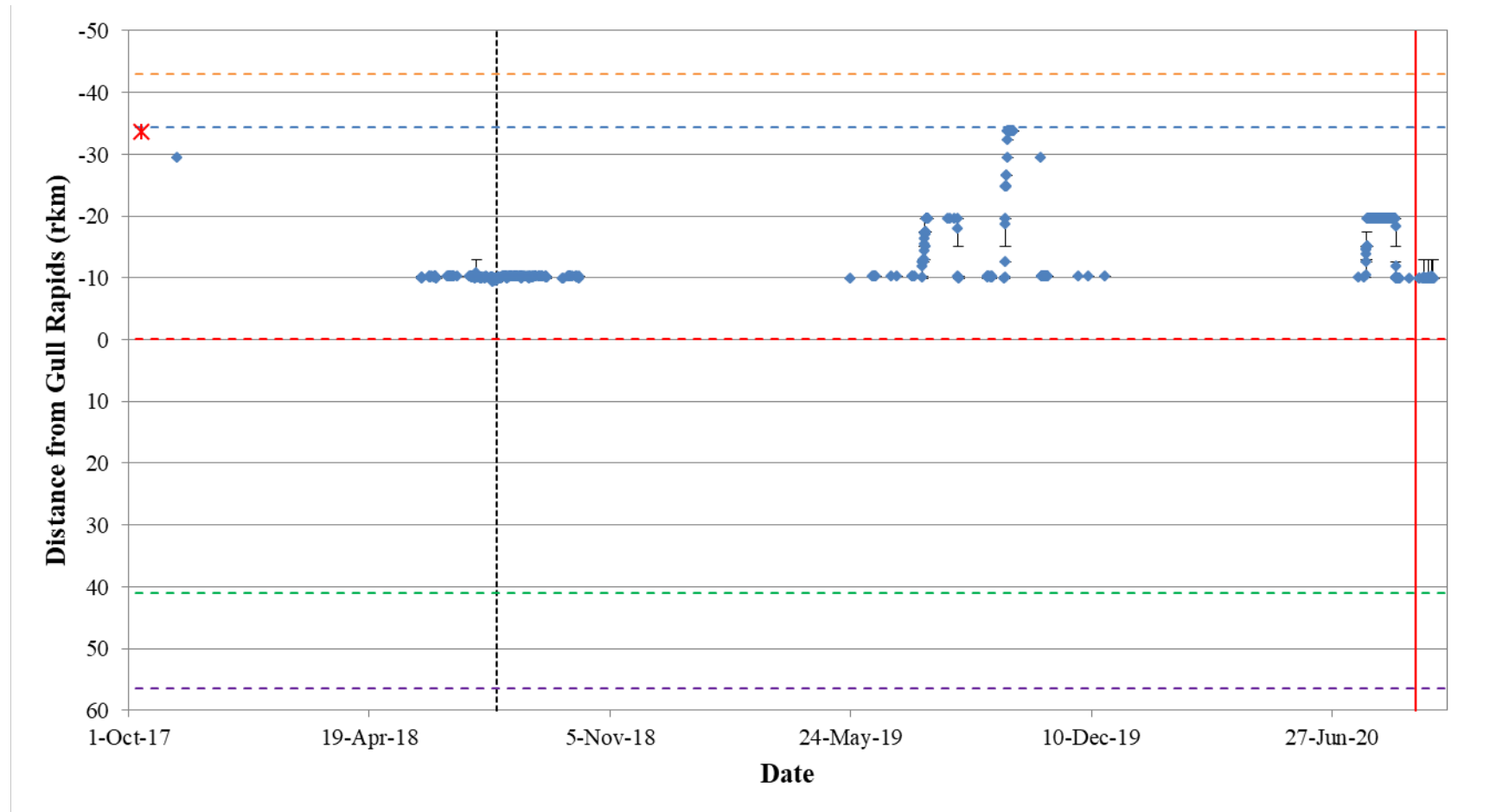


Figure A2-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31732) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

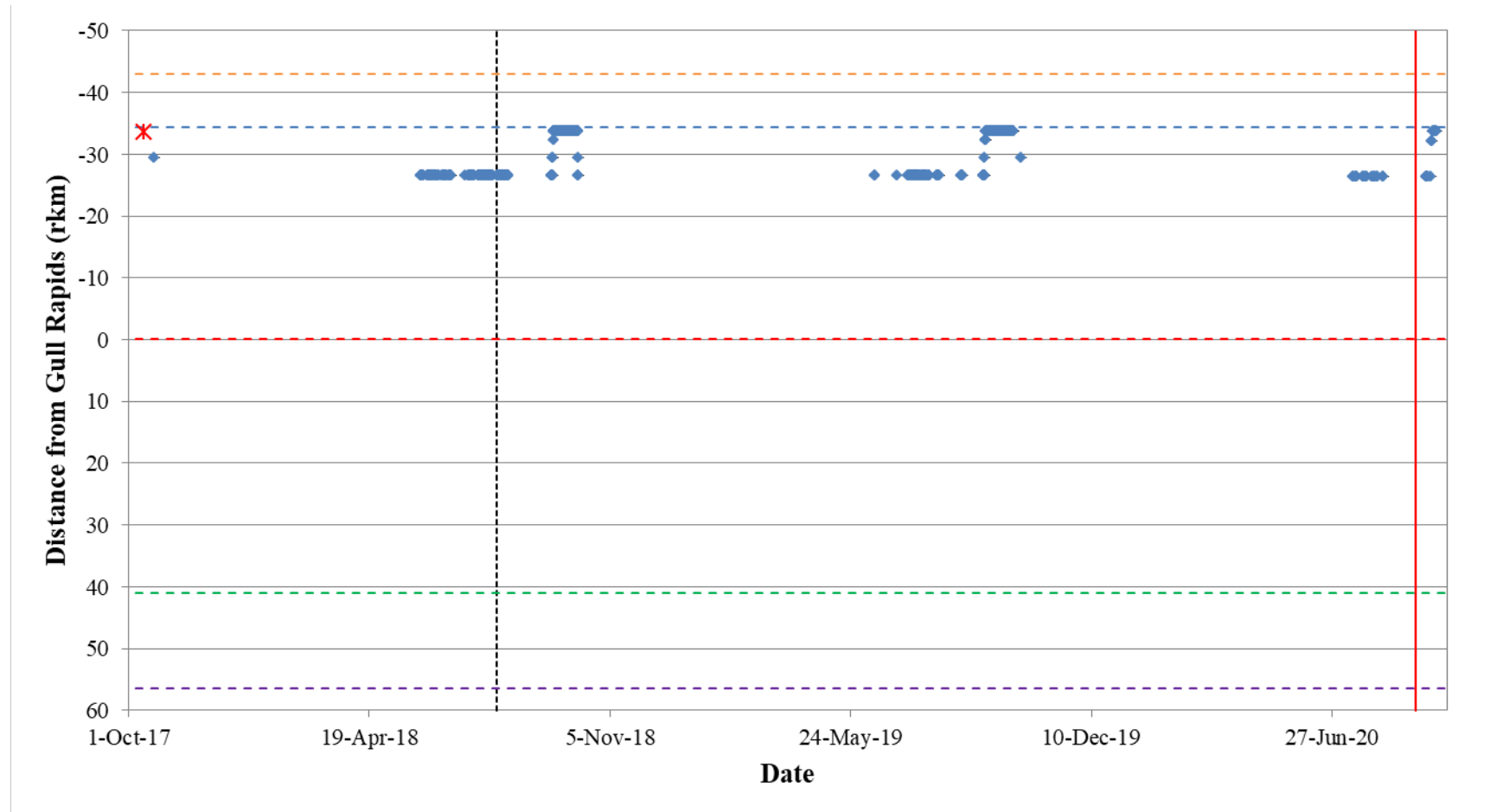


Figure A2-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31733) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted 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).

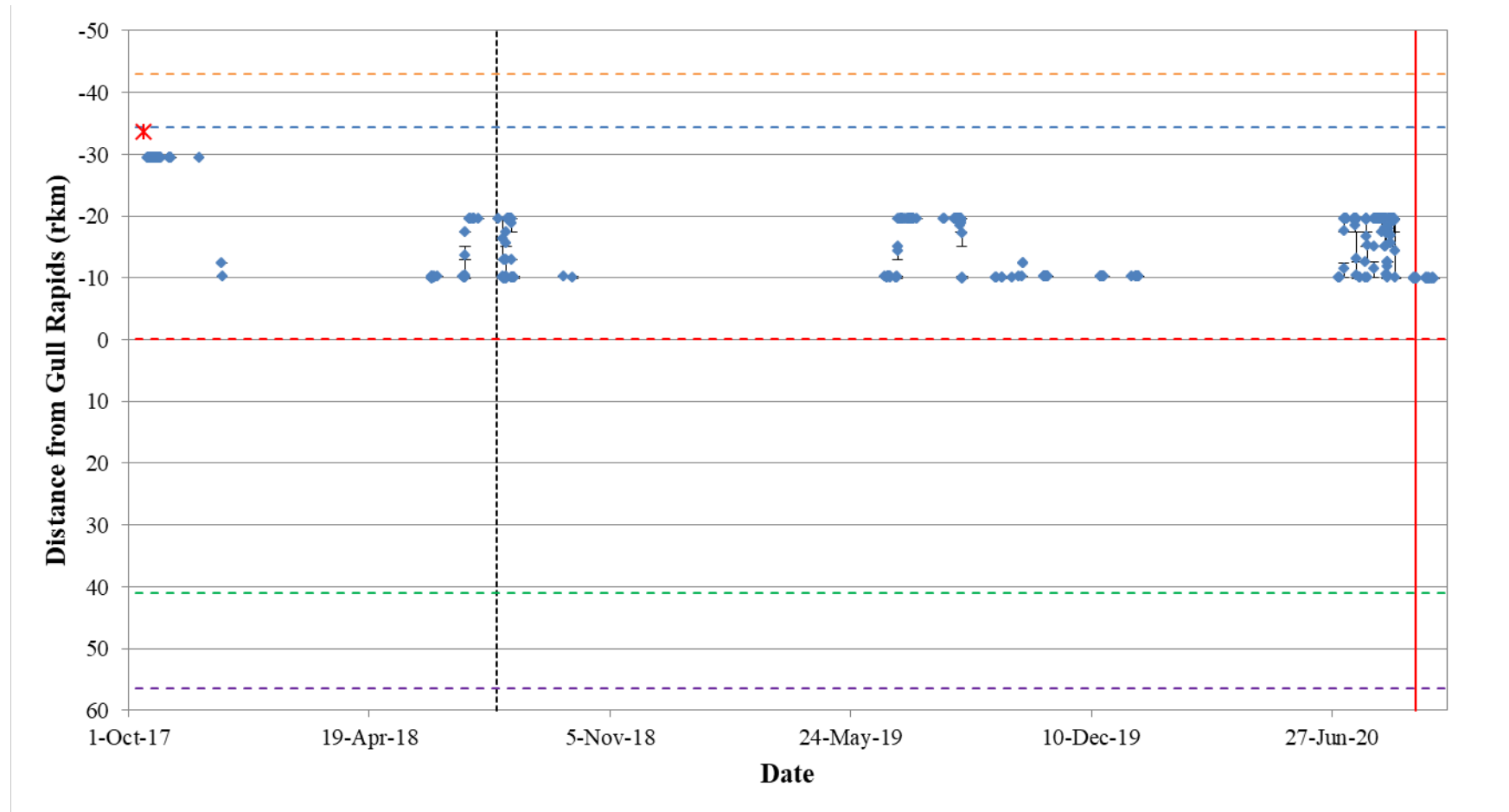


Figure A2-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31734) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

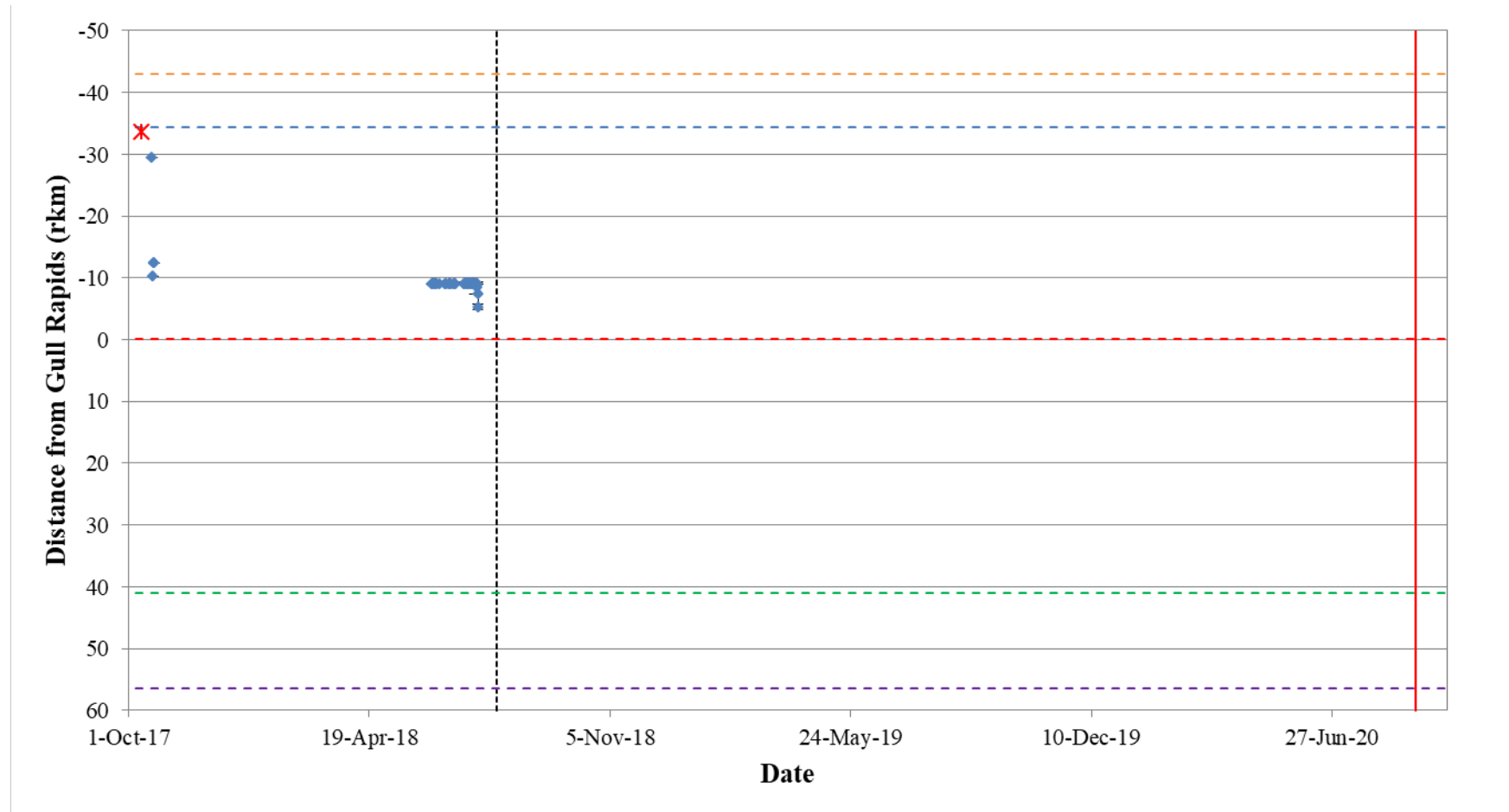


Figure A2-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31735) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

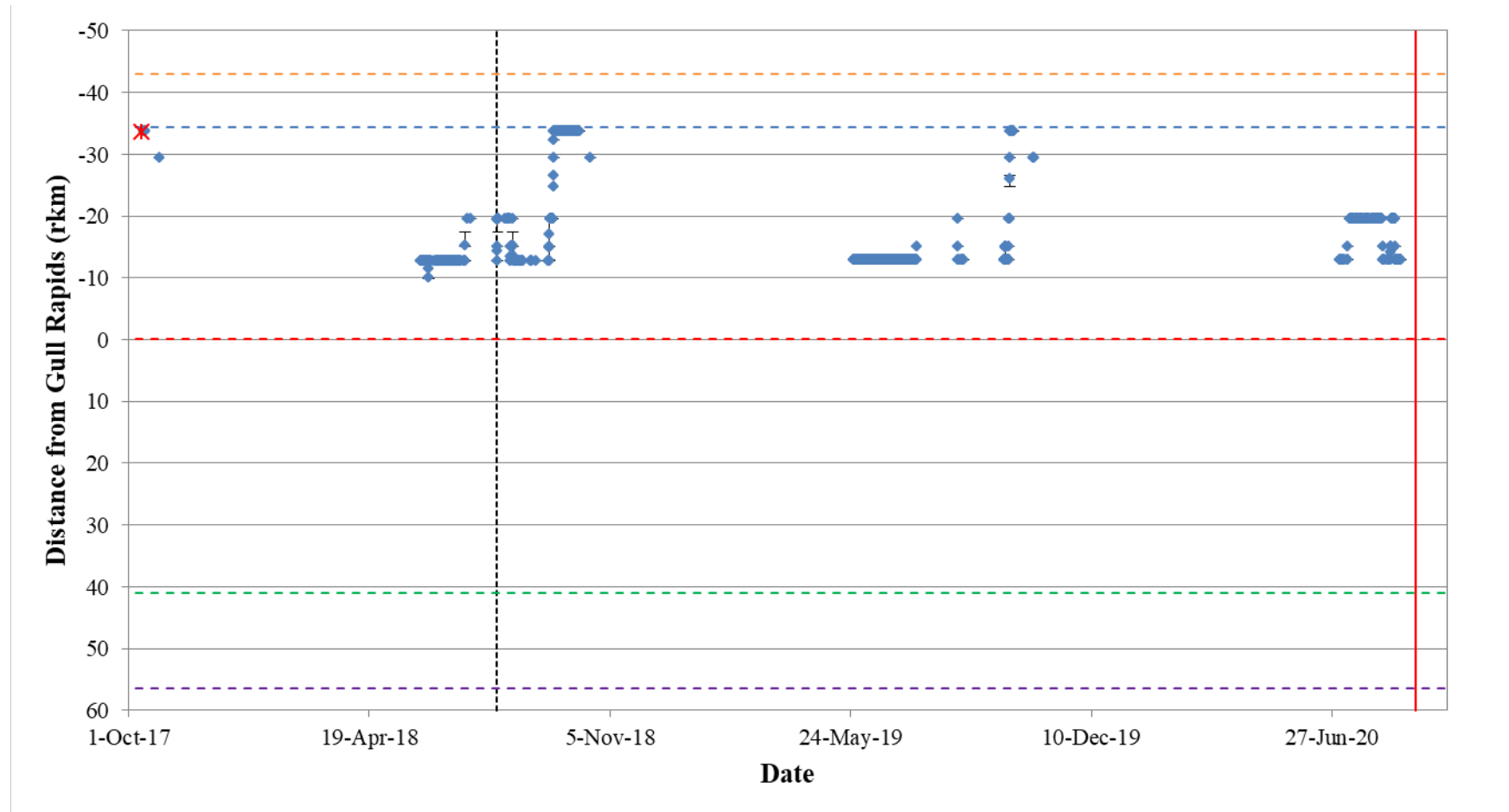


Figure A2-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31736) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

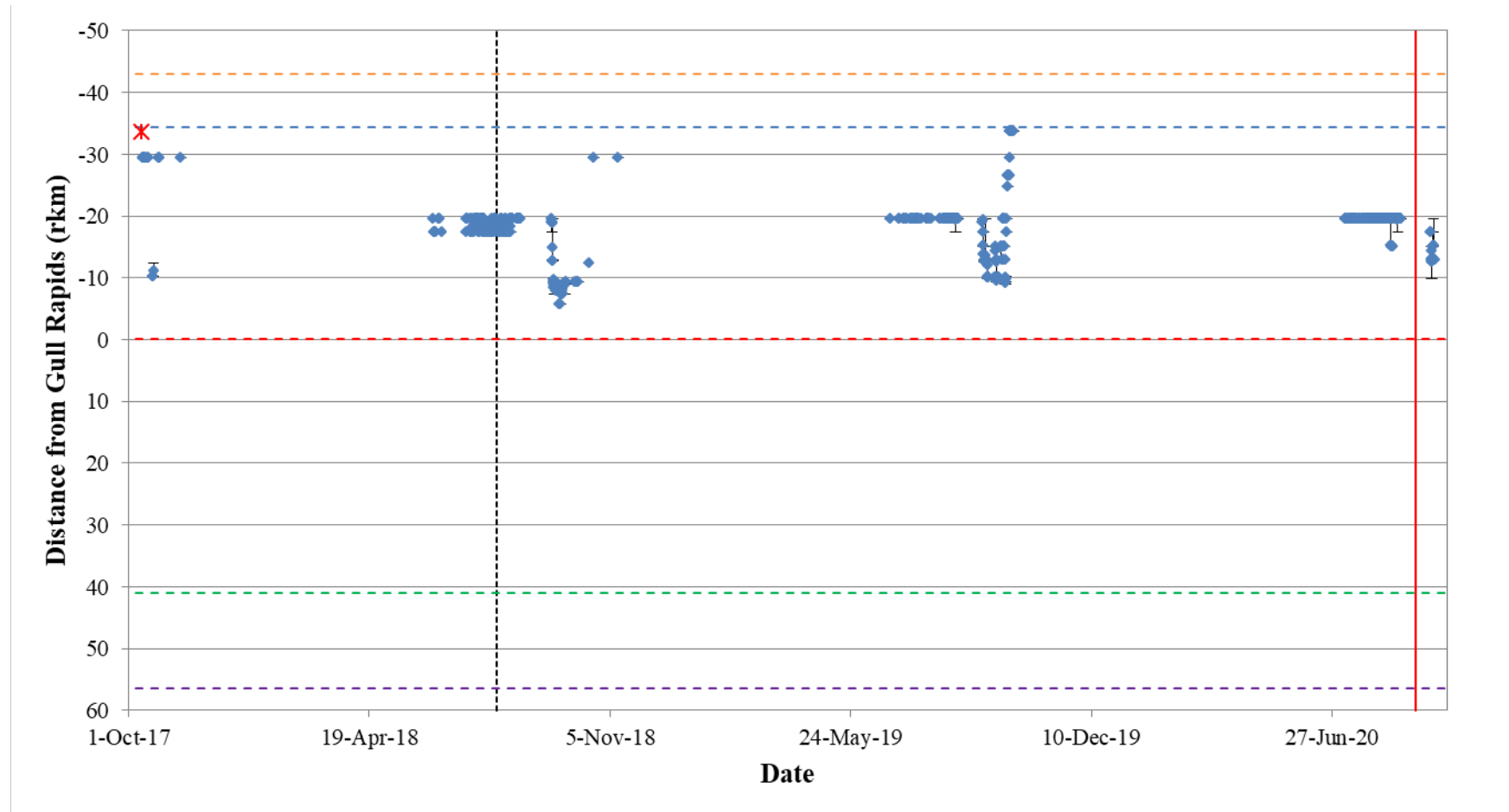


Figure A2-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31737) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

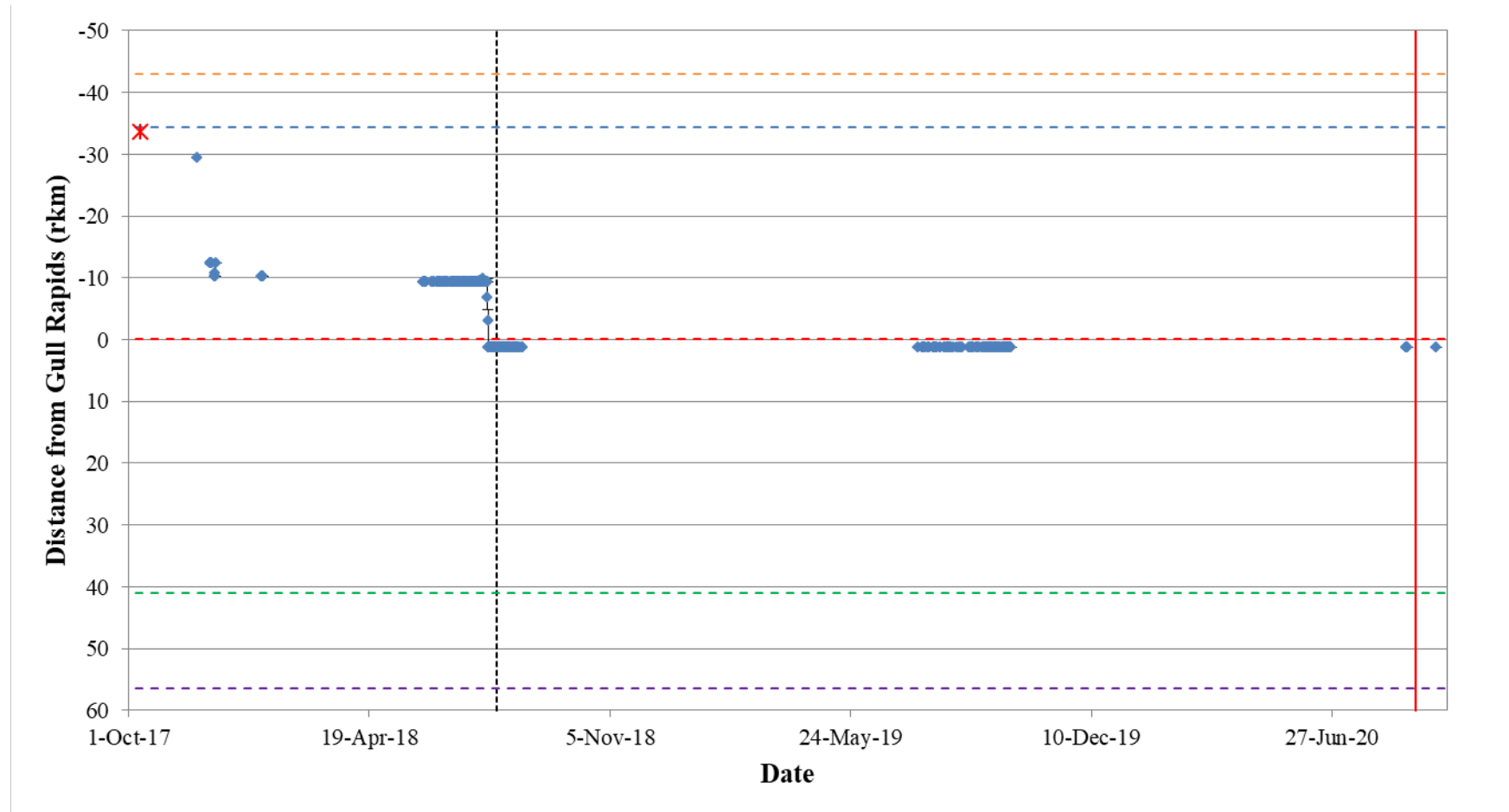


Figure A2-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31738) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

