



# Keeyask Generation Project Aquatic Effects Monitoring Plan

## Lake Whitefish Movement Monitoring Report

AEMP-2017-03



# **KEEYASK GENERATION PROJECT**

## **AQUATIC EFFECTS MONITORING PLAN**

REPORT #AEMP-2017-03

### **LAKE WHITEFISH MOVEMENT MONITORING IN THE NELSON RIVER BETWEEN CLARK LAKE AND THE LIMESTONE GENERATING STATION, OCTOBER 2015 TO OCTOBER 2016: YEAR 3 CONSTRUCTION**

Prepared for

Manitoba Hydro

By

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# SUMMARY

## Background

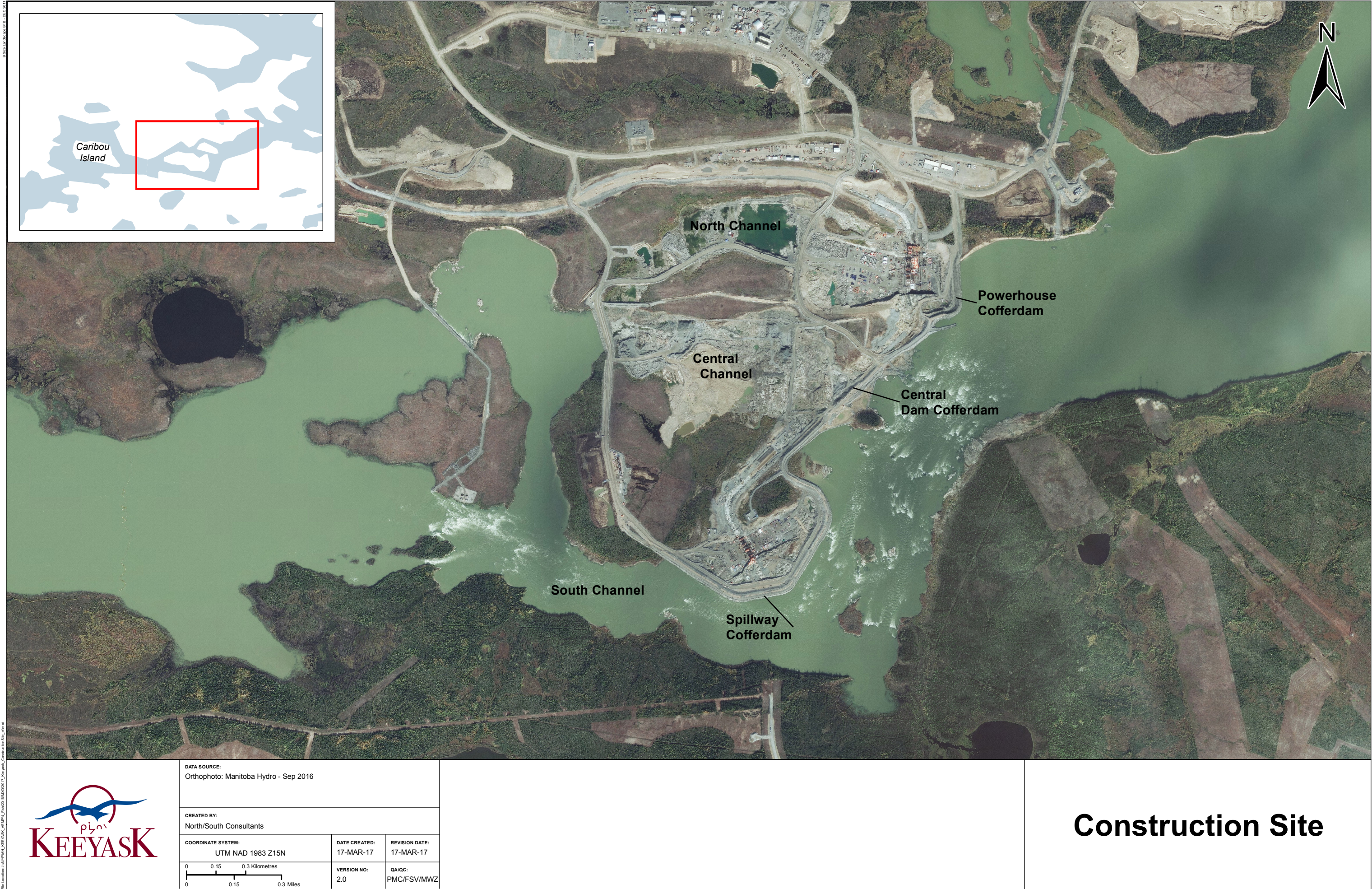
The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the Keeyask Generating Station (GS) on the environment. Besides measuring the accuracy of the predictions made and actual effects of the GS on the environment, monitoring 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. During 2014 and 2015, cofferdams were constructed that blocked the north and central channels and a portion of the south channel of Gull Rapids (see map below). In 2016 there was little in-stream construction prior to the completion of field studies in fall: the central portion of the Central Dam Cofferdam was widened in April/May and work on the Tailrace Summer Level Cofferdam was started on August 4 and 5 and then stopped until October. With so little in-stream construction activity prior to completing field work in the fall, possible construction-related impacts to the aquatic environment during this period were limited to indirect effects (e.g., potential impacts to water quality from discharge at the cofferdam, runoff from disturbed terrestrial areas).

The movements of Lake Whitefish over Birthday Rapids and Gull Rapids were monitored prior to construction, but because different methods are being used for AEMP data collection, the results of the two programs can't be compared. While pre-construction studies did not record detailed fish movement patterns between Clark Lake and Stephens Lake, the data indicated that the majority of Lake Whitefish continued to live in the area where they had been tagged and did not swim across rapids into different parts of the river. When fish occasionally crossed either Birthday or Gull rapids, they did so in the summer or fall, which suggests that these movements were not a necessary part of spring egg-laying behavior. A small number of Lake Whitefish also moved downstream through the generating stations/spillways along the lower Nelson River.

This report presents results of Lake Whitefish movement monitoring from October 2015 to October 2016 and provides a summary of data collected since the monitoring program was initiated in fall 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; abundant in the Keeyask Area; known to pass through Gull Rapids in either direction; and resilient enough to survive the acoustic tagging procedure.





Map of instream structures at the Keeyask generating station site, September 2016.



**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?*

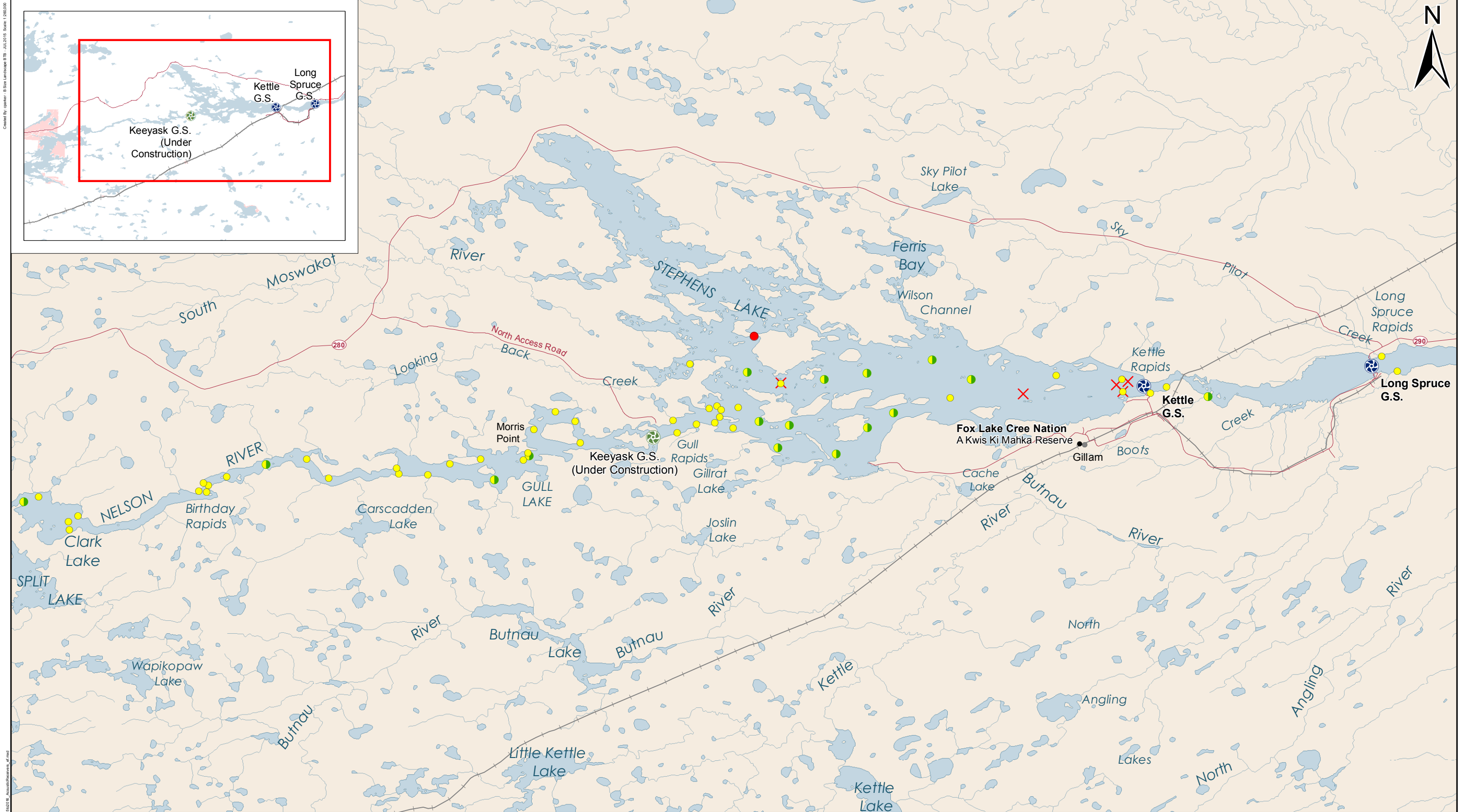
If Lake Whitefish are in the river close to the construction area, they could be harmed by high amounts of mud in the water or they could be trapped inside an area that will be drained.

*How many Lake Whitefish are moving through and/or away from 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, 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.

**What was done?**

The movements of Lake Whitefish were tracked using acoustic telemetry. This is a technique in which a tag 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 study area map below). Each fish is given a transmitter that sends out a unique ping, and the pings can be detected up to 1 kilometre (km) away from a receiver. By looking at the pings recorded by different receivers, the movement of each fish can be tracked. The transmitters are powered by batteries with a three-year life-span. Sixty Lake Whitefish were tagged, 20 upstream and 40 downstream of Gull Rapids, during fall 2014.





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DATA SOURCE:  
Government of Manitoba, Province of Manitoba, Manitoba Hydro

CREATED BY:  
North/South Consultants

COORDINATE SYSTEM: UTM NAD 1983 Z 14N	DATE CREATED: 09-FEB-15	REVISION DATE: 16-FEB-17
0 0.45 0.9 Kilometres	VERSION NO: 1.0	DATE: CMP/YYY/ZZZ

0 0.35 0.7 Miles

**Legend**

**Acoustic Receivers**

- Winter 2015/2016
- Open-water 2016
- Open-water 2016 lost
- Winter 2015/2016 lost
- Winter 2015/2016 and Open-water 2016

- Generating Station (Existing)
- Generating Station (Under Construction)
- Highway
- Rail
- First Nation Reserve

**2016 Acoustic Receivers**  
Clark Lake to Limestone Reservoir

Map showing study area. 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.

**What was found?**

How far, and where Lake Whitefish moved depended on the individual fish and whether they lived upstream of Gull Rapids or downstream of Gull Rapids (in Stephens Lake). Movements also depend on the water temperature/season.

Results of the study to date suggest that few Lake Whitefish move through Gull Rapids. Of the 20 whitefish tagged upstream, only one has moved downstream through the rapids and none have moved up.

Upstream of Gull Rapids, 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, more than 65% of detected fish made upstream movements to the base of Birthday Rapids or further into Clark Lake. 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 Gull Rapids in the fall, presumably to spawn.

**What does it mean?**

Lake Whitefish are using habitat immediately downstream of the construction site at Gull Rapids and do not seem to be disturbed by construction activity. Movements through Gull Rapids have been rare with only one tagged fish swimming downstream through Gull Rapids in 2015, so it does not appear so far that construction is causing fish to leave the area.

**What will be done next?**

Tags were implanted in Lake Whitefish in fall 2014 and will last until 2017. Additional Lake Whitefish will be tagged in the spring of 2017 so that movement data can continue to be collected during the construction of the generating station. Ongoing tracking of fish throughout construction will provide additional information about where the fish are moving, what kinds of habitats these fish need to use over several years, when they are spawning and when they are feeding. Tracking will also show where fish are relative to instream construction and if there is the potential that they could be at risk as a result of various construction activities.



# ACKNOWLEDGEMENTS

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

Saul Mayham and Kelvin Kitchokeesik of Tataskweyak Cree Nation and John Henderson of Fox Lake Cree Nation are thanked for their local expertise and assistance in conducting the field work.

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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; Murray *et al.* 2015). 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 the majority of Lake Whitefish did not move upstream or downstream over rapids into adjacent study reaches; instead, they remained within the reach where they had been tagged. Those few fish that moved over one or more sets of rapids did so in the summer or fall, suggesting that these movements were not associated with a life history event such as spawning. A small number of Lake Whitefish also moved downstream through the generating stations/spillways along the lower Nelson River. Additional information on long distance movements was obtained from mark-recapture studies; for example, Walleye were shown to move between the North and South Moswakot Rivers and Stephens Lake. As pre-Project studies were not designed to record detailed movement patterns of in the Clarke Lake to Stephens Lake reach as a whole, their results are not directly comparable to the movement data being collected under the AEMP.

In fall 2014, 60 adult Lake Whitefish were tagged with three-year acoustic transmitters to assess the frequency of movement through Gull Rapids and to monitor the potential impact construction of the Keeyask GS had on movements. Movements of these whitefish during fall 2014 (from September 25 to October 25) are provided in Hrenchuk and Barth (2015), and movements from October 15, 2014 to October 11, 2015, are presented in Lavergne and Hrenchuk (2016). Results from October 12, 2015 to October 19, 2016 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. The broad objective of Lake Whitefish movement monitoring is to better understand their movements and habitat use during generating station construction, with particular focus on movements in the vicinity of Gull Rapids.

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)?

## 2.0 STUDY SETTING

The study area for the Lake Whitefish movement monitoring program encompasses an approximately 110 km long reach of the Nelson River from Clark Lake to the upstream end of the Limestone reservoir. 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 Gull Rapids (Map 1). Current is restricted to the main section of the lake, with off-current bays outside the main channel. The Assean River is the only major tributary to Clark Lake, and flows into the north side. Downstream from the outlet of Clark Lake, the Nelson River narrows and water velocity increases for a 3 km stretch, known as Long Rapids. For the next 7 km, the river widens, and water velocity decreases.

Birthday Rapids is located approximately 10 km downstream of Clark Lake and 30 km upstream of Gull Rapids (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 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 17 km upstream of Gull Rapids 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 Gull Rapids. 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).

Gull Rapids is located approximately 3 km downstream of Caribou Island on the Nelson River (Map 1). Two large islands and several small islands occur within the rapids, prior to the river narrowing. The rapids are approximately 2 km in length, and the river elevation drops approximately 11 m along its 2 km length. A summary of construction activities at Gull Rapids is provided in Section 2.1.

Just below Gull Rapids, the Nelson River enters Stephens Lake. Stephens Lake was formed in 1971 by construction of the Kettle GS. Between Gull Rapids and Stephens Lake there is an approximately 6 km long reach of the Nelson River that, although affected by water regulation at the Kettle GS, remains riverine habitat with moderate velocity. 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 Gull Rapids.

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 (Map 1).

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, which extends into the south channel of Gull Rapids, was completed in 2015.

Work began to construct the Tailrace Summer Level Cofferdam on August 4 and 5, 2016 and then was suspended until October. Work also took place to widen the central portion of the Central Dam Cofferdam (Map 4) in late April and early May. With so little in-stream construction activity prior to completing field work in the fall, possible construction-related impacts to the aquatic environment during this period were limited to indirect effects (e.g., potential impacts to water quality from discharge at the cofferdam, runoff from disturbed terrestrial areas).

Split Lake outflows from late 2015 to the end of June 2016 were relatively high, generally ranging between 3500–4000 m<sup>3</sup>/s. The 75th percentile flow for Split Lake outflow is approximately 3,500 m<sup>3</sup>/s. Flow increased sharply in July 2016, reaching a peak of 4,700 m<sup>3</sup>/s in August, before declining. Water levels varied in conjunction with flow, however, some winter staging was apparent from December to May. During the winter of 2015/2016, water levels rose to approximately 155.5 m ASL. Water level on Gull Lake ranged from 154–155 m ASL for most of the open-water season.

## 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 range (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 was designed to monitor adult Lake Sturgeon (Hrenchuk and Barth 2017), however the same array is also used to monitor juvenile Lake Sturgeon (Lacho and Hrenchuk 2017), Walleye (Hrenchuk and Lacho 2017), and Lake Whitefish.

#### 3.1.1 ACOUSTIC TRANSMITTER APPLICATION

Lake Whitefish, measuring 372–565 millimetre (mm) fork length, were tagged with Vemco V13 acoustic transmitters (1,141-day battery life) between September 25 and October 8, 2014. Due to difficulty in capturing Lake Whitefish in the Gull Lake area, only 20 were tagged upstream of Gull Rapids; 40 were tagged downstream of Gull Rapids in Stephens Lake (Tables 1 and 2). Lake Whitefish were captured using a boat electrofisher to decrease potential stress and mortality (Hrenchuk and Barth 2015). All Lake Whitefish tagged upstream of Gull Rapids were captured immediately downstream of Birthday Rapids (32 river kilometres [rkm] upstream of Gull Rapids) (Map 6). In Stephens Lake, fish were captured along the north shore of the Nelson River, 0.5 to 1.3 rkm downstream of Gull Rapids (Map 4). Each acoustically-tagged whitefish was measured for fork length and weight, and marked with an external Floy® tag. Acoustic tags were applied through surgical implantation in the coelomic cavity as described in McDougall *et al.* (2013).

#### 3.1.2 ACOUSTIC RECEIVERS

Since 2014, stationary acoustic receivers (VEMCO model VR2 and VR2W) were used to continuously monitor tagged Lake Whitefish between Clark Lake and the Keeyask GS construction site, Stephens Lake, and the Long Spruce reservoir. 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 these receivers was to determine whether fish that had moved into the Long Spruce reservoir the preceding year had continued to move downstream.

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. 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.

The retrieval of receivers deployed during winter has proved challenging; several were lost in previous winters, likely because of ice (Hrenchuk and Barth 2013). Because it appears that receivers will only remain safe from ice if deployed at depths greater than 10 m, the number of possible receiver locations during winter, especially in Gull Lake, is limited.

### **3.1.2.1 WINTER 2015/2016**

The stationary acoustic receiver array for the winter 2015/2016 (October 12, 2015 to April 30, 2016) period consisted of 21 receivers. Four were set upstream of Gull Rapids, 16 throughout Stephens Lake, and one in the Long Spruce reservoir (Maps 3, 4, and 5).

During the 2015/2016 monitoring period in Stephens Lake, two receivers were added to the array used in 2014/2015 to increase detection coverage: #114226 at rkm 9.9; and #114241 at rkm 26.0 (Map 4). Two receivers set at rkm 6.1 and 6.3 downstream of the Keeyask GS construction site were lost in 2014/2015 and were not replaced in 2015/2016.

### **3.1.2.2 OPEN-WATER 2016**

An array of 60 receivers was used during the 2016 open-water period (defined as May 1 to October 19, 2016). Twenty-six were set upstream of Gull Rapids (as far upstream as the inlet of Clark Lake), 29 in Stephens Lake, three in the Long Spruce reservoir, and two in the Limestone reservoir (Maps 6, 7, and 8).

The 2016 open-water array differed slightly from arrays used in previous years. Two receivers (#100656 and #125101) were set in locations that had not been used previously (Map 6). Receiver #100656 was set at rkm -46.9 near the Assean River to monitor potential upstream movements. Receiver #125101 was set at rkm -24.3 to allow for better detection coverage within the riverine area between Birthday Rapids and Gull Lake. Three additional receivers were set in Stephens Lake. Receiver #4495 (at rkm 7.0 in the north arm of Stephens Lake) and #129183 (at rkm 20 at the entrance to Ferris Bay) were set to monitor fish leaving the coverage of the existing receiver array. Receiver #107993 was set at rkm 36.1 in lower Stephens Lake to provide better detection coverage in this area (Map 7). Two additional receivers were set immediately downstream of the Long Spruce GS (#100779 at rkm 57.6; and #114234 at rkm 58.6) in the Limestone reservoir to monitor potential movements through the GS (Map 8).

Receiver “gates” were deployed in several key areas: four between Clark Lake and Gull Rapids (44.0, 34.0, 19.0, and 10.0 rkms upstream of Gull Rapids), and two in Stephens Lake (4.5 and 40.0 rkms downstream of Gull Rapids) (Maps 7 and 8). Receiver “gates” consisted of two or

more acoustic receivers set parallel to flow to provide 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 interpolation of coarse-scale positions (*i.e.* which zone) during periods which fish remain undetected. Should a fish be detected within a zone but then go undetected for a period of time, we can be confident that it is still located within that zone outside of receiver detection range, as it was not detected passing through a gate. The area upstream of Gull Rapids was divided into five zones (Map 7; zones 1–5), while Stephens Lake was divided into two zones (Map 8; zones 6 and 7). The Long Spruce reservoir is referred to as Zone 8 and the Limestone reservoir as Zone 9. The location of the “gates” has remained consistent since first set in 2012. On October 19, 2016, the majority of receivers were removed and a subset ( $n = 21$ ) were redeployed to monitor movements during winter 2016/2017.

### 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 Gull Rapids representing a distance of 0 rkm. The area located downstream of Gull Rapids (*i.e.*, Stephens Lake and the Long Spruce reservoir) were given positive (+) distance values from Gull Rapids, 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 Gull Rapids 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 was calculated and plotted.

## 4.0 RESULTS

Section 4.1 provides a summary of Lake Whitefish movements prior to winter 2015/2016 (since the study began in 2014). Tables 1 and 2 provide acoustic tagging and biological information associated with each tagged fish. Figures 1 and 2 show receiver locations both upstream and downstream of Gull Rapids during the 2015/16 winter and 2016 open-water periods. Figures 3 to 15 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 Appendices A1-1 to A1-4.

### 4.1 2014–2015 RESULTS SUMMARY

#### 4.1.1 UPSTREAM OF GULL RAPIDS

Twenty fish were tagged upstream of Gull Rapids in 2014 (Table 1), but, since that time, several tags have gone missing and are considered lost:

- #33802 was tagged downstream of Birthday Rapids (rkm -33) on October 8, 2014. It subsequently moved downstream and was last detected in Gull Lake at rkm -12.9 on October 29, 2014 (Appendix A2-6).
- #33797 was tagged downstream of Birthday Rapids (rkm -33) on October 8, 2014, and it has not subsequently been detected (Appendix A2-2).
- #33800 was tagged downstream of Birthday Rapids (rkm -33) on October 8, 2014, and was last detected one day later at rkm -32.3 (Appendix A2-4).

One fish was captured during an experimental gillnetting program and suffered mortality (Lavergne *et al.* 2016):

- #33820 was tagged downstream of Birthday Rapids (rkm -33) on October 8, 2014, and was last detected at rkm -26.5 on July 29, 2015 before being captured at rkm -21.0 on August 15, 2015 (Appendix A2-17).

A single fish moved downstream into Stephens Lake during the open-water period in 2015:

- #33805 was tagged downstream of Birthday Rapids (rkm -33) on October 8, 2014. It was detected in Gull Lake (rkm -11.8 to -5.8) from June 20 to 29, 2015. It was next detected in Stephens Lake at rkm 2.7 on October 5, 2015 (Appendix A2-9).

Therefore, accounting for the 20 fish originally tagged, the three missing fish, the one gillnetting mortality, and the one fish that moved downstream into Stephens Lake, a total of 15 Lake Whitefish were available to be detected upstream of Gull Rapids during winter 2015/2016.

### **4.1.2 STEPHENS LAKE**

Forty Lake Whitefish were tagged in Stephens Lake in 2014 (Table 2). Seven are considered missing due to a lack of detections:

- #6360 moved downstream immediately after being tagged at rkm 1.6 on September 30, 2014. It was last detected at rkm 16.8 on October 20, 2014 (Appendix A3-4).
- #6366 moved downstream immediately after being tagged at rkm 1.6 on September 30, 2014. It was last detected at rkm 16.8 on October 19, 2014 (Appendix A3-10).
- #33823 moved downstream immediately after being tagged at rkm 1.6 on October 4, 2014. It was last detected at rkm 7.7 on November 11, 2014 (Appendix A3-33).
- #6362 and #6369 were tagged downstream of Gull Rapids at rkm 1.3 on September 30, 2014, and were briefly detected at rkm 4.5 immediately after tagging. Neither fish has been detected since October 12, 2014 (Appendices A3-6 and A3-13).
- #33799 was tagged downstream of Gull Rapids at rkm 1.3 on September 30, 2014 and was last detected on October 24, 2014 at rkm 4.3 (Appendix A3-24).
- #6373 was tagged at rkm 1.6 on September 25, 2014 and was detected for a single day at rkm 4.3 on October 7, 2014 (Appendix A3-17).

No fish were detected within the Long Spruce reservoir, thus, these missing fish did not move downstream through the Kettle GS.

A single fish moved downstream through Gull Rapids into Stephens Lake in 2015 (as discussed in section 4.1.1).

Therefore, accounting for the 40 fish originally tagged, the seven missing fish, and the one fish that moved downstream through Gull Rapids, a total of 34 Lake Whitefish were available to be detected in Stephens Lake during winter 2015/2016.