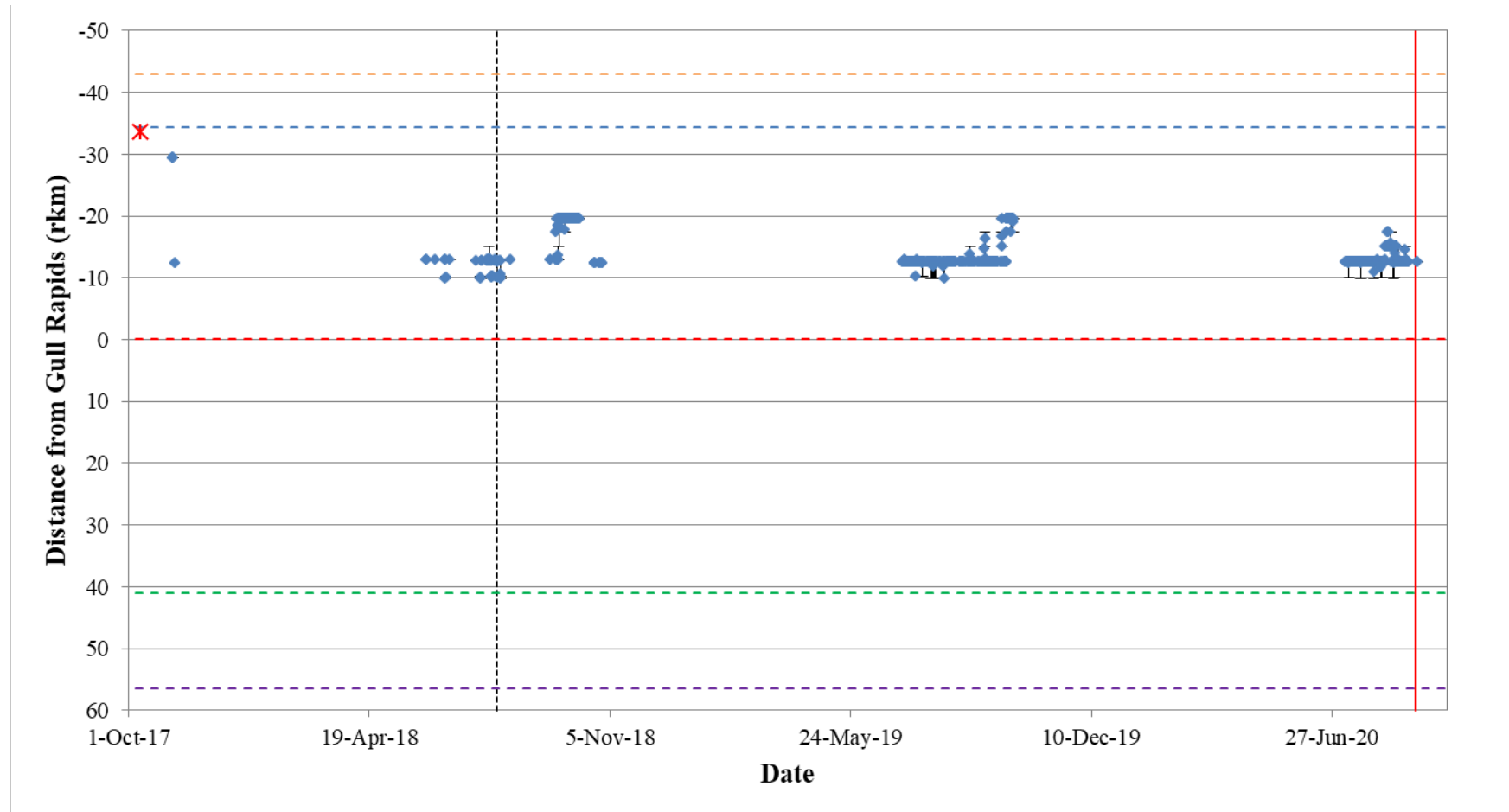


Figure A2-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31739) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

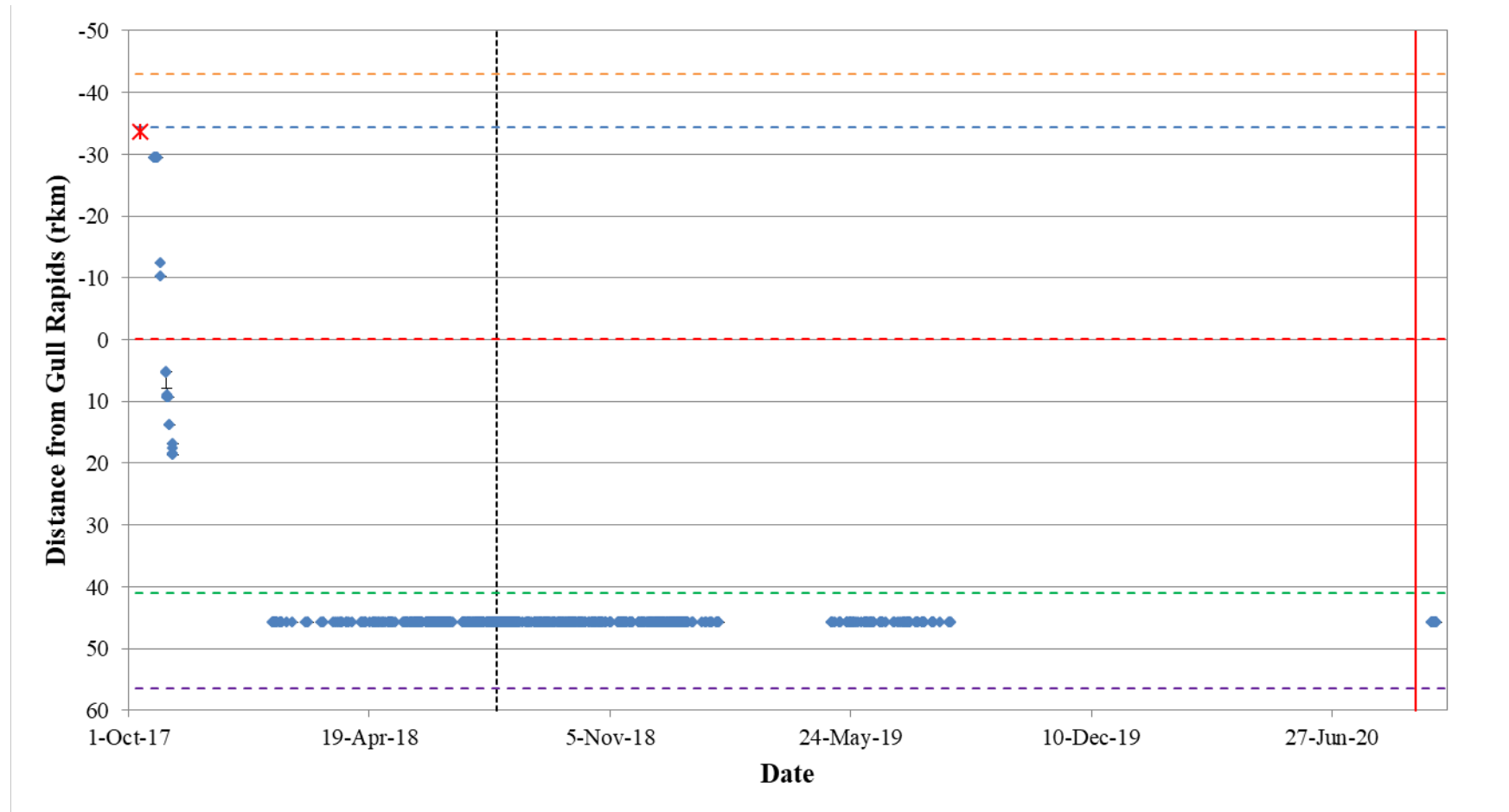


Figure A2-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31740) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

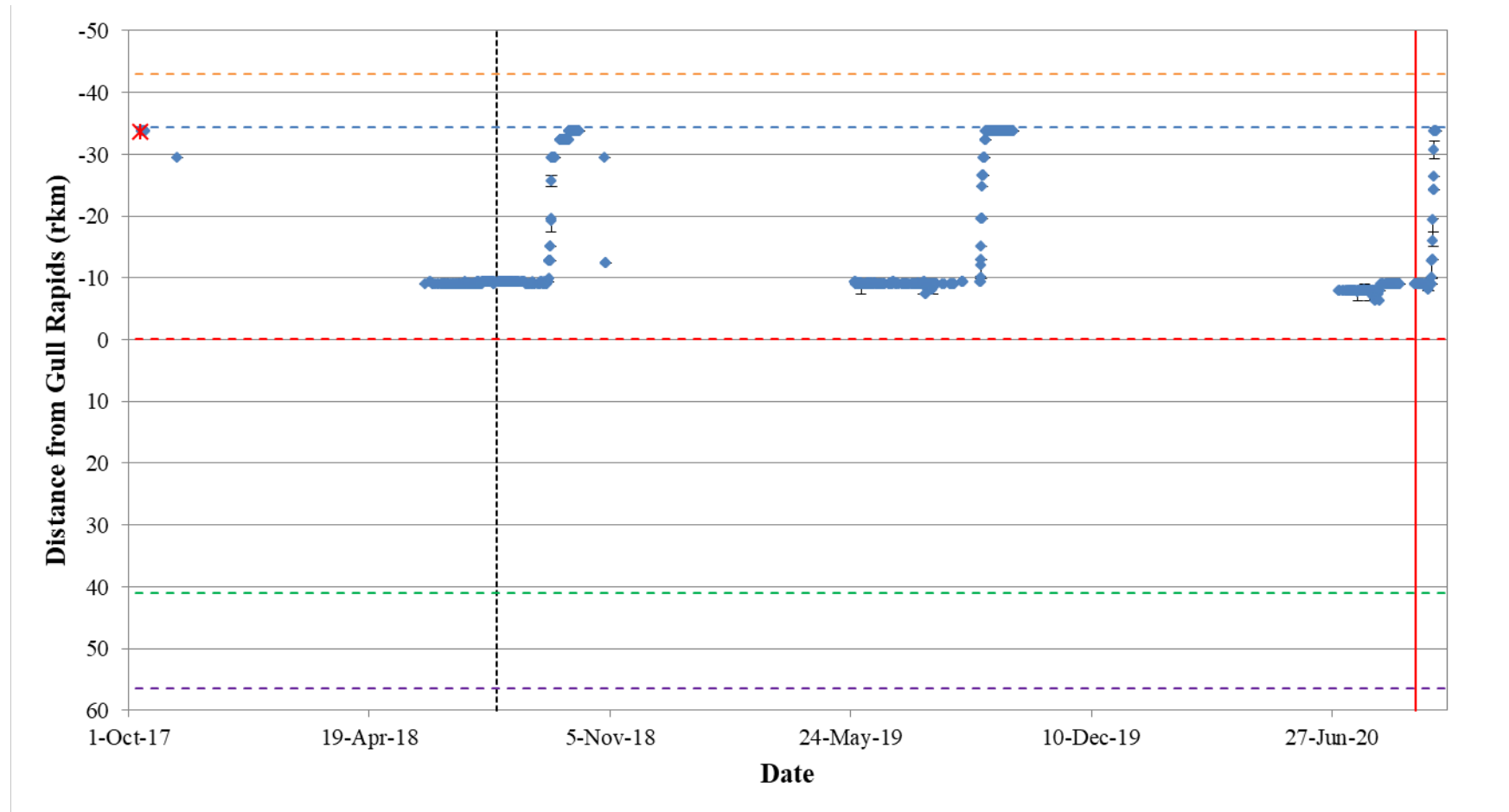


Figure A2-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31741) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

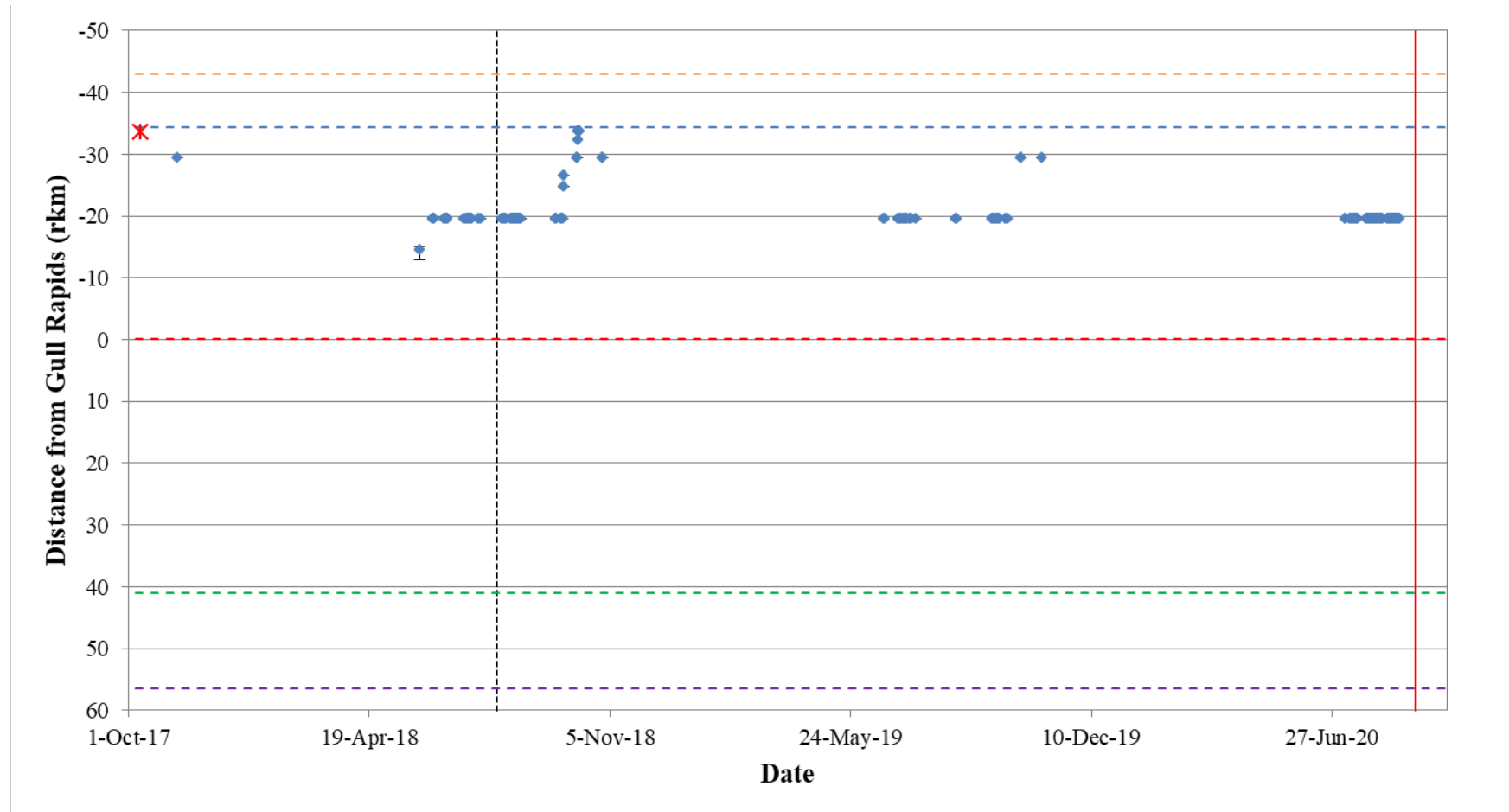


Figure A2-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31742) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

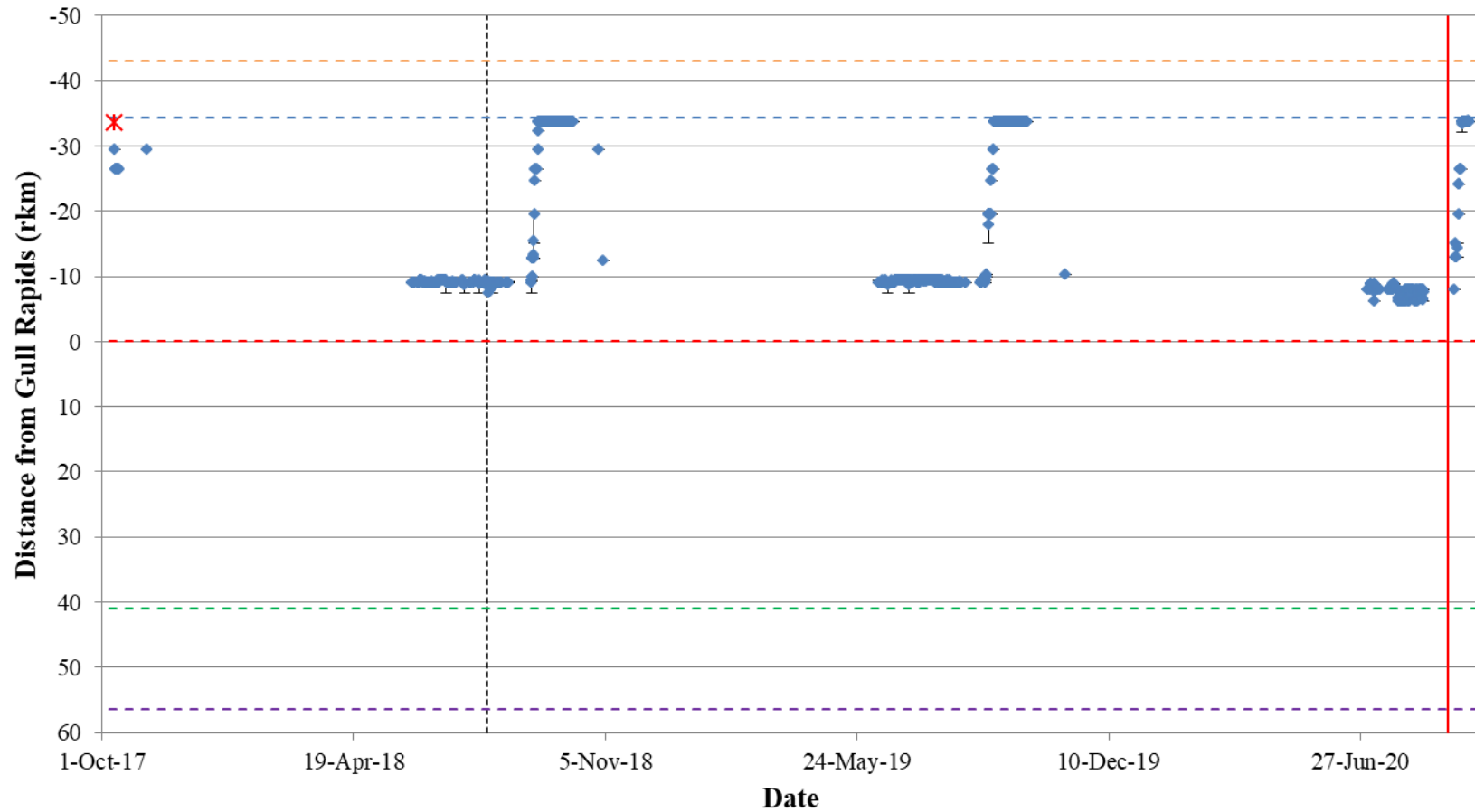


Figure A2-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31743) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

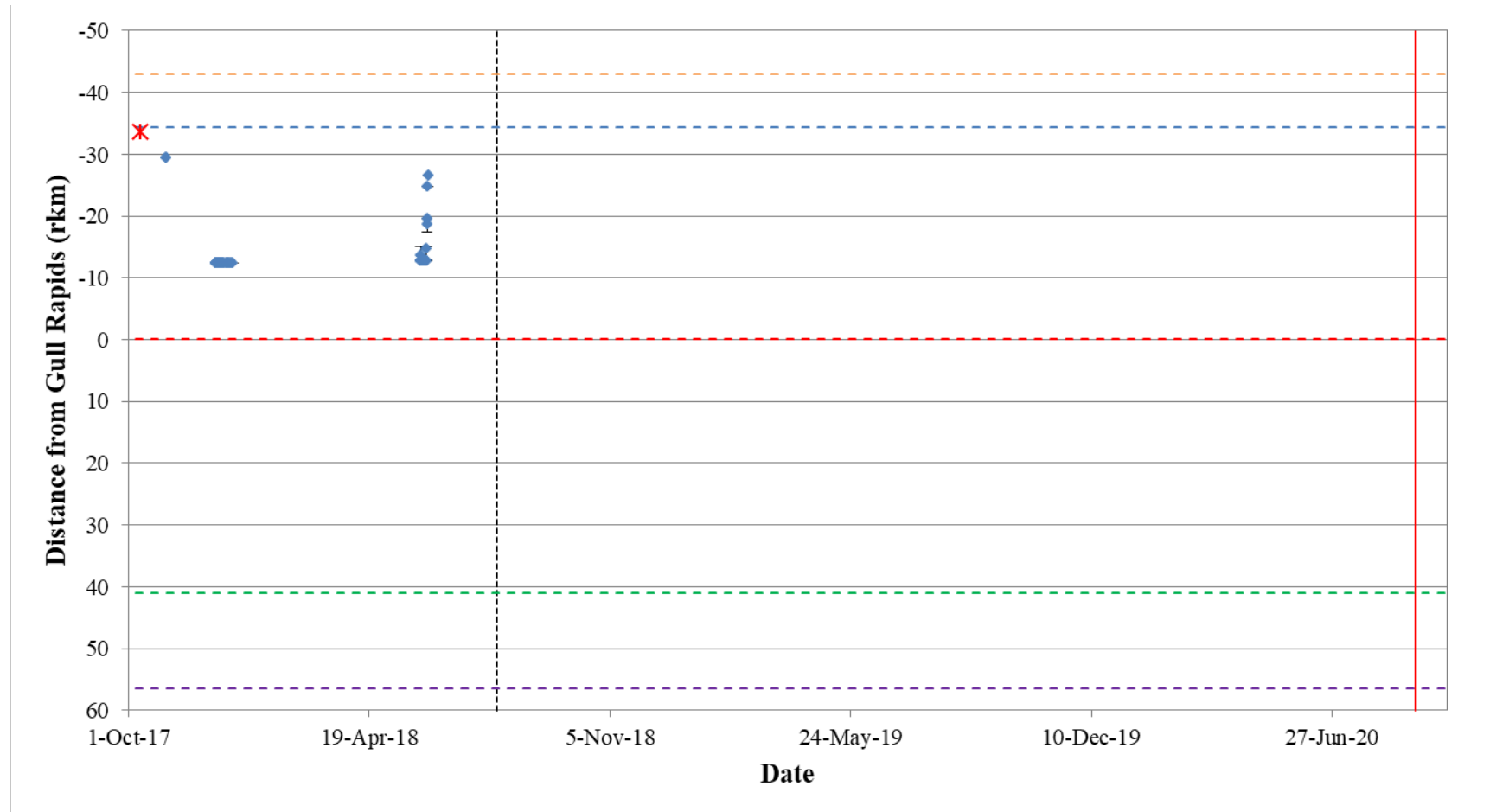


Figure A2-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31744) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal 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).

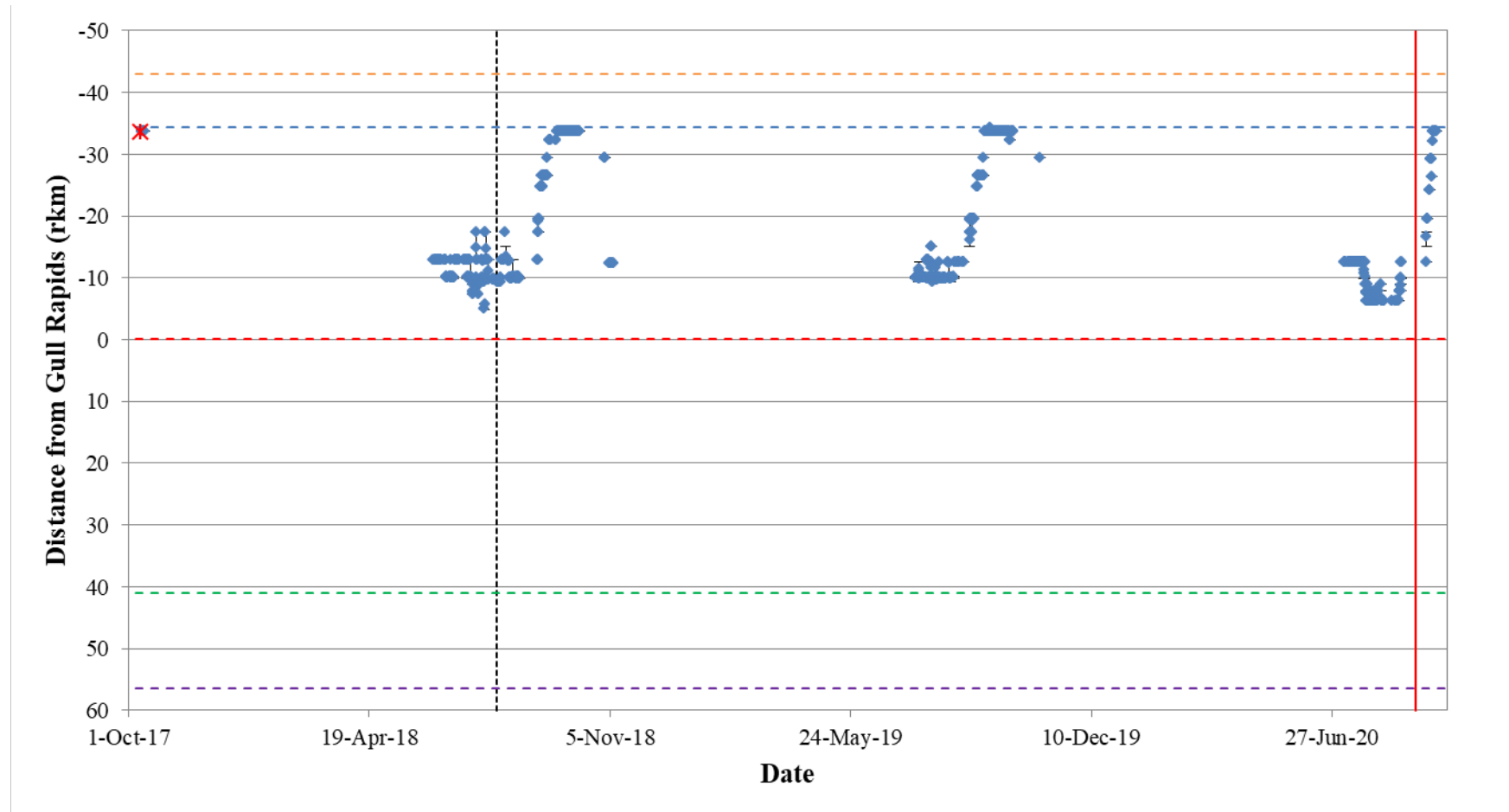


Figure A2-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31745) in the Nelson River between Clark Lake and the Keeyask GS, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal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

Figure 1 is a scatter plot showing the distance from gull rapids (rkm) over time. The y-axis is labeled "Distance from Gull Rapids (rkm)" and ranges from -50 to 60, with 0 at the top. The x-axis is labeled "Date" and shows dates from 1-Oct-17 to 27-Jun-20. The plot includes several horizontal dashed lines: a red line at 0, a green line at approximately 38, a blue line at approximately 35, an orange line at approximately 38, and a purple line at approximately 56. A vertical dashed black line is positioned at approximately 2018-08-01, and a vertical solid red line is at 2020-06-27. Data points are represented by blue diamonds with vertical error bars. A red 'X' marks the first observation on 1-Oct-17 at approximately 35 rkm. The data shows a general trend of decreasing distance from rapids over time, with a notable increase in distance (moving further from rapids) around late 2019 and early 2020.



= 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 2020

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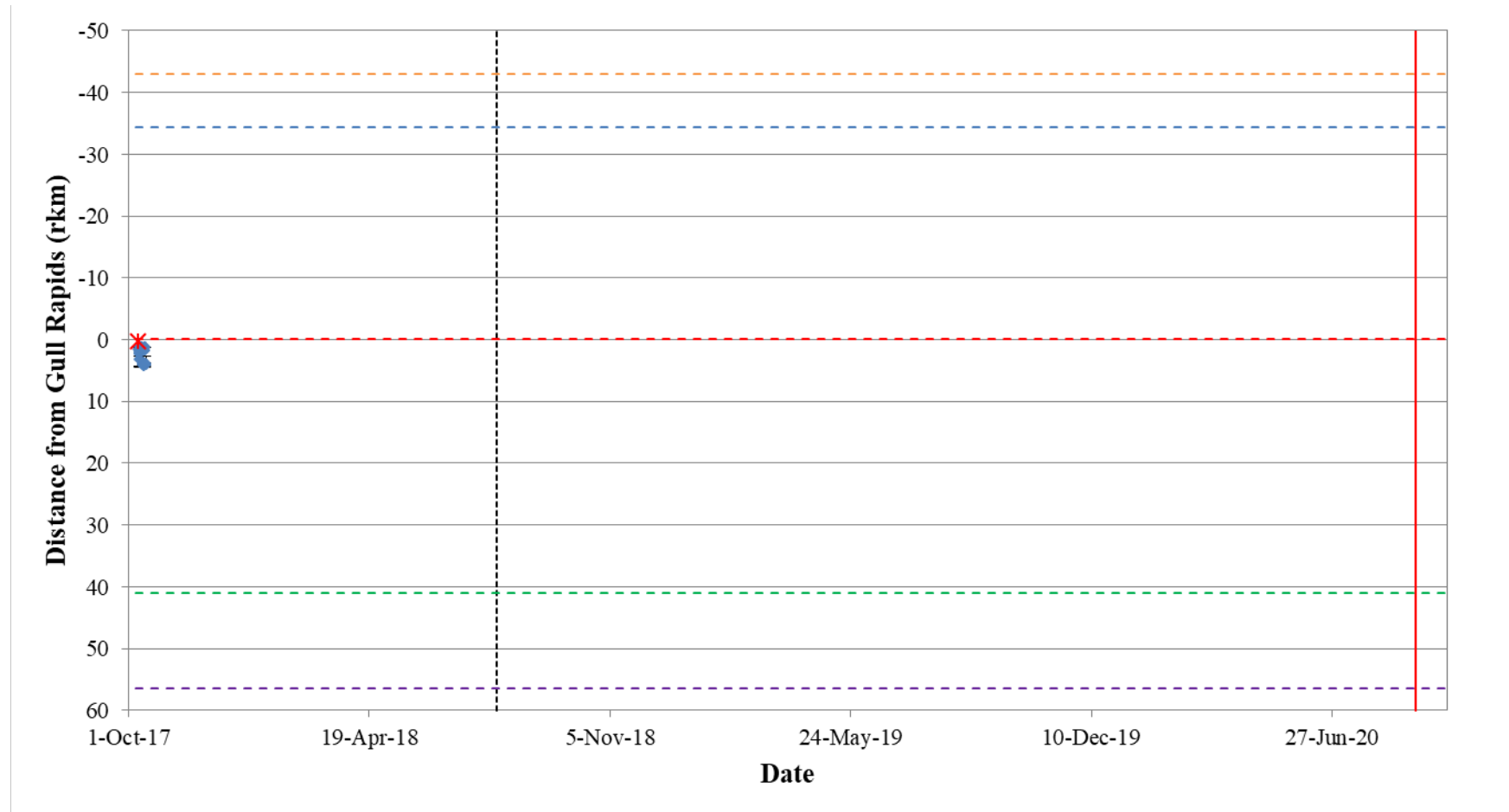


Figure A3-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31698) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

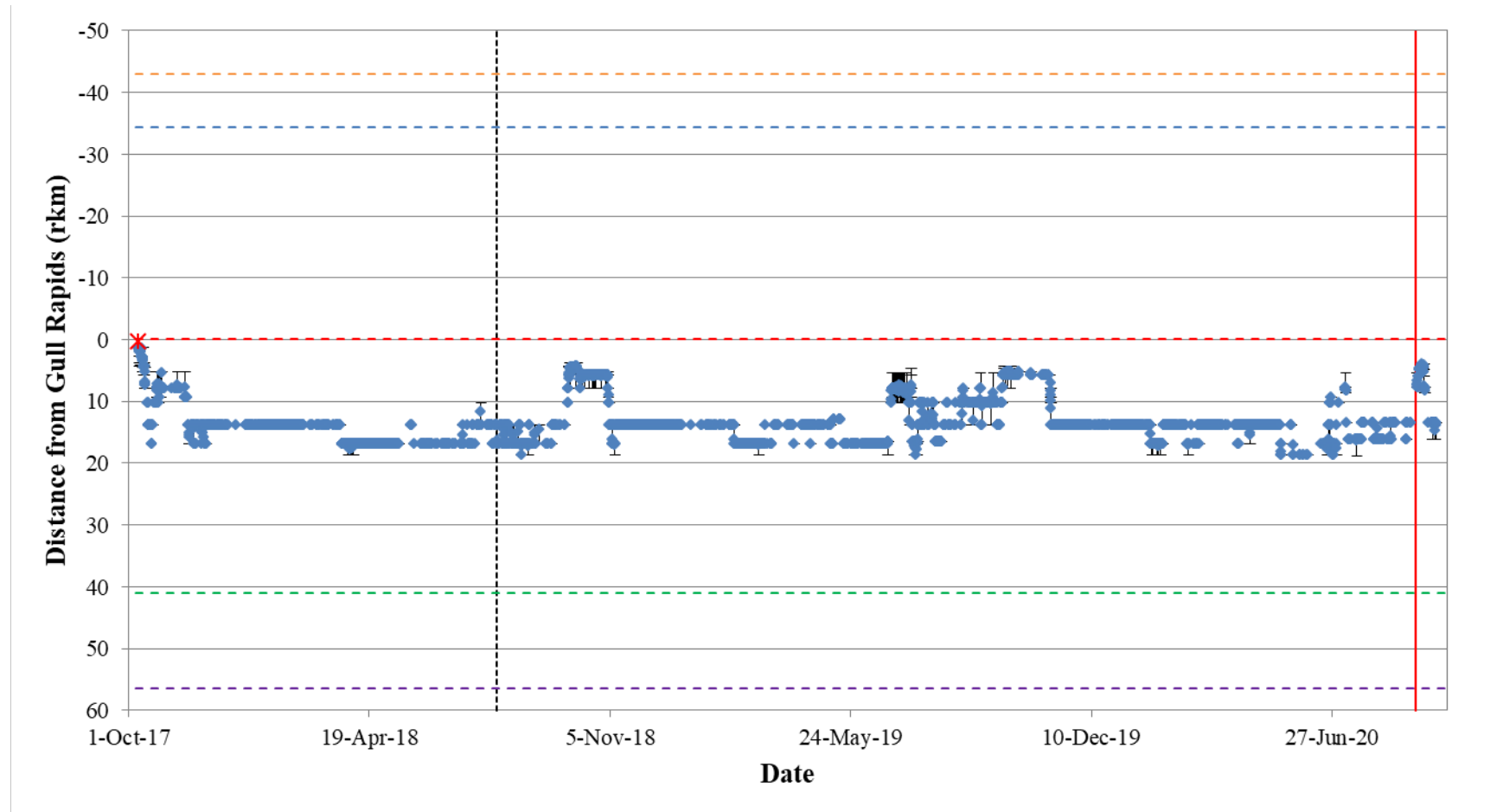


Figure A3-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31699) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

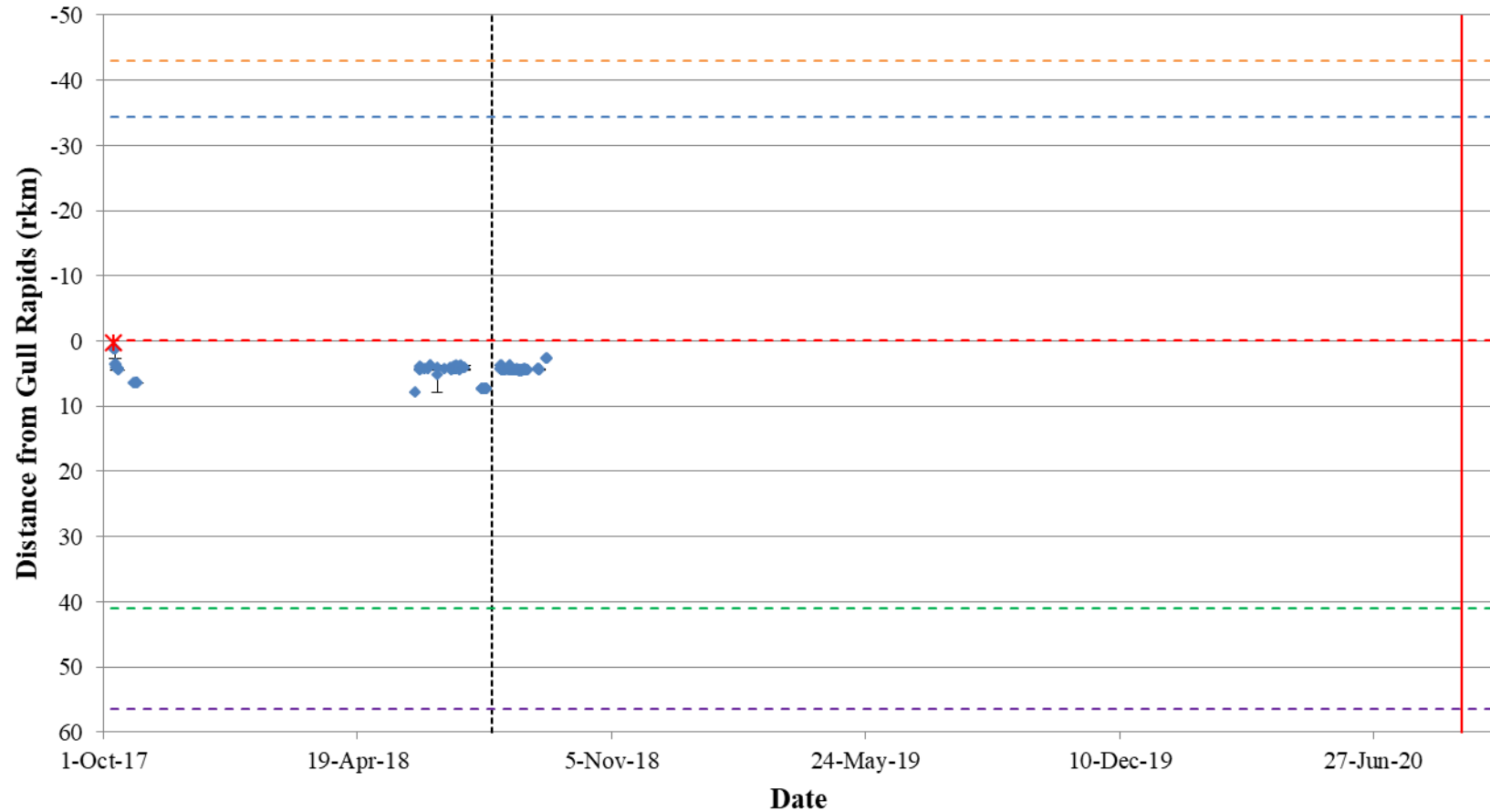


Figure A3-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31700) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

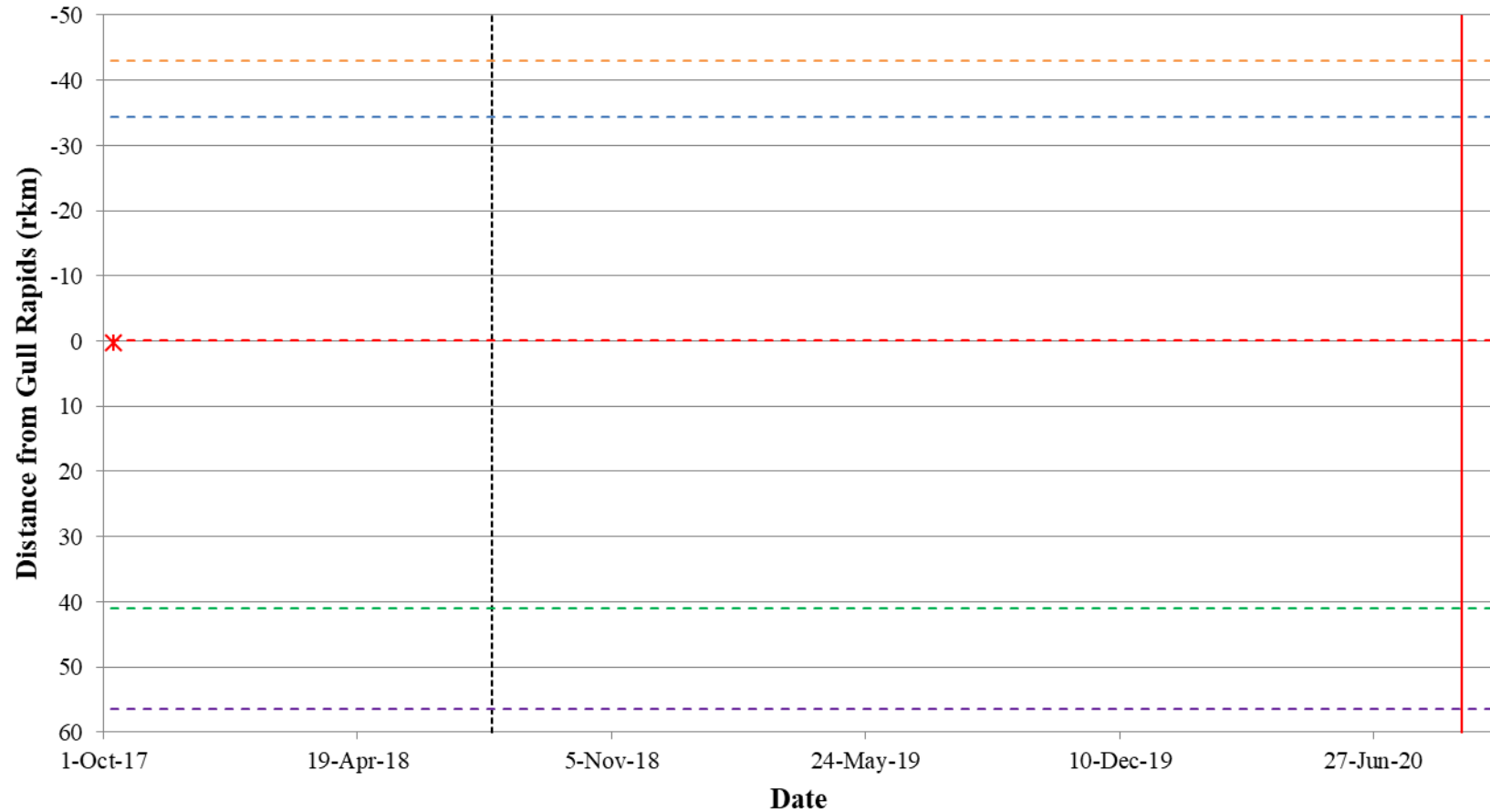


Figure A3-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31701) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

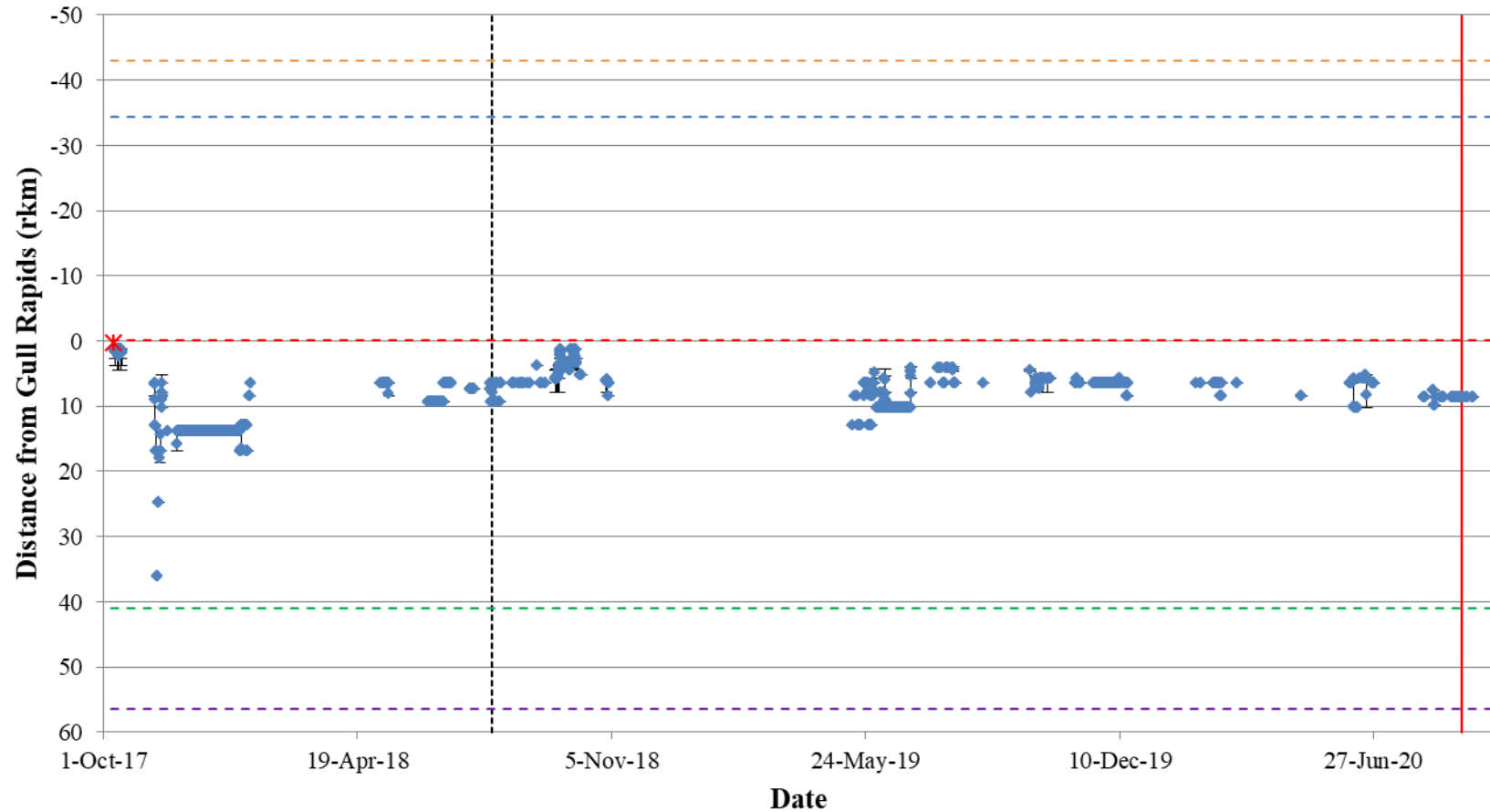


Figure A3-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31702) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

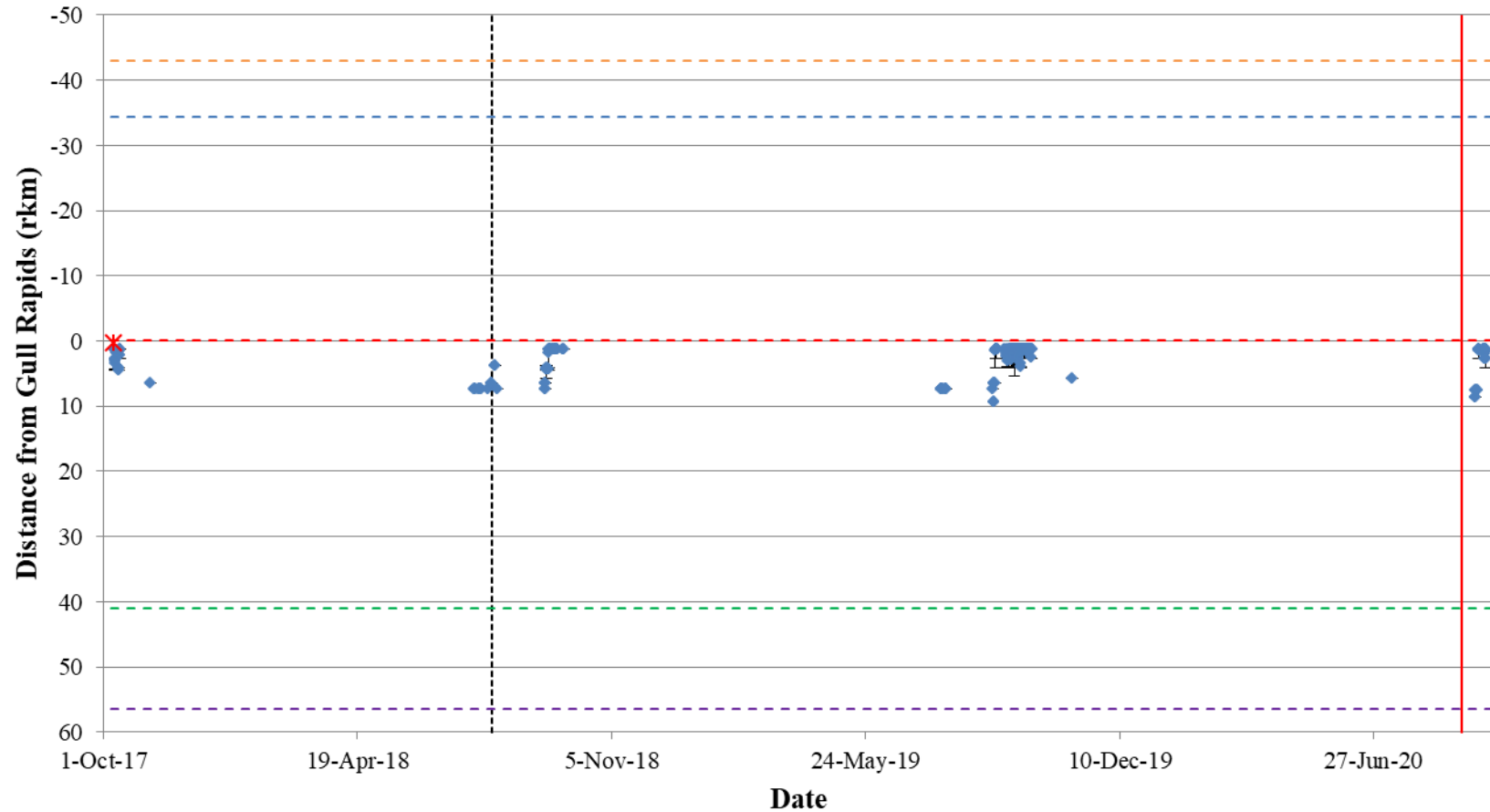


Figure A3-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31703) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