## **4.2 WINTER 2015/2016**

### **4.2.1 UPSTREAM OF GULL RAPIDS**

All four receivers deployed upstream of Gull Rapids during winter were retrieved. Five of the 15 Lake Whitefish available were located a total of 1,221 times (range: 24–994 detections per individual) (Appendix A1-1). Fish were detected on 2 to 23 days of the 202 day winter period (0–



11% of the time) for an average of 7 days, or 3% of the study period (StDev = 9.1 days). One fish (#33816) was located between the inlet to Clark Lake (rkm -48.2) and rkm -12.9 in Gull Lake. Three fish (#33793, #33803, and #33805) were detected exclusively in the riverine habitat downstream of Birthday Rapids (rkm -33.8 to -29.4). The fifth fish (#33798) was located between rkm -29.4 in the riverine habitat downstream of Birthday Rapids and rkm -12.9 in Gull Lake (Figures 3 and 4; Appendix A1-1). No fish were located by the receiver at rkm -9.9. The majority of detections ( $n = 1,005$ ; 82%) were logged by the receiver set in the riverine area downstream of Birthday Rapids (rkm -29.4) (Figure 4).

## 4.2.2 STEPHENS LAKE

Eleven of the 16 receivers deployed in Stephens Lake during winter were retrieved. Three receivers located at rkms 10.5, 33.0, and 40.0 could not be retrieved due to the buildup of large woody debris that occurred during the winter months. The two receivers closest to Kettle GS (rkm 40.8) could not be retrieved (Map 4). Inspection with the sonar used to locate receivers after winter (Lowrance HDS) revealed that they were covered by sediment.

Eleven of the 34 available Lake Whitefish were located a total of 45,957 times (range: 5–19,163 detections per individual) (Appendix A1-2). Fish were detected on 1 to 108 of the 202 day winter period (0–53% of the time) for an average of 30 days, or 15% of the study period (StDev = 41.5 days). The farthest upstream detections occurred at rkm 7.7 (by seven fish; 64%), while the furthest downstream occurred at rkm 21.0 (by three fish; 27%) (Appendix A1-2). The average overall movement range was 4.9 rkm (range: 0.0–13.3 rkm) (Figures 5 and 6; Appendix A1-2). The majority of detections ( $n = 39,256$ ; 85%) were logged at two receivers, one in the former channel of the Moosenose River (rkm 13.4) and one in the southern portion of Stephens Lake (rkm 14.9) (Figure 6).

## 4.3 OPEN-WATER 2016

### 4.3.1 ACOUSTIC RECEIVER RETRIEVAL

All stationary acoustic receivers deployed upstream of Gull Rapids (26), in the Long Spruce reservoir (3), and in the Limestone reservoir (2) during the 2016 open-water period were successfully retrieved (Maps 6 and 8). One of the 29 receivers deployed in Stephens Lake (#4495; rkm 7.0) was caught on submerged trees approximately one month after it was deployed (Map 7). No data was retrieved from this receiver.

### 4.3.2 UPSTREAM OF GULL RAPIDS

Fifteen Lake Whitefish were available to be detected during the 2016 open-water period. Twelve of these fish were located between 68 and 9,704 times for 4–106 days of the 172 day open-water period (2–62% of the time; Appendix A1-3). The average movement range was 21.8 rkm (StDev = 12.6 rkm; range: 0.1–41.1 rkm). The furthest upstream detections occurred in Clark Lake at rkms -48.2 and -46.9 (by five fish; 33%), while the furthest downstream occurred at rkm -5.8 (by one fish; 8%) (Figure 7). No tagged Lake Whitefish moved downstream through Gull Rapids (Table A1-3).

#### 4.3.2.1 PROPORTIONAL DISTRIBUTION

As in 2015, individual Lake Whitefish used zones 3 (river reach from Birthday Rapids to Gull Lake) and 4 (upper basin of Gull Lake) most often, spending a total of 21% (StDev = 29%; range: 0–79%) and 50% (StDev = 38%; range: 0–100%) of the study period in these areas, respectively (Figures 13 and 14). Zones 1 (Clark Lake), 2 (river reach from Clark Lake to Birthday Rapids), and 5 (lower basin of Gull Lake) were used less frequently: Zone 1 (7%; StDev = 9%; range 0–21%), Zone 2 (6%; StDev = 11%; range 0–33%), and Zone 5 (17%; StDev = 26%; range 0–61%) (figures 13 and 14). A greater proportion of fish were detected in Gull Lake (zones 4 and 5) in the spring and summer than in the fall:

- Gull Lake was used an average of 79% of the time (StDev = 5%; range: 67–83%) between May 26 and September 13, 2016; and
- 29% (StDev = 10%; range: 17–58%) between September 14 and October 19, 2016.

#### 4.3.2.2 MOVEMENT PATTERNS

During the 2016 open-water period, the majority of detections were logged by two receivers located in Gull Lake at rkm -12.9 (n = 6,615; 22%) and rkm -9.0 (n = 6,672; 22%; Figure 10). During the spawning period (September 23 to October 19, 2016), four fish (#33798, #33806, #33822, and #33826) made distinct upstream movements to Birthday Rapids. During this time, 69% of detections (n = 2,196) were logged immediately downstream of Birthday Rapids at rkm -33.8 (Figure 11).

Eight of the 12 fish detected during the 2016 open-water period were located primarily in Gull Lake (between rkm -19.5 and -7.4) during spring and summer, and moved upstream in the fall. All eight fish displayed similar patterns of movement during open-water 2015.

- Four moved through Birthday Rapids and into Clark Lake between September 12 and October 4:



- #33803, #33804, and #33813 were last located at the mouth of the Assean river (rkm -46.9) (Appendices A2-7, A2-8, and A2-15). It is likely that these fish moved upstream into the river to spawn; and
- #33816 was last located at the inlet to Clark Lake (rkm -48.2) on October 4, 2016 (Appendix A2-16).
- Four moved to the base of Birthday Rapids:
  - #33798 and #33806 were last located at rkm -33.8 on October 19, 2016 (Appendix A2-3, A2-10);
  - #33822 was last located at rkm -32.3 on October 19, 2016 (Appendix A2-18); and
  - #33826 was last located at rkm -34.3 on August 31, 2016 (Appendix A2-19).

Two were located exclusively upstream of Gull Lake:

- #33830 was only located within 4.9 rkm of Birthday Rapids (Appendix A2-20); and
- #33807 was detected near the base of Birthday Rapids (rkm -33.8) on September 16, 2016 and moved upstream into Clark Lake to the mouth of the Assean River (-46.9 rkm) on September 19 (Appendix A2-11).
  - This fish likely moved upstream into the Assean River.

The two remaining fish were located exclusively within Gull Lake for 11 to 16 detection days:

- #33808 remained at the upstream end of Gull Lake (rkm -19.5 to -19.4) from July 10 to August 1 (Appendix A2-12); and
- #33793 was detected a total of 68 times over 11 detection days. The fish was first detected at rkm -19.5 on July 4, 2016 before moving downstream where it was last detected at rkm -7.4 on July 25 (Appendix A2-1).

### 4.3.3 STEPHENS LAKE

Nineteen of the 34 tagged Lake Whitefish available to be detected during the 2016 open-water period were located between two and 4,717 times over 1–45 days of the 172 day study period (1–26% of the time) (Appendix A1-4). The average movement range was 8.0 rkm (StDev = 6.5 rkm; range = 0–19.8 rkm). The farthest upstream detections occurred at rkm 1.2 (by 15 fish; 79%), while the furthest downstream occurred at rkm 21.0 (by one fish; 5%) (Appendix A1-4). A single fish (#6372) was located at the entrance to Ferris Bay (rkm 20.0). No fish moved upstream through Gull Rapids or downstream through the Kettle GS.

#### 4.3.3.1 PROPORTIONAL DISTRIBUTION

As in open-water 2015, Lake Whitefish used Zone 6 more frequently than Zone 7 (referred to as Zones 1 and 2, respectively, in previous reports). On average, fish spent 55% (StDev = 46%;

range: 0–100%) of the time in Zone 6 and 45% (StDev = 46%; range: 0–100%) in Zone 7 (Figures 13 and 14). The proportion of fish using Zone 6 increased over the study period:

- Zone 6 was used an average of 54% of the time (StDev = 4%; range: 42–68%) between May 26 and October 10, 2016; and
- 81% (StDev = 8%; range: 68–89%) between October 11 and 19, 2016.

#### 4.3.3.2 MOVEMENT PATTERNS

During the 2016 open-water period the majority of detections ( $n = 2,790$ ; 22%) were recorded at rkm 13.9 (Figure 15). During the spawning period (September 23 to October 19, 2016) 43% of detections ( $n = 2,582$ ) were logged within 2.7 rkms of Gull Rapids (Figure 16).

Nine of the 19 Lake Whitefish detected during the 2016 open-water period spent the majority of the time (78–100%) downstream of rkm 5.0 (Zone 7).

- Seven made brief upstream movements into Zone 6:
  - Five (#6357, #6358, #6361, #6372, and #33818) were located within 1.2 rkm of Gull Rapids in the fall (between September 17 and October 16, 2016) for 3–7 days (Appendices A3-1, A3-2, A3-5, A3-16, A3-30); and
  - Two (#6364 and #33796) were located as far upstream as rkm 3.8 for a single day (October 16, 2016) (Appendices A3-8 and A3-23).
- Two were only located in lower Stephens Lake:
  - #6376 was located for a single day (September 17, 2016) at rkm 13.0 (Appendix A3-20); and
  - #33821 was detected between rkms 9.4 and 13.0 for 3 days between June 14 and August 10, 2016 (Appendix A3-32).

The remaining ten fish spent the majority (75–100%) of the open-water season in Zone 6.

- All ten were detected as far upstream as 1.2 rkm for 1–6 days:
  - Six (#6375, #33805, #33811, #33817, #33819, and #33825) made brief (1 to 4 day) downstream movements into Zone 7 (Appendices A3-19, A2-9, A3-26; A3-29; A3-31; A3-35); and
  - Four (#33795, #33810, #33814, and #33832) remained in Zone 6 for the entire open water period (Appendices A3-22, A3-25, A3-27, A3-40).

## 5.0 DISCUSSION

This report presents results of the second year (October 2015 to October 2016) of a three-year Lake Whitefish movement monitoring study initiated in September 2014. These acoustic transmitters will last at least until November 2017. An additional 60 Lake Whitefish will be tagged in fall 2017, allowing the tracking of Lake Whitefish to continue until 2020.

### 5.1 EVALUATION OF METHODOLOGY

Acoustic telemetry has proven effective for monitoring long distance movements of Lake Whitefish in the Keeyask Study Area (Murray and Barth 2007; Lavergne and Hrenchuk 2016); however, relative to similar studies on adult and juvenile Lake Sturgeon (Hrenchuk and Barth 2016; Lacho and Hrenchuk 2016), results are more difficult to interpret. Based on experimental gillnetting data, Lake Whitefish often use areas where receiver coverage is poor such as off-current embayments, tributaries, and shallow habitats. Therefore, it can be expected that the detection frequency for tagged whitefish will be less than that observed for sturgeon, and a greater proportion of tagged Lake Whitefish will either not be detected for extended periods or never be detected during the study. For example, of the 60 whitefish tagged above and below Gull Rapids during fall 2014, 10 (17%) have not been detected since being tagged and only 31 (52%) were detected in open-water 2016.

During the 2016 open-water period, additional receivers were placed at tributary confluences in the north arm of Stephens Lake to account for Lake Whitefish that may be leaving the southern portion of Stephens Lake. Upstream of Gull Rapids, a single receiver was placed at the mouth of the Assean River, which is a known spawning site (Johnson 2005; Lavergne and Hrenchuk 2016). Four tagged whitefish were last located at this receiver in September and October, 2016, and it is likely that these four fish moved into the Assean River to spawn. In Stephens Lake, receivers were placed in the North Arm and at the mouth of Ferris Bay, a known spawning location (Michaluk *et al.* 2011; Keeyask Hydropower Limited Partnership 2014). The receiver placed in the North Arm was caught on submerged trees and could not be downloaded during the 2016 open-water season; however, one fish was located by the receiver set at the mouth of Ferris Bay.

Due to ice conditions, the majority of receivers are removed for the winter period. Receivers placed near spawning locations at Birthday Rapids and Gull Rapids cannot be deployed over winter because of ice conditions. These receivers are removed in early October, prior to ice formation. In 2015, receivers were removed on October 11 when the water temperature was 8.3°C. Lake Whitefish are known to spawn in the area when water temperature falls below 8°C, and, thus, some spawning movements were likely missed. In 2016, water temperature in the Nelson River dropped quickly and measured only 4.3°C when receivers were removed on

October 19. As a result, receivers were in place to track spawning movements both upstream and downstream of Gull Rapids in 2016 (Section 5.3).

## 5.2 WINTER 2015/16

The quantity of data collected during the winter months is generally lower than during open-water. Similar to the 2014/2015 winter period, a large proportion of Lake Whitefish tagged upstream of Gull Rapids went undetected during 2015/2016 with only five of the 15 fish (33%) located. The habitat in Stephens Lake is more conducive to over-winter receiver deployment (due to depths >10 m) and, as such, the receiver coverage is more widespread. Despite this, the proportion of whitefish detected in Stephens Lake during the winter period (29%) was similar to upstream of Gull rapids (33%).

## 5.3 OPEN-WATER 2016

The quantity of data collected for Lake Whitefish is on average lower relative to that of other species tagged with acoustic transmitters in this study area. The overall low number of detections in the open-water season makes it difficult to distinguish movement patterns of whitefish. Upstream of Gull Rapids, 12 of 15 fish (80%) were detected. These fish were split into three groups: those that remained primarily in Gull Lake but made upstream movements in the fall, those that remained exclusively in Gull Lake, and those that remained between Clark Lake and Gull Lake. Similar to open-water 2015, Lake Whitefish used zones 3 (river reach from Birthday Rapids to Gull Lake) and 4 (upper basin of Gull Lake) most often during the spring and summer months. During the fall a large proportion of fish (67%) made upstream movements to the base of Birthday Rapids or further into Clark Lake.

In Stephens Lake, 19 of 34 fish (56%) were detected. These fish were not detected for large portions of the open-water season, however, because of the presence of the receiver gates, their locations could be inferred. These detected whitefish were split into two groups: those that remained close to Gull Rapids (Zone 6) and those that were located further downstream in Stephens Lake (Zone 7) for the majority of the study period. Use of the two zones was similar, with Zone 6 being used 54.2% of the time and Zone 7 being used 45.8% of the time. However, the use of Zone 6 increased during the spawning period.

Lake Whitefish spawn when water temperatures drop below 8°C. Upstream of Gull Rapids, Lake Whitefish are known to spawn at Birthday Rapids and in the Assean River (Johnson 2005). In Stephens Lake, whitefish spawn at the base of Gull Rapids, in the North and South Moswakot rivers, and in Ferris Bay (Michaluk *et al.* 2011; Keeyask Hydropower Limited Partnership 2014). Water temperature reached 8°C upstream of Gull Rapids and in Stephens Lake on October 6, however, in both areas, fish began moving upstream when water temperatures dropped below 14°C. Upstream of Gull Rapids, five fish were located at the base of Birthday Rapids, and four

moved upstream into the Assean River. In Stephens Lake, fifteen fish were located at the base of Gull Rapids for at least part of the spawning period. Despite Ferris Bay being a known spawning location no fish moved upstream into this area during the 2016 spawning period.

## 5.4 KEY QUESTIONS

The AEMP identified key questions for Lake Whitefish movement monitoring, two of which are relevant to the construction period and are addressed in the discussion below.

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

No tagged Lake Whitefish moved through Gull Rapids during the 2015/16 study year. Since the study was initiated in fall, 2014, a single tagged fish has moved downstream through Gull Rapids (Lavergne and Hrenchuk 2016), and none have moved upstream. As discussed for the adult Lake Sturgeon (Hrenchuk and Barth 2017), it is possible that upstream fish movement past the construction site is no longer possible because all flow has been diverted to the south channel and the south channel itself was partially constricted by construction of the spillway cofferdam in 2015. Although no Lake Whitefish have moved upstream through the rapids since the study began, no adult Lake Sturgeon have moved upstream since cofferdam construction yet had previously. Discharge in the Nelson River has been above median levels since the start of construction, further increasing water velocity in the south channel.

*Are whitefish utilizing habitat in the vicinity of construction activities (particularly during spawning)?*

Upstream of Gull Rapids, Lake Whitefish primarily used the riverine area between Birthday Rapids and Gull Lake (Zone 3) and the upper basin of Gull Lake (Zone 4). Only one of the 12 detected fish was located at the receiver closest to Gull Rapids. The results follow what was observed in 2014/2015 and indicate that Lake Whitefish tagged upstream are not using habitat directly upstream of the construction site.

In contrast, a considerable proportion of the whitefish population tagged downstream of Gull Rapids continue to inhabit the upper 6 km of Stephens Lake during the open-water period. During the 2016 spawning period, fish were located in this area for 89% of the time, with many fish located near the base of Gull Rapids. Therefore, it appears that Lake Whitefish spawned at the base of Gull Rapids during 2016.

## 6.0 SUMMARY AND CONCLUSIONS

- In open-water 2016, Lake Whitefish upstream of Gull Rapids moved upstream to spawning sites at Birthday Rapids and further upstream in the Assean River. A total of ten fish were located at or above the base of Birthday Rapids in the fall during the spawning season. In Stephens Lake, a large proportion of the detected whitefish were located near the base of Gull Rapids during this time.
- The key questions as described in the AEMP for Lake Whitefish movement monitoring during construction of the Keeyask GS are:
  - *What is the number (or the proportion) of tagged Lake Whitefish that move past the construction site?*

Results of this study to date suggest that a small proportion of the Lake Whitefish population from either Gull or Stephens lakes moves through Gull Rapids. Of the 20 whitefish tagged upstream of Gull Rapids, one (or 5%) moved downstream and into Stephens Lake sometime between June and October, 2015. There have been no upstream movements through the rapids.

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

The majority of Lake Whitefish tagged upstream of Gull Rapids do not appear to be using habitat directly upstream of the construction site. A large proportion of whitefish tagged downstream in Stephens Lake continue to use the area immediately downstream of Gull Rapids, including during the spawning period.

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## **TABLES**

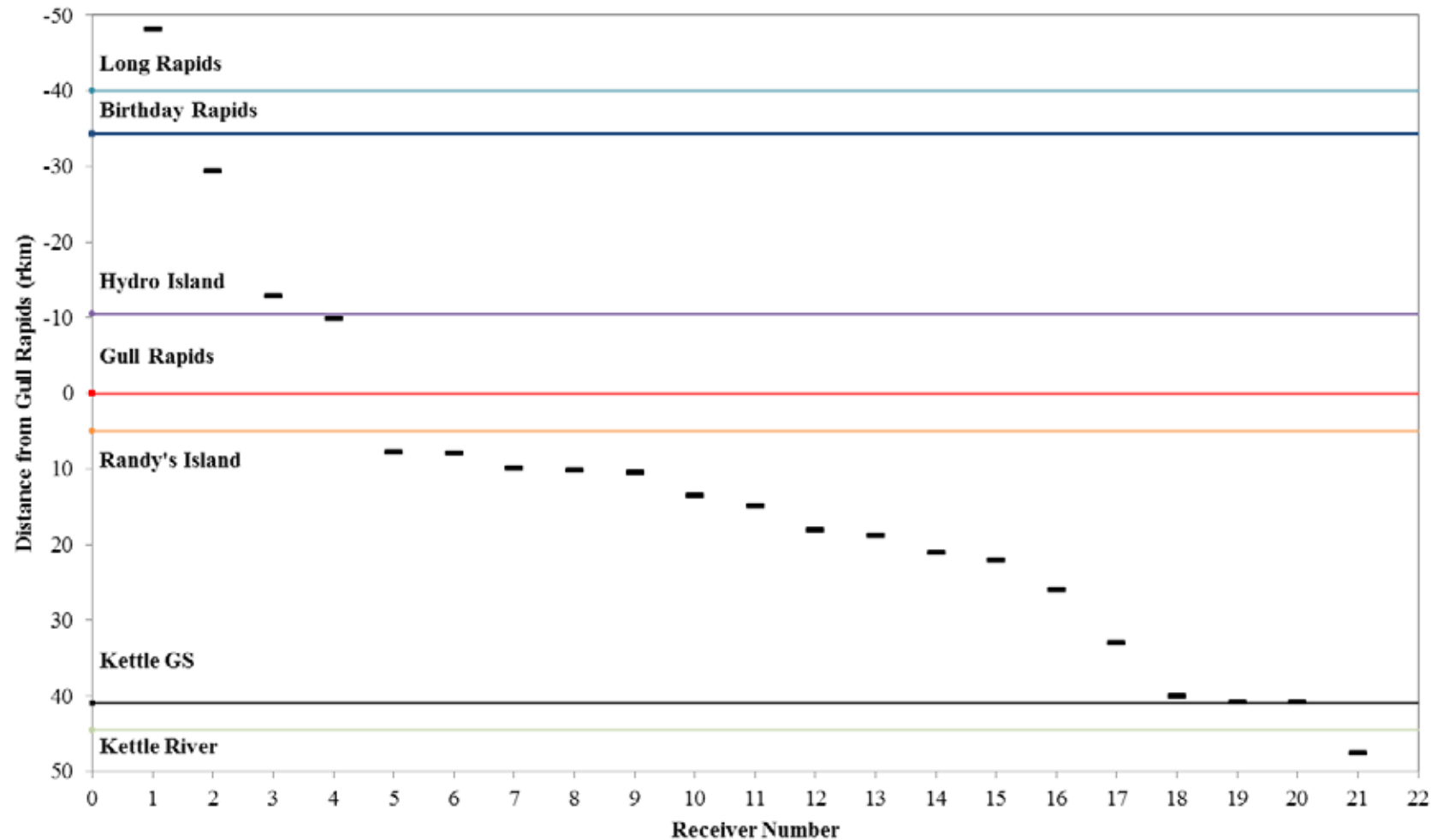
**Table 1: Acoustic-tag and biological information for each Lake Whitefish tagged with an acoustic transmitter in the Nelson River upstream of Gull Rapids, fall 2014.**

Acoustic Tag ID	Floy Tag #	Date Tagged	Tag Life (days)	Expiry Date	Fork Length (mm)	Weight (g)
33822	105434	7-Oct-14	1141	20-Nov-17	455	1825
33826	105436	7-Oct-14	1141	20-Nov-17	433	1200
33830	105437	7-Oct-14	1141	20-Nov-17	449	1500
33793	105950	8-Oct-14	1141	21-Nov-17	425	2350
33797	105949	8-Oct-14	1141	21-Nov-17	534	3350
33798	105447	8-Oct-14	1141	21-Nov-17	464	1775
33800	105439	8-Oct-14	1141	21-Nov-17	416	1025
33801	105948	8-Oct-14	1141	21-Nov-17	529	2450
33802	105448	8-Oct-14	1141	21-Nov-17	503	2300
33803	105438	8-Oct-14	1141	21-Nov-17	500	2150
33804	105440	8-Oct-14	1141	21-Nov-17	482	1625
33805	105947	8-Oct-14	1141	21-Nov-17	434	1400
33806	105449	8-Oct-14	1141	21-Nov-17	495	1925
33807	105446	8-Oct-14	1141	21-Nov-17	461	1375
33808	105944	8-Oct-14	1141	21-Nov-17	444	1850
33809	105945	8-Oct-14	1141	21-Nov-17	482	1725
33812	105442	8-Oct-14	1141	21-Nov-17	560	3425
33813	105946	8-Oct-14	1141	21-Nov-17	438	1325
33816	105444	8-Oct-14	1141	21-Nov-17	452	1650
33820	105445	8-Oct-14	1141	21-Nov-17	493	1725

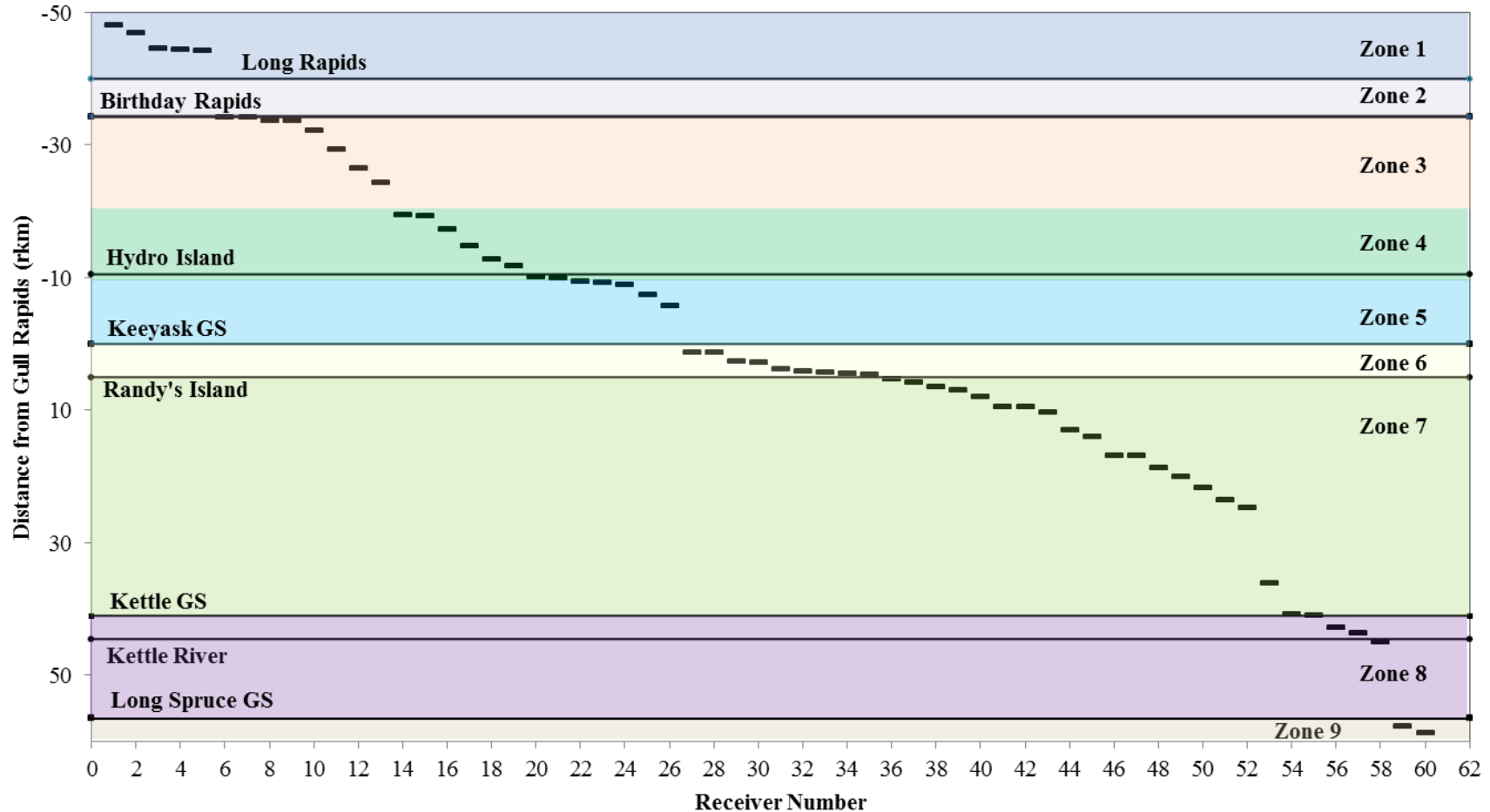
**Table 2: Acoustic-tag and biological information for each Lake Whitefish tagged with an acoustic transmitter in Stephens Lake, fall 2014.**