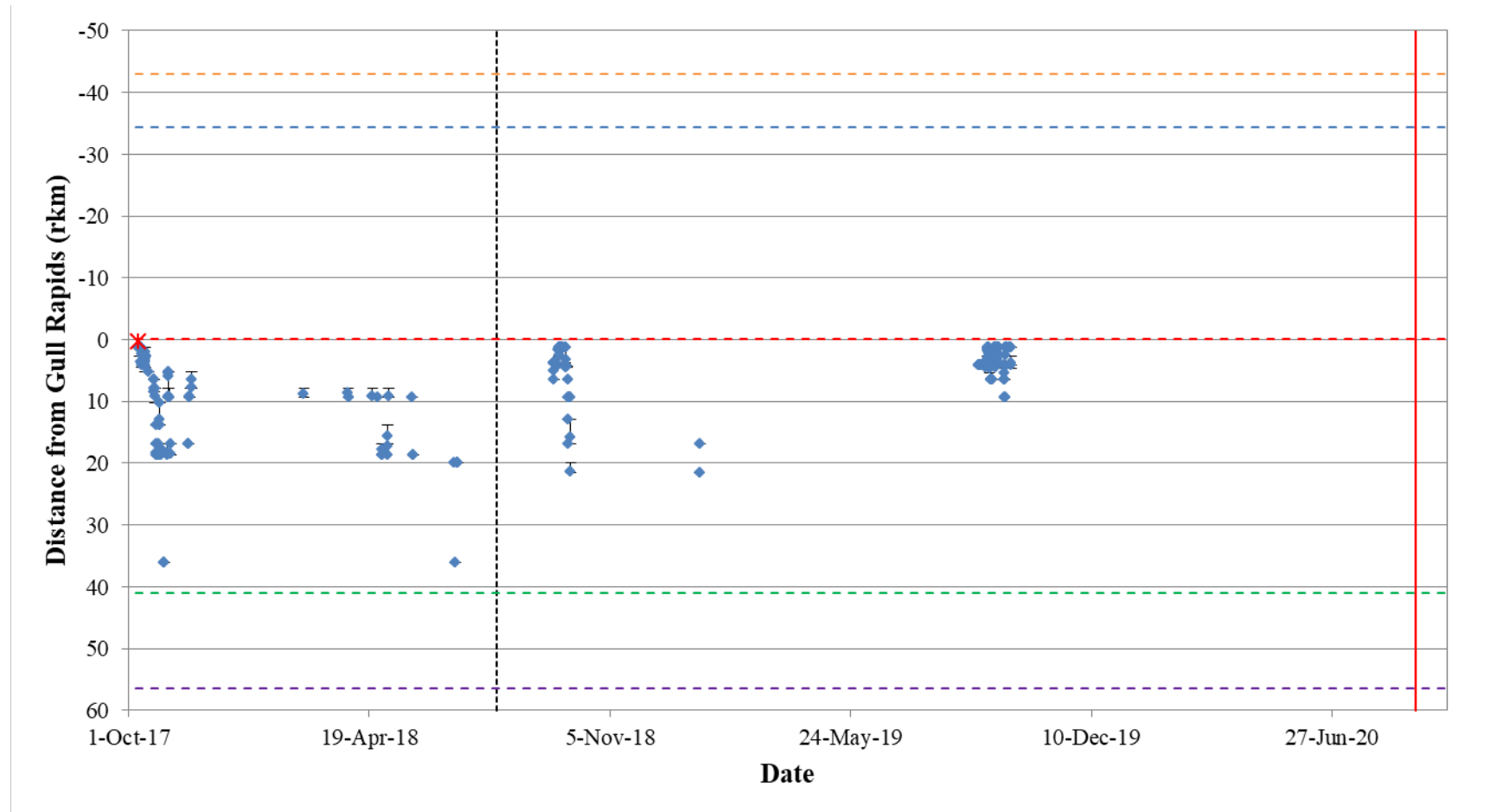


Figure A3-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31704) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

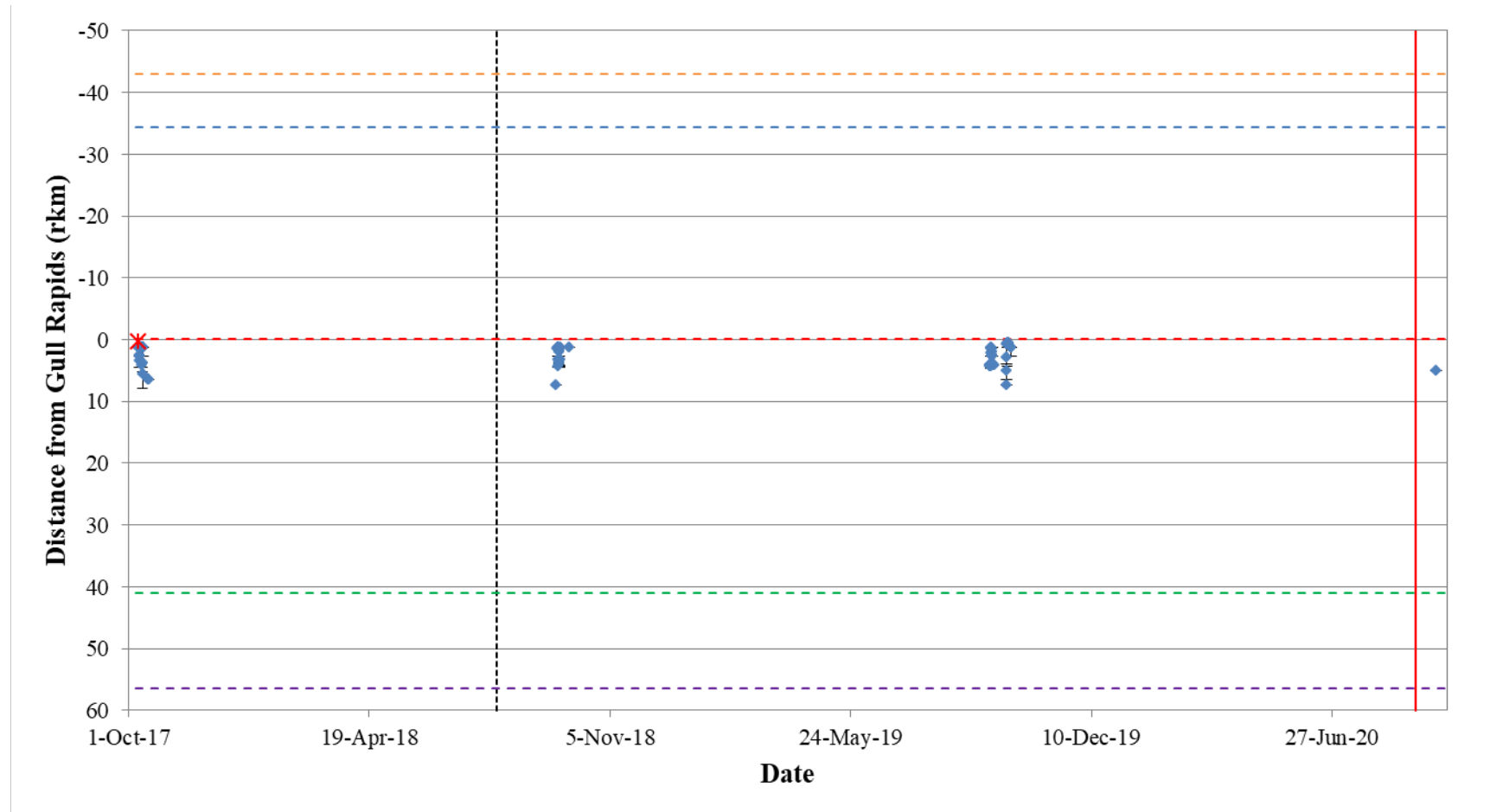


Figure A3-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31705) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

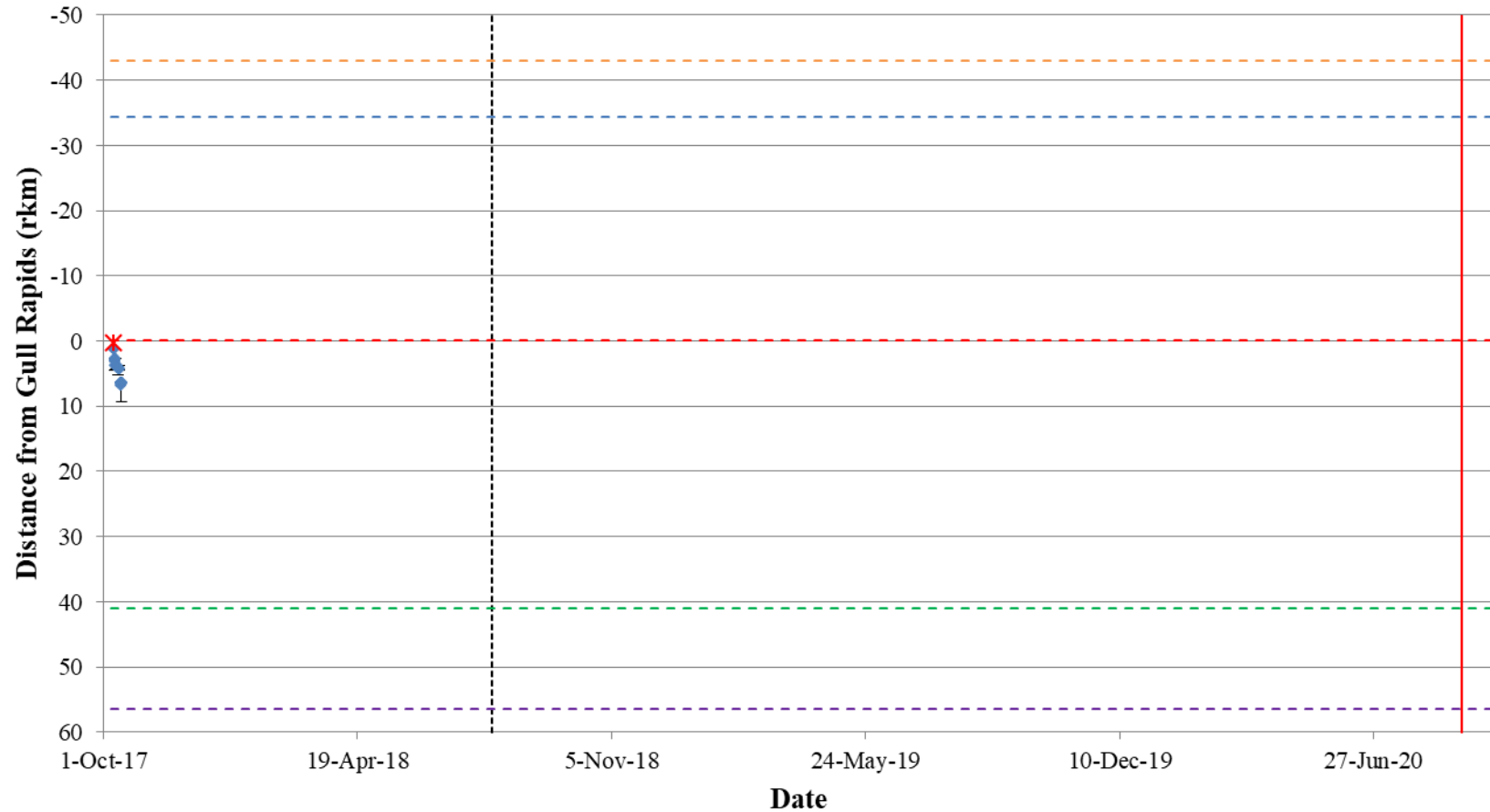


Figure A3-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31706) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

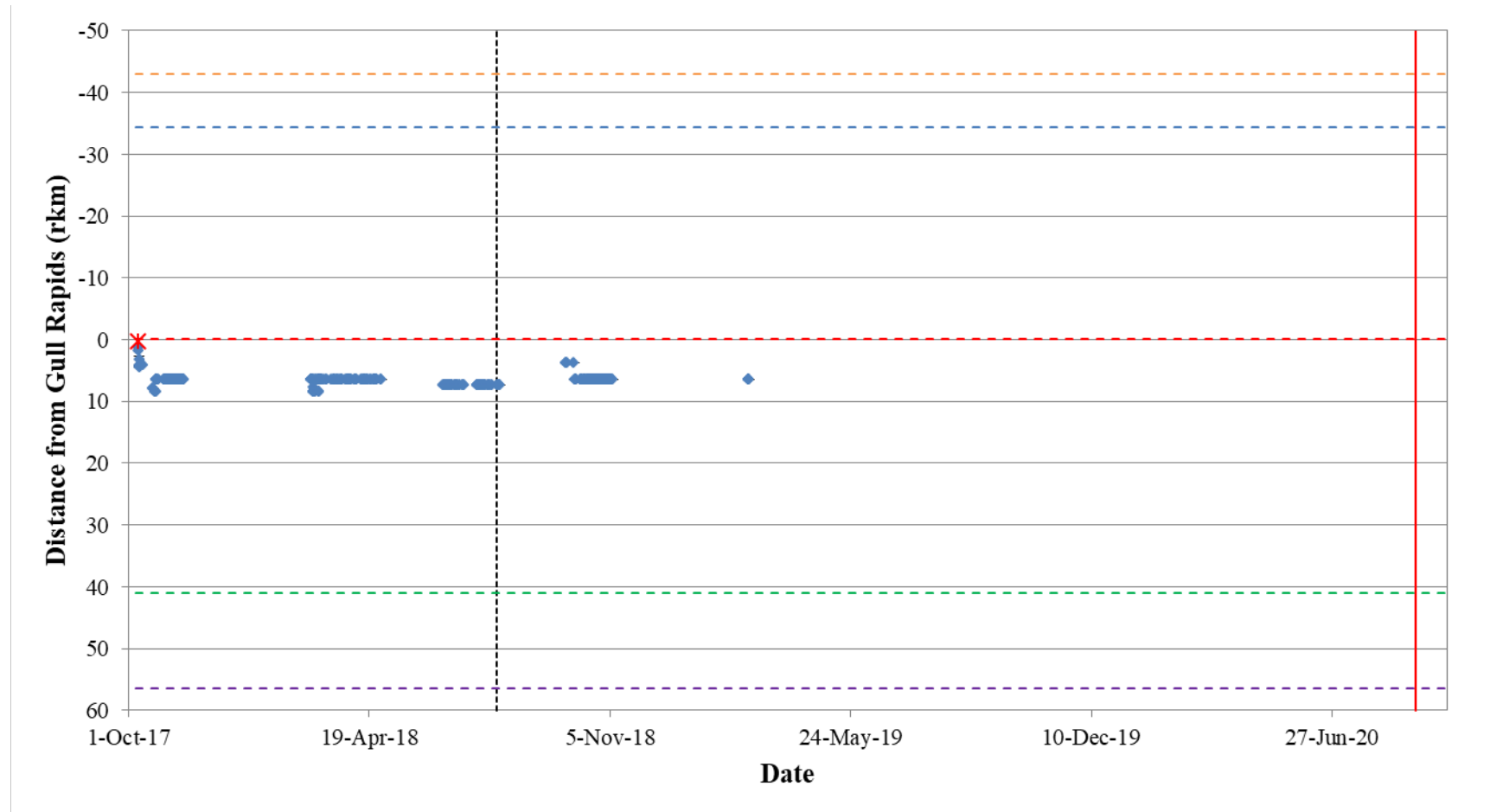


Figure A3-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31707) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

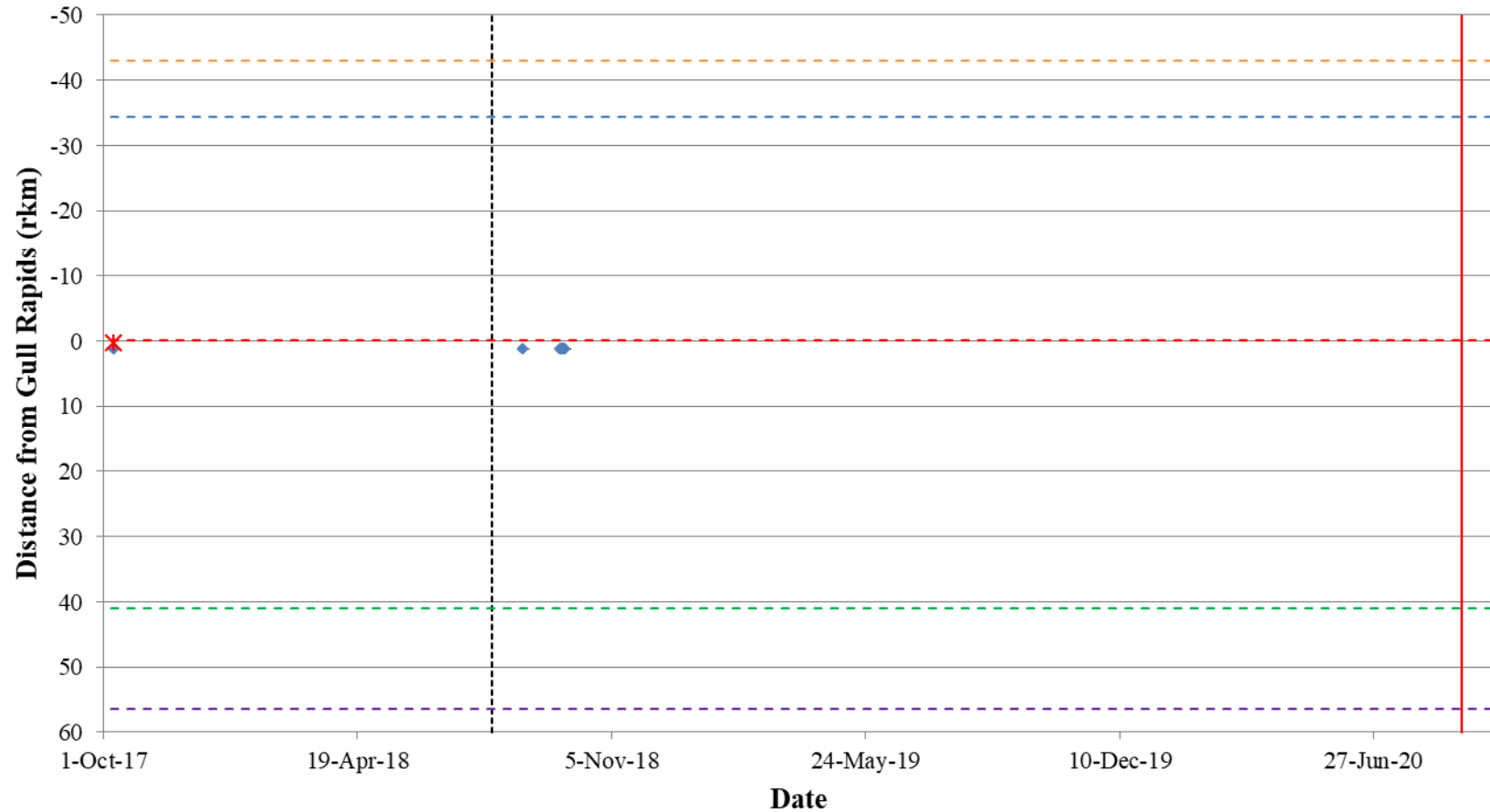


Figure A3-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31708) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

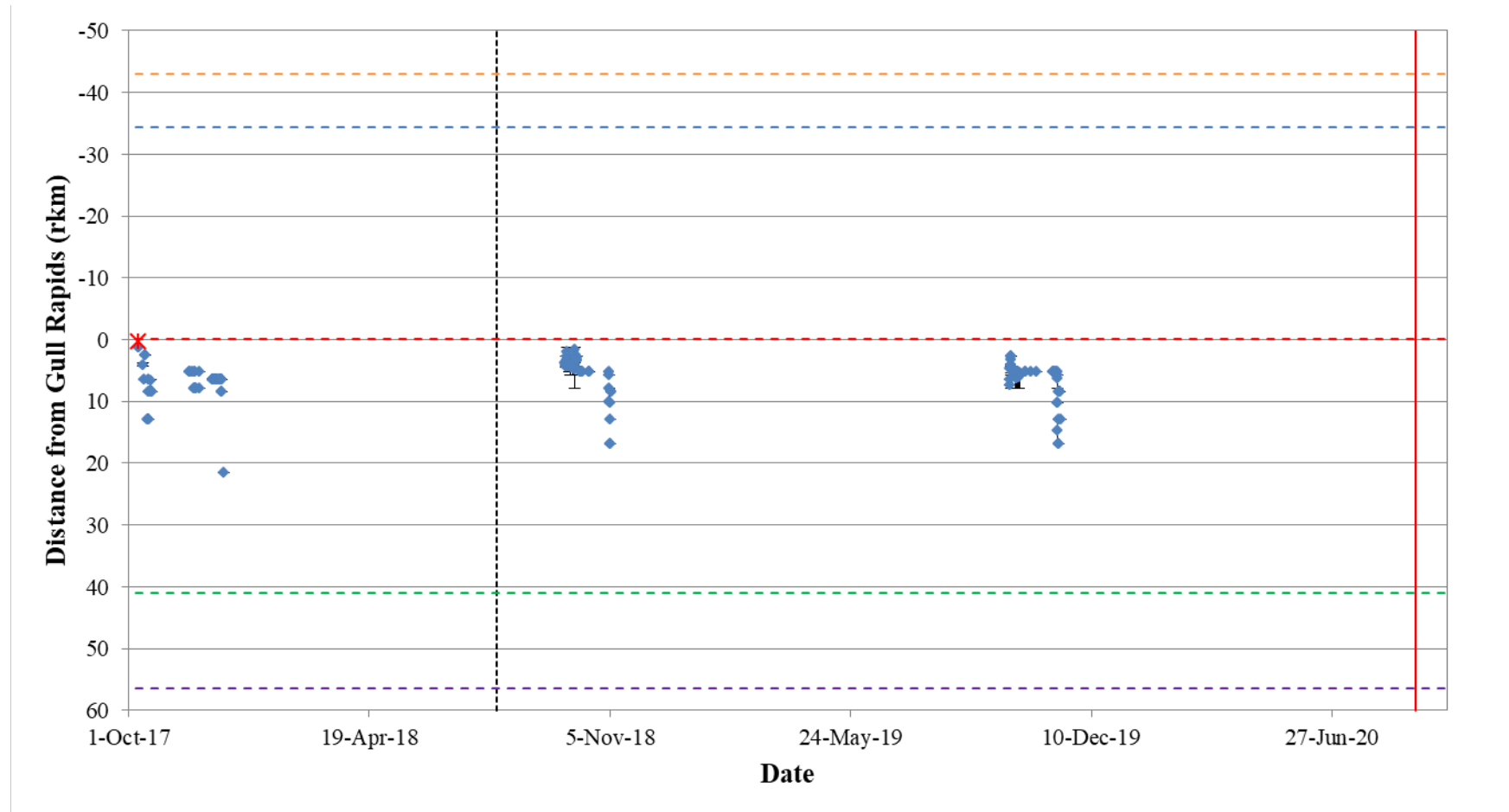


Figure A3-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31709) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

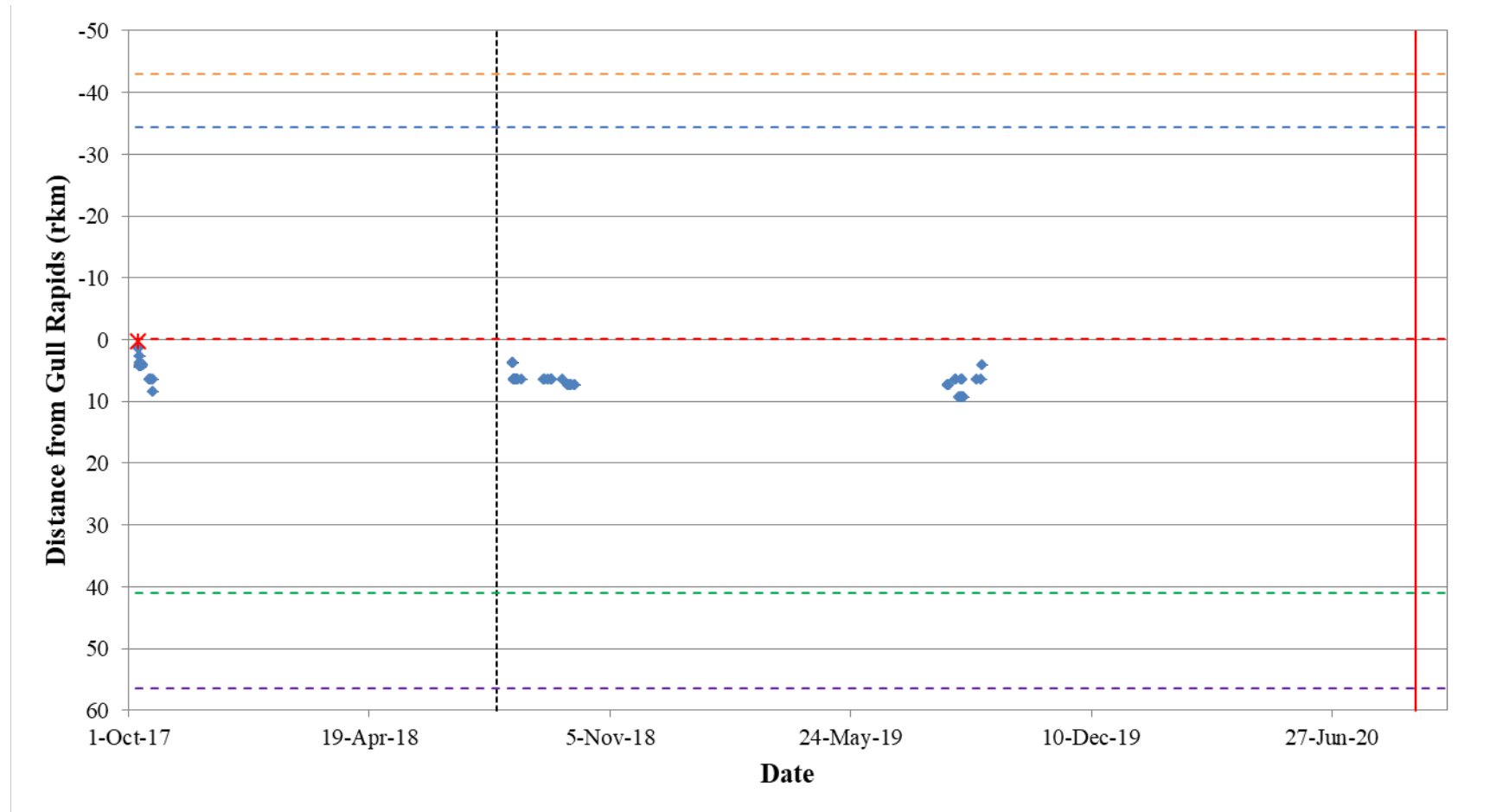


Figure A3-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31710) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

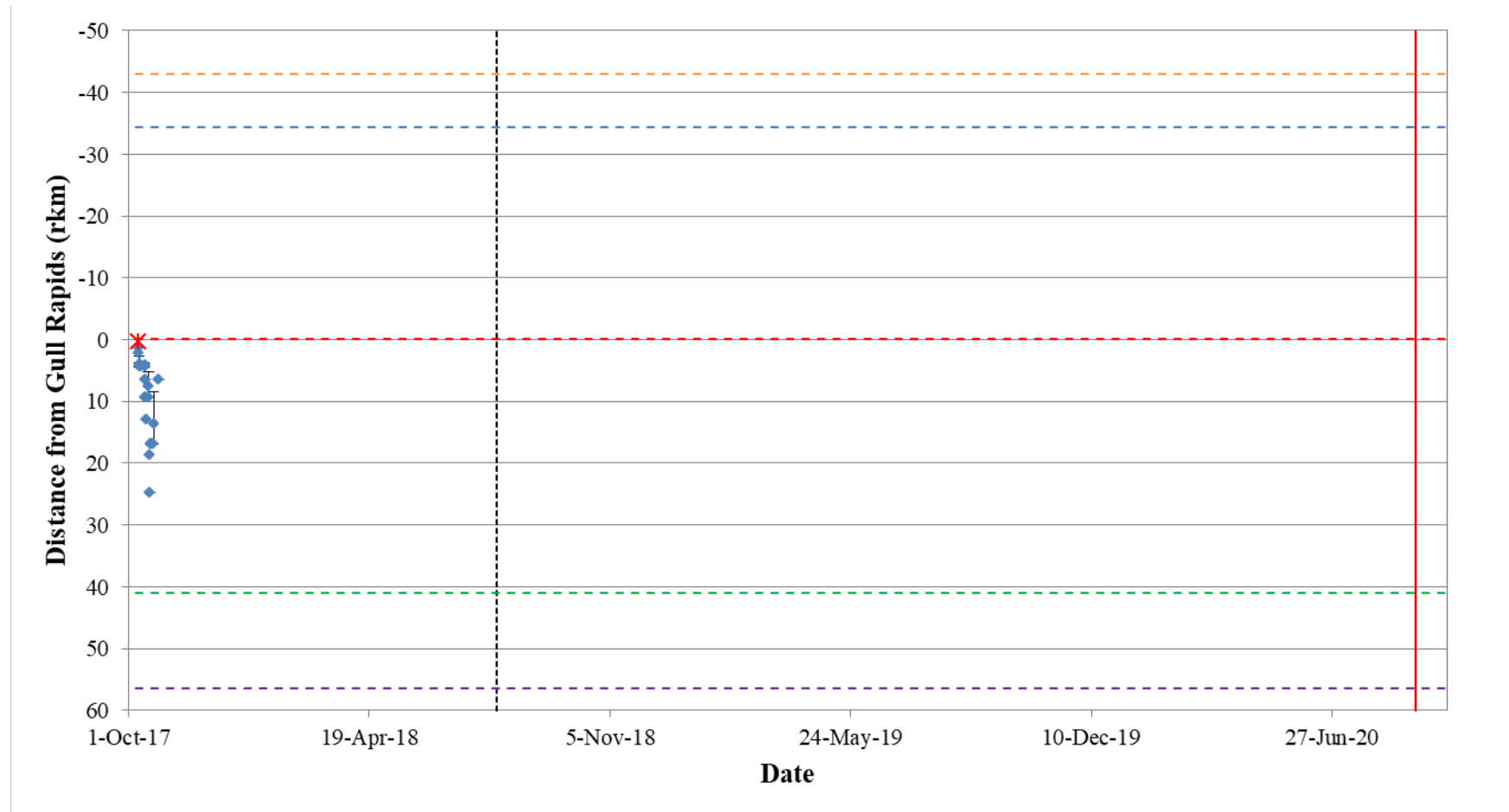


Figure A3-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31711) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

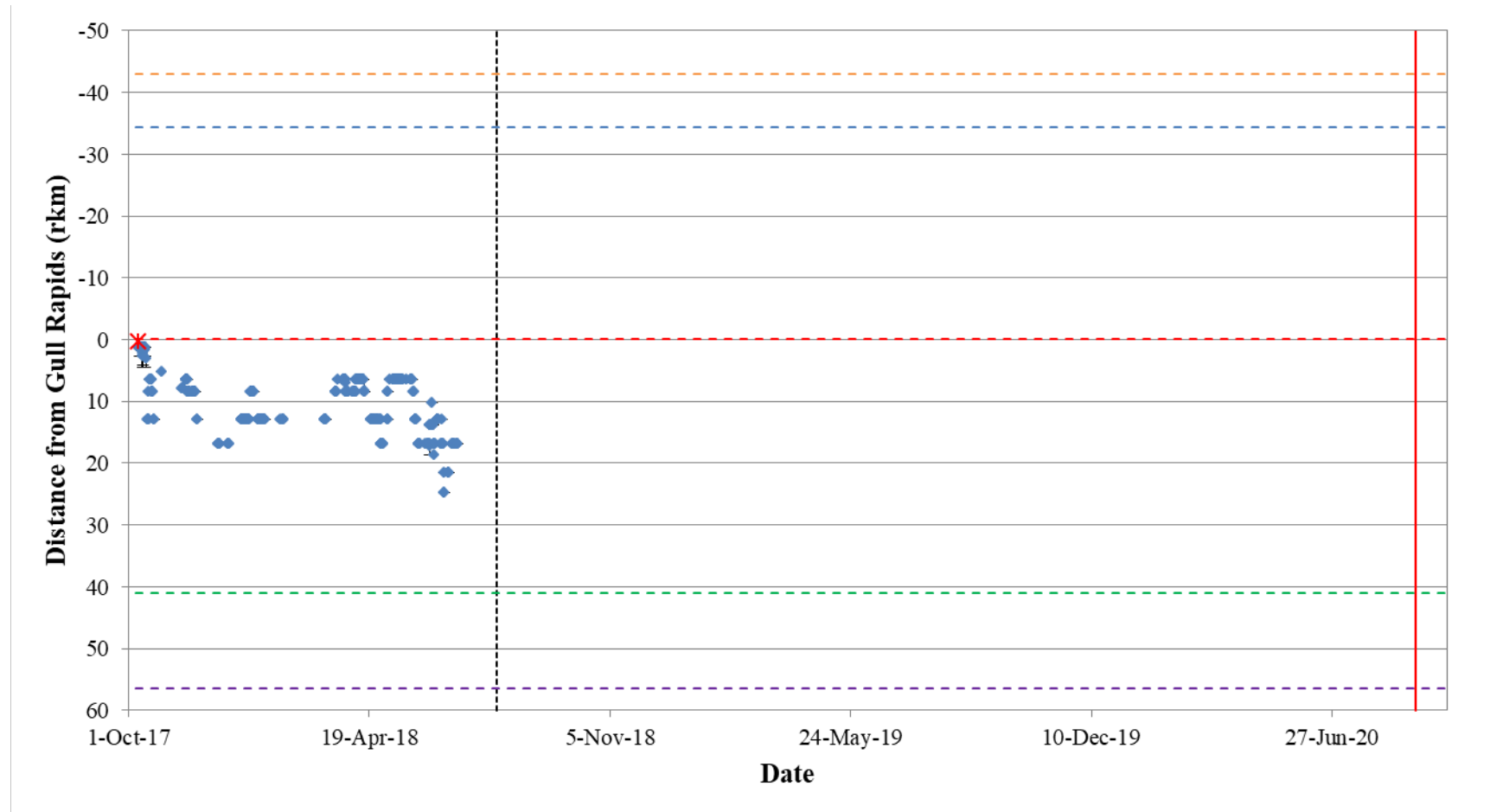


Figure A3-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31712) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

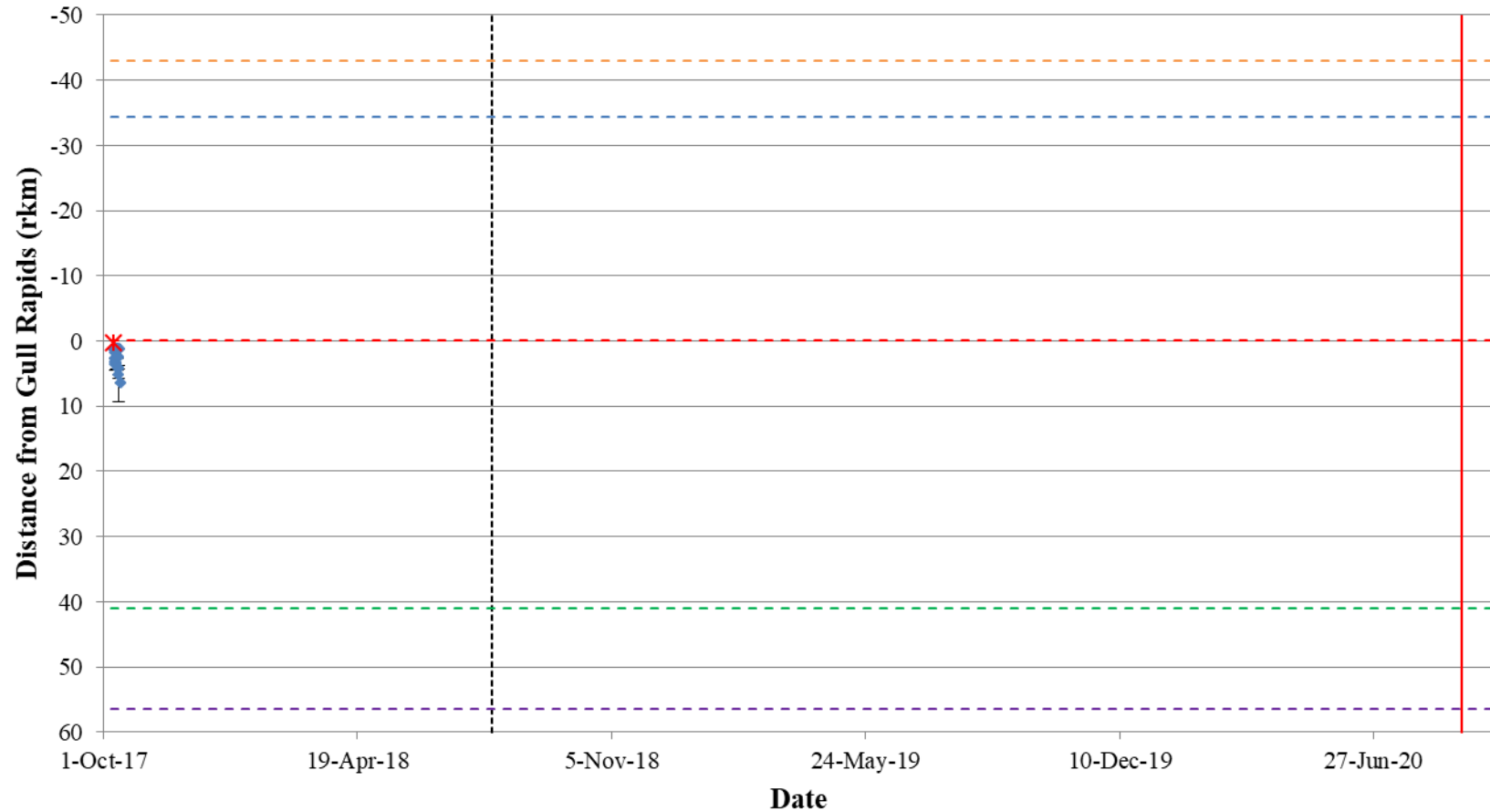


Figure A3-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31713) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

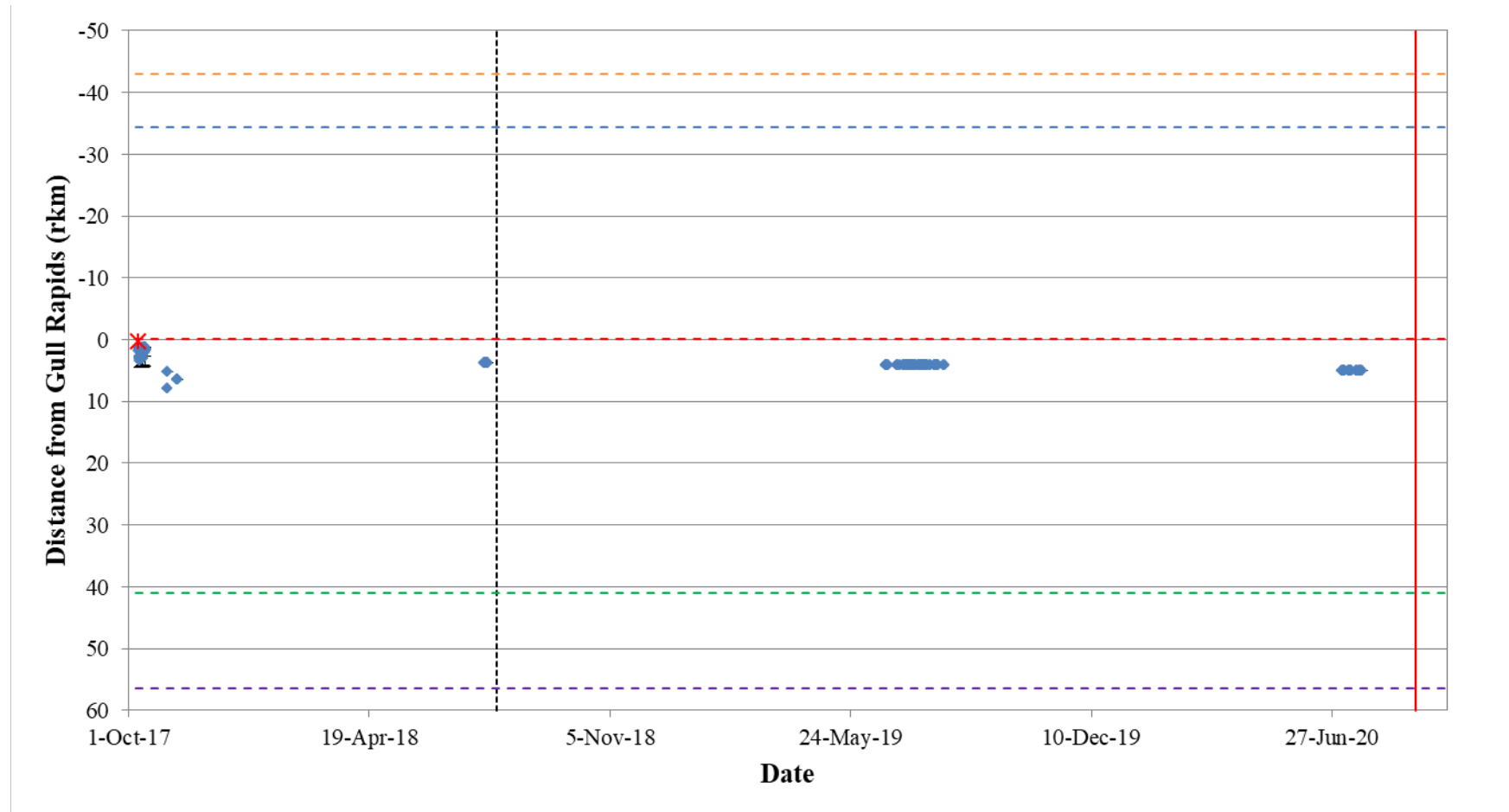


Figure A3-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31714) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

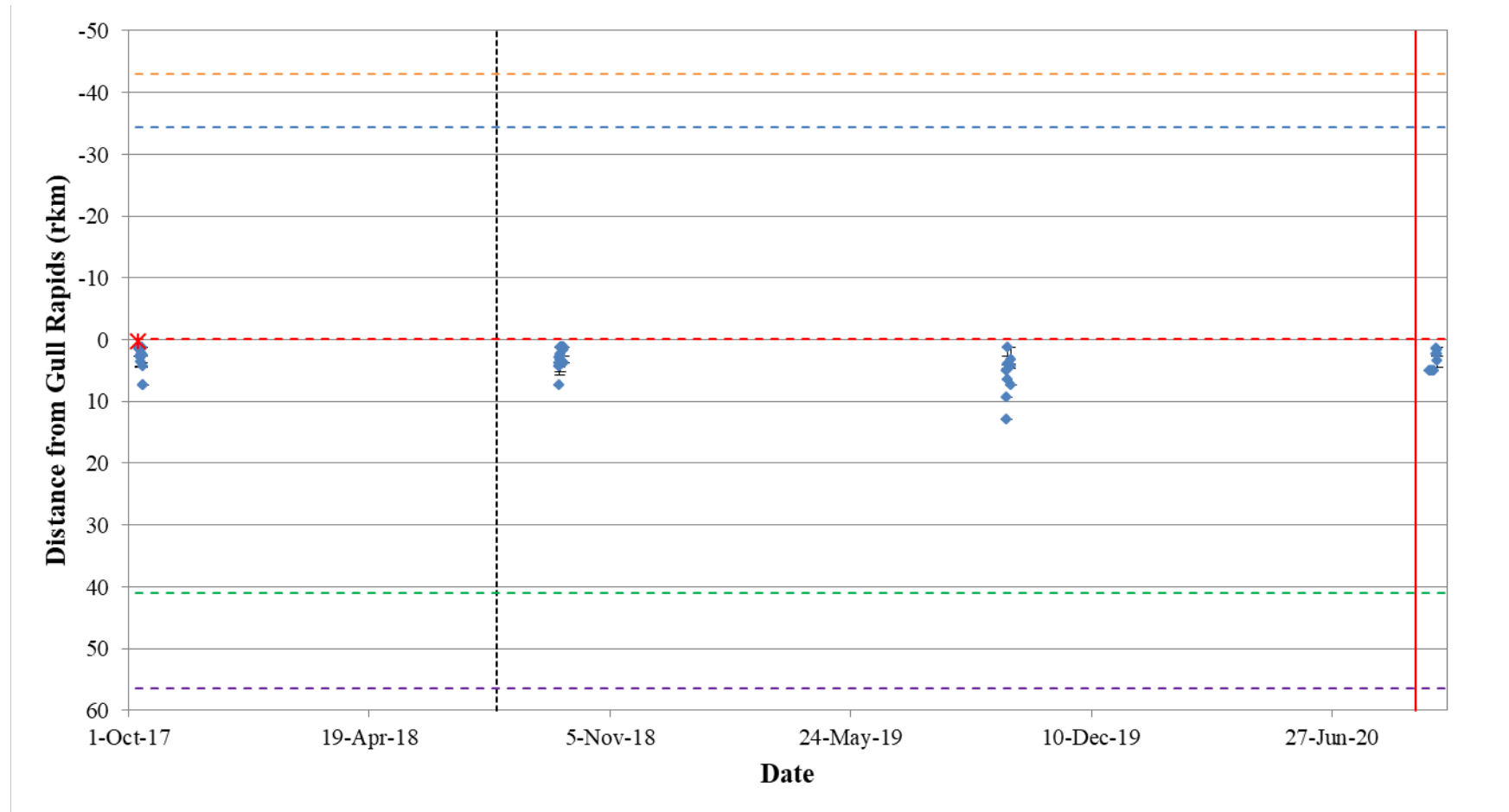


Figure A3-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31715) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

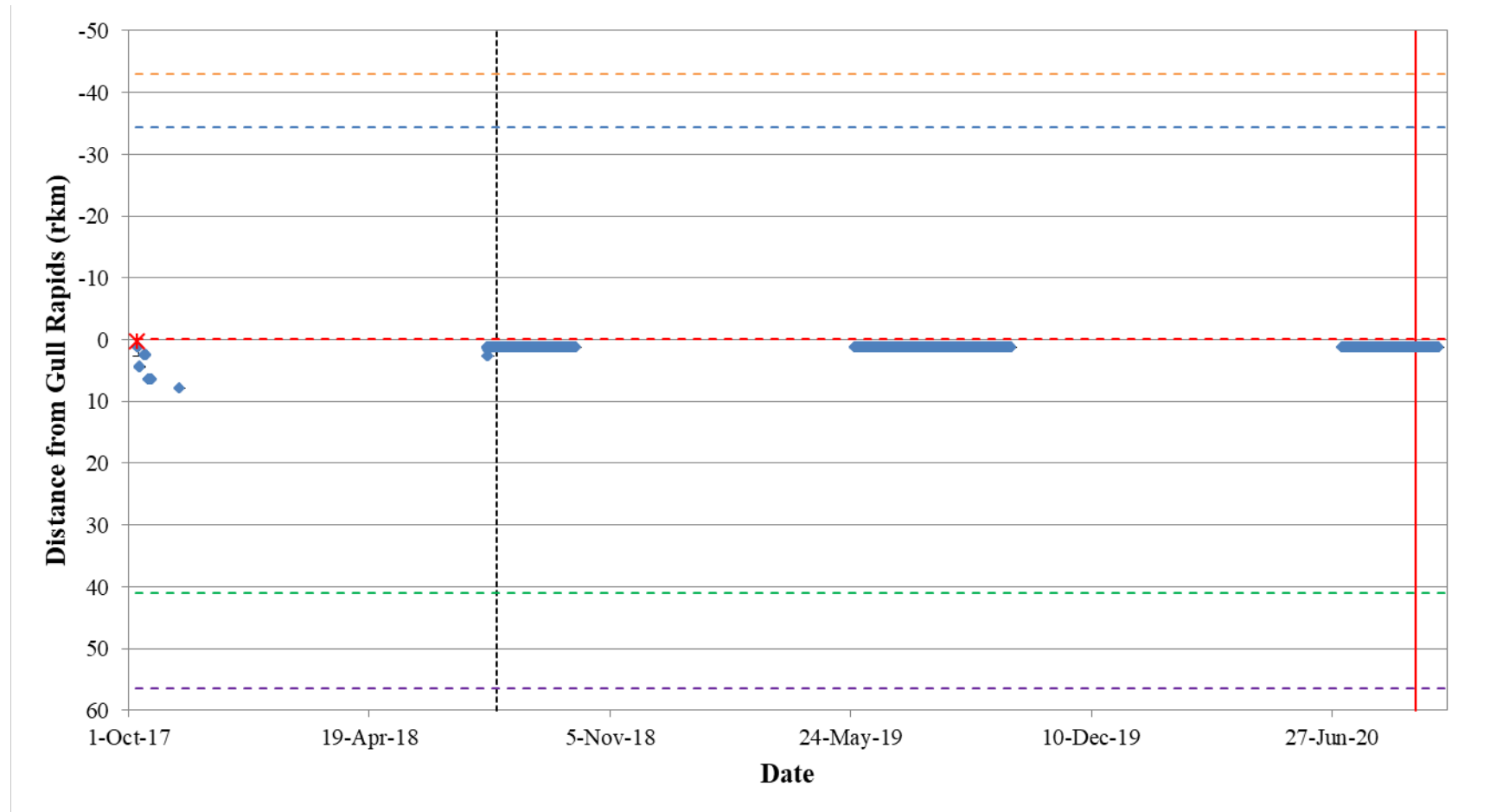


Figure A3-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31716) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

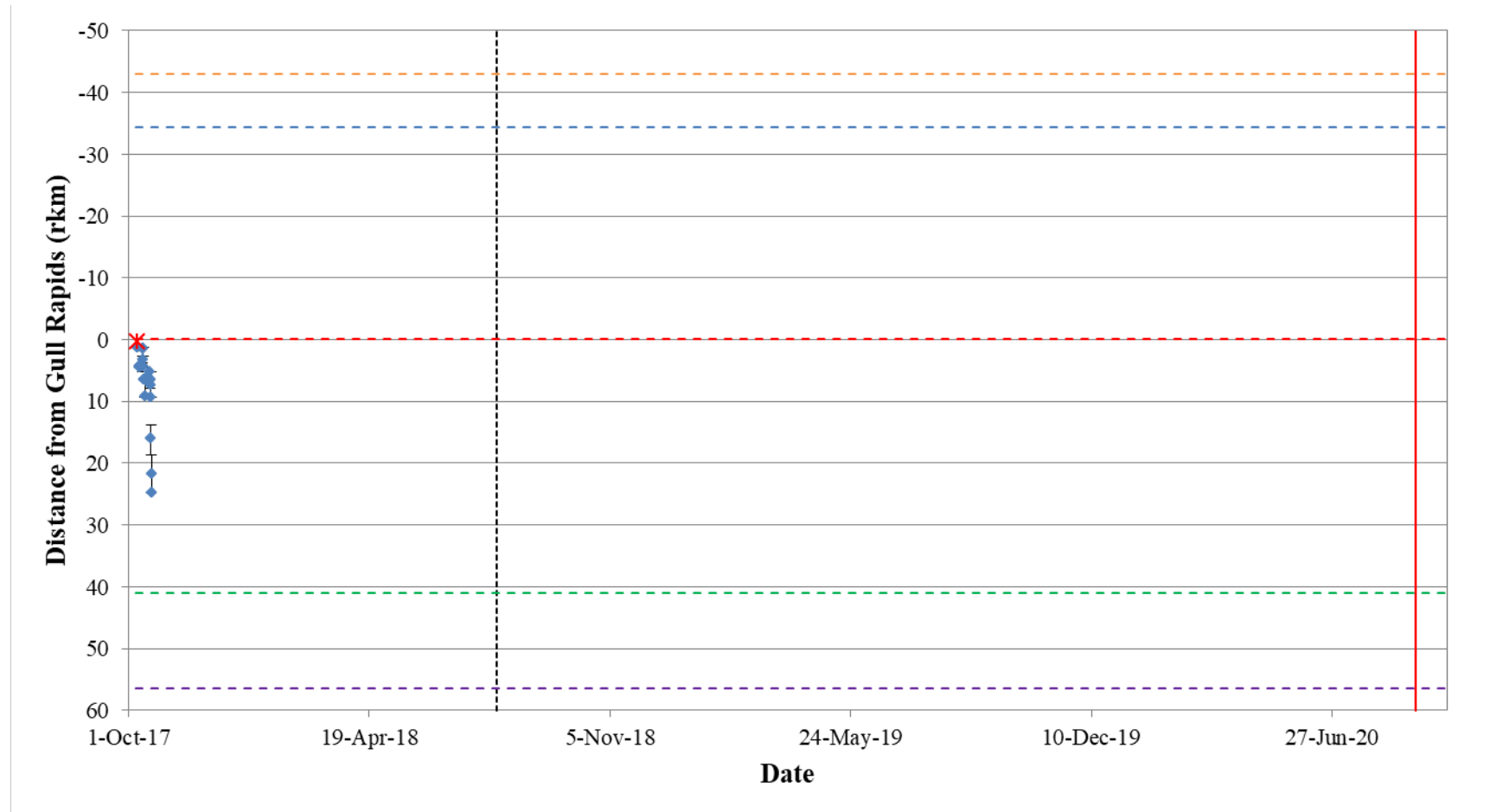


Figure A3-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31717) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