Acoustic Tag ID	Floy Tag #	Date tagged	Tag life (days)	Expiry date	Fork length (mm)	Weight (g)
6367	99688	25-Sep-14	1141	8-Nov-17	508	2100
6368	99689	25-Sep-14	1141	8-Nov-17	495	2050
6372	99685	25-Sep-14	1141	8-Nov-17	482	1800
6373	99686	25-Sep-14	1141	8-Nov-17	541	2900
6374	N/A	25-Sep-14	1141	8-Nov-17	510	2300
6375	99687	25-Sep-14	1141	8-Nov-17	492	1750
6376	99683	25-Sep-14	1141	8-Nov-17	380	900
6357	99651	30-Sep-14	1141	9-Nov-17	436	1500
6358	99675	30-Sep-14	1141	9-Nov-17	503	2400
6359	99674	30-Sep-14	1141	9-Nov-17	520	2300
6360	99673	30-Sep-14	1141	9-Nov-17	460	1700
6361	99672	30-Sep-14	1141	9-Nov-17	495	2300
6362	99654	30-Sep-14	1141	9-Nov-17	514	2500
6363	99655	30-Sep-14	1141	9-Nov-17	489	1900
6364	99656	30-Sep-14	1141	9-Nov-17	445	1600
6365	99657	30-Sep-14	1141	9-Nov-17	524	3000
6366	99658	30-Sep-14	1141	9-Nov-17	440	1700
6369	99700	30-Sep-14	1141	9-Nov-17	538	3000
6370	99652	30-Sep-14	1141	9-Nov-17	560	3700
6371	99651	30-Sep-14	1141	9-Nov-17	520	3500
33794	99696	30-Sep-14	1141	9-Nov-17	552	2700
33795	99697	30-Sep-14	1141	9-Nov-17	483	2200
33796	99699	30-Sep-14	1141	9-Nov-17	372	950
33799	99698	30-Sep-14	1141	9-Nov-17	549	2900
33810	99694	30-Sep-14	1141	9-Nov-17	551	3250
33811	99670	30-Sep-14	1141	9-Nov-17	448	1600
33814	99692	30-Sep-14	1141	9-Nov-17	446	1600
33815	99693	30-Sep-14	1141	9-Nov-17	538	2600
33817	99671	30-Sep-14	1141	9-Nov-17	508	2400
33818	99690	30-Sep-14	1141	9-Nov-17	456	1850
33819	99691	30-Sep-14	1141	9-Nov-17	565	3150
33821	105450	4-Oct-14	1141	17-Nov-17	459	1575
33823	105432	4-Oct-14	1141	17-Nov-17	454	1750
33824	105430	4-Oct-14	1141	17-Nov-17	519	2650
33825	105426	4-Oct-14	1141	17-Nov-17	442	1325
33827	105433	4-Oct-14	1141	17-Nov-17	410	1800
33828	105429	4-Oct-14	1141	17-Nov-17	494	2150
33829	105427	4-Oct-14	1141	17-Nov-17	506	2400
33831	105431	4-Oct-14	1141	17-Nov-17	538	2700
33832	105428	4-Oct-14	1141	17-Nov-17	549	2725

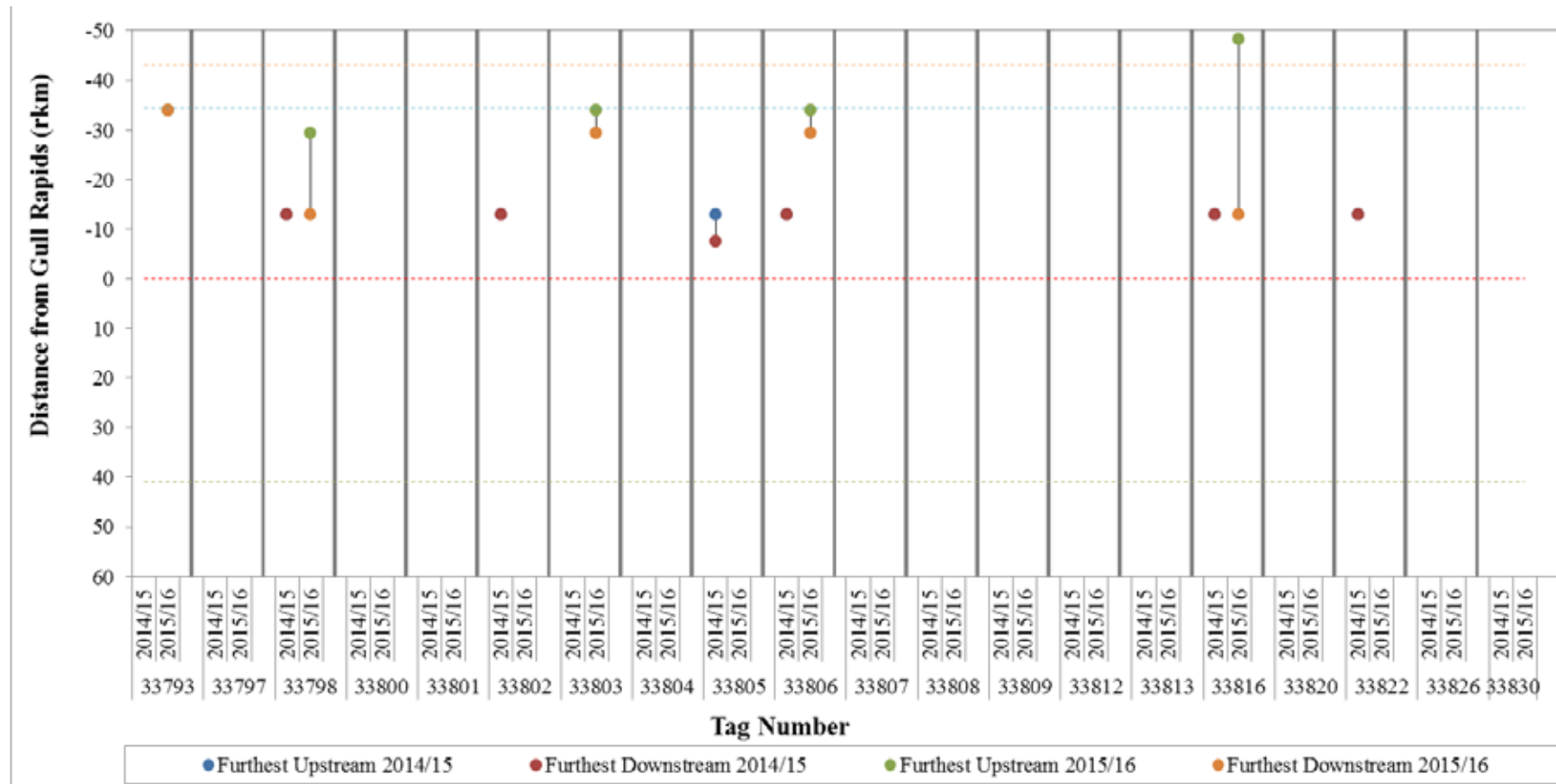
## FIGURES



**Figure 1:** Locations of stationary acoustic receivers (dashes) in relation to the base of Gull Rapids (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Limestone GS between October, 2015 and June, 2016.

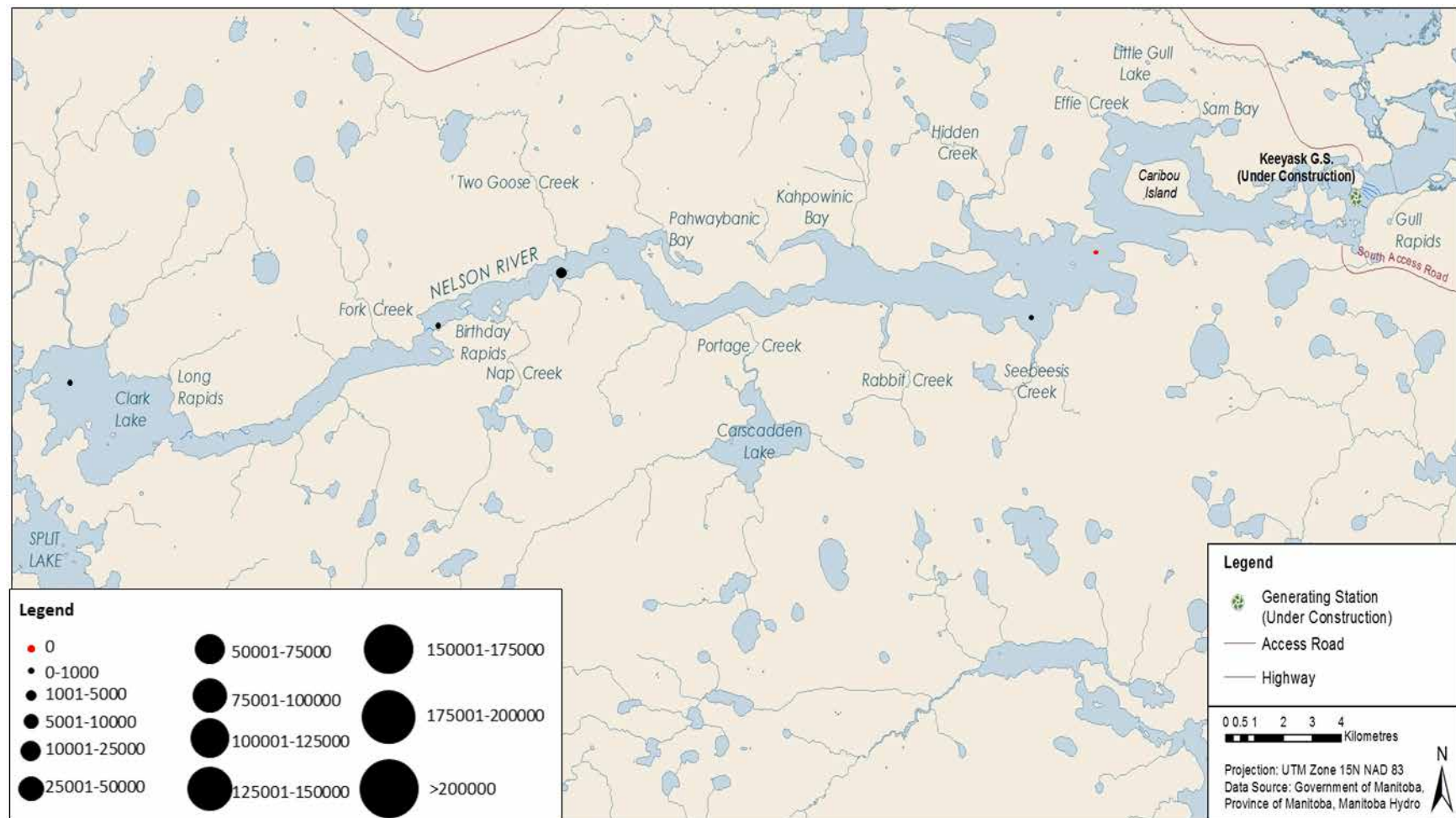


**Figure 2:** Locations of stationary acoustic receivers (dashes) in relation to the base of Gull Rapids (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Limestone GS between June and October, 2016. River zones upstream and downstream of Gull Rapids are indicated by shading.



**Figure 3:** Detection ranges for individual Lake Whitefish ( $n = 20$ ) tagged with acoustic transmitters upstream of Gull Rapids during the 2014/15 (October 15, 2014 to April 30, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS).





**Figure 4:** Relative number of detections at each acoustic receiver set between Clark Lake and Gull Rapids during winter 2015/2016 (October 12, 2015, to May 1, 2016). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

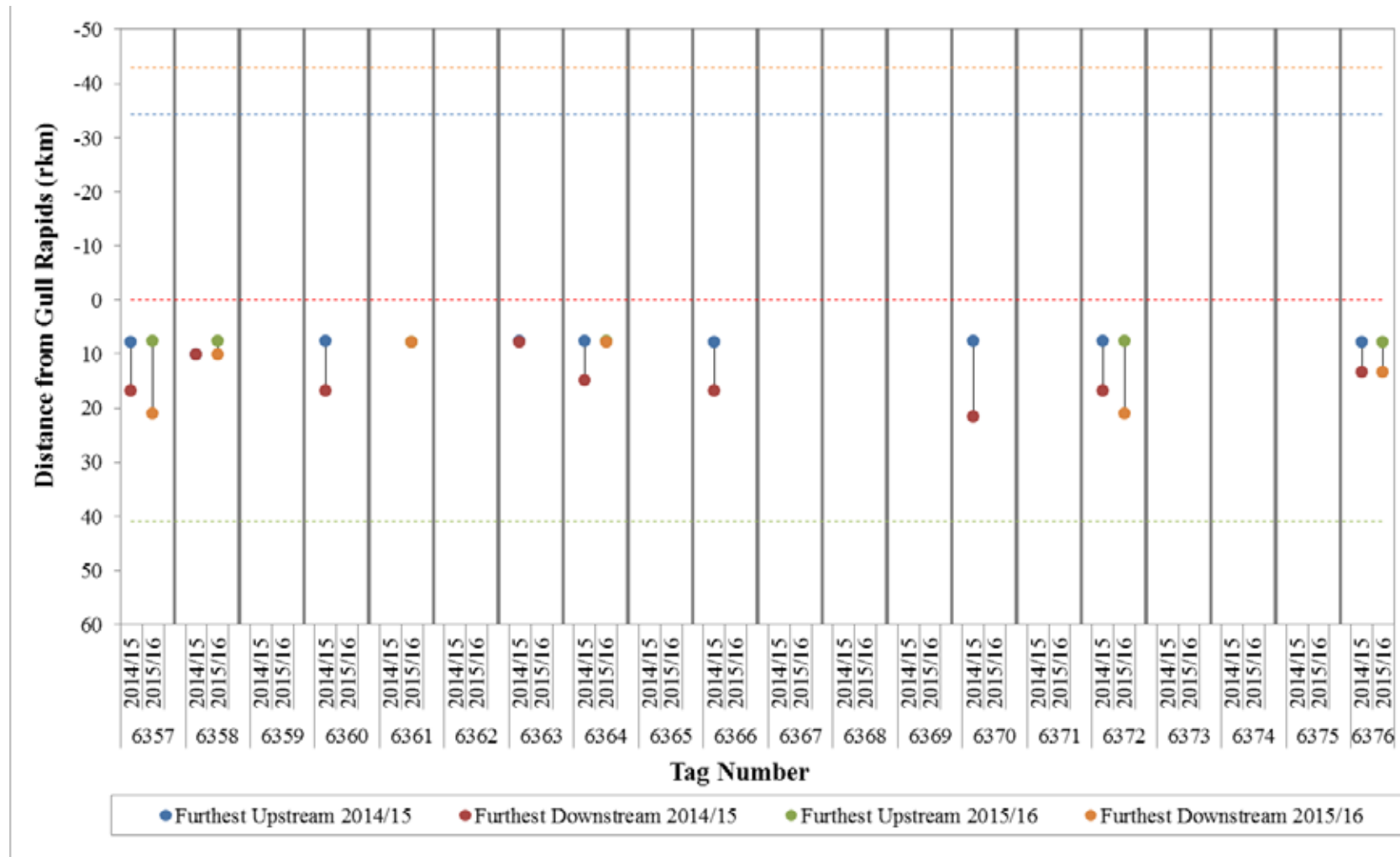
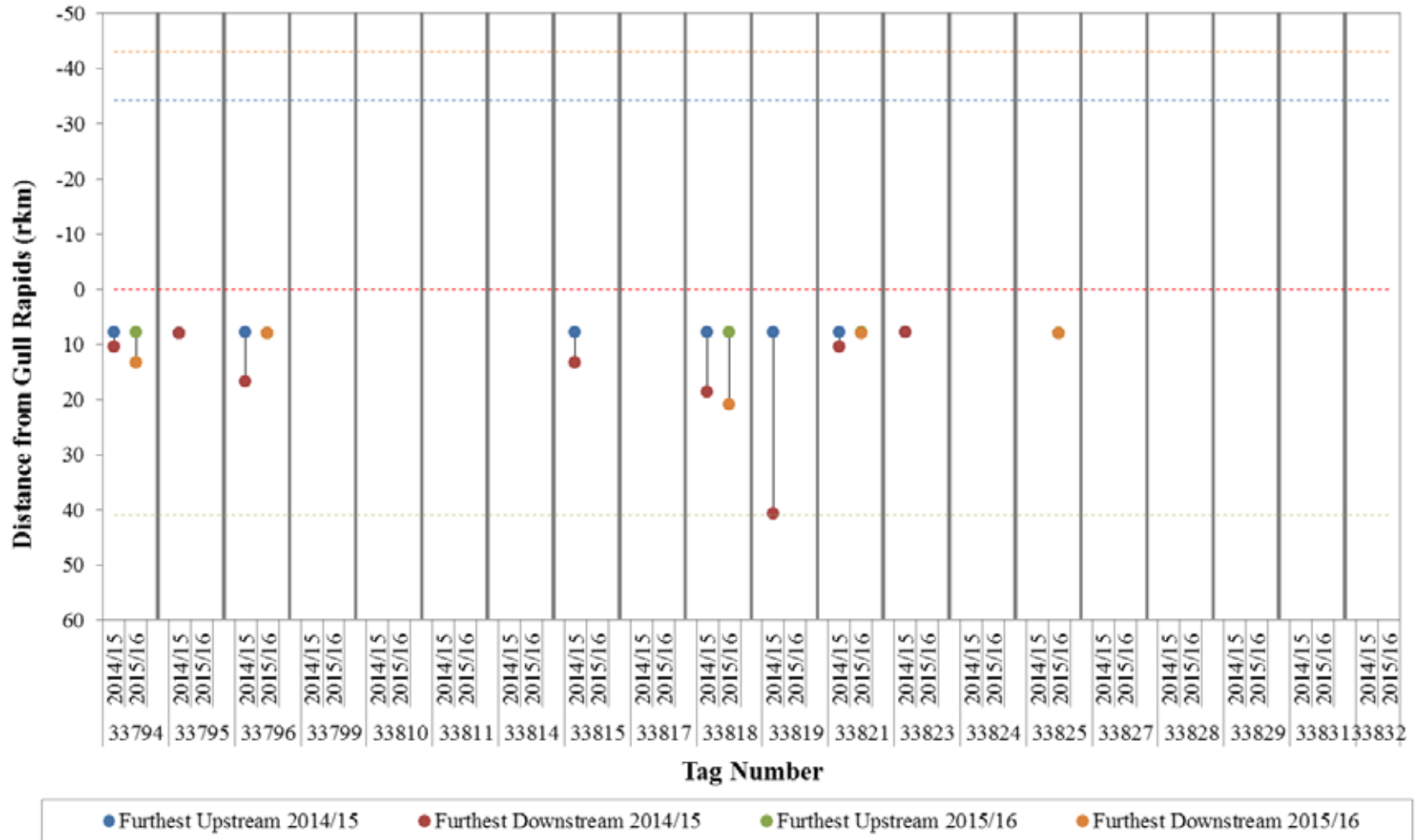
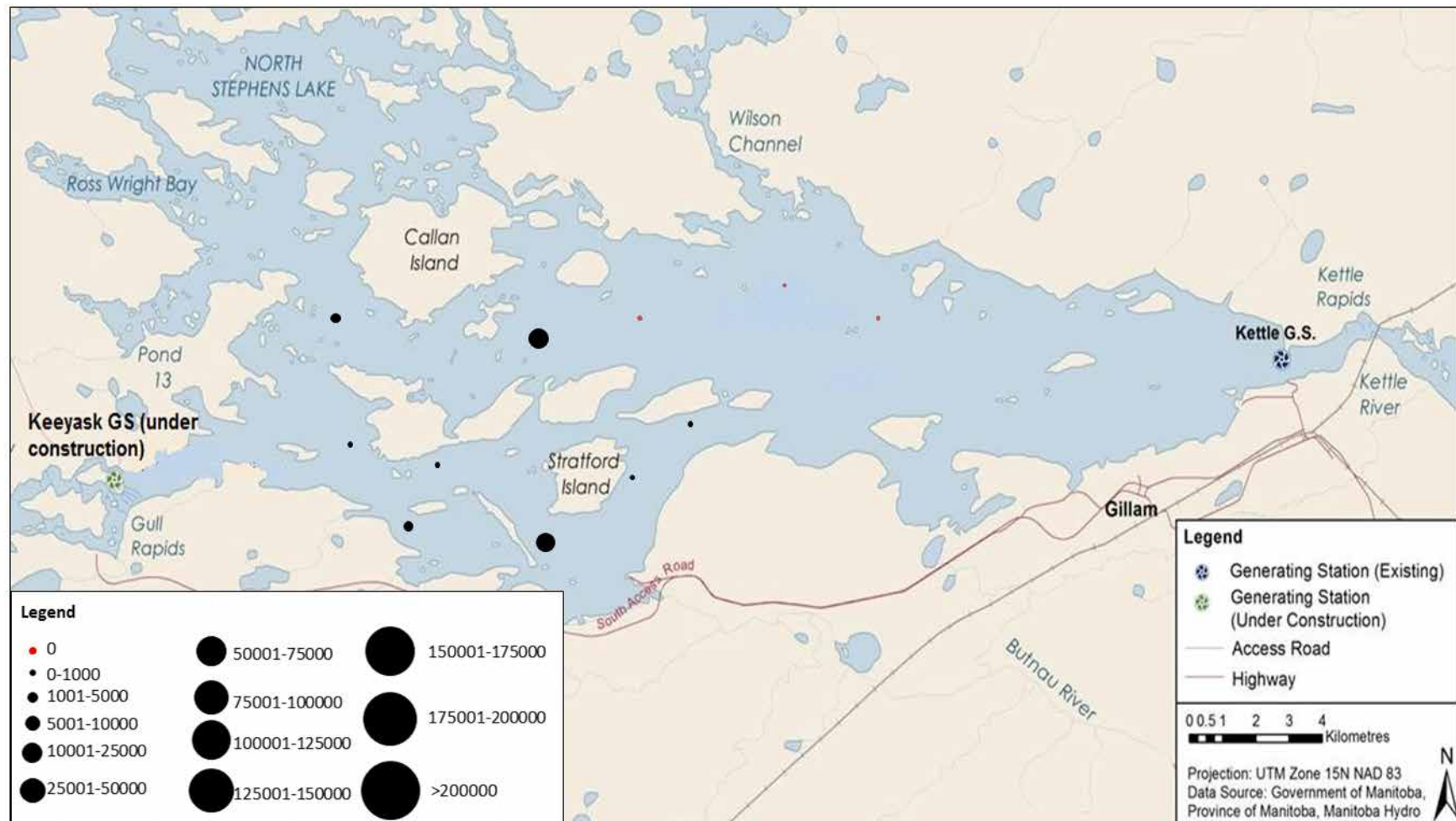


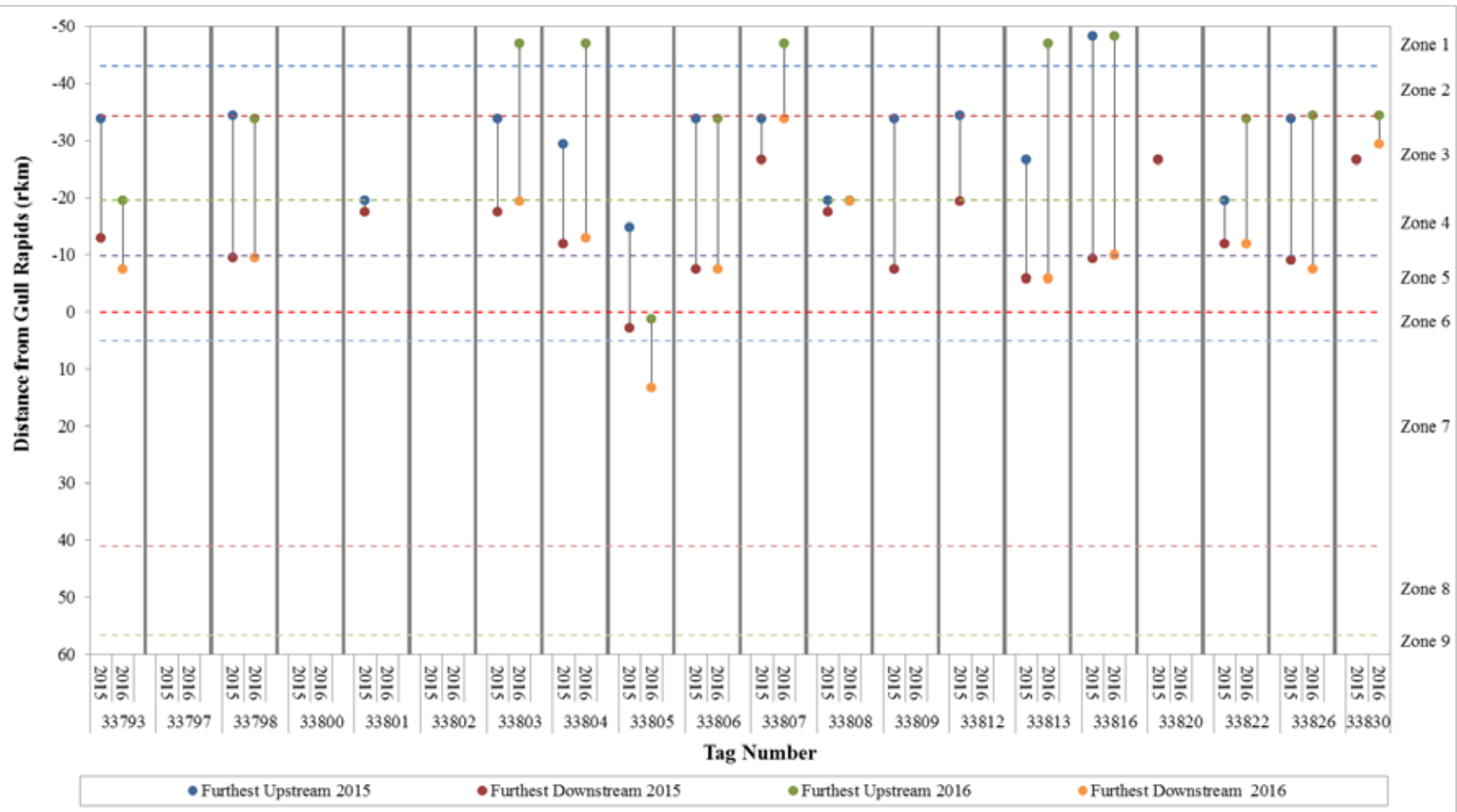
Figure 5: Detection ranges for individual Lake Whitefish ( $n = 40$ ) tagged with acoustic transmitters in Stephens Lake during the 2014/15 (October 15, 2014 to April 30, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS).