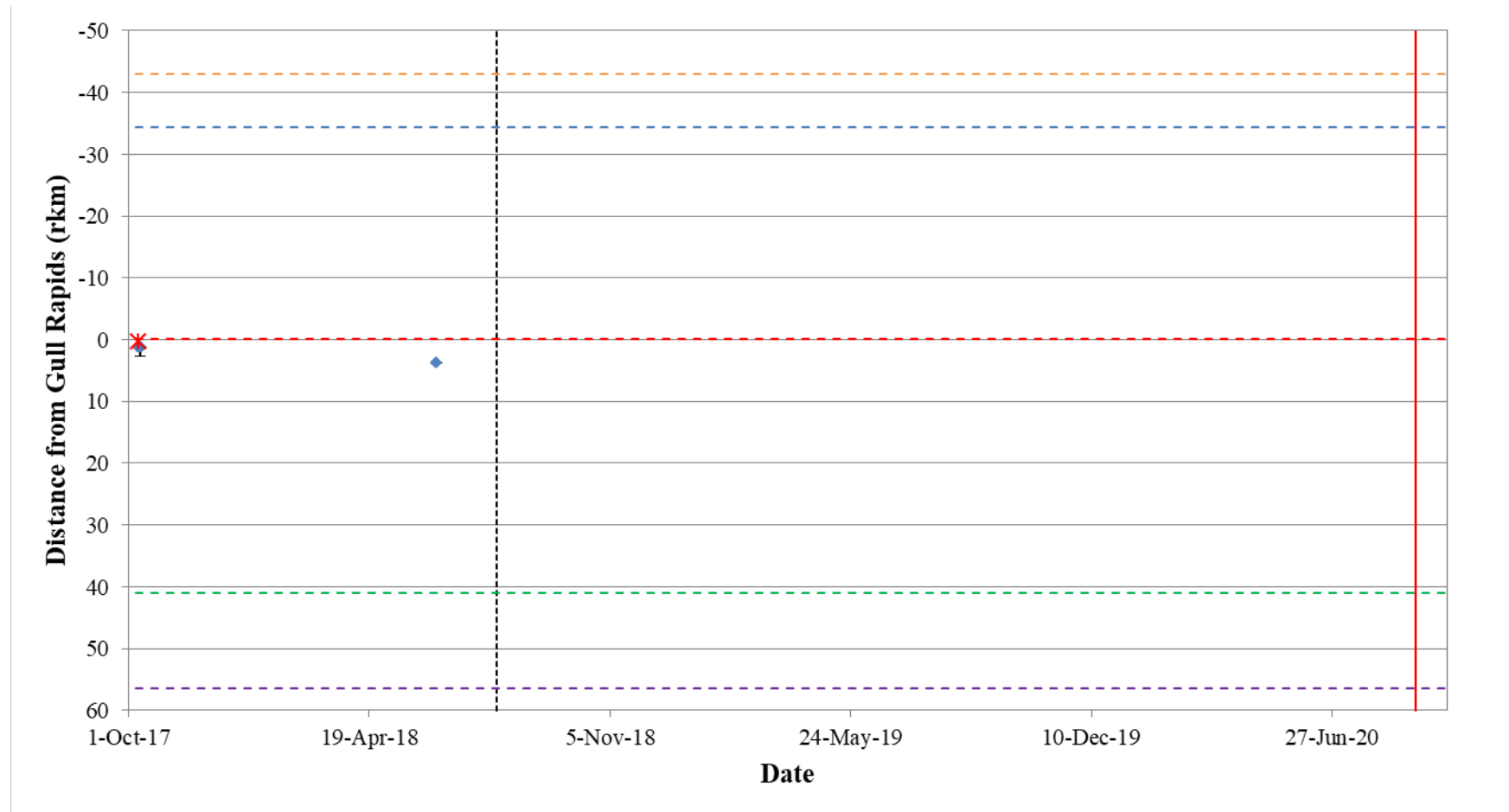


Figure A3-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31718) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

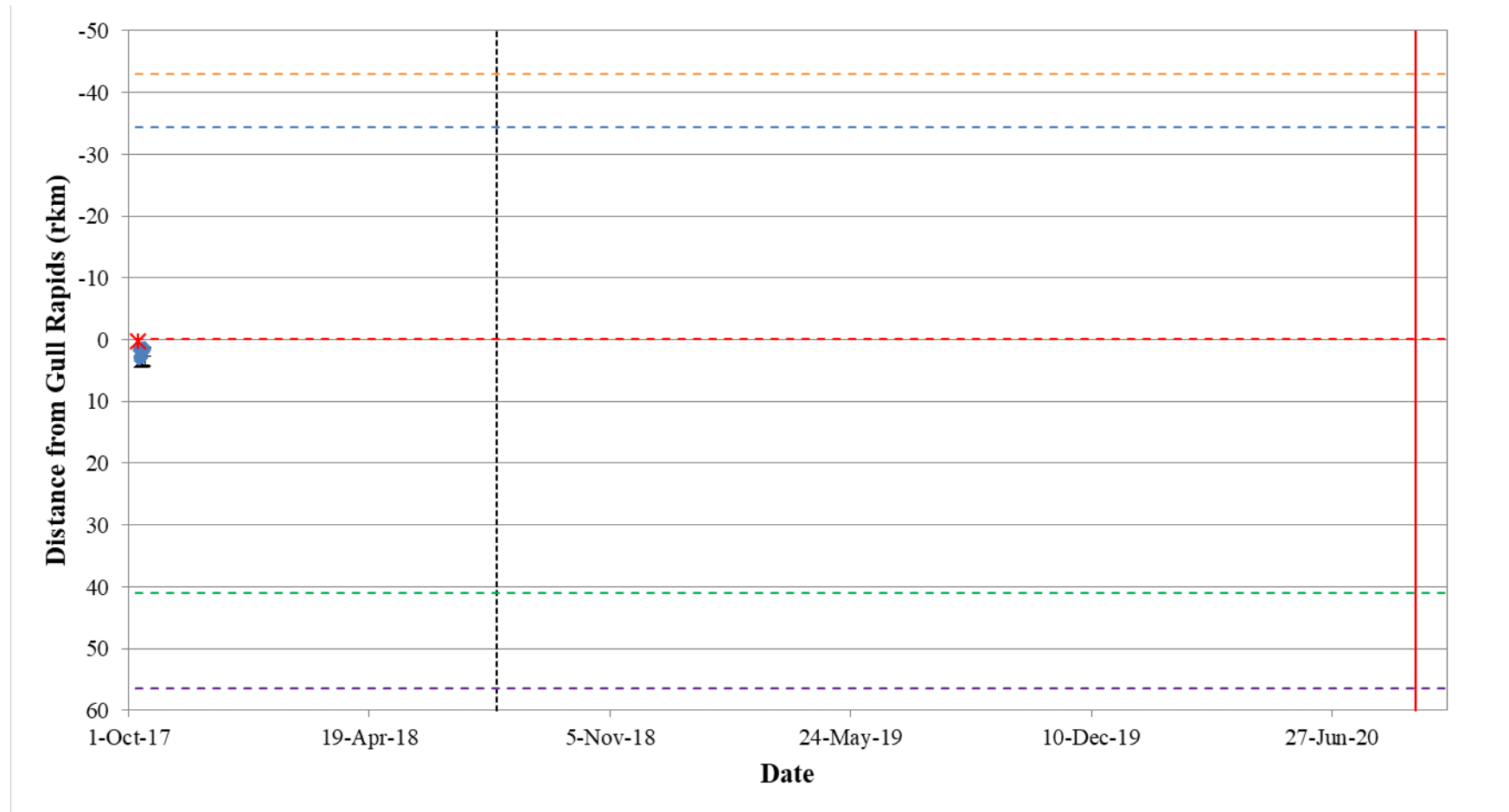


Figure A3-22: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31719) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

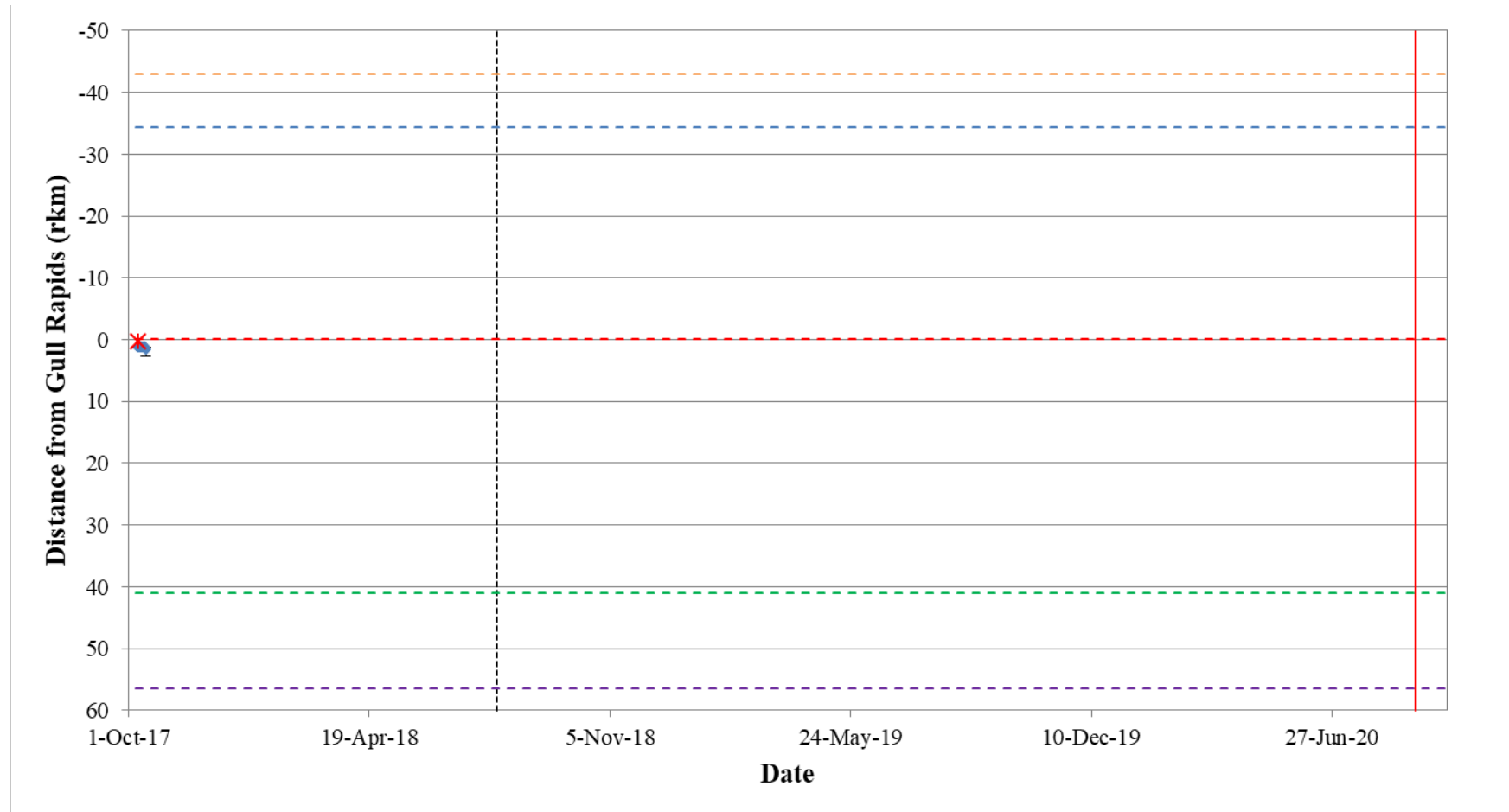


Figure A3-23: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31720) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

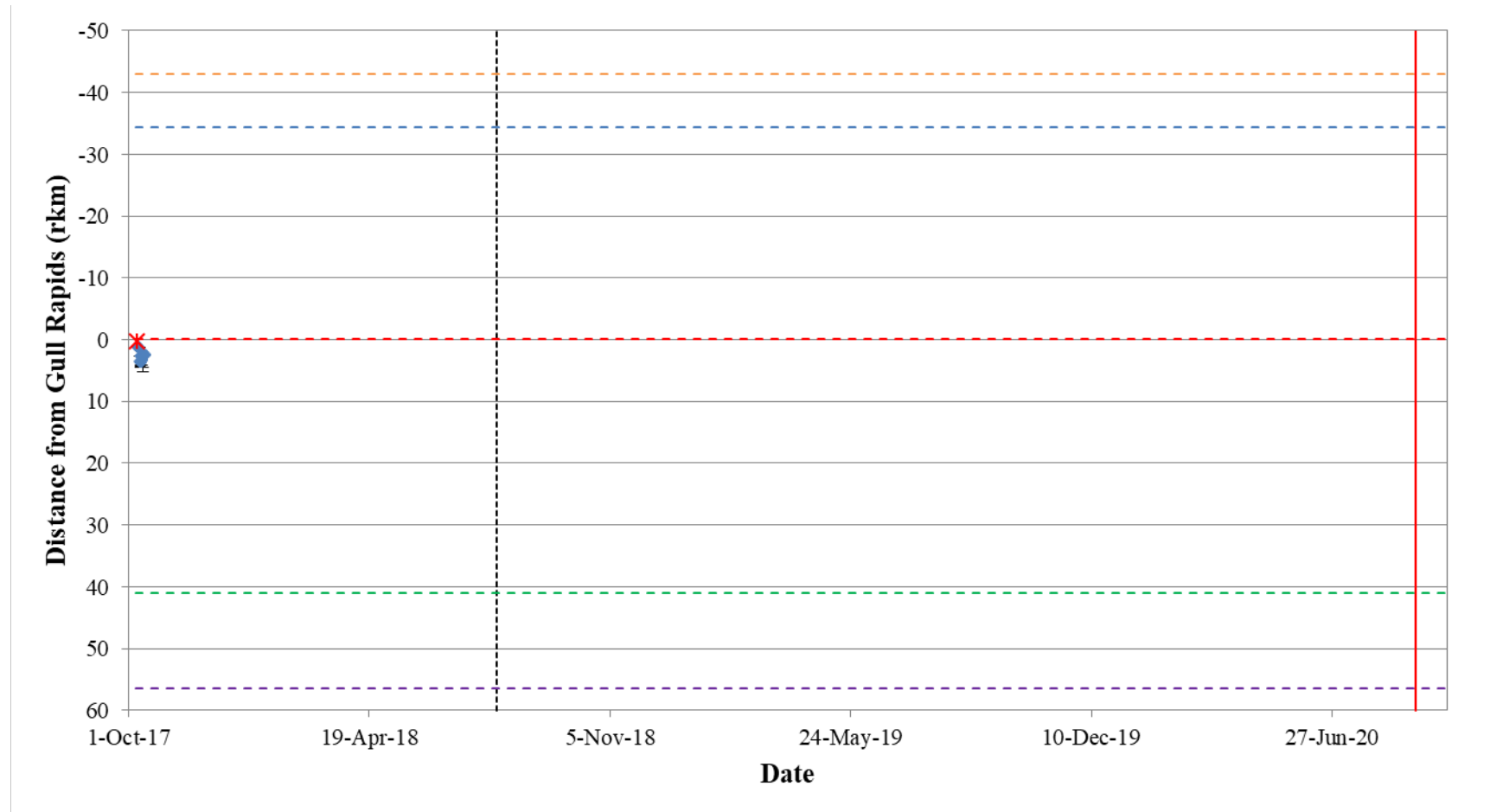


Figure A3-24: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31721) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

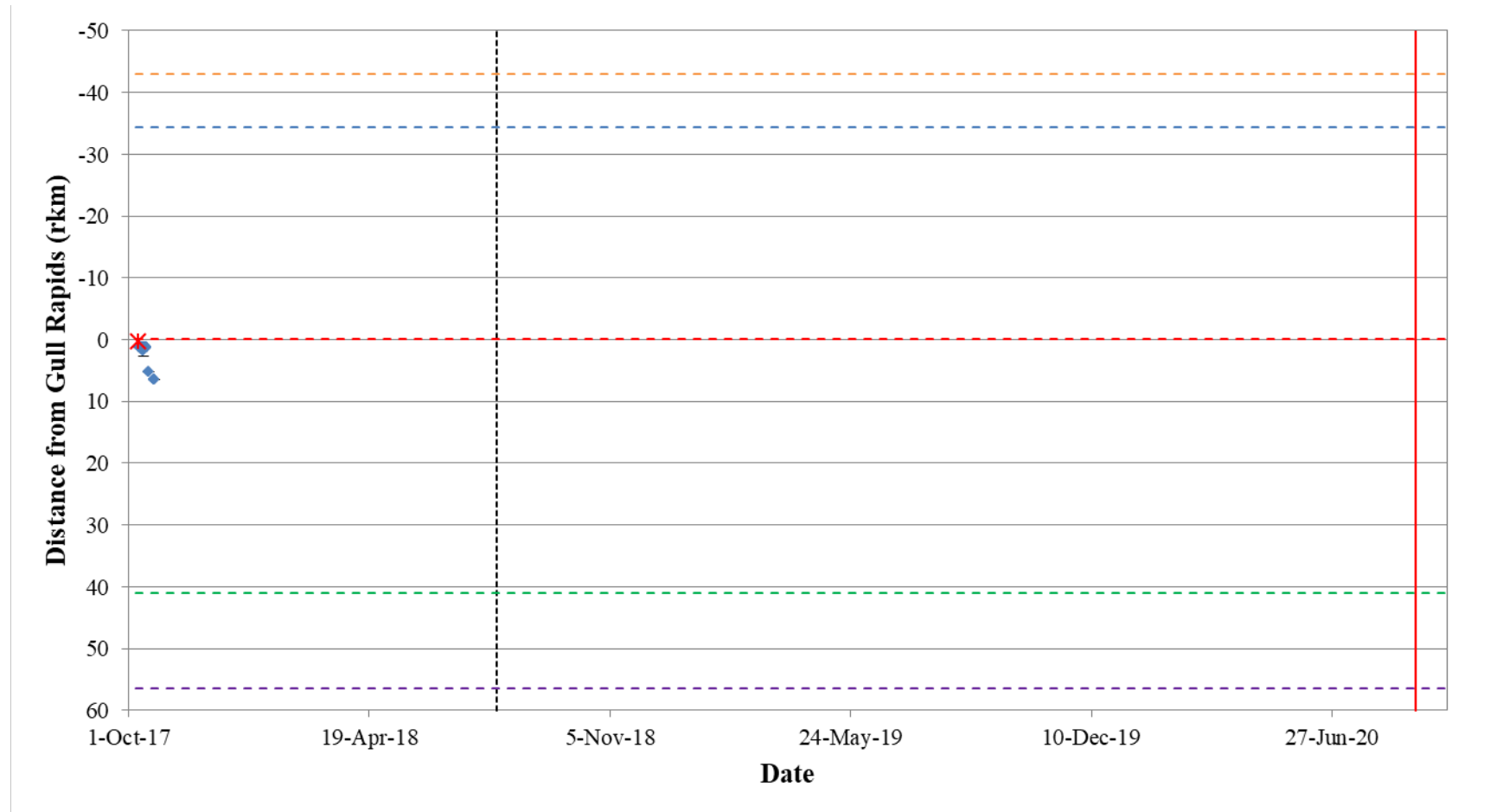


Figure A3-25: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31723) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

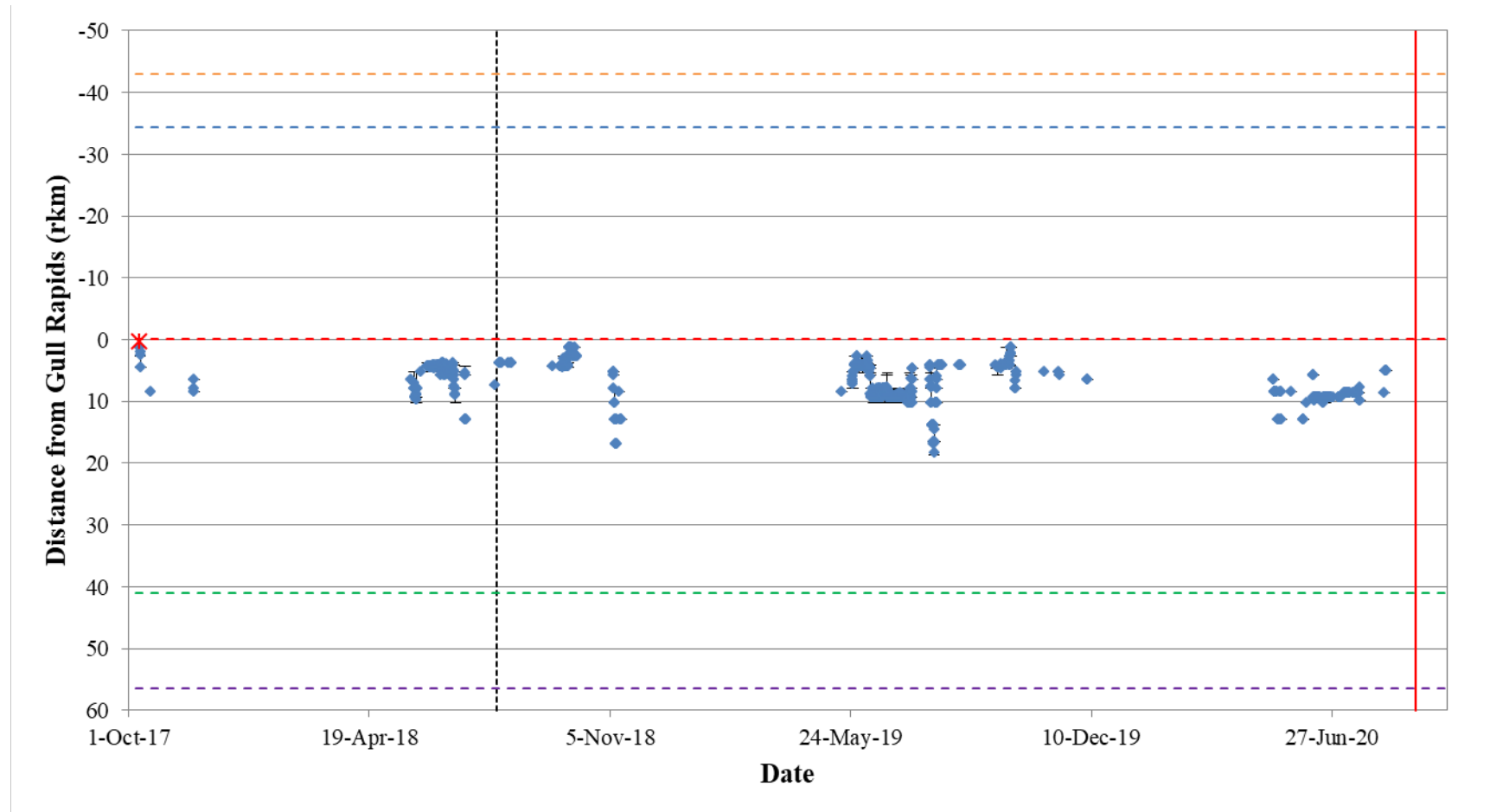


Figure A3-26: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31724) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

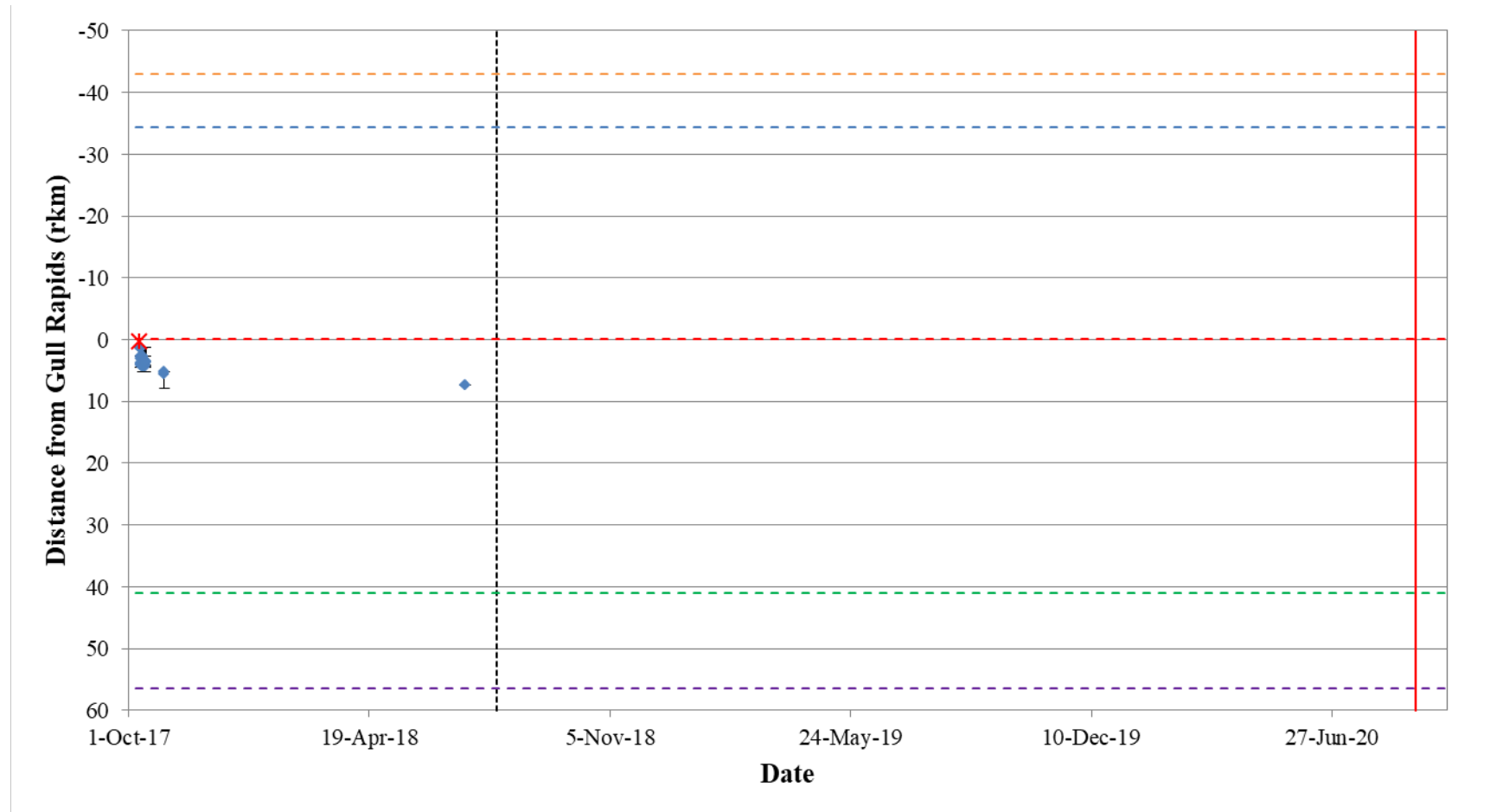


Figure A3-27: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31725) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