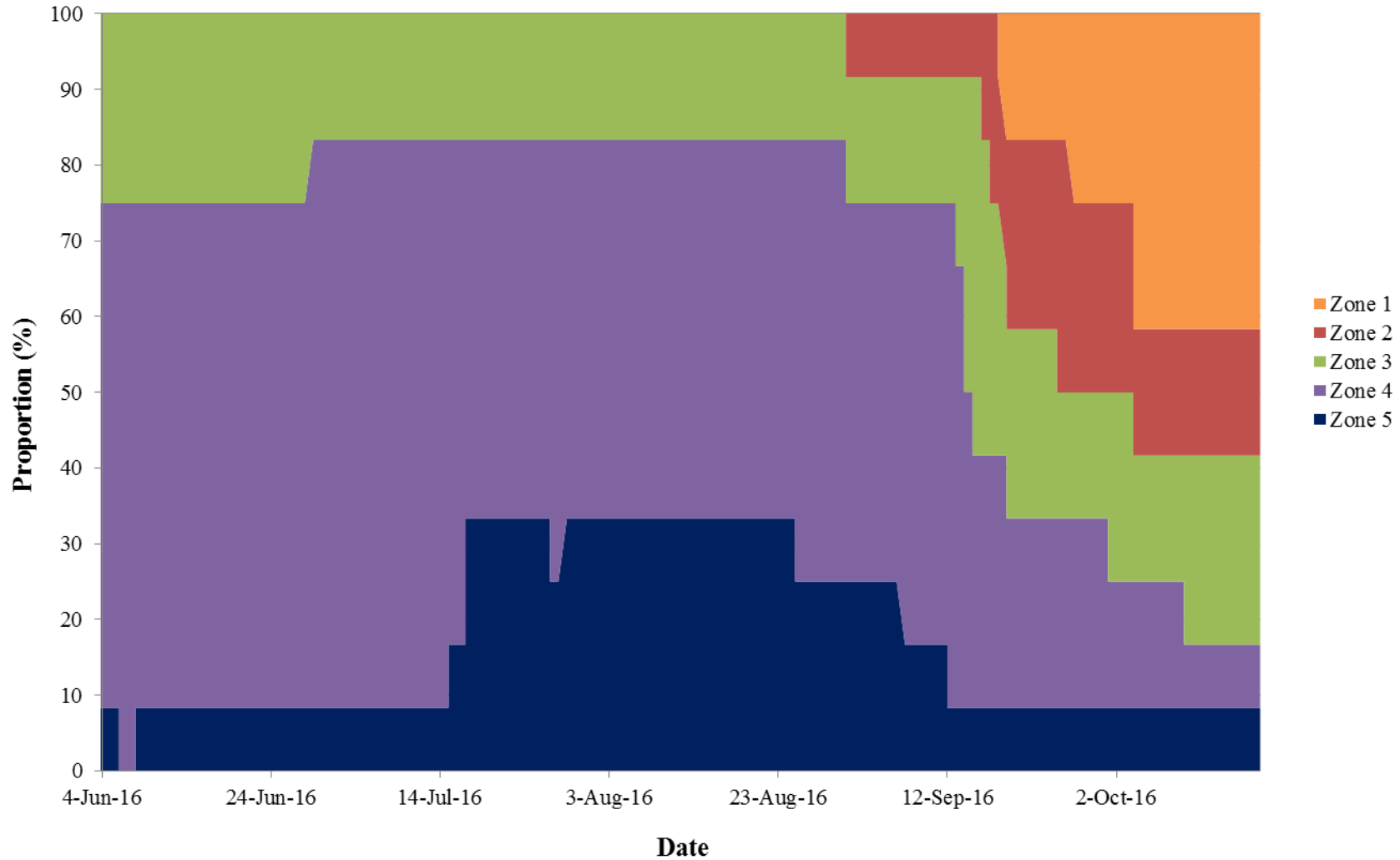
**Figure 5:** Detection ranges for individual Lake Whitefish ( $n = 40$ ) tagged with acoustic transmitters in Stephens Lake during the 2014/15 (15 October, 2014 to 30 April, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS) (continued).



**Figure 6:** Relative number of detections at each acoustic receiver set in Stephens Lake during winter 2015/2016 (October 12, 2015, to May 1, 2016). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

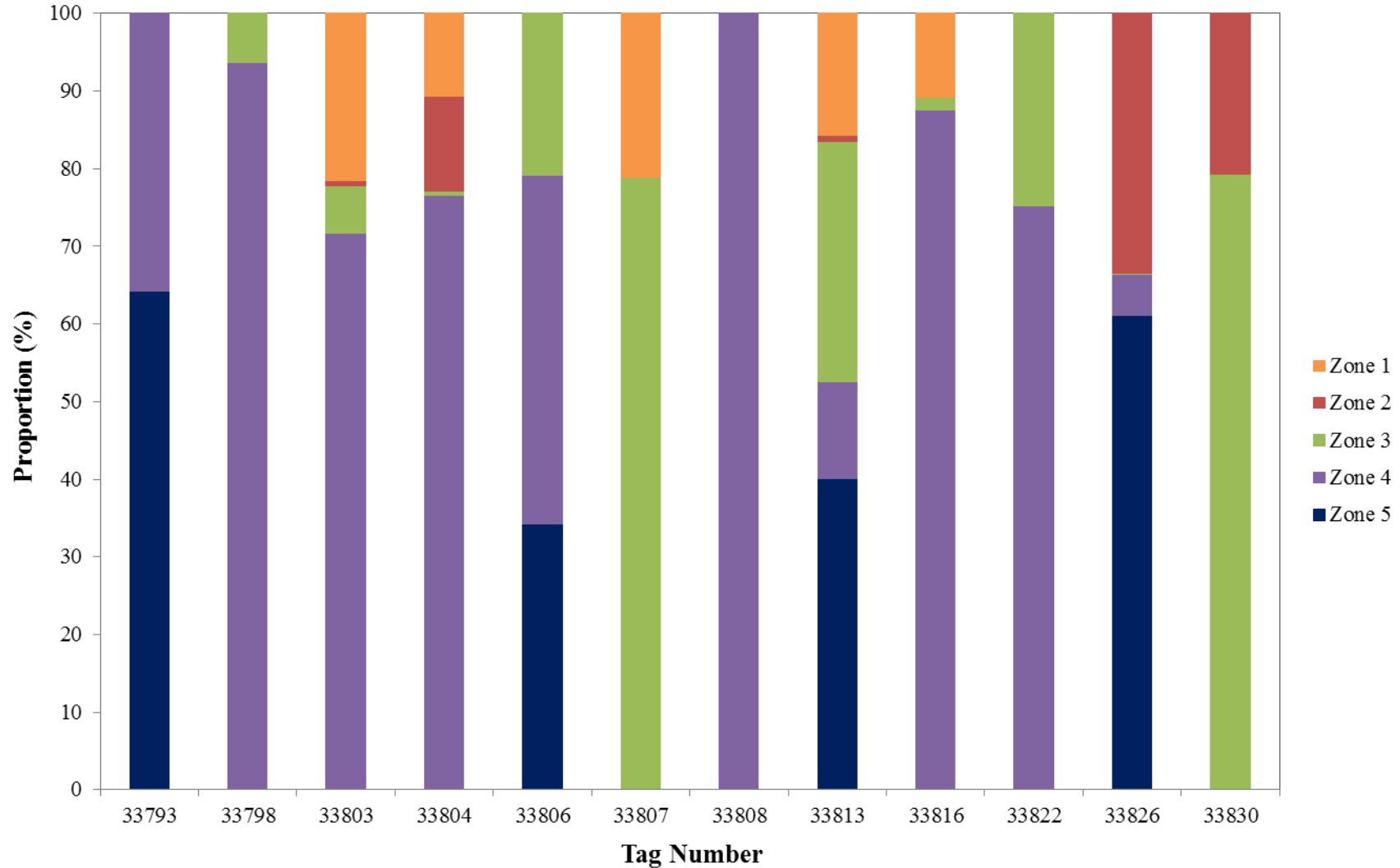


**Figure 7:** Detection ranges for individual Lake Whitefish ( $n = 20$ ) tagged with acoustic transmitters in Gull Lake during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. Horizontal dotted lines demarcate zones.



**Figure 8:** Proportional distribution of acoustic-tagged Lake Whitefish within five river zones between Clark Lake and Gull Rapids during a portion of the 2016 open-water period (June 4 to October 19).





**Figure 9: Proportion of time spent within five river zones between Clark Lake and Gull Rapids by individual acoustic-tagged Lake Whitefish during the 2016 open-water period (June 4 to October 19).**



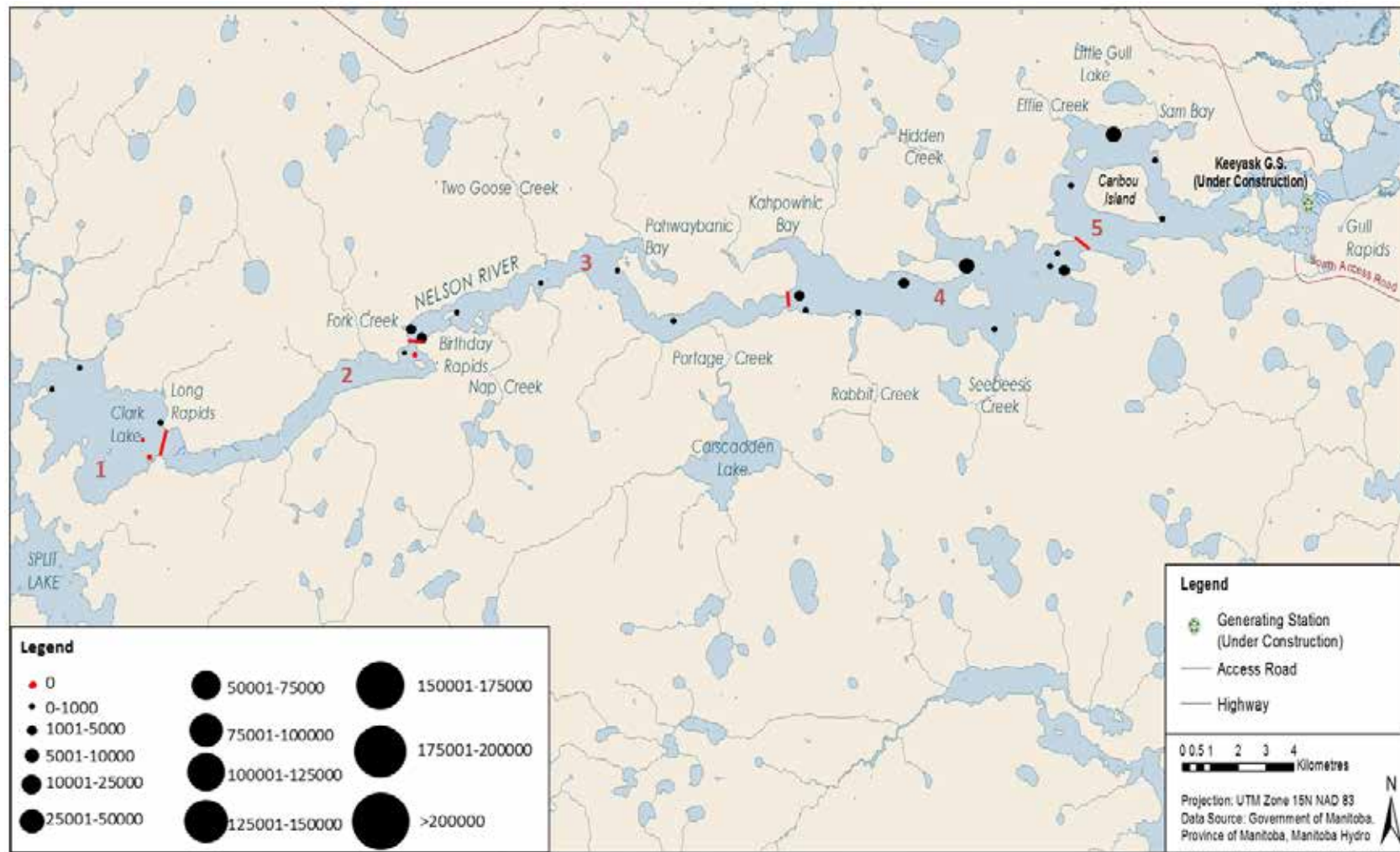
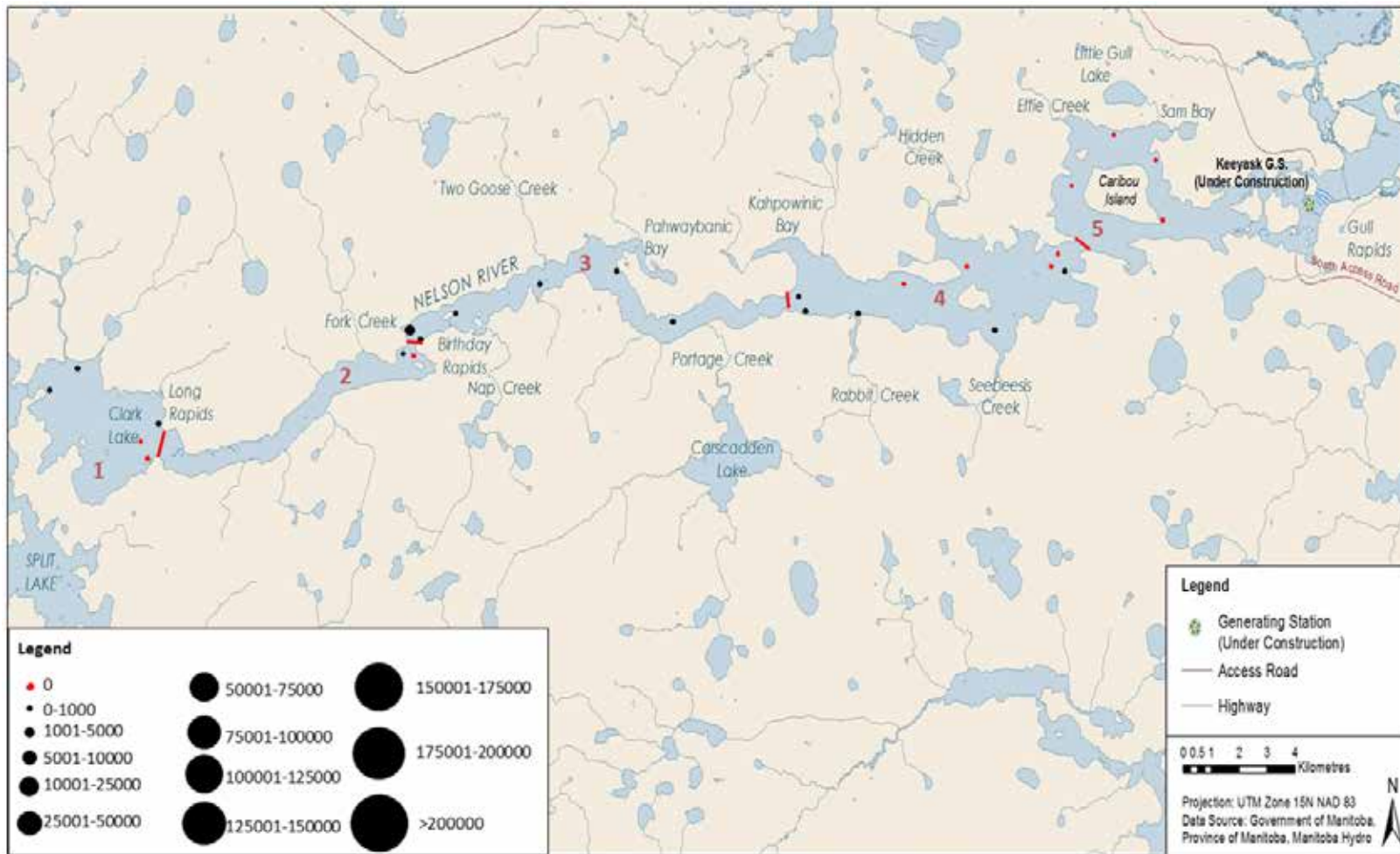


Figure 10: Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and Gull Rapids during the 2016 open-water period (May 1 to October 19). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot. The river is divided into five "zones" based on placement of receiver "gates."



**Figure 11:** Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and Gull Rapids during the 2016 spawning period (September 23 to October 19). Dates were selected based on water temperatures (less than 12°C) in order to capture movement of Lake Whitefish to spawning sites. 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 12: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. Horizontal dotted lines demarcate zones.

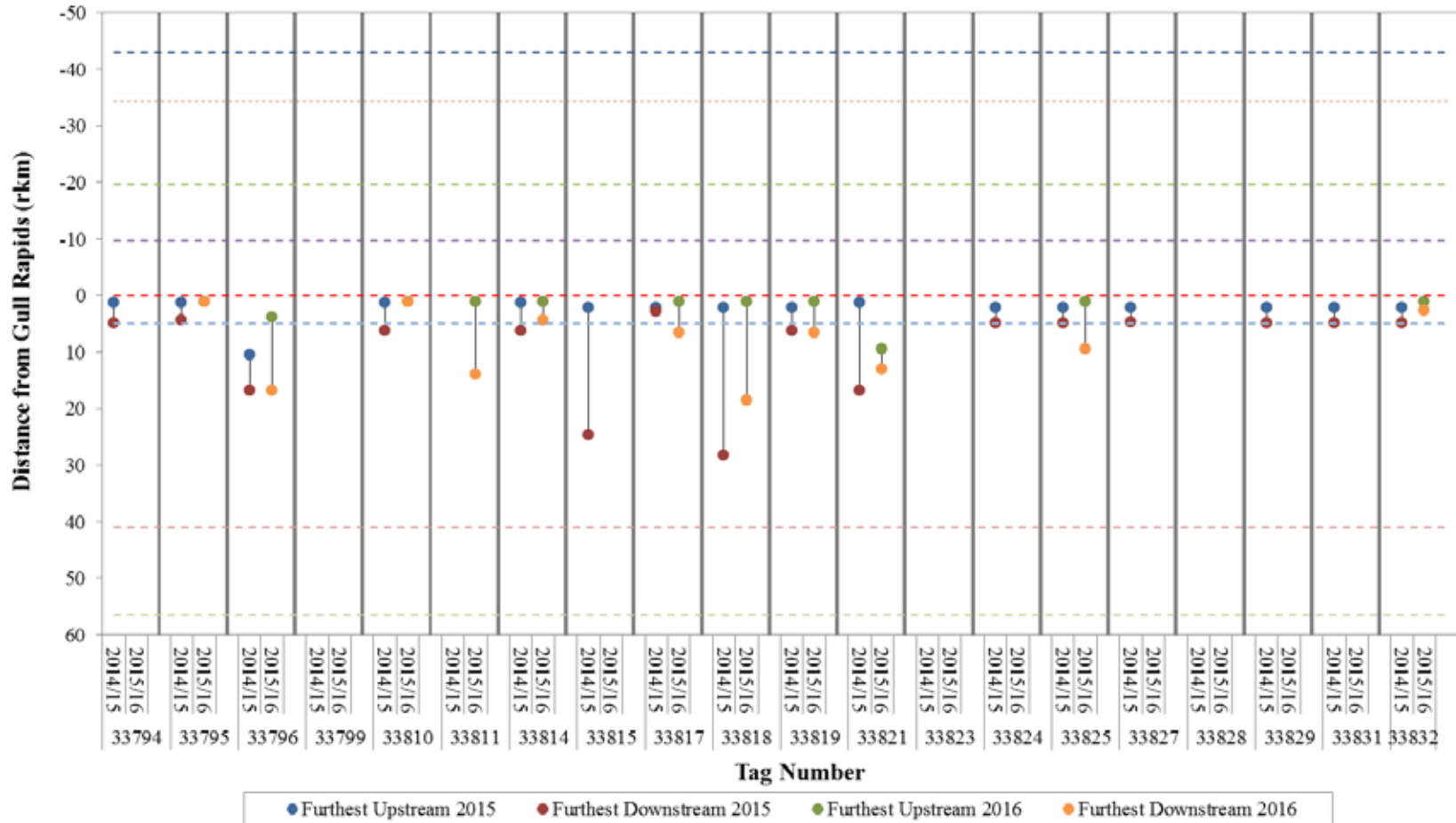
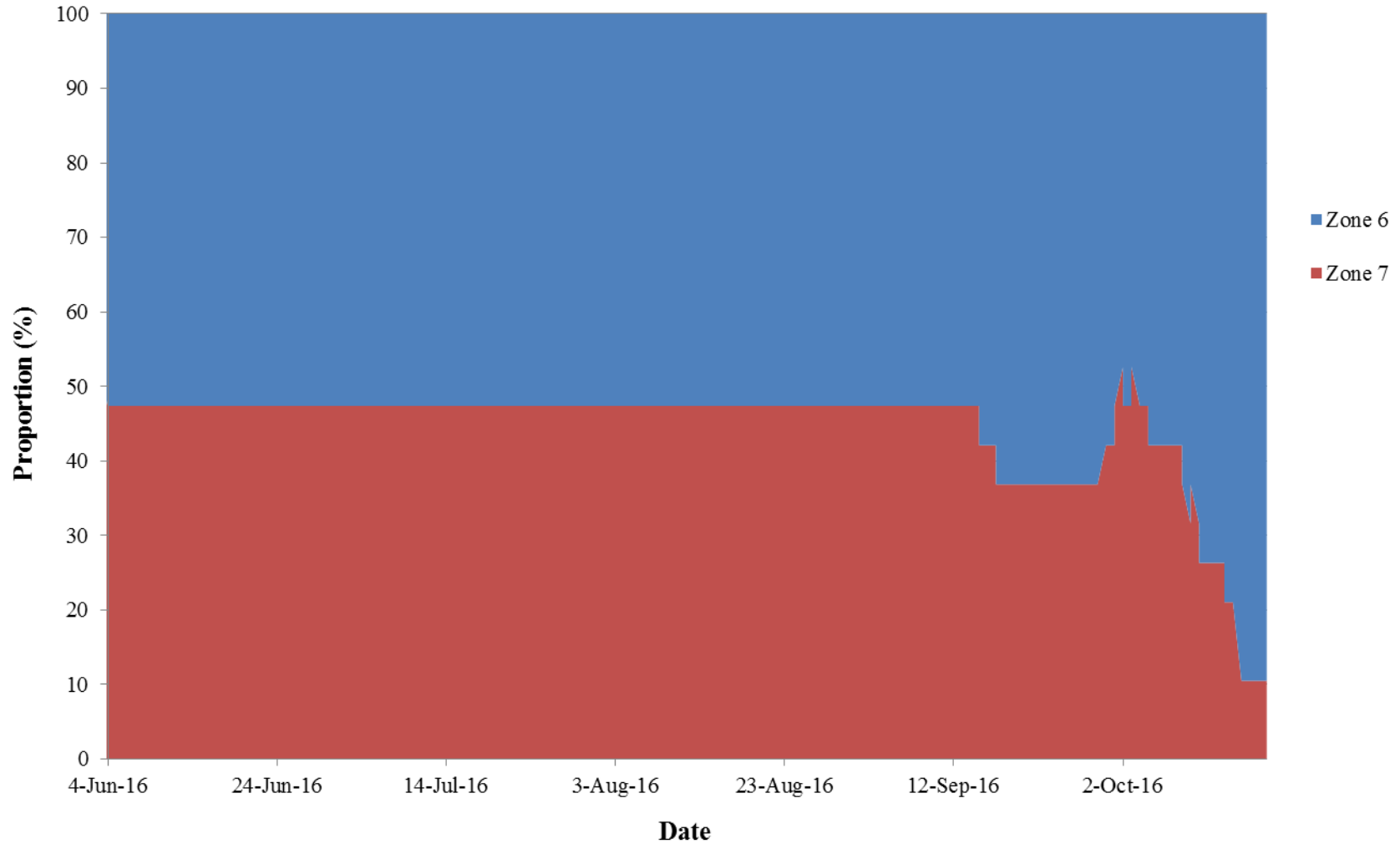
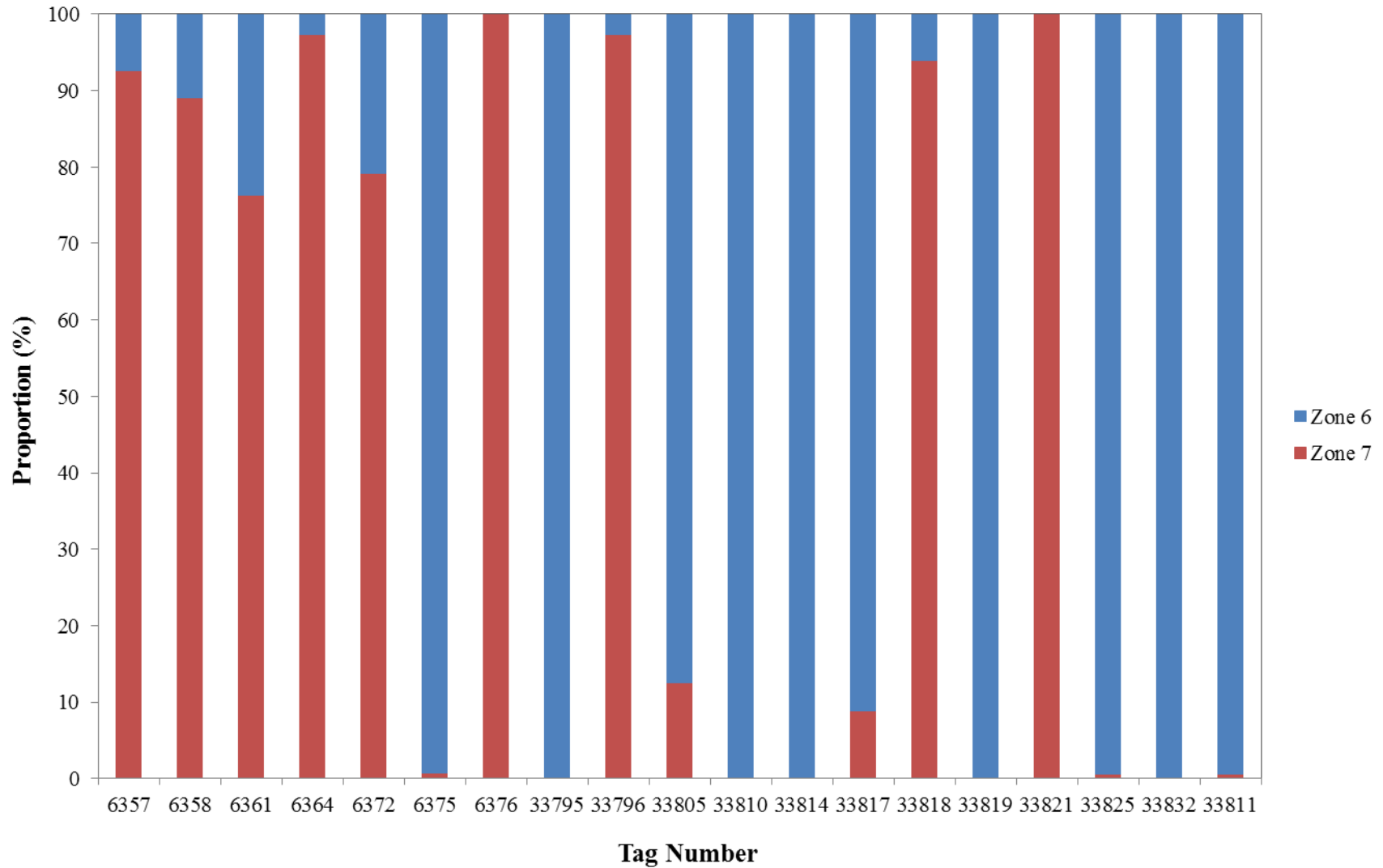


Figure 12: Detection ranges for individual Lake Whitefish ( $n = 40$ ) tagged with acoustic transmitters in Stephens Lake during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. Horizontal dotted lines demarcate zones (continued).