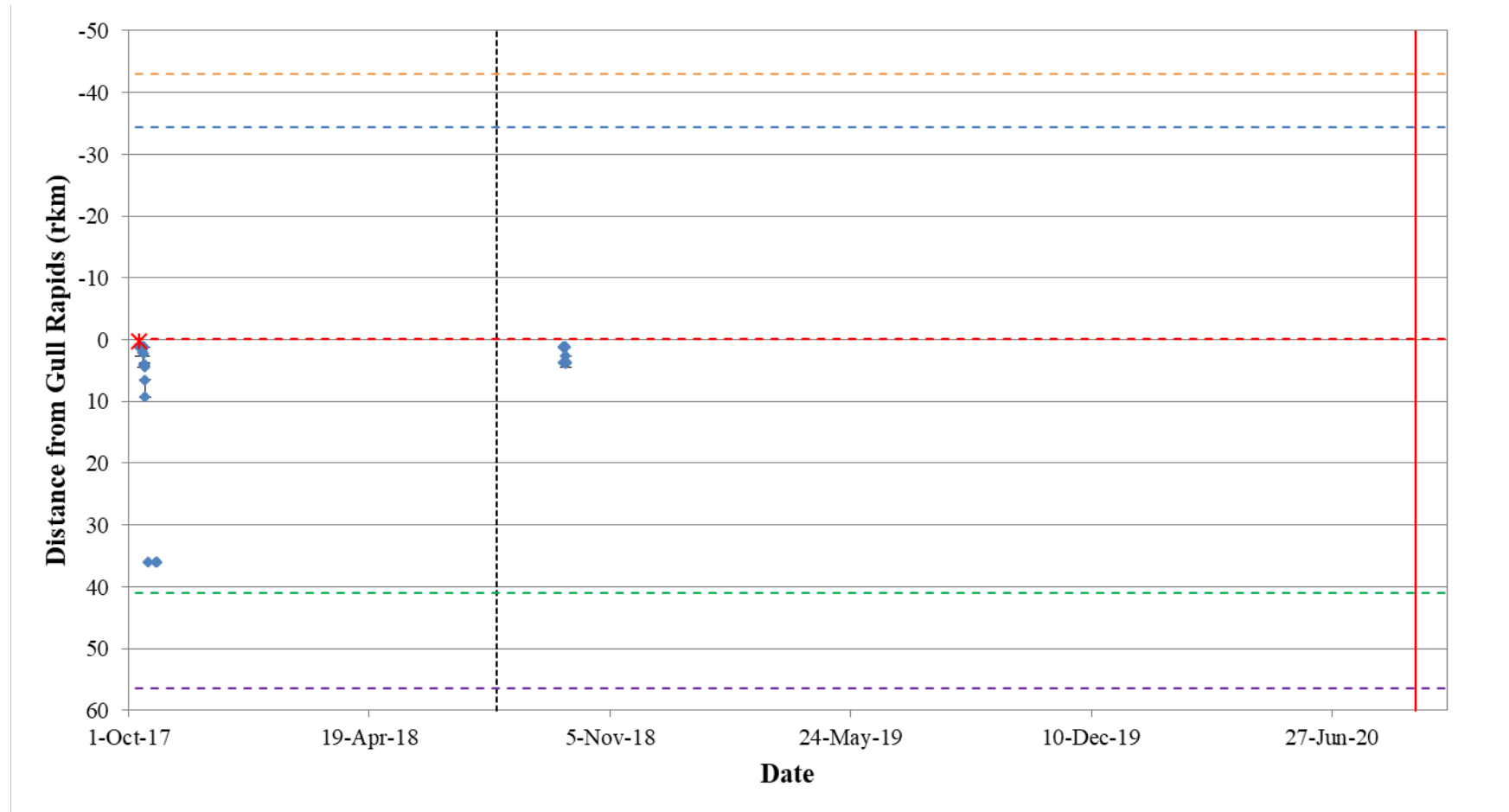


Figure A3-28: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31747) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

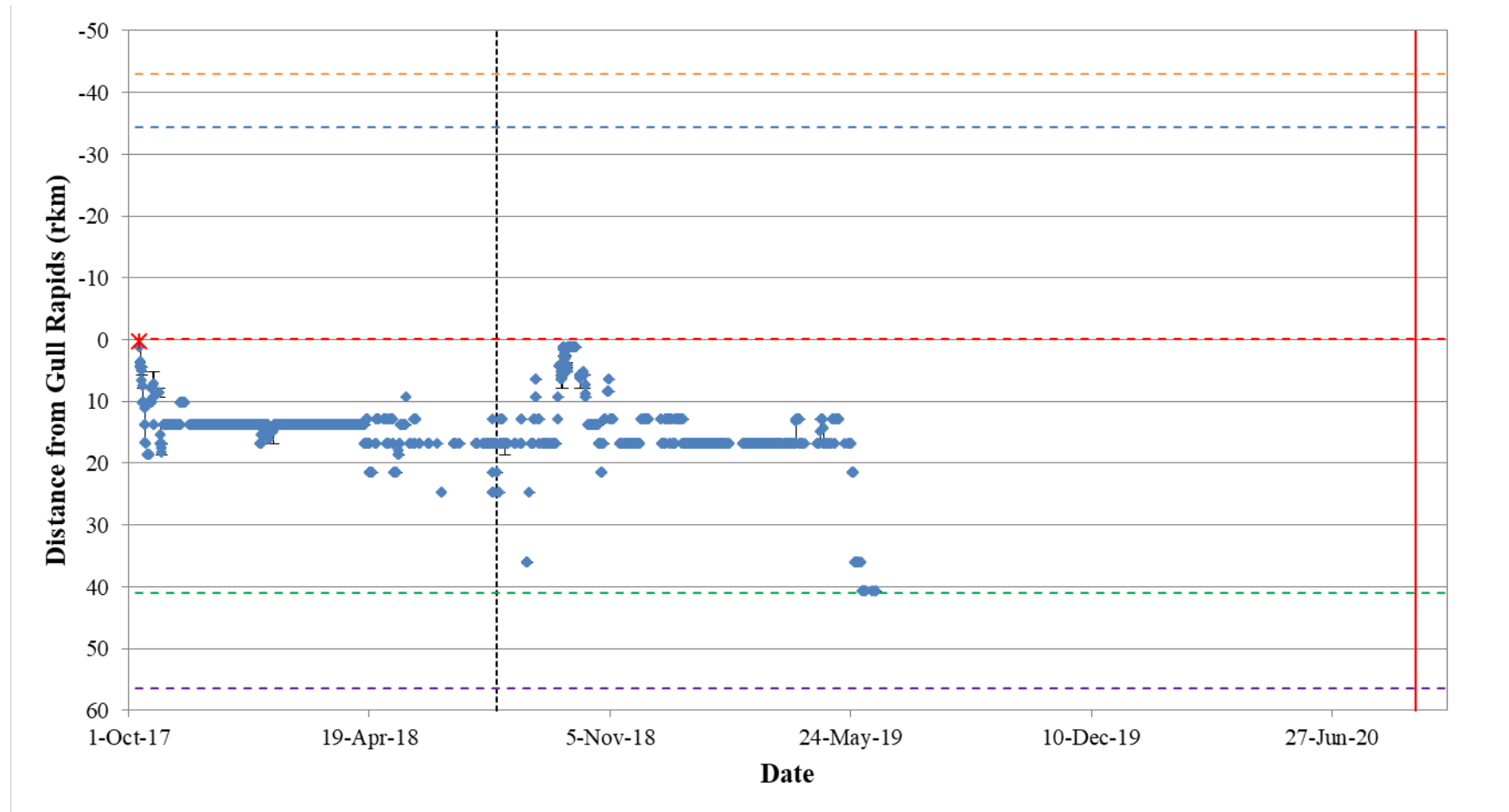


Figure A3-29: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31748) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

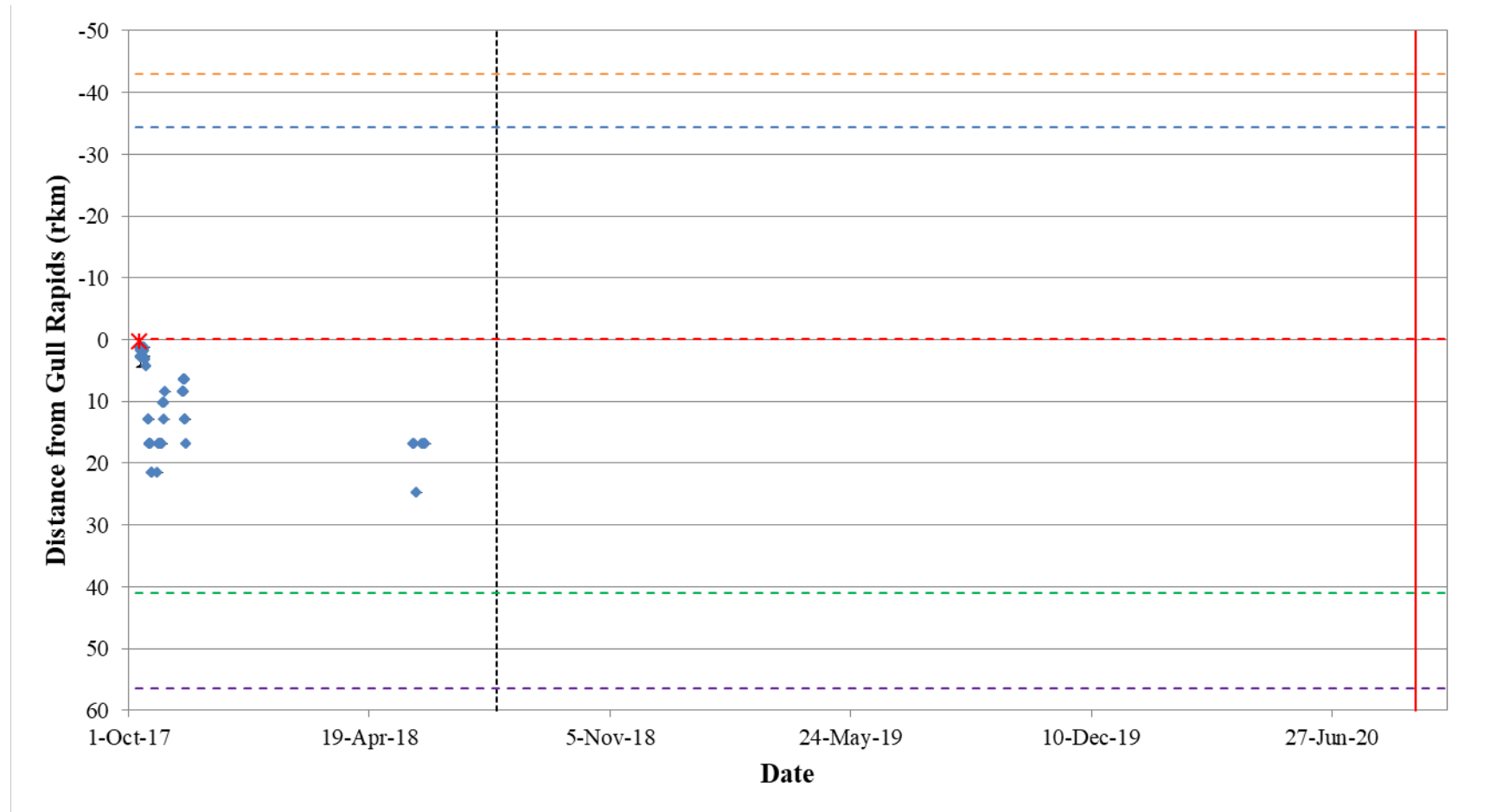


Figure A3-30: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31749) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

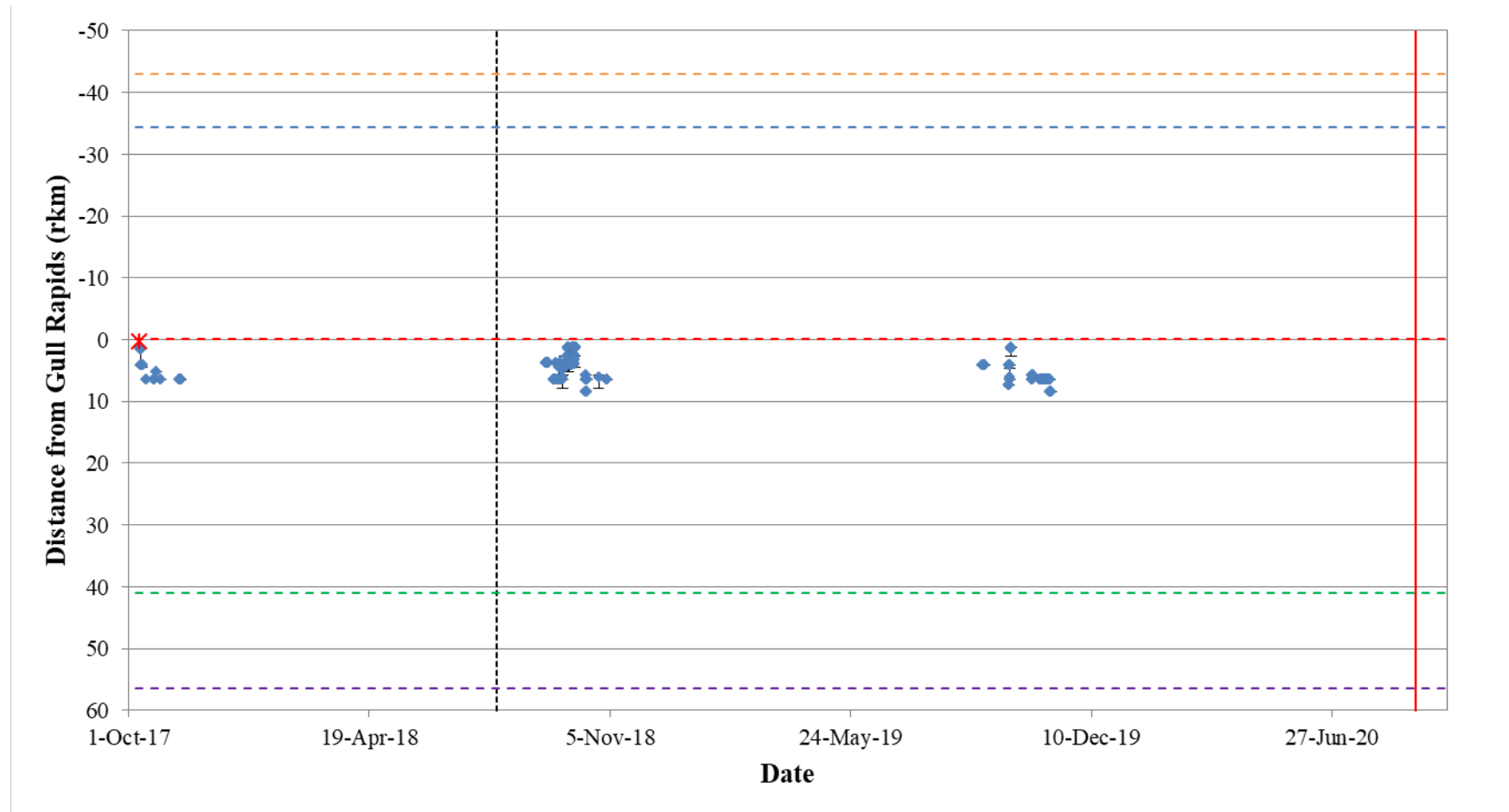


Figure A3-31: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31750) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

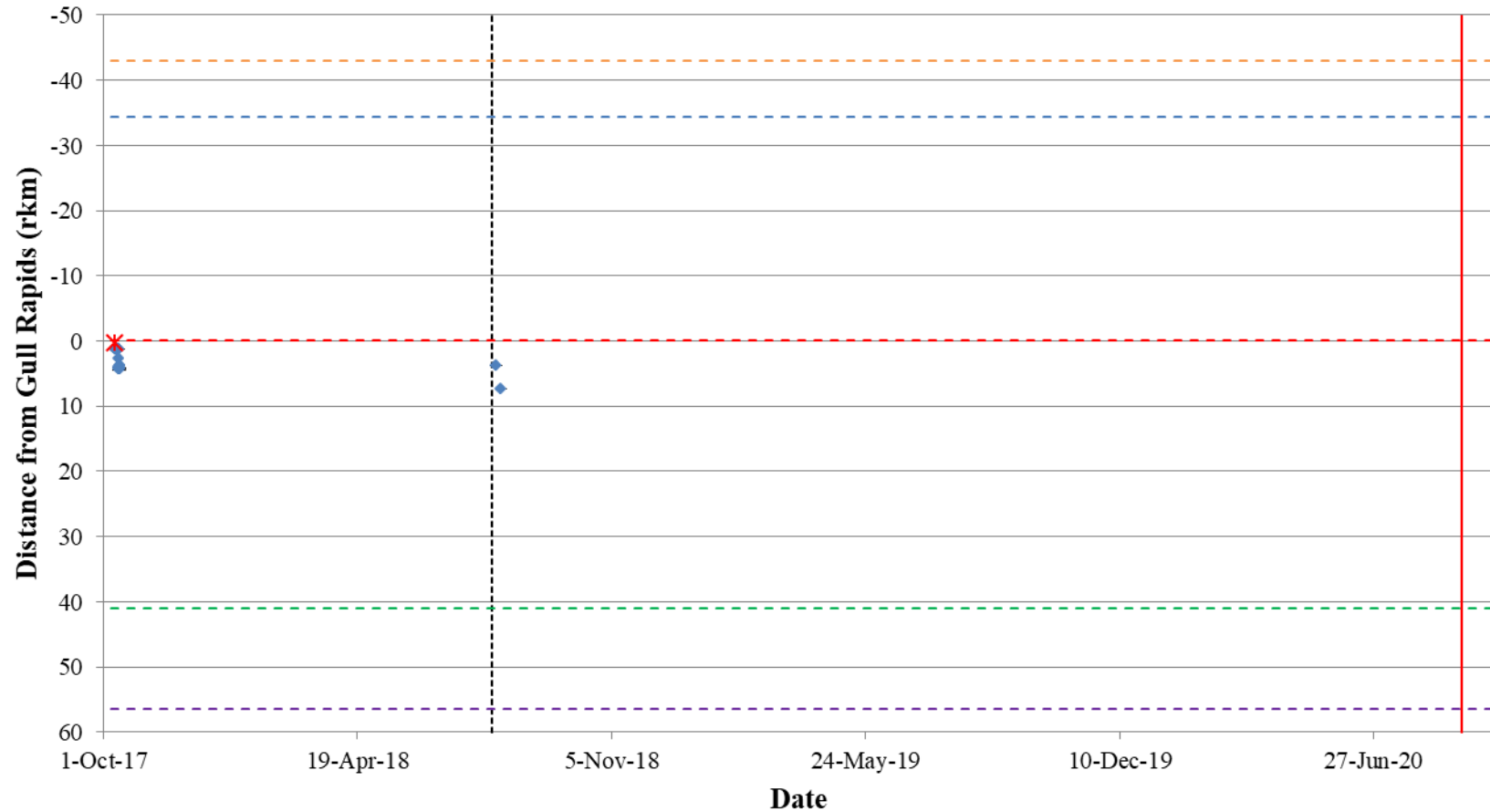


Figure A3-32: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31751) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

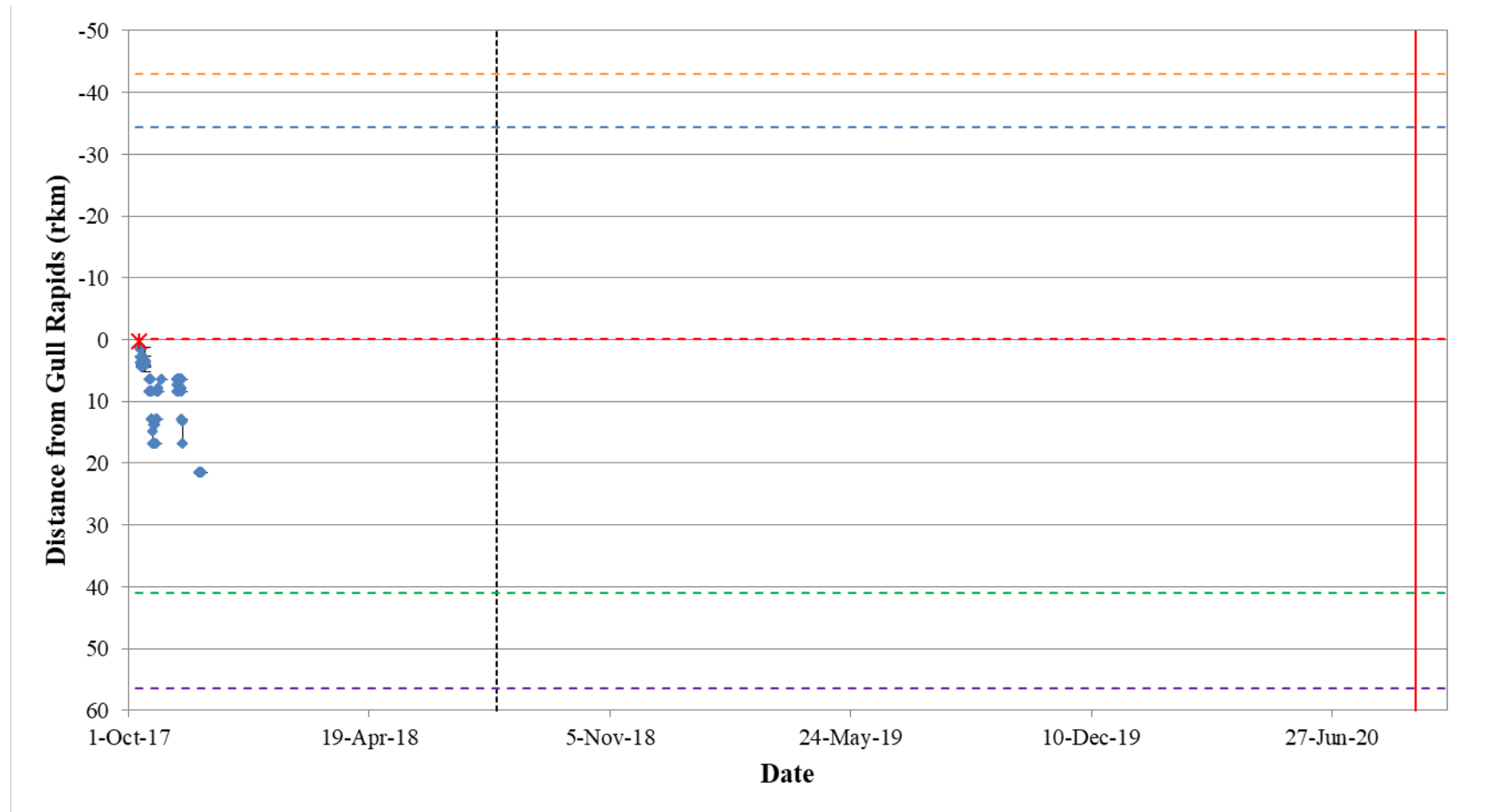


Figure A3-33: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31752) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