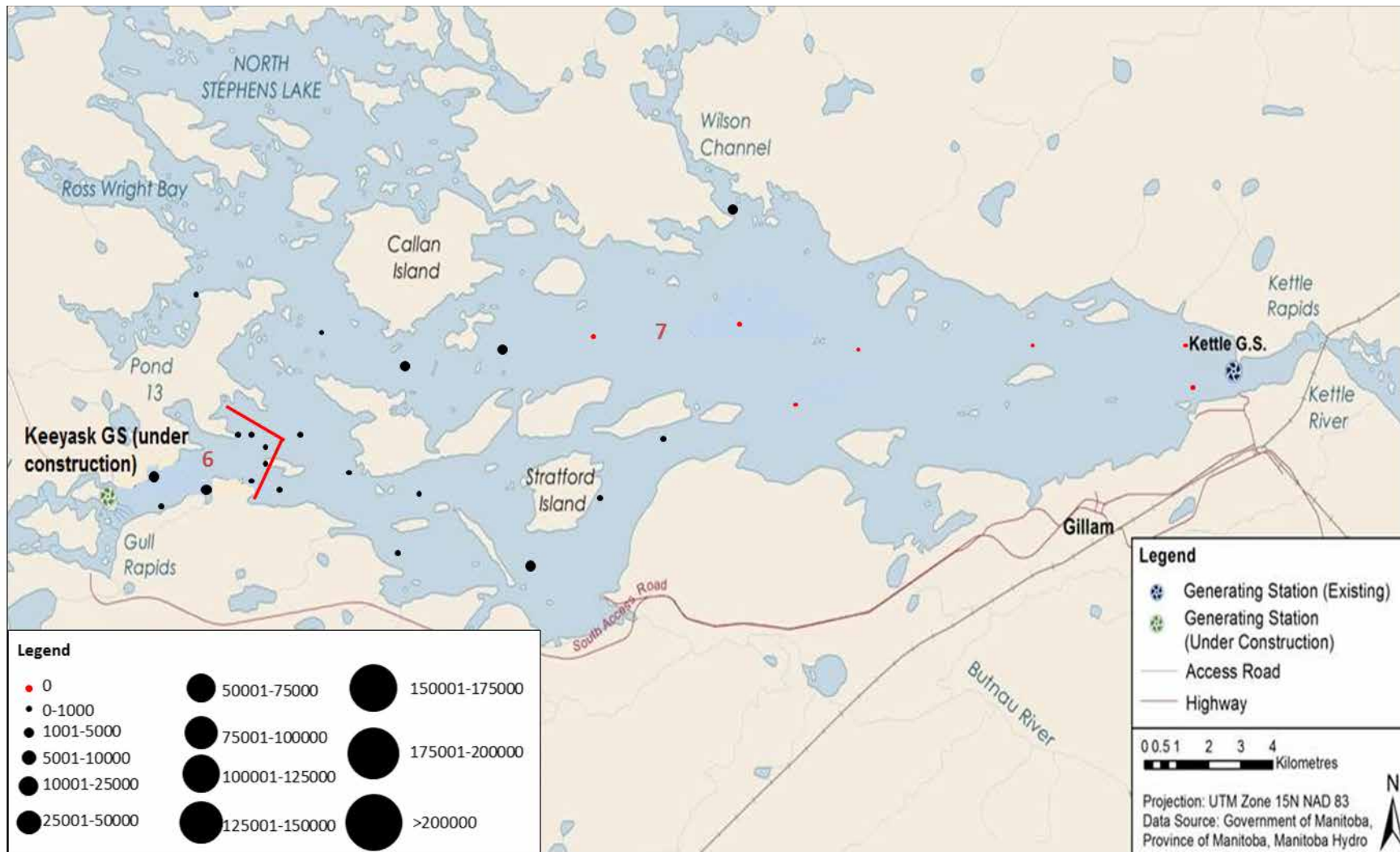


**Figure 13:** Proportional distribution of acoustic-tagged Lake Whitefish in Stephens Lake between Gull Rapids and the Kettle GS during the 2016 open-water period (June 4 to October 19).



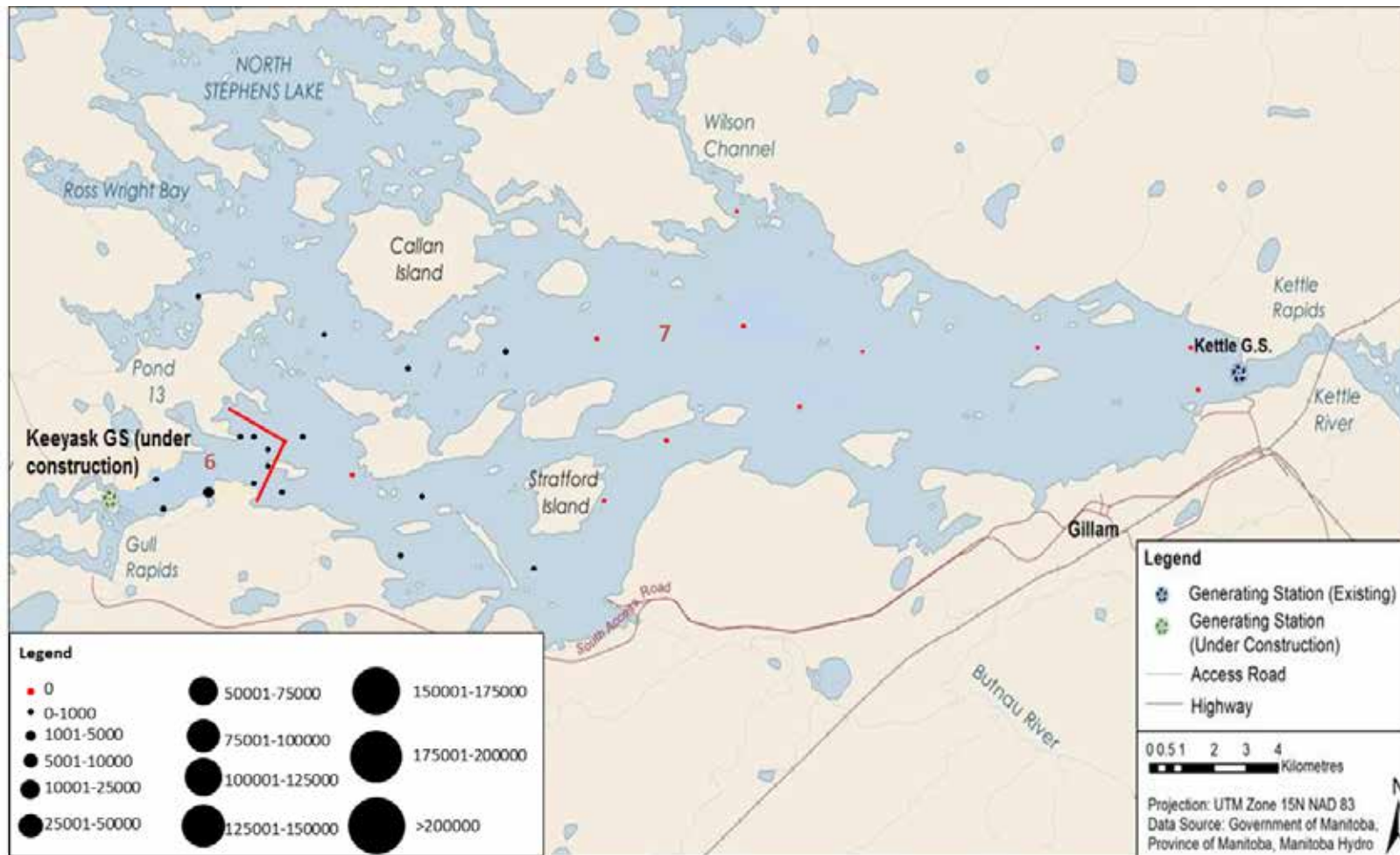
**Figure 14: Proportion of time spent in Stephens Lake between Gull Rapids and the Kettle GS by individual acoustic-tagged Lake Whitefish during the 2016 open-water period (June 4 to October 19).**





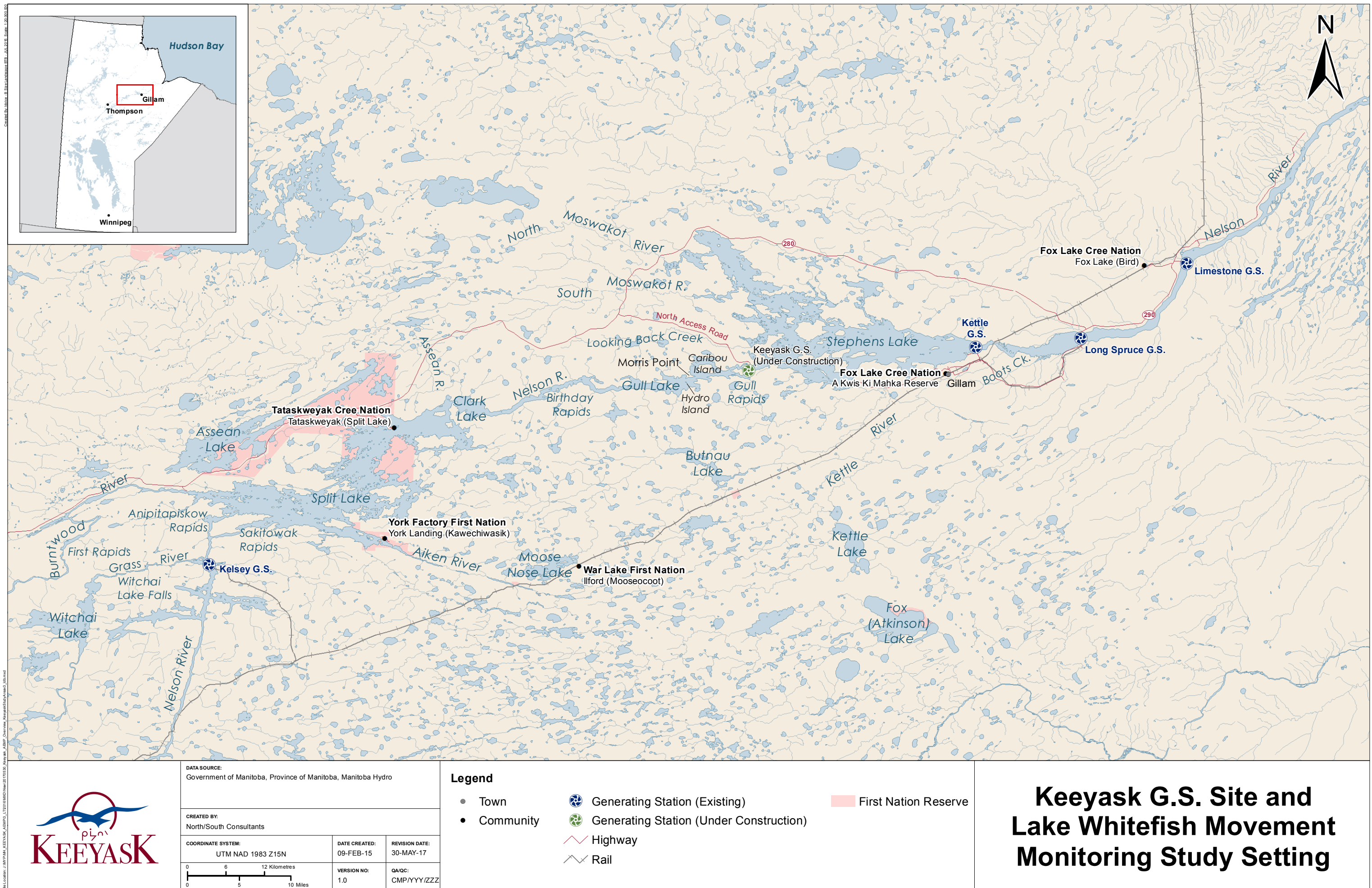
**Figure 15:** Relative number of detections at each acoustic receiver set in Stephens Lake during the 2016 open-water period (May 1 to October 19). Relative number of detections indicated by size of bubble. Receivers with no detections indicated with red dot. The river is divided into two "zones" based on placement of receiver "gates."



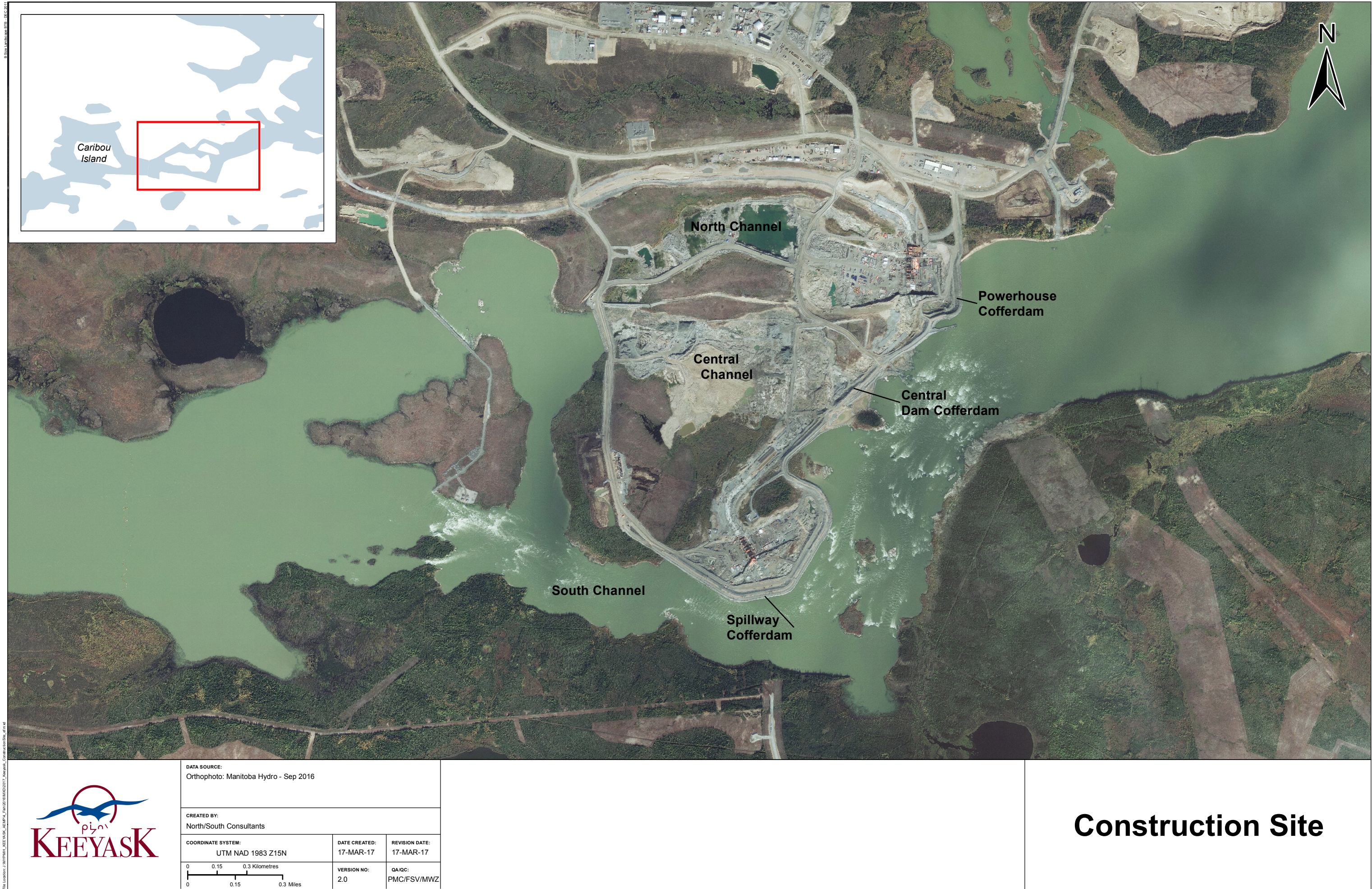


**Figure 16:** Relative number of detections at each acoustic receiver set in Stephens Lake during the 2016 spawning period (September 23 to October 19). Dates selected based on water temperatures (less than 12°C) in order to capture movement of Lake Whitefish to spawning sites. Relative number of detections 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."

## MAPS

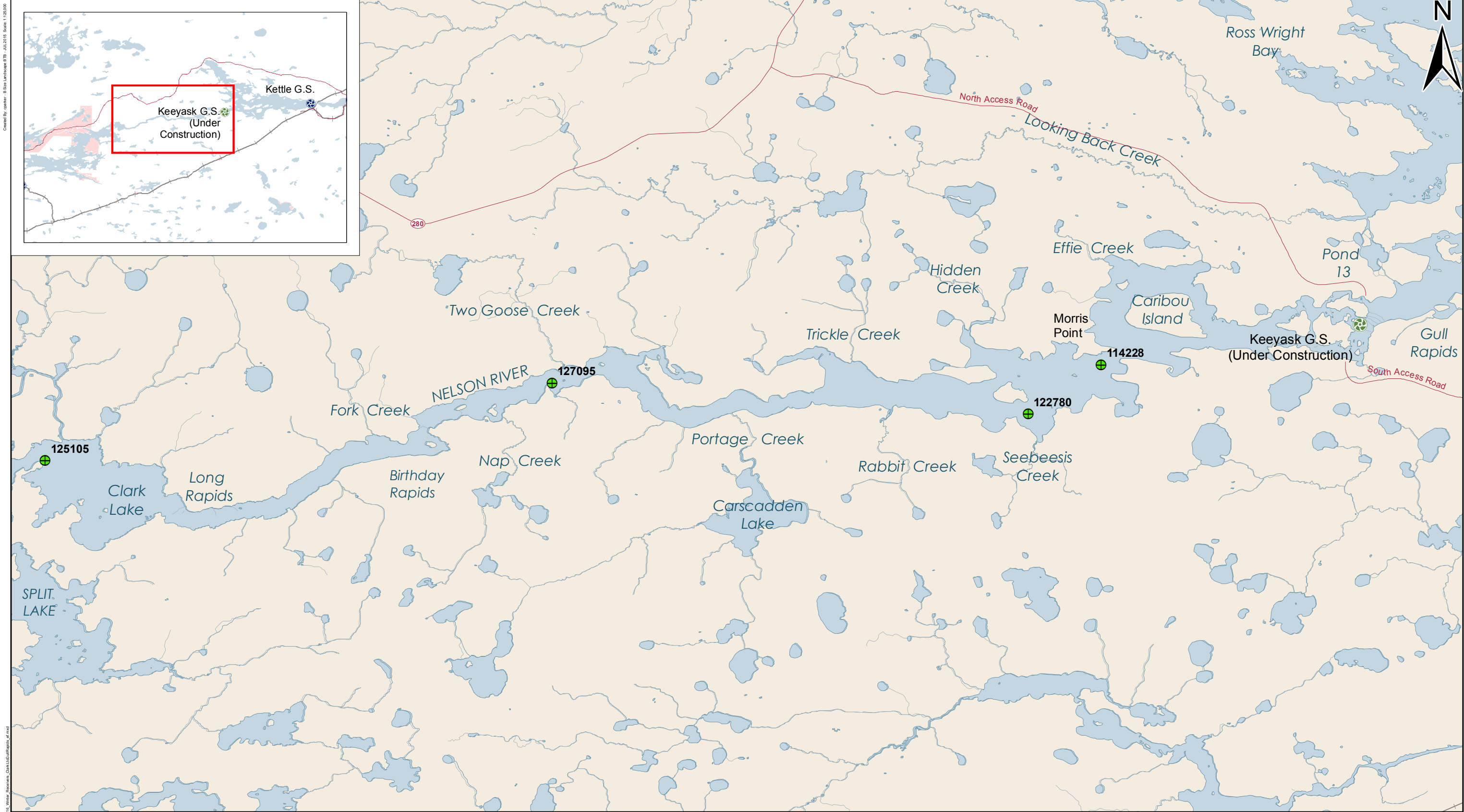







Map 2: Map of intream structures at the Keeyask Generating Station site, September 2016.







Map 3: Locations of stationary receivers set in the Nelson River from Clark Lake to Gull Rapids between October 2015 and June 2016.

DATA SOURCE: Government of Manitoba, Province of Manitoba, Manitoba Hydro		
CREATED BY: North/South Consultants		
COORDINATE SYSTEM: UTM NAD 1983 Z14N	DATE CREATED: 09-FEB-15	REVISION DATE: 01-NOV-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

**Legend**

**Receiver Locations**

- Receiver Locations
- Generating Station (Existing)
- Generating Station (Under Construction)

Highway

Rail

First Nation Reserve

**Winter 2015/16**

**Acoustic Receiver Locations:**


Clark Lake to Gull Rapids

Map 3: Locations of stationary receivers set in the Nelson River from Clark Lake to Gull Rapids between October 2015 and June 2016.



Created by: gowker - B Size Landscape RTB - JUL 2015 Scale: 1:144,511



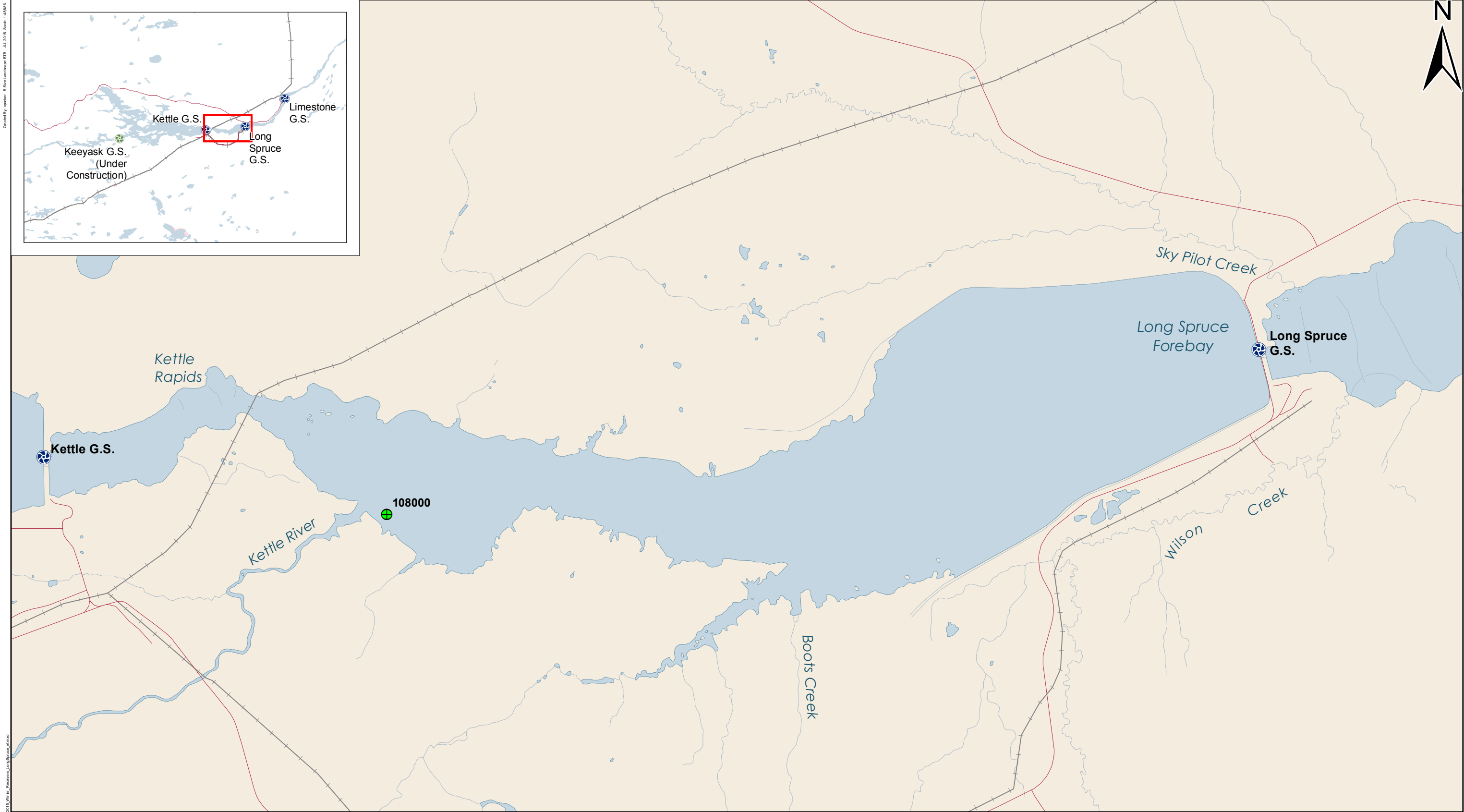


Map 4: Locations of stationary receivers set in Stephens Lake from Gull Rapids to Kettle GS between October 2015 and June 2016. The former (pre-impoundment) river channel is shown in light blue.

DATA SOURCE: Government of Manitoba, Province of Manitoba, Manitoba Hydro		
CREATED BY: North/South Consultants		
COORDINATE SYSTEM: UTM NAD 1983 Z14N	DATE CREATED: 09-FEB-15	REVISION DATE: 08-JUN-17
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

**Legend**  
**Receiver Locations**  
● Retrieved  
● Lost  
● Generating Station (Existing)  
● Generating Station (Under Construction)  
— Highway  
— Rail  
— First Nation Reserve

## Winter 2015/16 Acoustic Receiver Locations: Stephens Lake



DATA SOURCE: Government of Manitoba, Province of Manitoba, Manitoba Hydro		
CREATED BY: North/South Consultants		
COORDINATE SYSTEM: UTM NAD 1983 Z14N	DATE CREATED: 09-FEB-15	REVISION DATE: 28-OCT-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

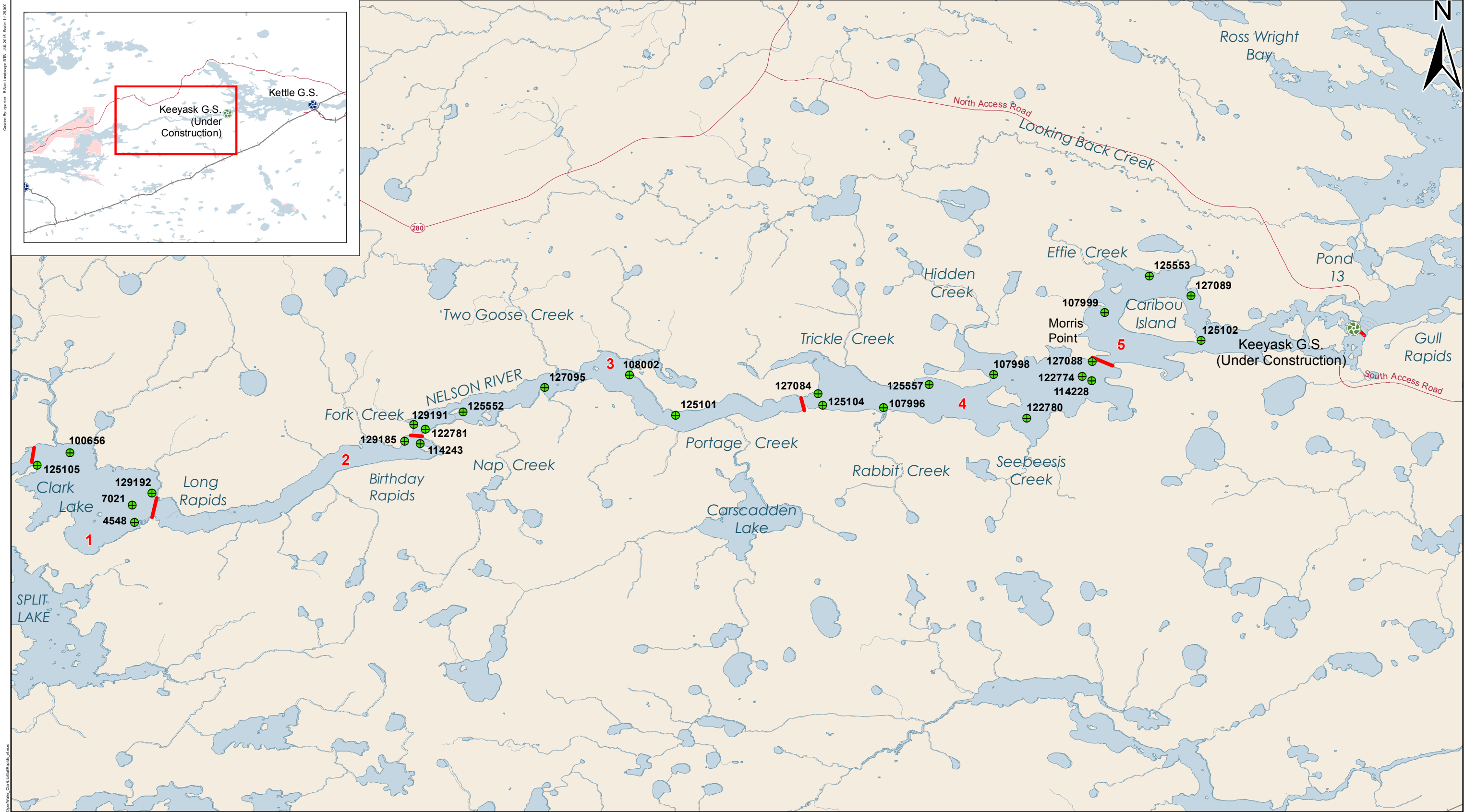
**Legend**

- Receiver Locations
- Generating Station (Existing)
- Generating Station (Under Construction)

- Highway
- Rail
- First Nation Reserve

**Winter 2015/16  
Acoustic Receiver Locations:  
Long Spruce Reservoir**

**Map 5: Location of the stationary receiver set in the Long Spruce reservoir between October 2015 and June 2016.**



DATA SOURCE: Government of Manitoba, Province of Manitoba, Manitoba Hydro		
CREATED BY: North/South Consultants		
COORDINATE SYSTEM: UTM NAD 1983 Z14N	DATE CREATED: 09-FEB-15	REVISION DATE: 28-OCT-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

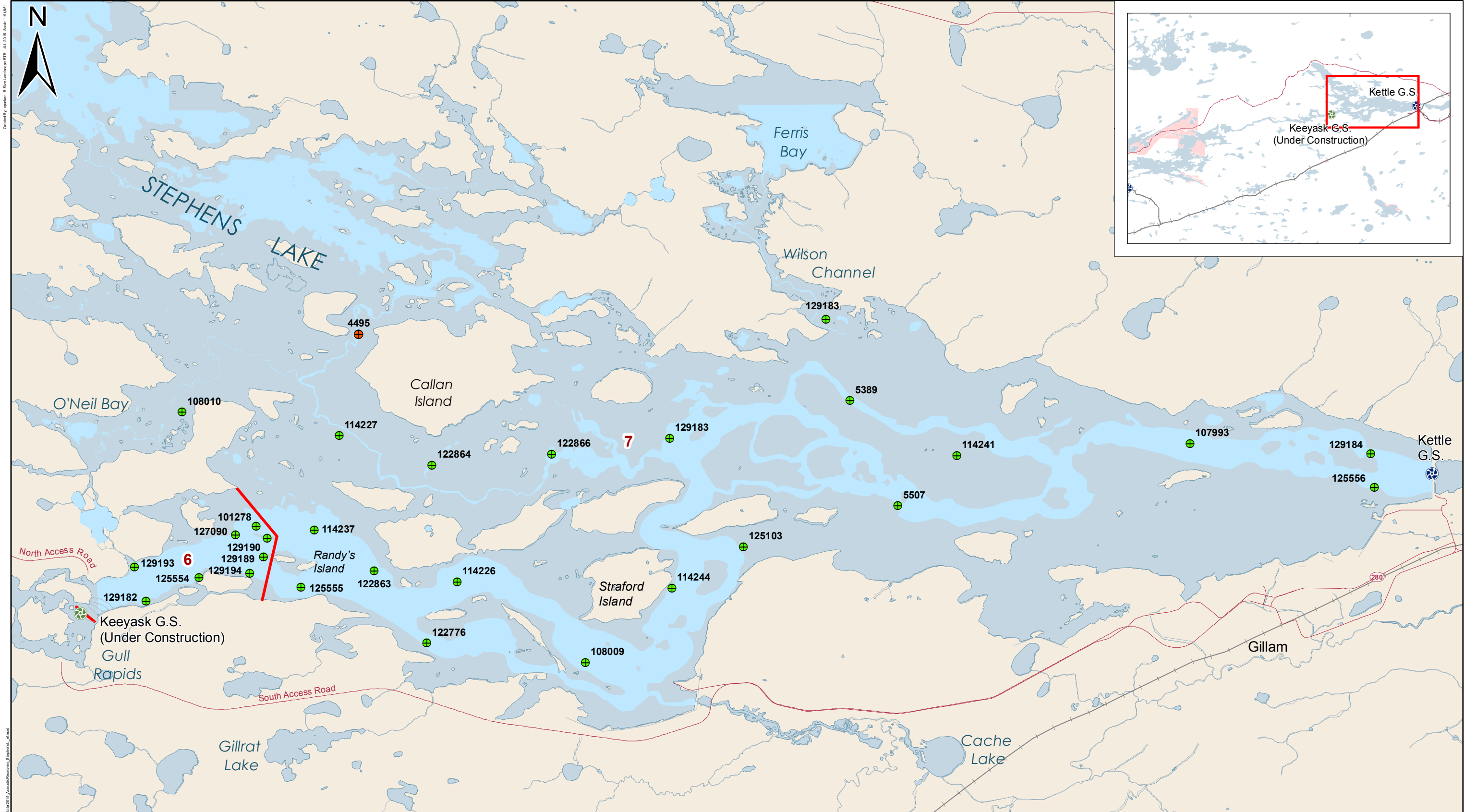
- Legend**
- Receiver Locations
  - Generating Station (Existing)
  - Generating Station (Under Construction)
  - Highway
  - Rail
  - First Nation Reserve

**Open-water 2016  
Acoustic Receiver Locations:  
Clark Lake to Gull Rapids**

**Map 6: Locations of stationary receivers set in the Nelson River from Clark Lake to Gull Rapids between June and October 2016. The river is divided into five "zones" based on placement of receiver "gates".**



Created by: cawker - B Size Landscape RTB - JUL 2015 Scale: 1:64,811



File Location: I:\MPS\NAU\KEEYASK\KEEYASK\_Figures\BMAPS\BMAPS010105\_OverviewMap2015\_AcousticReceiverLocations\_Simplified.dwg



DATA SOURCE: Government of Manitoba, Province of Manitoba, Manitoba Hydro		
CREATED BY: North/South Consultants		
COORDINATE SYSTEM: UTM NAD 1983 Z14N	DATE CREATED: 09-FEB-15	REVISION DATE: 04-NOV-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

#### Legend

##### Receiver Locations

- Retrieved
- Lost

Generating Station (Existing)

Generating Station (Under Construction)

Zones

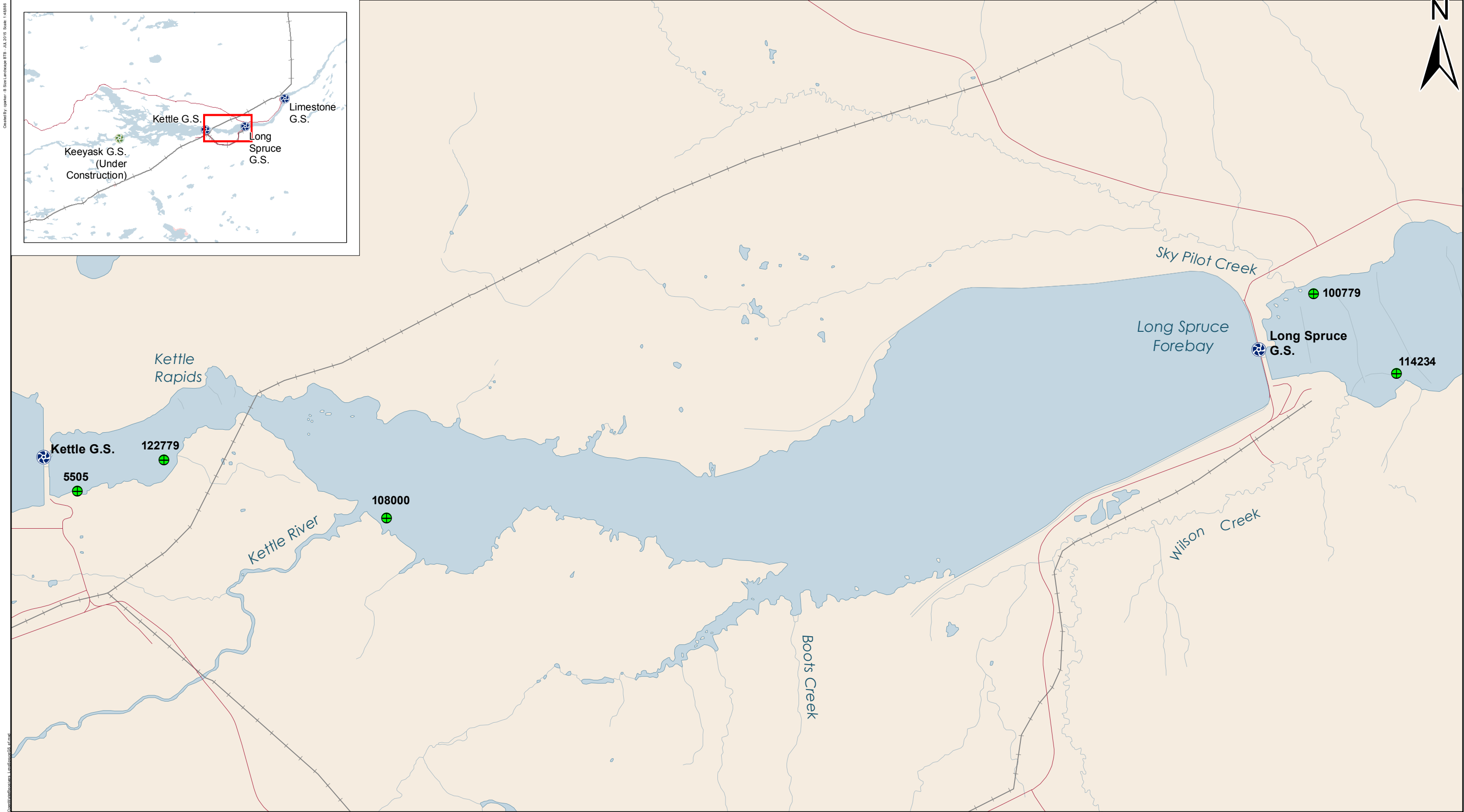
Highway


Rail

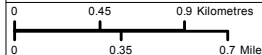
First Nation Reserve

## Open-water 2016 Acoustic Receiver Locations: Stephens Lake







**Map 7:** Locations of stationary receivers set in Stephens Lake between June and October 2016. The river is divided into two "zones" based on placement of receiver "gates". The pre-impoundment river channel is shown in light blue.





DATA SOURCE: Government of Manitoba, Province of Manitoba, Manitoba Hydro		
CREATED BY: North/South Consultants		
COORDINATE SYSTEM: UTM NAD 1983 Z14N	DATE CREATED: 09-FEB-15	REVISION DATE: 16-FEB-17
	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

**Legend**

-  Receiver Locations
-  Generating Station (Existing)
-  Generating Station (Under Construction)
-  Highway
-  Rail
-  First Nation Reserve

## Open-water 2016 Acoustic Receiver Locations

Long Spruce and Limestone Reservoirs

**Map 8: Locations of stationary receivers set in the Long Spruce reservoir (Zone 8) between June and October 2016, and in the Limestone reservoir (Zone 9) between July and October 2016.**



# APPENDICES

# APPENDIX 1:

## DETECTION SUMMARIES FOR LAKE WHITEFISH TAGGED AND MONITORED IN THE KEEYASK STUDY AREA BETWEEN 2014 AND 2016.

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Table A1-1:	Detection summary for Lake Whitefish tagged upstream of Gull Rapids during the 2014/15 (October 15, 2014 to April 30, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods. ....	54
Table A1-2:	Detection summary for Lake Whitefish tagged in Stephens Lake downstream of Gull Rapids during the 2014/15 (October 15, 2014 to April 30, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods.....	55
Table A1-3:	Detection summary for Lake Whitefish tagged upstream of Gull Rapids during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. ....	57
Table A1-4:	Detection summary for Lake Whitefish tagged in Stephens Lake downstream of Gull Rapids during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. ....	58

**Table A1-1: Detection summary for Lake Whitefish tagged upstream of Gull Rapids during the 2014/15 (October 15, 2014 to April 30, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods. Movements of fish not detected since tagging in fall 2014 are highlighted in green, those considered lost or dead are highlighted in red and fish that moved downstream through Gull Rapids are highlighted in blue.**

Tag ID	Date Tagged	Winter 2014/2015					Winter 2015/2016				
		# of Detections	# of Detection Days	Furthest u/s (rkm)	Furthest d/s (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Furthest u/s (rkm)	Furthest d/s (rkm)	Movement Range (rkm)
33793	8-Oct-14	0	-	-	-	-	95	2	-33.8	-33.8	0.0
33797	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33798	8-Oct-14	37	1	-12.9	-12.9	0.0	34	3	-29.4	-12.9	16.5
33800	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33801	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33802	8-Oct-14	137	2	-12.9	-12.9	0.0	0	-	-	-	-
33803	8-Oct-14	0	-	-	-	-	74	2	-33.8	-29.4	4.4
33804	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33805	8-Oct-14	902	13	-12.9	-7.5	5.4	0	-	-	-	-
33806	8-Oct-14	208	7	-12.9	-12.9	0.0	994	23	-33.8	-29.4	4.4
33807	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33808	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33809	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33812	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33813	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33816	8-Oct-14	8	1	-12.9	-12.9	0.0	24	4	-48.2	-12.9	35.3
33820	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33822	7-Oct-14	43	2	-12.9	-12.9	0.0	0	-	-	-	-
33826	7-Oct-14	0	-	-	-	-	0	-	-	-	-
33830	7-Oct-14	0	-	-	-	-	0	-	-	-	-

**Table A1-2: Detection summary for Lake Whitefish tagged in Stephens Lake downstream of Gull Rapids during the 2014/15 (October 15, 2014 to April 30, 2015) and 2015/16 (October 12, 2015 to April 30, 2016) winter periods. Movements of fish not detected since tagging in fall 2014 are highlighted in green and those considered lost or dead are highlighted in red.**

Tag ID	Date Tagged	Winter 2014/2015					Winter 2015/2016				
		# of Detections	# of Detection days	Furthest u/s (rkm)	Furthest d/s (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Furthest u/s (rkm)	Furthest d/s (rkm)	Movement Range (rkm)
6357	30-Sep-14	21618	139	7.9	16.8	8.9	18168	108	7.7	21.0	13.3
6358	30-Sep-14	56	3	10.2	10.2	0.0	103	4	7.7	10.2	2.5
6359	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6360	30-Sep-14	132	2	7.7	16.8	9.1	0	-	-	-	-
6361	30-Sep-14	0	-	-	-	-	6	2	7.9	7.9	0.0
6362	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6363	30-Sep-14	153	10	7.7	7.9	0.2	0	-	-	-	-
6364	30-Sep-14	994	22	7.7	14.9	7.2	264	12	7.7	7.9	0.2
6365	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6366	30-Sep-14	37	1	7.9	16.8	8.9	0	-	-	-	-
6367	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6368	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6369	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6370	30-Sep-14	3514	42	7.7	37.8	30.1	0	-	-	-	-
6371	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6372	25-Sep-14	590	7	7.7	16.8	9.1	88	2	7.7	21.0	13.3
6373	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6374	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6375	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6376	25-Sep-14	29858	153	7.9	13.4	5.5	19163	68	7.9	13.4	5.5

Table A1-2: Continued.

Tag ID	Date Tagged	Winter 2014/2015					Winter 2015/2016				
		# of Detections	# of Detection Days	Furthest u/s (rkm)	Furthest d/s (rkm)	Movement Range (rkm)	# of Detections	# of Detection days	Furthest u/s (rkm)	Furthest d/s (rkm)	Movement Range (rkm)
33794	30-Sep-14	703	9	7.7	10.5	2.8	101	8	7.7	13.4	5.7
33795	30-Sep-14	501	4	7.9	7.9	0.0	0	-	-	-	-
33796	30-Sep-14	8573	59	7.7	16.8	9.1	20	3	7.9	7.9	0.0
33799	30-Sep-14	0	-	-	-	-	0	-	-	-	-
33810	30-Sep-14	0	-	-	-	-	0	-	-	-	-
33811	30-Sep-14	0	-	-	-	-	0	-	-	-	-
33814	30-Sep-14	0	-	-	-	-	0	-	-	-	-
33815	30-Sep-14	5238	33	7.7	13.4	5.7	0	-	-	-	-
33817	30-Sep-14	0	-	-	-	-	0	-	-	-	-
33818	30-Sep-14	9928	65	7.7	18.7	11.0	6869	100	7.7	21.0	13.3
33819	30-Sep-14	302	6	7.7	40.8	33.1	0	-	-	-	-
33821	4-Oct-14	23628	119	7.7	10.5	2.8	1170	18	7.7	7.9	0.2
33823	4-Oct-14	15	2	7.7	7.7	0.0	0	-	-	-	-
33824	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33825	4-Oct-14	0	-	-	-	-	5	1	7.9	7.9	0.0
33827	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33828	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33829	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33831	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33832	4-Oct-14	0	-	-	-	-	0	-	-	-	-

**Table A1-3: Detection summary for Lake Whitefish tagged upstream of Gull Rapids during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. Movements of fish not detected since tagging in fall 2014 are highlighted in green, those considered lost or dead are highlighted in red, and fish that moved downstream through Gull Rapids are highlighted in blue.**

Tag ID	Date tagged	Open-water 2015					Open-water 2016				
		# of Detections	# of Detection Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Movement Range (rkm)
33793	8-Oct-14	4121	45	-33.8	-12.9	20.9	68	11	-19.5	-7.4	12.1
33797	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33798	8-Oct-14	8810	67	-34.3	-9.5	24.8	3837	65	-33.8	-9.5	24.3
33800	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33801	8-Oct-14	72	4	-19.5	-17.4	2.1	0	-	-	-	-
33802	8-Oct-14	0	-	-	-	-	0	-	-	-	-
33803	8-Oct-14	1462	43	-33.8	-17.4	16.4	873	27	-46.9	-19.4	27.5
33804	8-Oct-14	3832	60	-29.4	-11.8	17.6	4436	78	-46.9	-12.9	34.0
33805	8-Oct-14	522	12	-11.8	2.9	14.7	407	15	1.2	13.4	12.2
33806	8-Oct-14	2839	43	-33.8	-7.4	26.4	2474	44	-33.8	-7.4	26.4
33807	8-Oct-14	48	4	-33.8	-26.5	7.3	78	4	-46.9	-33.8	13.1
33808	8-Oct-14	149	14	-19.5	-17.4	2.1	356	16	-19.5	-19.4	0.1
33809	8-Oct-14	2274	30	-33.8	-7.4	26.4	0	-	-	-	-
33812	8-Oct-14	184	9	-34.3	-19.4	14.9	0	-	-	-	-
33813	8-Oct-14	4248	50	-26.5	-5.8	20.7	9704	94	-46.9	-5.8	41.1
33816	8-Oct-14	3743	72	-48.2	-9.3	38.9	189	10	-48.2	-9.9	38.3
33820	8-Oct-14	487	8	-26.5	-26.5	0.0	0	-	-	-	-
33822	7-Oct-14	4656	68	-19.5	-11.8	7.7	7784	106	-33.8	-11.8	22.0
33826	7-Oct-14	276	14	-33.8	-9.0	24.8	824	39	-34.3	-7.4	26.9
33830	7-Oct-14	573	22	-26.5	-26.5	0.0	106	5	-34.3	-29.4	4.9



**Table A1-4: Detection summary for Lake Whitefish tagged in Stephens Lake downstream of Gull Rapids during the 2015 (June 4 to October 11) and 2016 (May 1 to October 19) open-water periods. Movements of fish not detected since tagging in fall 2014 are highlighted in green and those considered lost or dead are highlighted in red.**

Tag ID	Date tagged	Open-water 2015					Open-water 2016				
		# of Detections	# of Detection Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Movement Range (rkm)
6357	30-Sep-14	11658	30	7.9	19.0	11.1	4717	45	1.2	21.0	19.8
6358	30-Sep-14	297	5	2.2	16.8	14.6	133	8	1.2	13.0	11.8
6359	30-Sep-14	1278	17	2.2	6.2	4.0	0	-	-	-	-
6360	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6361	30-Sep-14	606	8	1.3	4.9	3.6	191	7	1.2	9.4	8.2
6362	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6363	30-Sep-14	685	16	3.6	3.6	0.0	0	-	-	-	-
6364	30-Sep-14	5070	13	1.3	7.9	6.6	1461	11	3.8	13.9	10.1
6365	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6366	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6367	25-Sep-14	148	4	2.2	5.8	3.6	0	-	-	-	-
6368	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6369	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6370	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6371	30-Sep-14	0	-	-	-	-	0	-	-	-	-
6372	25-Sep-14	1210	15	1.3	10.5	9.2	2291	40	1.2	20.0	18.8
6373	25-Sep-14	0	-	-	-	-	0	-	-	-	-
6374	25-Sep-14	165	9	2.2	7.9	5.7	0	-	-	-	-
6375	25-Sep-14	1034	10	1.3	7.9	6.6	376	13	1.2	6.5	5.3
6376	25-Sep-14	1477	20	10.5	16.8	6.3	49	1	13.0	13.0	0.0
33794	30-Sep-14	1804	17	1.3	4.9	3.6	0	-	-	-	-
33795	30-Sep-14	498	6	1.3	4.4	3.1	15	2	1.2	1.2	0.0

Table A1-4: Continued.