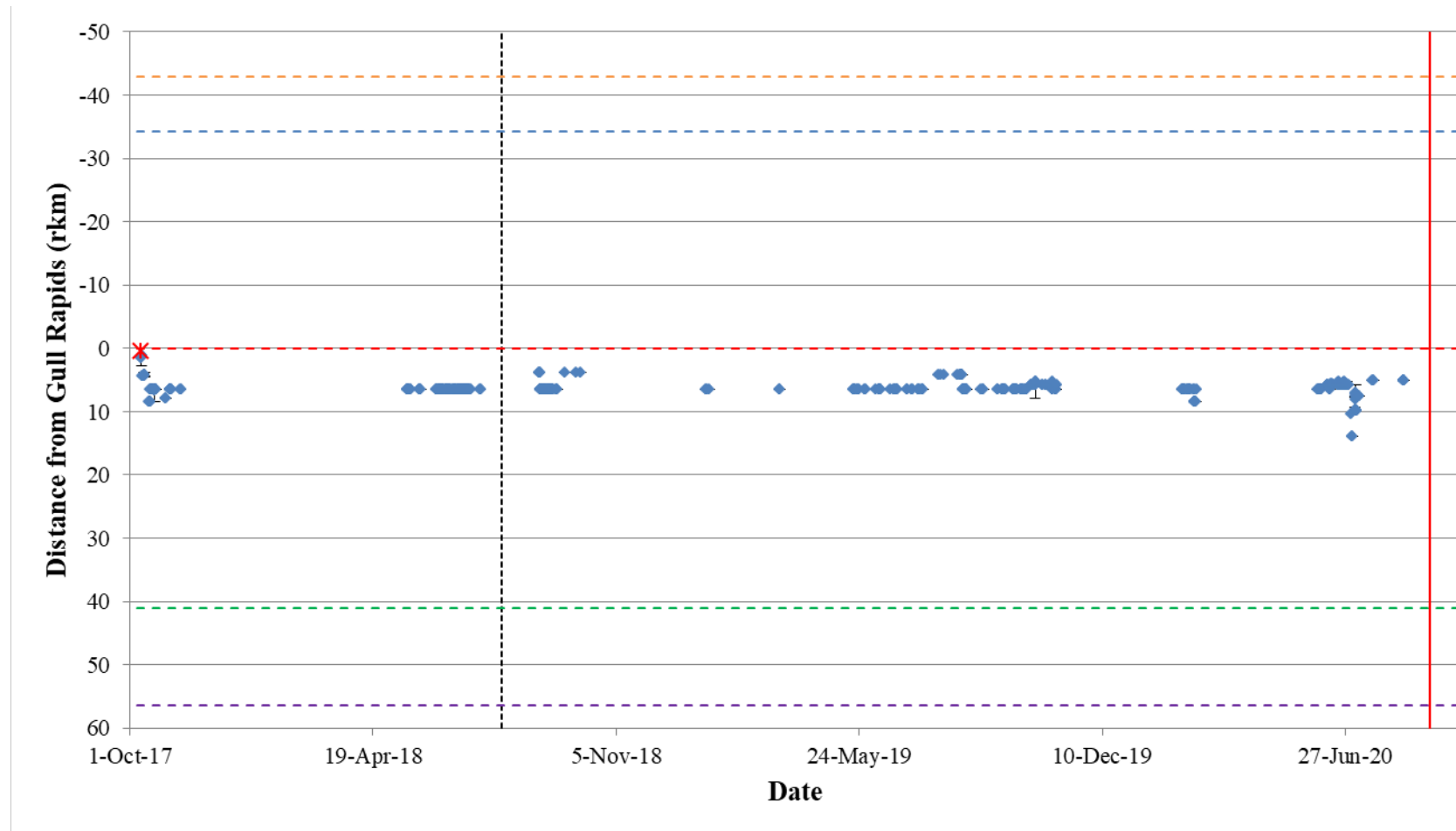


Figure A3-34: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31753) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

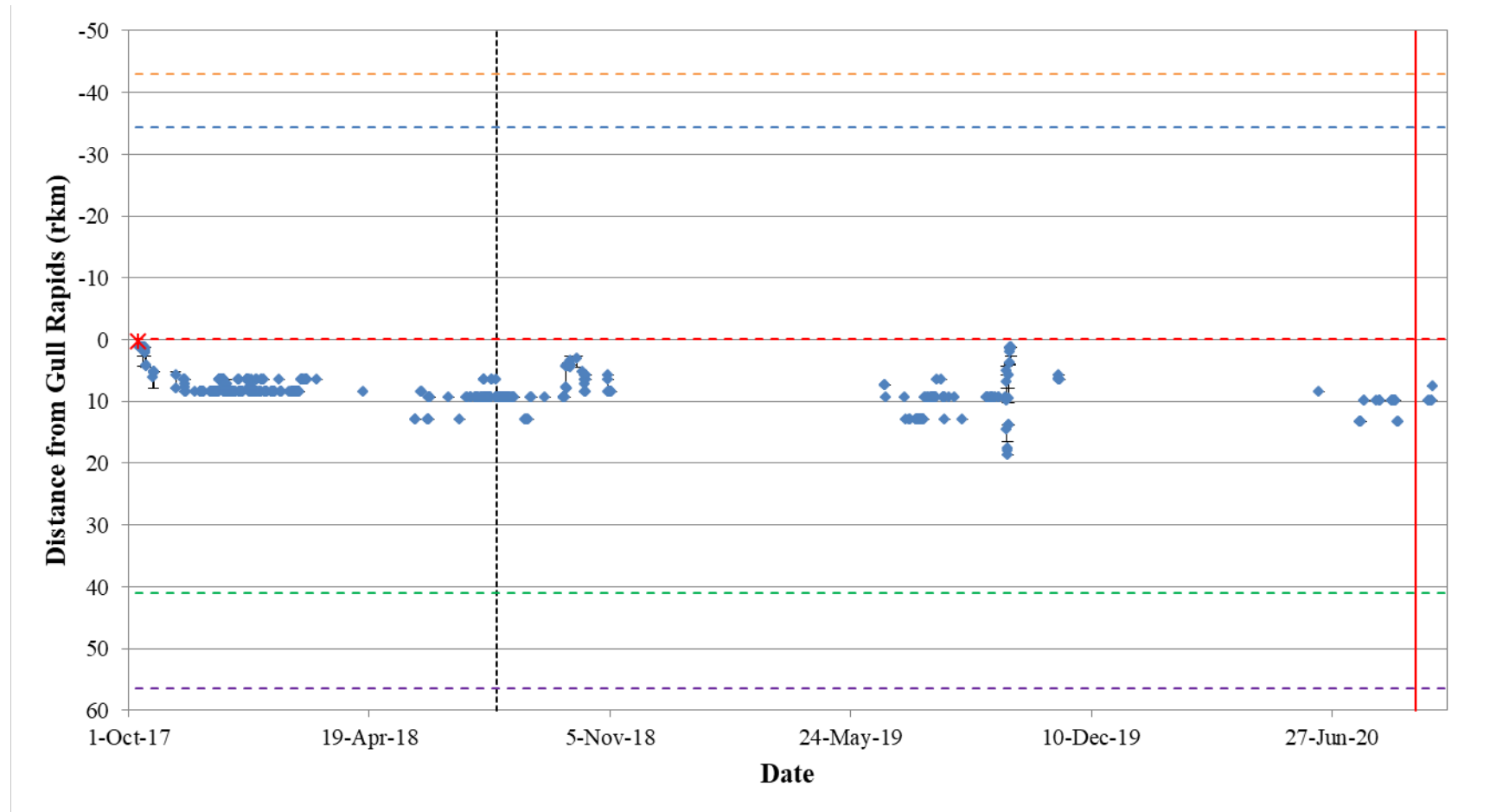


Figure A3-35: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31754) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

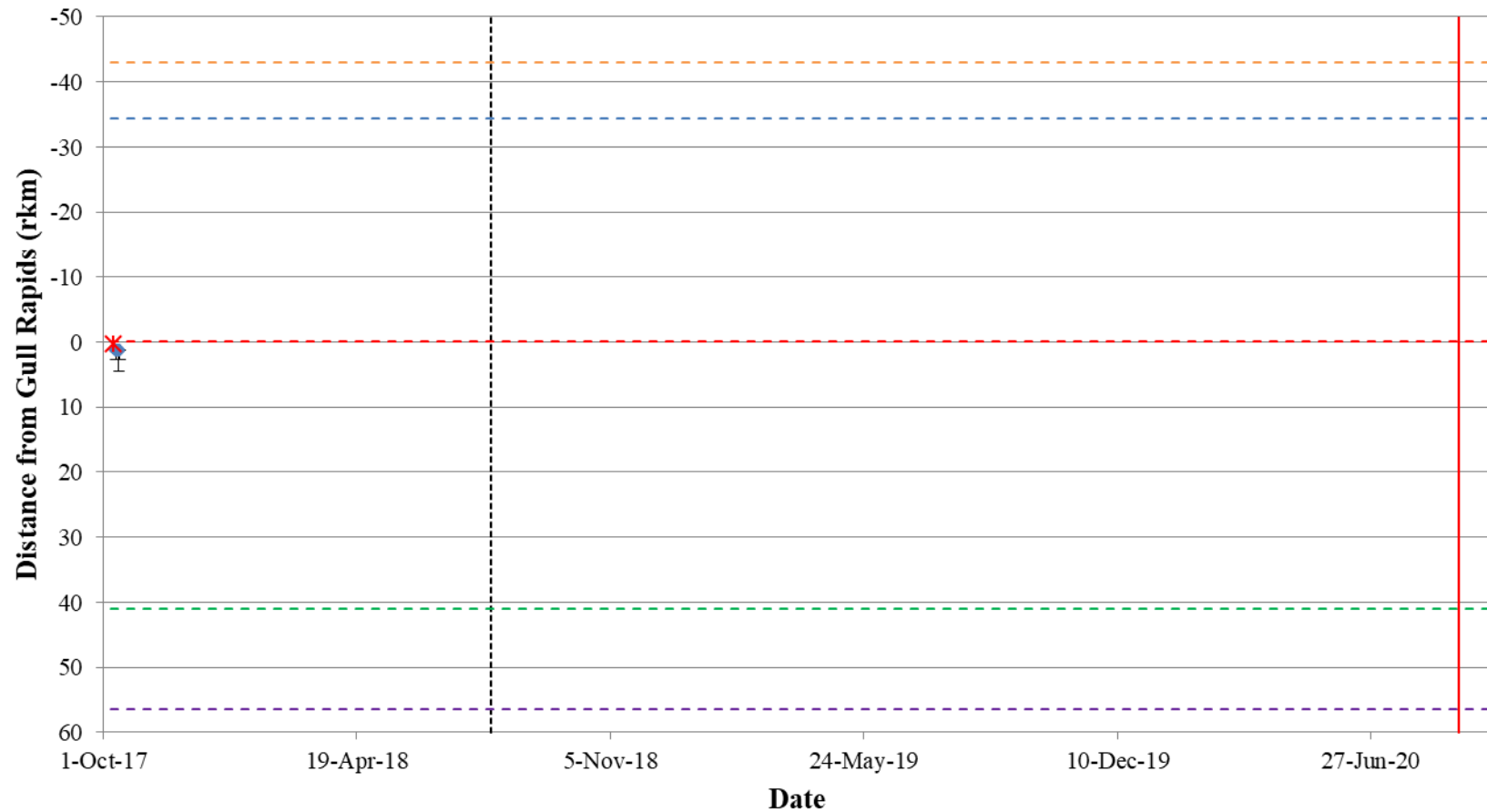


Figure A3-36: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31755) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

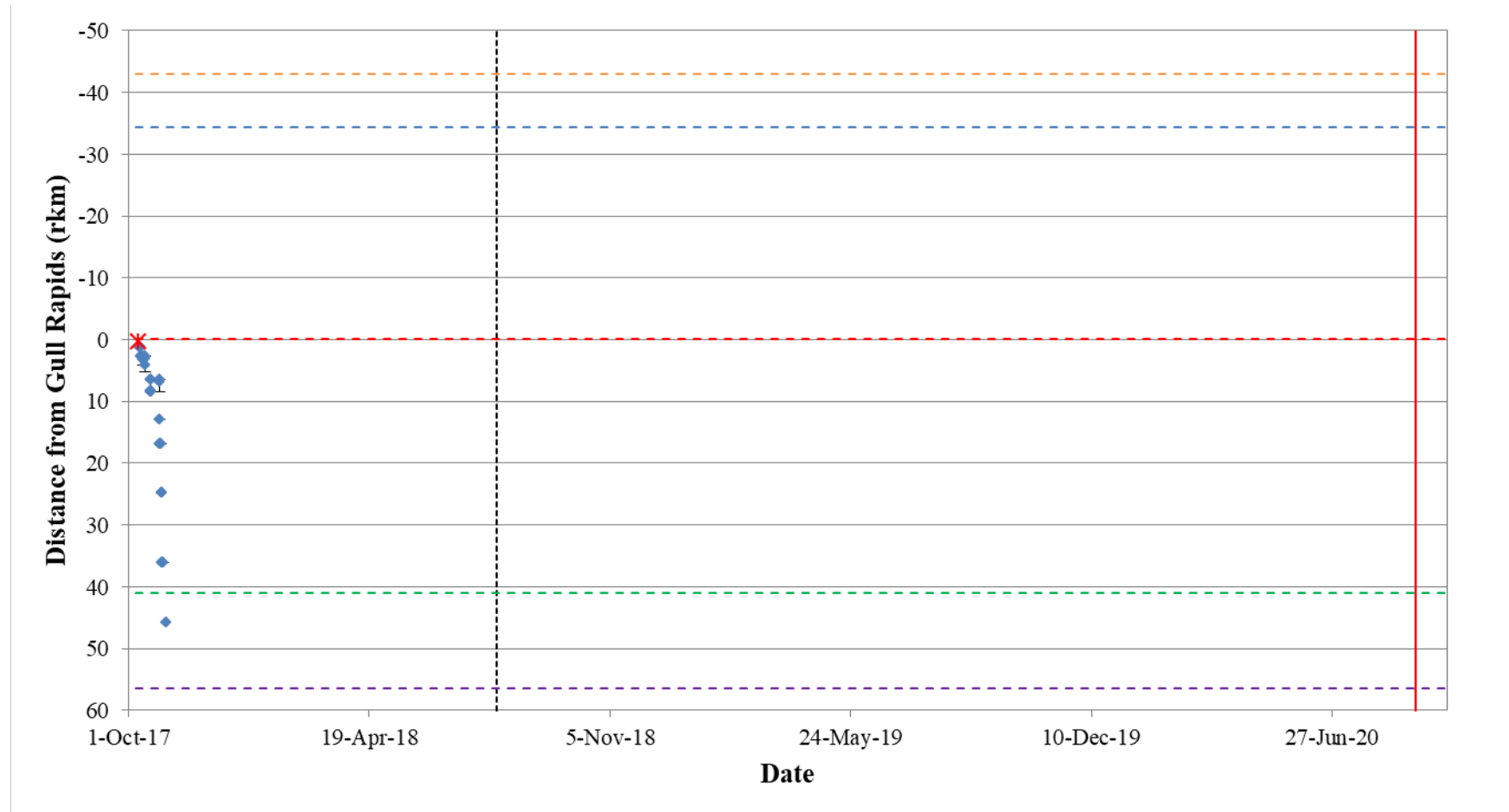


Figure A3-37: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31756) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

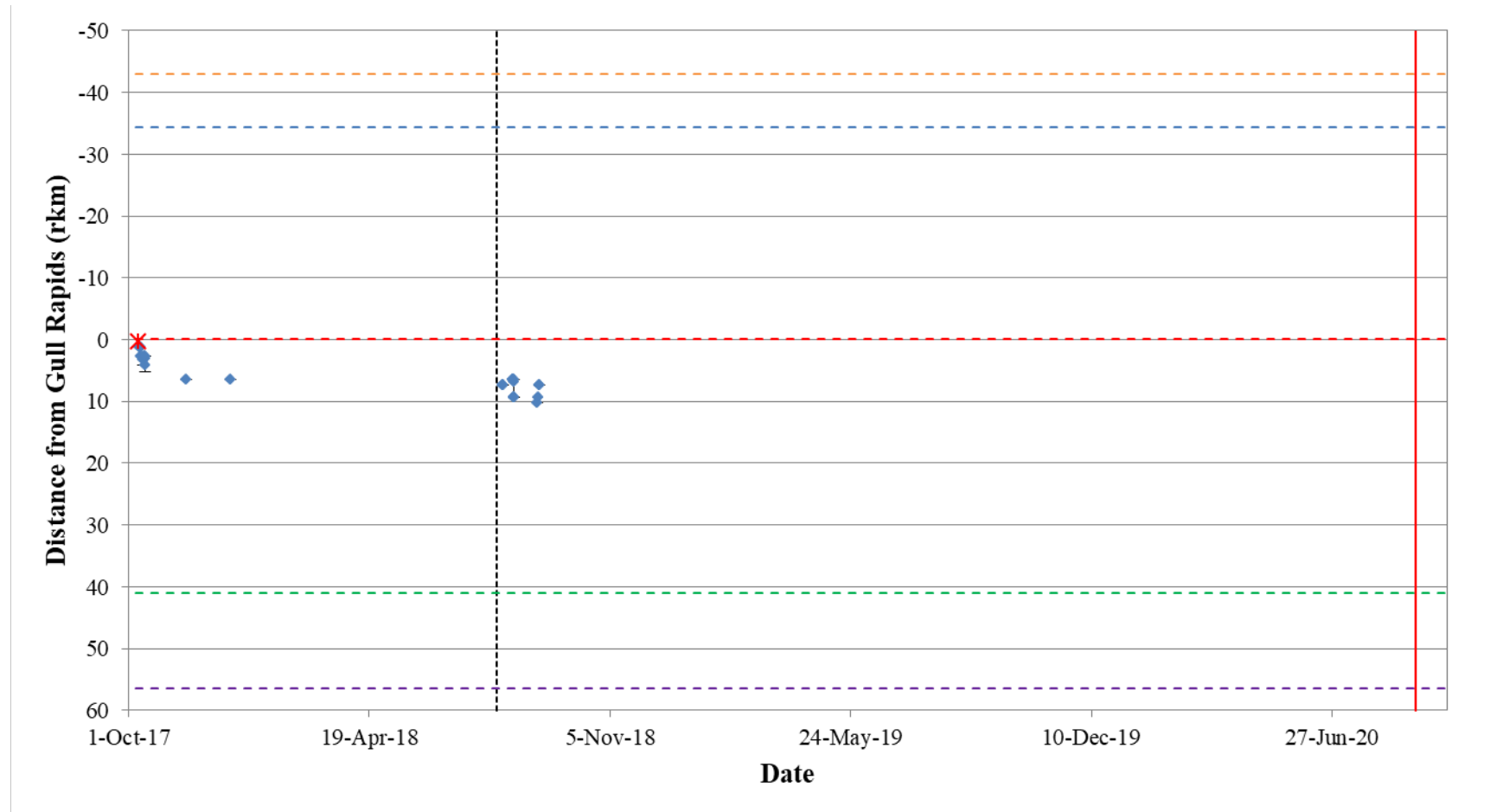


Figure A3-38: Position of a Lake Whitefish tagged with an acoustic transmitter (code #31757) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

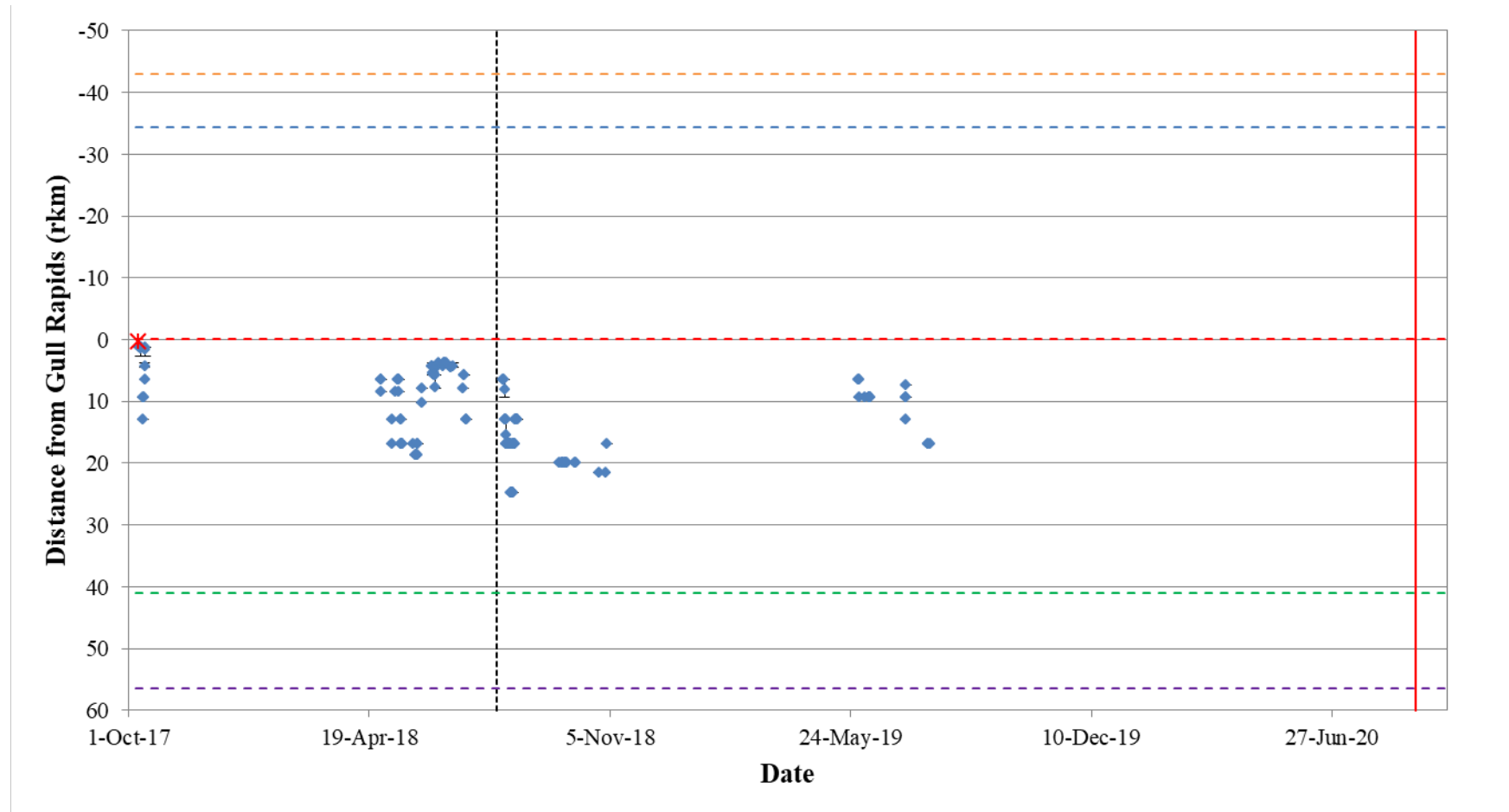


Figure A3-39: Position of a Lake Whitefish tagged with an acoustic transmitter (code #53761) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).

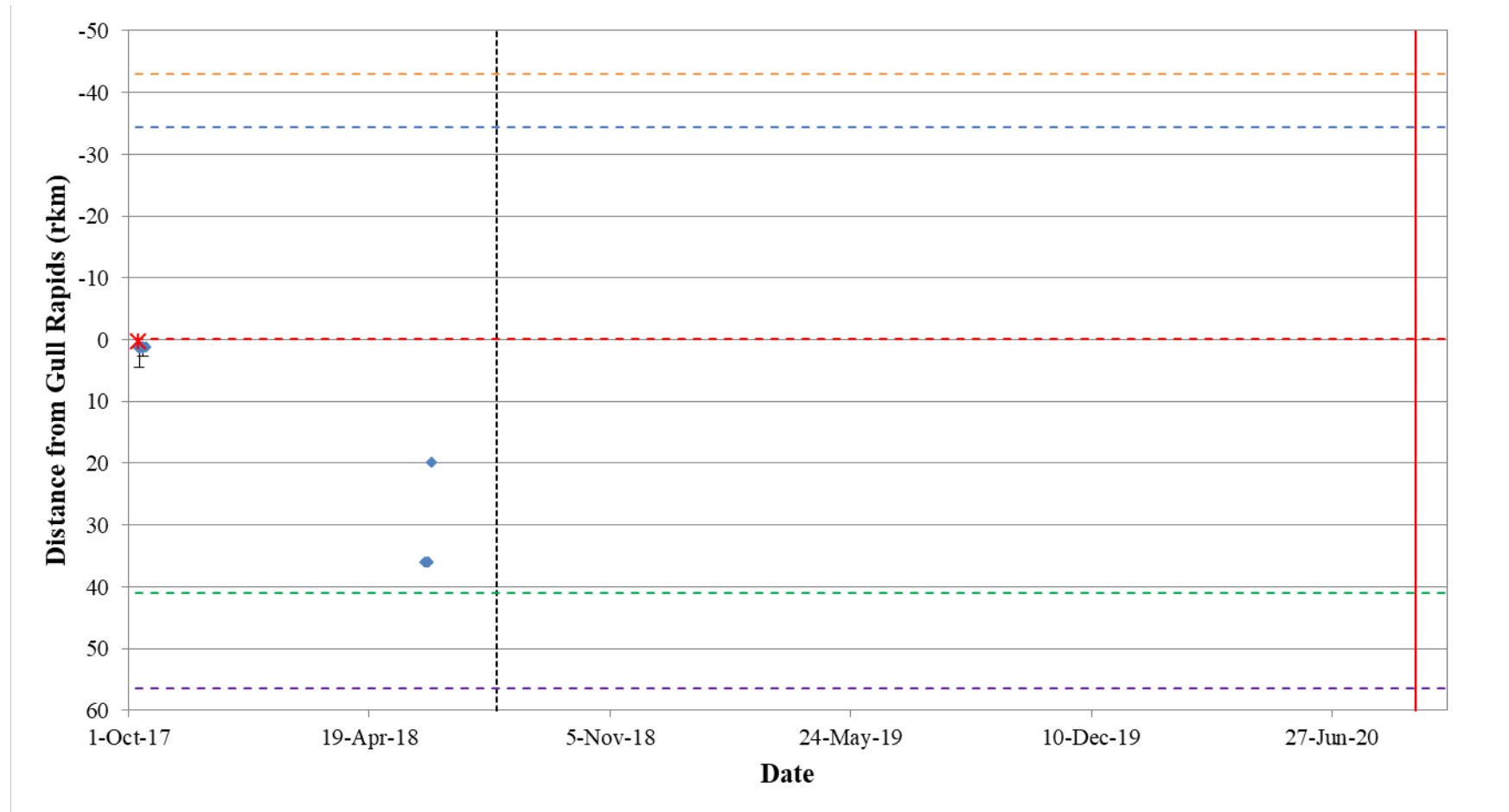


Figure A3-40: Position of a Lake Whitefish tagged with an acoustic transmitter (code #53762) in Stephens Lake, in relation to the Keeyask GS (rkm 0), from October 2017 to September 2020. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (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).