Tag ID	Date tagged	Open-water 2015					Open-water 2016				
		# of Detections	# of Detection Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Furthest U/S (rkm)	Furthest D/S (rkm)	Movement Range (rkm)
33796	30-Sep-14	882	8	10.5	16.8	6.3	1167	18	3.8	16.8	13.0
33799	30-Sep-14	0	-	-	-	-	0	-	-	-	-
33810	30-Sep-14	334	10	1.3	6.2	4.9	2	1	1.2	1.2	0.0
33811	30-Sep-14	0	-	-	-	-	46	4	1.2	13.9	12.7
33814	30-Sep-14	85	5	1.3	6.2	4.9	34	4	1.2	4.3	3.1
33815	30-Sep-14	4974	38	2.2	24.7	22.5	0	-	-	-	-
33817	30-Sep-14	98	4	2.2	2.9	0.7	14	3	1.2	6.5	5.3
33818	30-Sep-14	6568	67	2.2	28.3	26.1	747	44	1.2	18.6	17.4
33819	30-Sep-14	292	5	2.2	6.2	4.0	69	4	1.2	6.5	5.3
33821	4-Oct-14	6240	39	1.3	16.8	15.5	13	3	9.4	13.0	3.6
33823	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33824	4-Oct-14	701	10	2.2	4.9	2.7	0	-	-	-	-
33825	4-Oct-14	413	12	2.2	4.9	2.7	34	5	1.2	9.4	8.2
33827	4-Oct-14	285	7	2.2	4.7	2.5	0	-	-	-	-
33828	4-Oct-14	0	-	-	-	-	0	-	-	-	-
33829	4-Oct-14	52	2	2.2	4.9	2.7	0	-	-	-	-
33831	4-Oct-14	227	8	2.2	4.9	2.7	0	-	-	-	-
33832	4-Oct-14	632	4	2.2	4.9	2.7	15	2	1.2	2.7	1.5

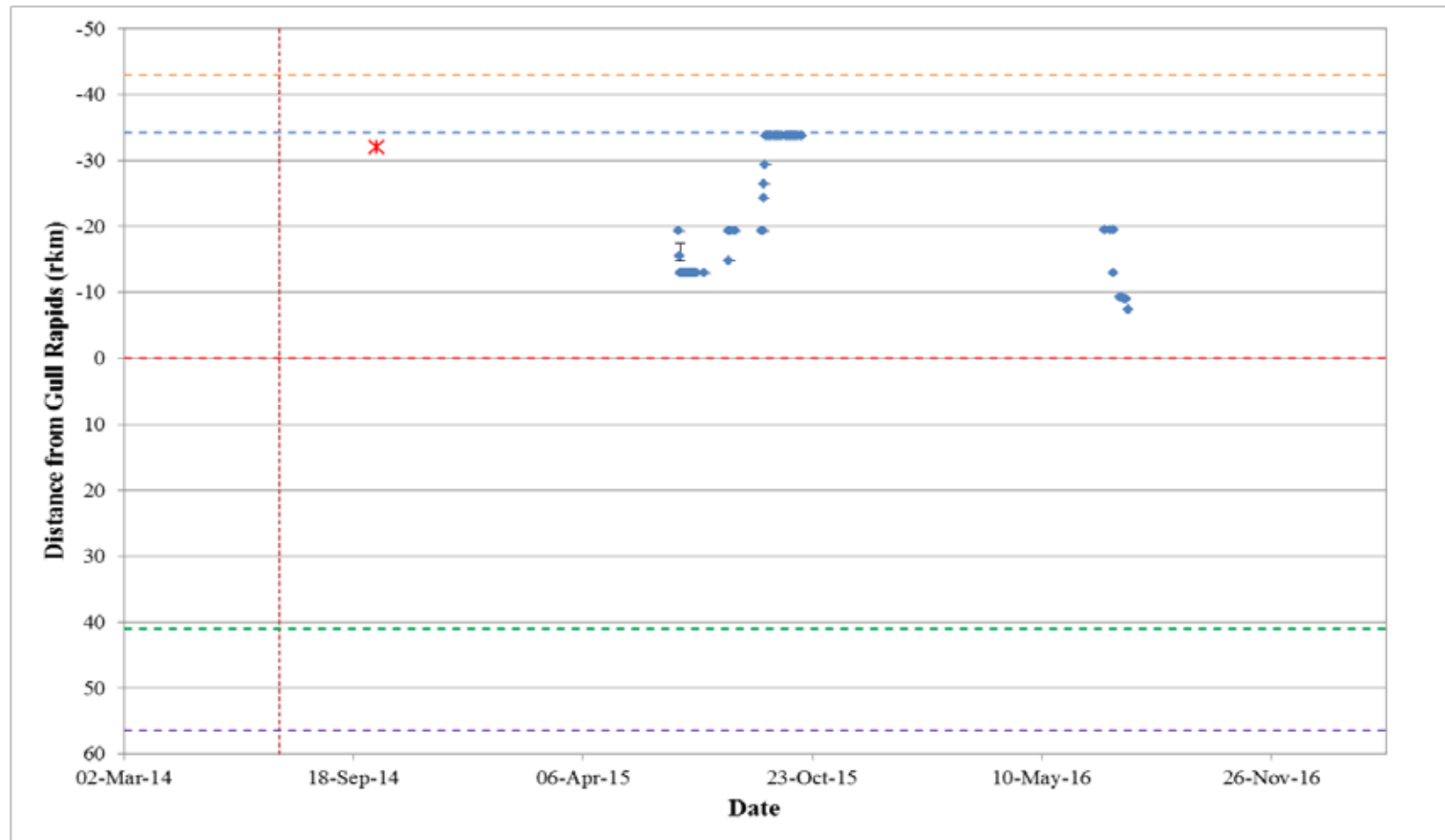
## APPENDIX 2:

# LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC-TAGGED LAKE WHITEFISH IN GULL LAKE, OCTOBER 2015 TO OCTOBER 2016

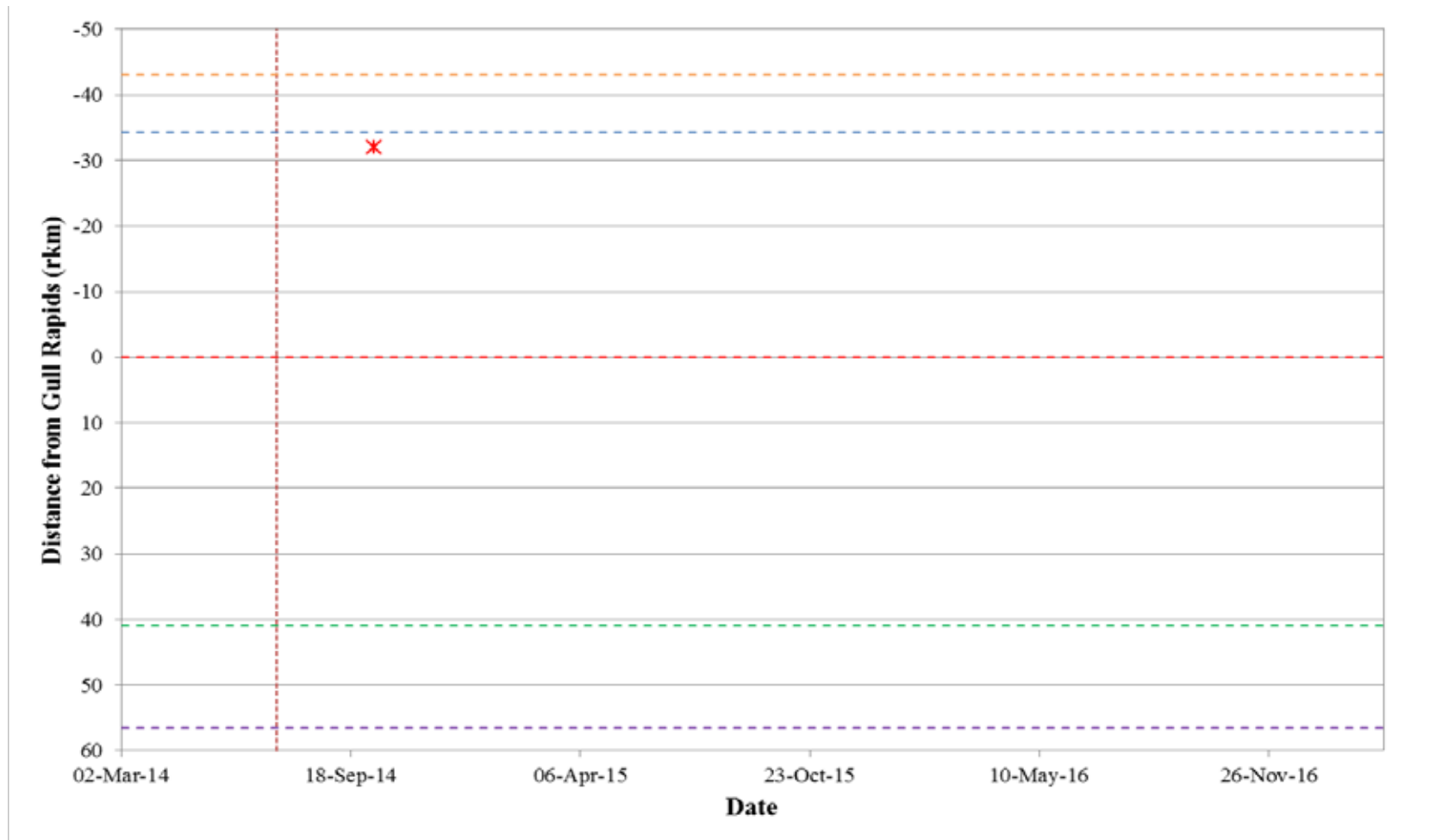
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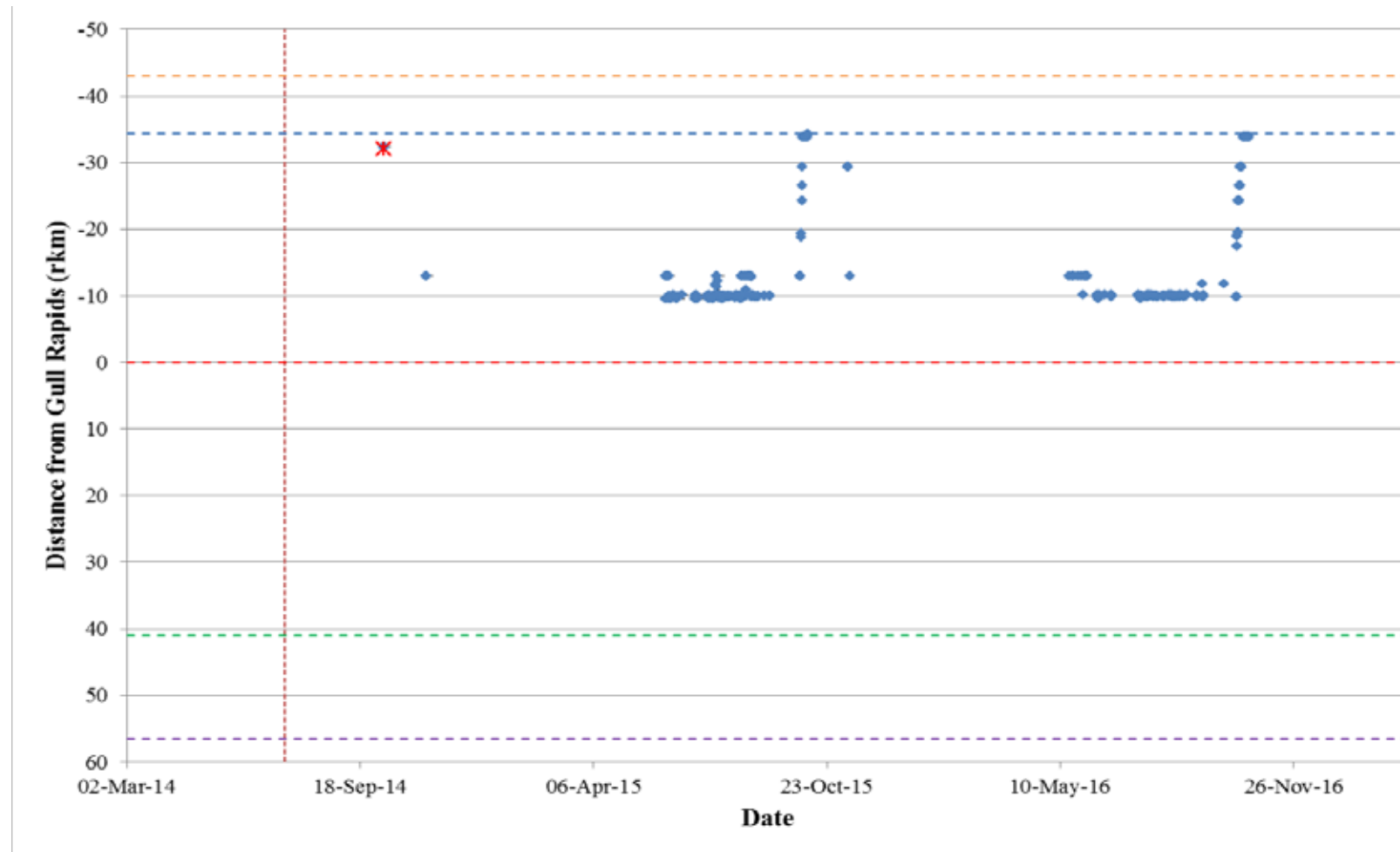


**Figure A2-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33793) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

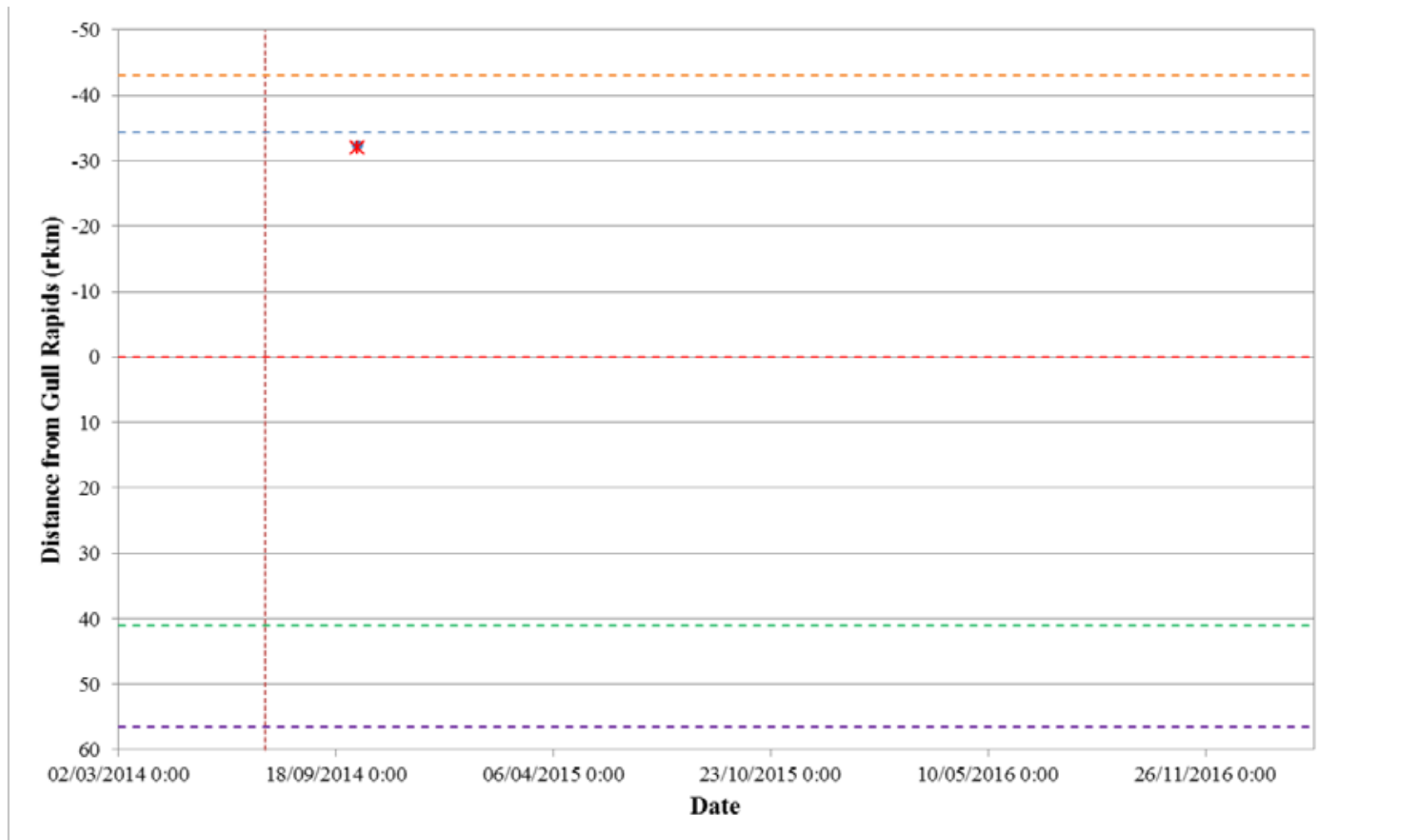


**Figure A2-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33797) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

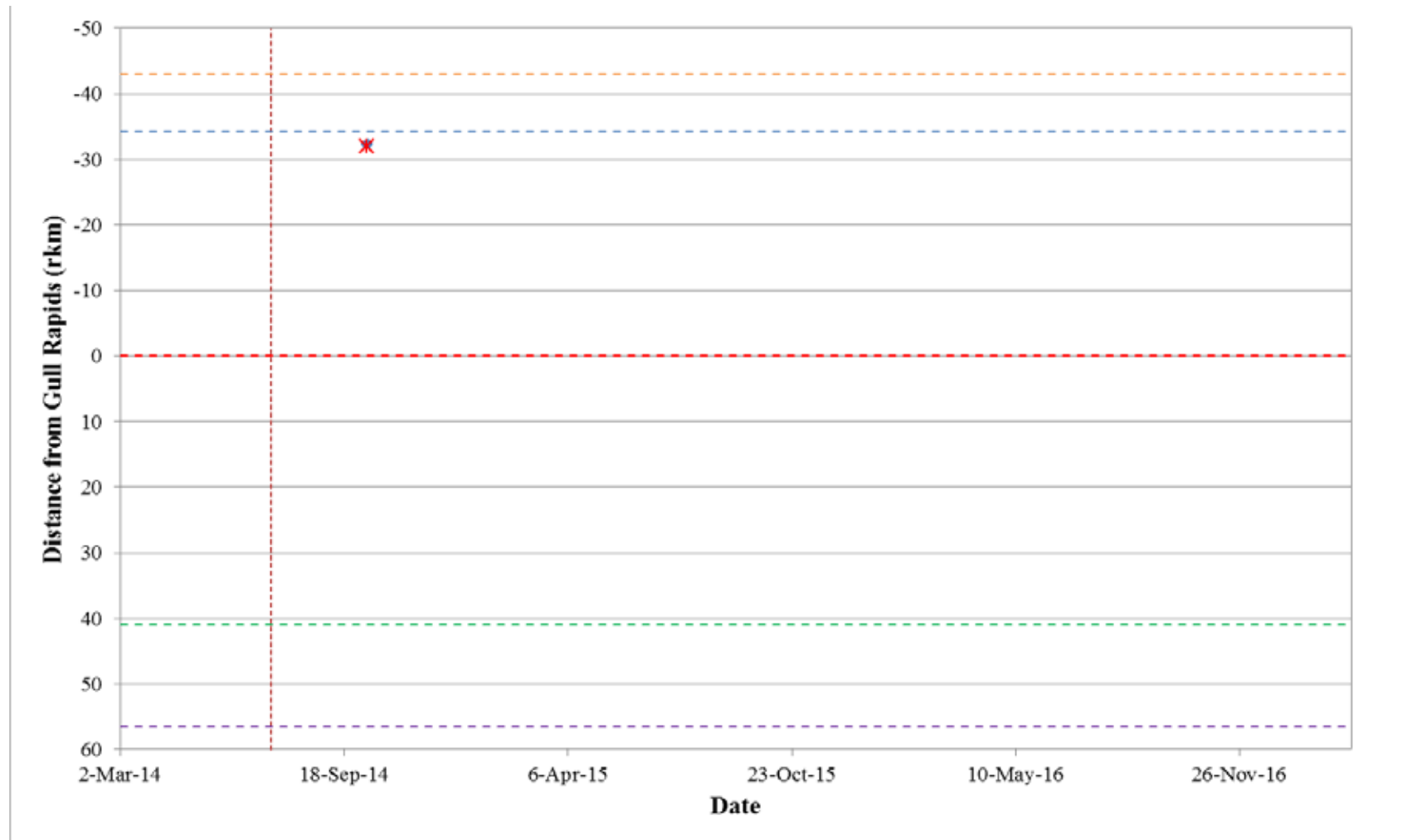




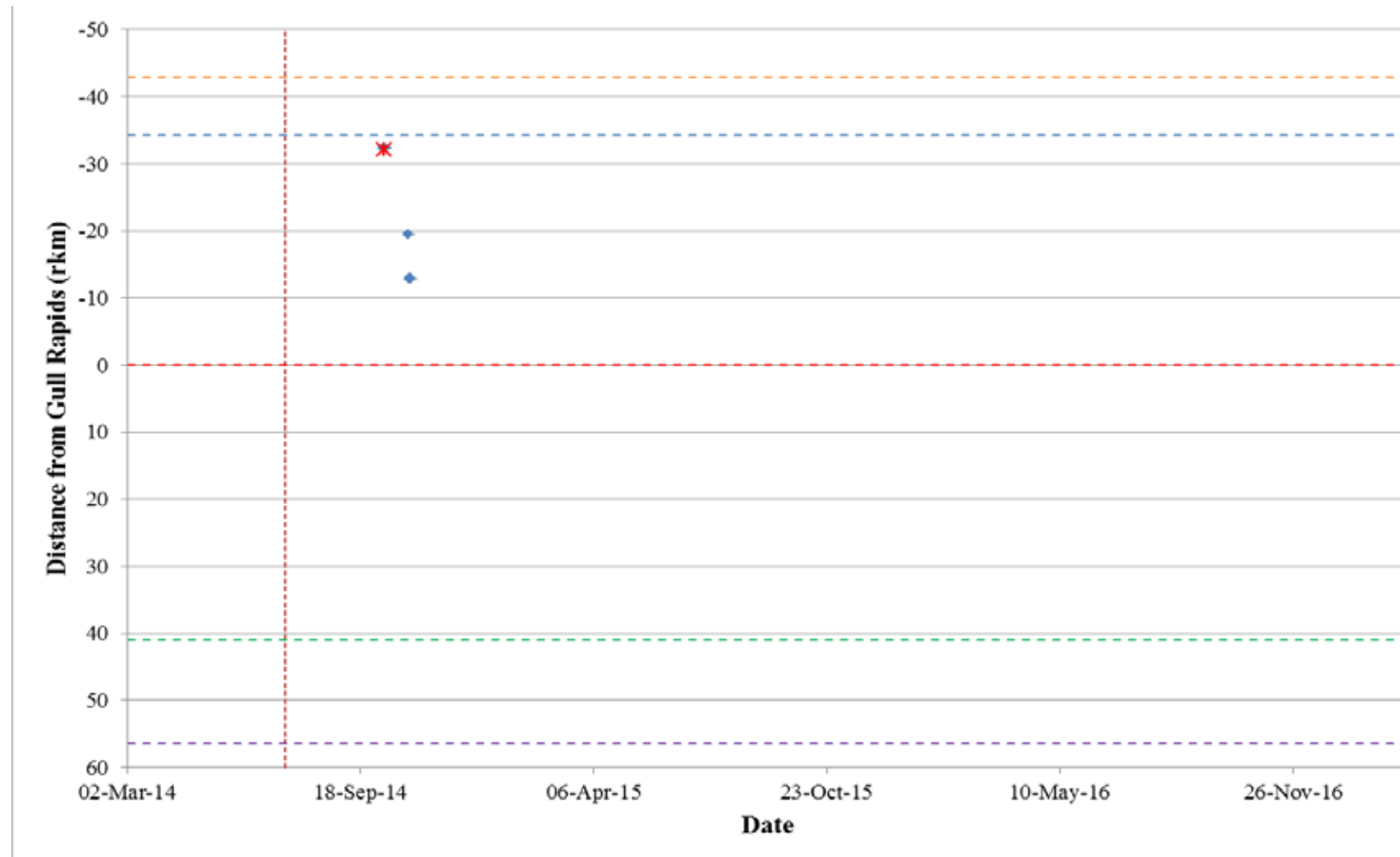
**Figure A2-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33798) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A2-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33800) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A2-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33801) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A2-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33802) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

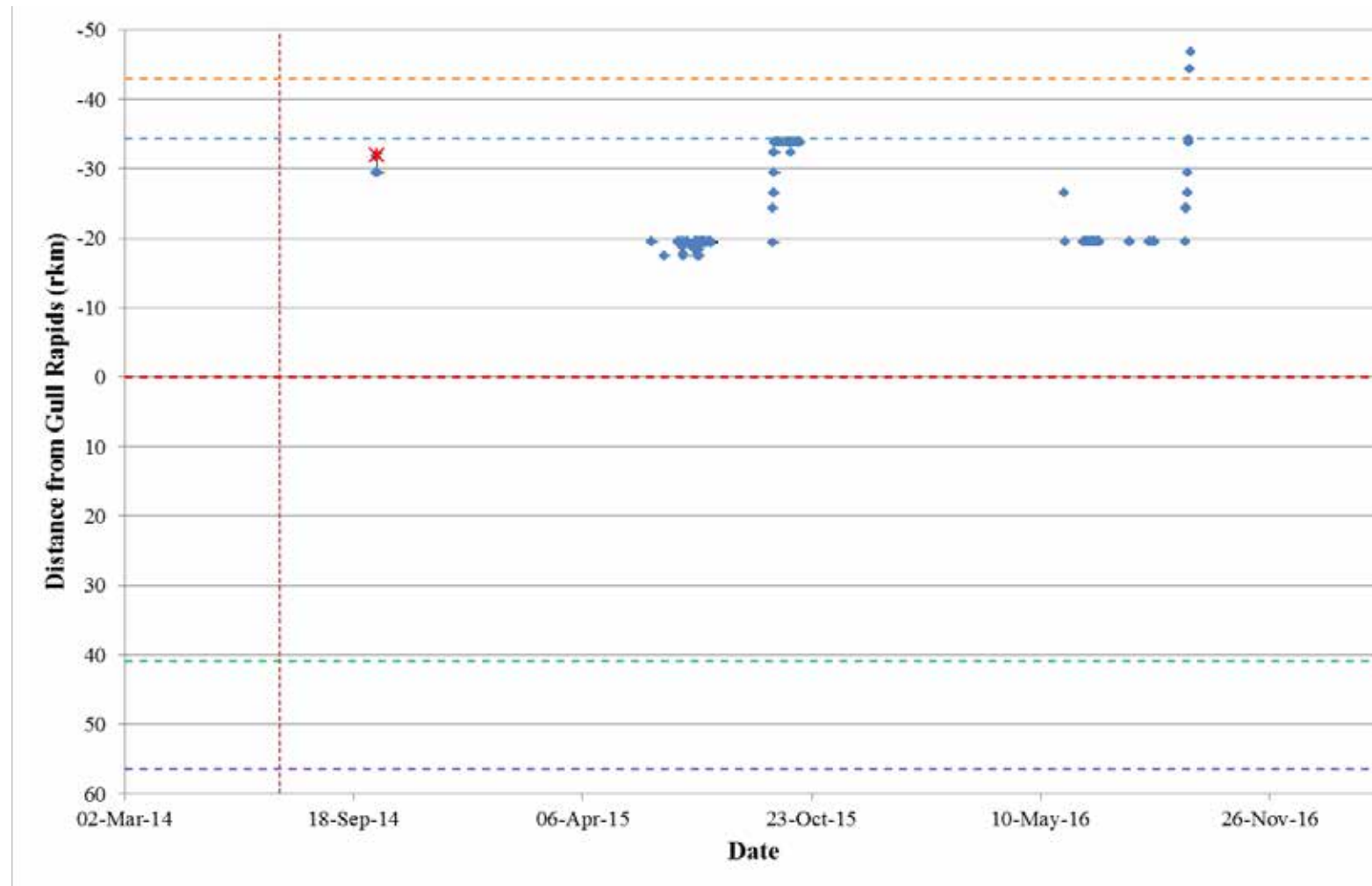
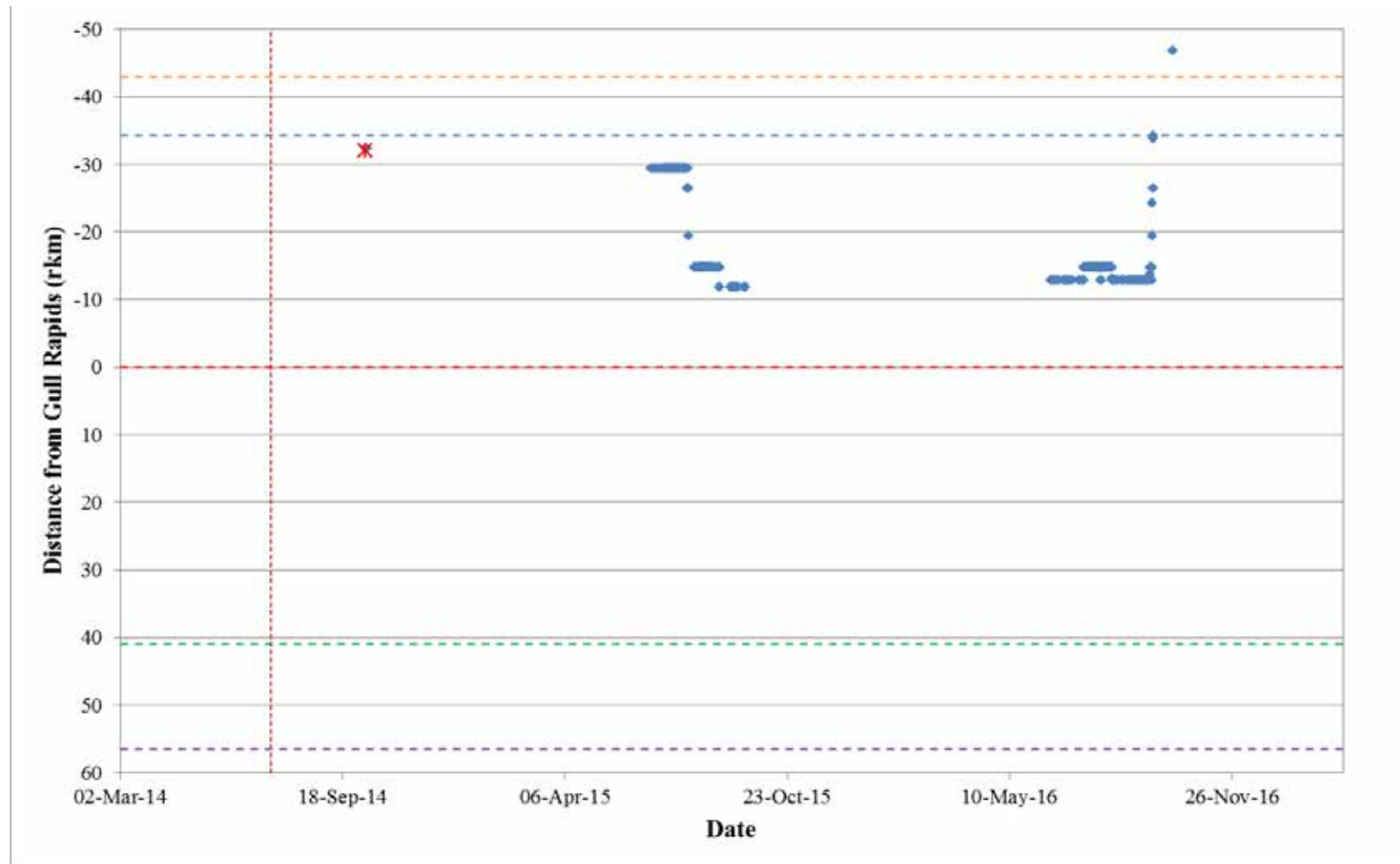


Figure A2-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33803) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A2-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33804) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



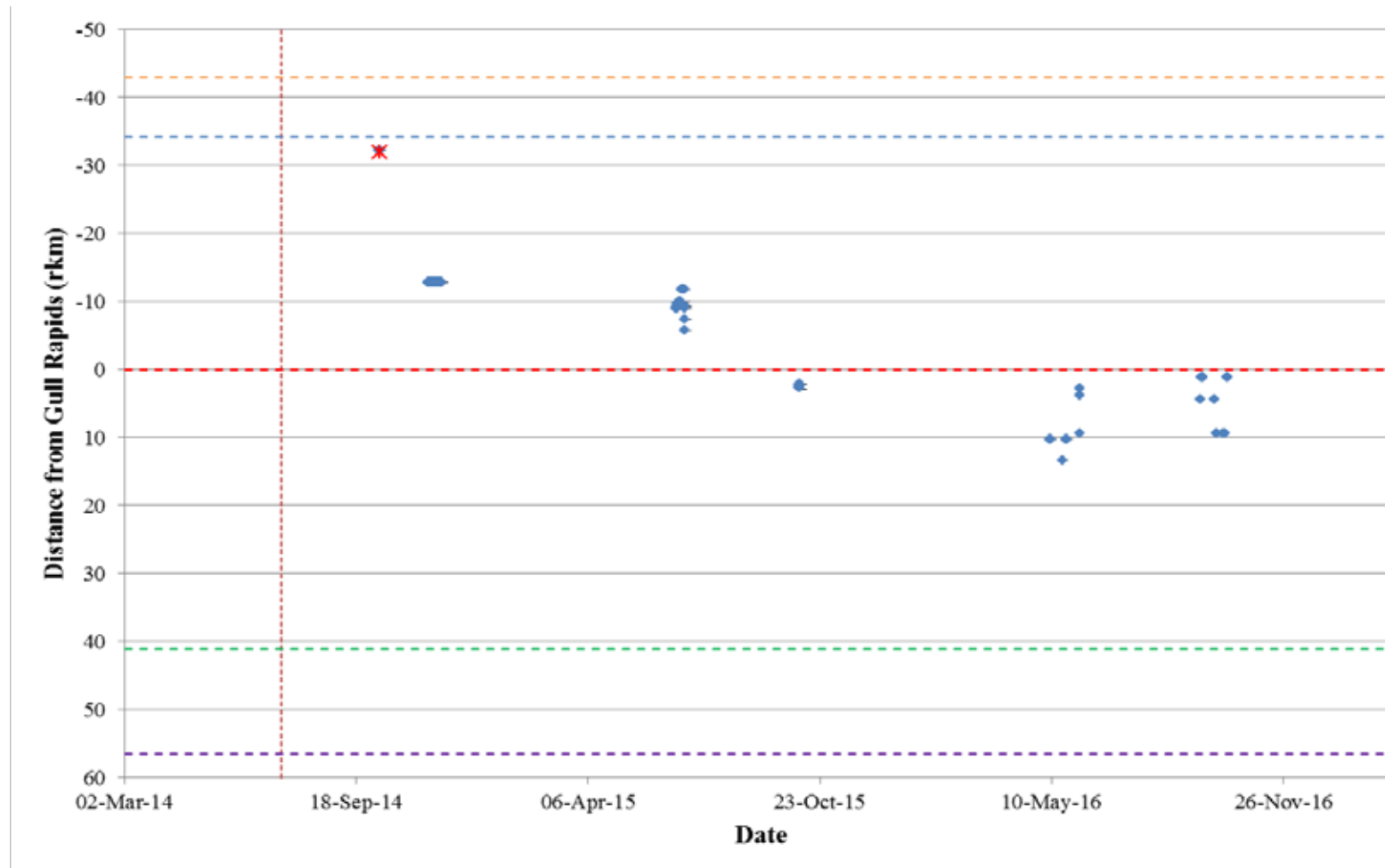
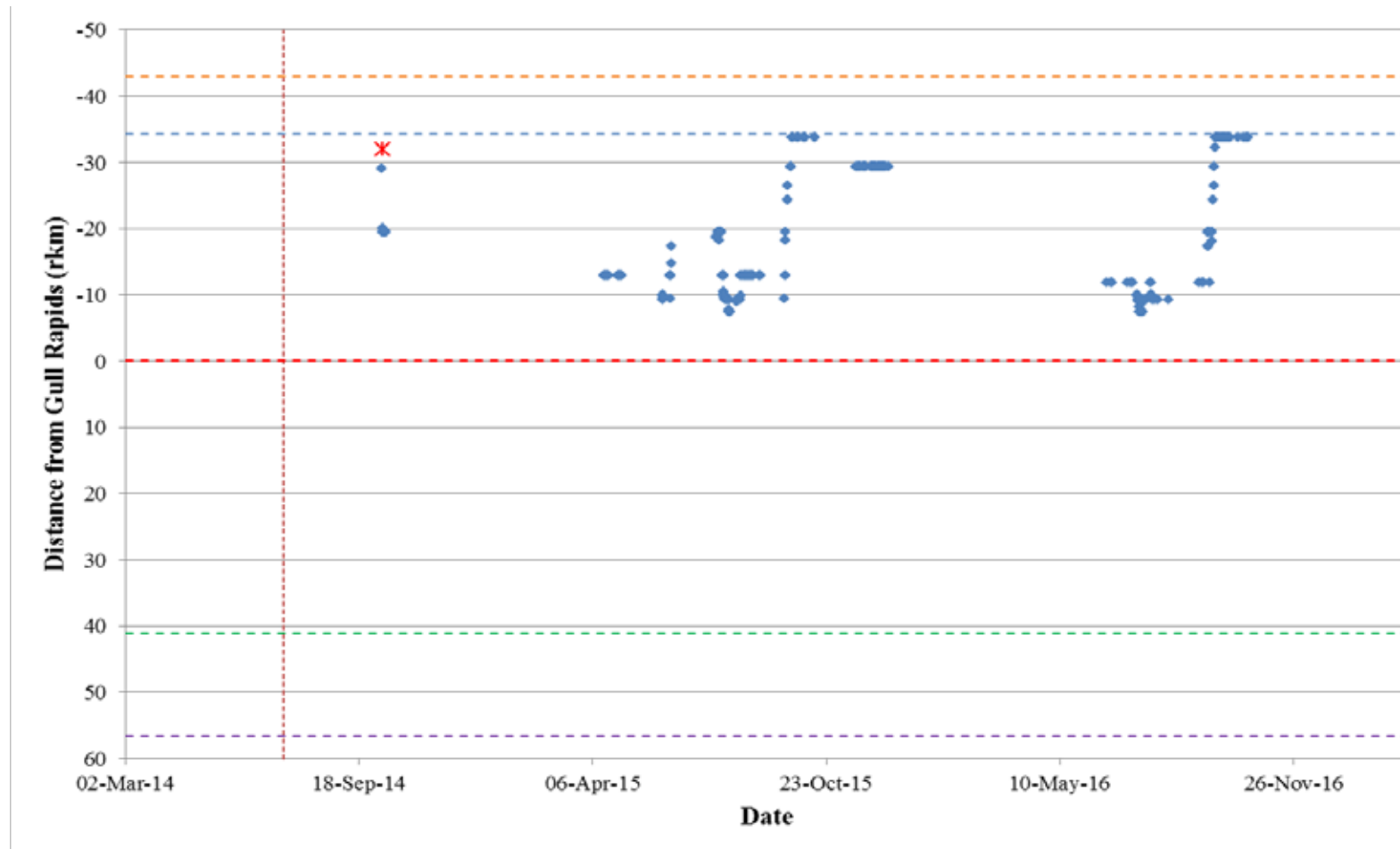
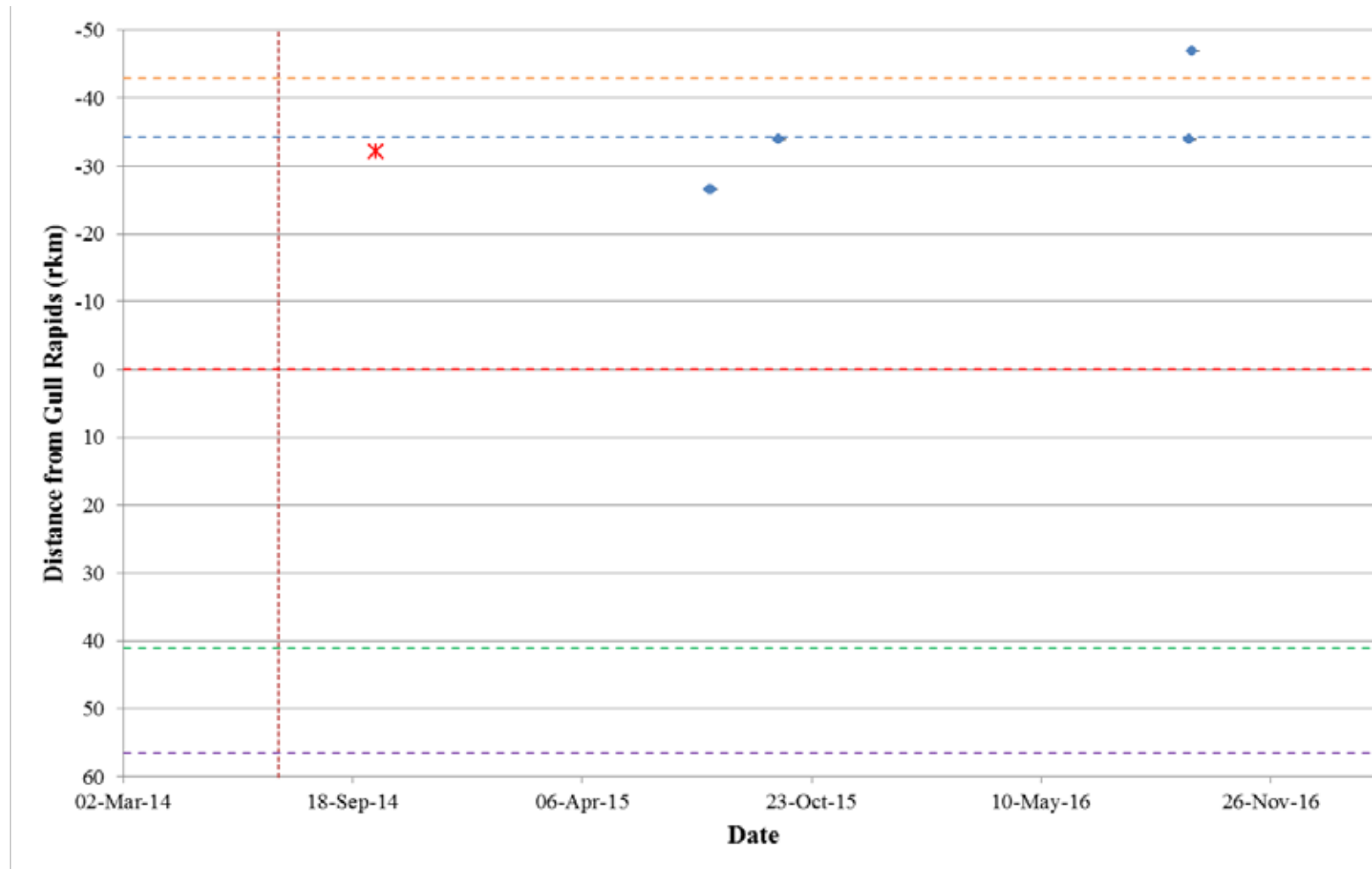


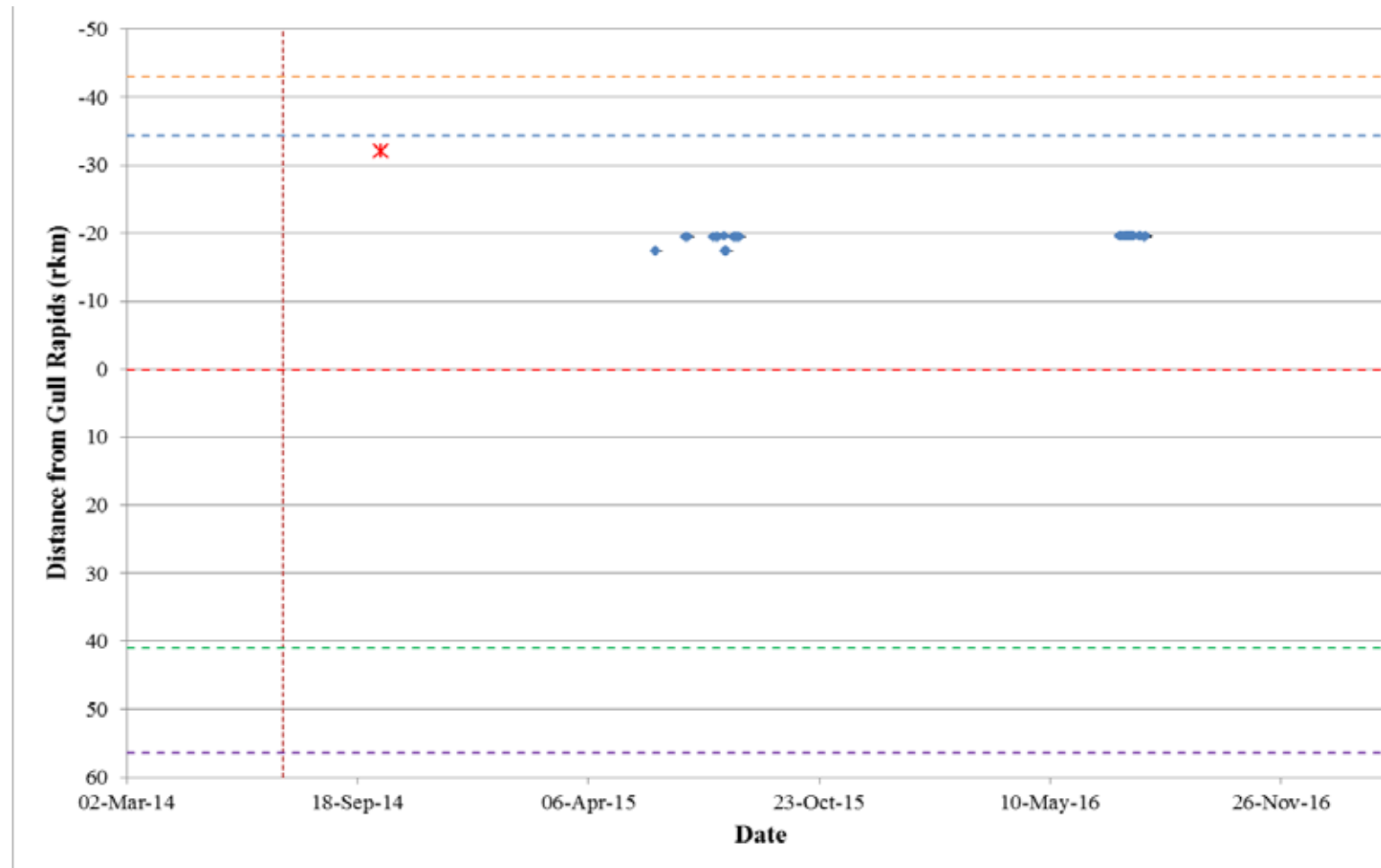
Figure A2-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33805) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



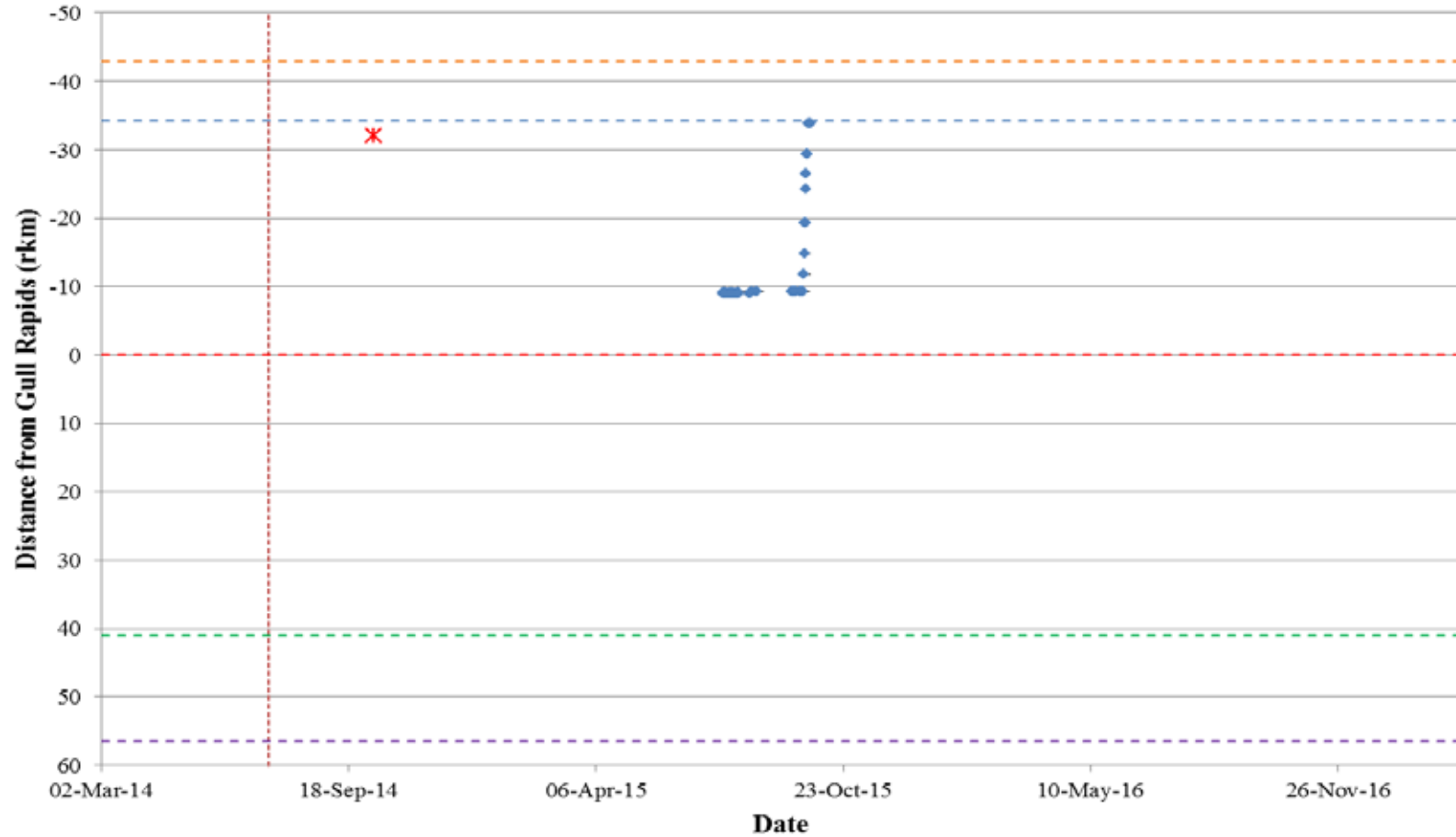
**Figure A2-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33806) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



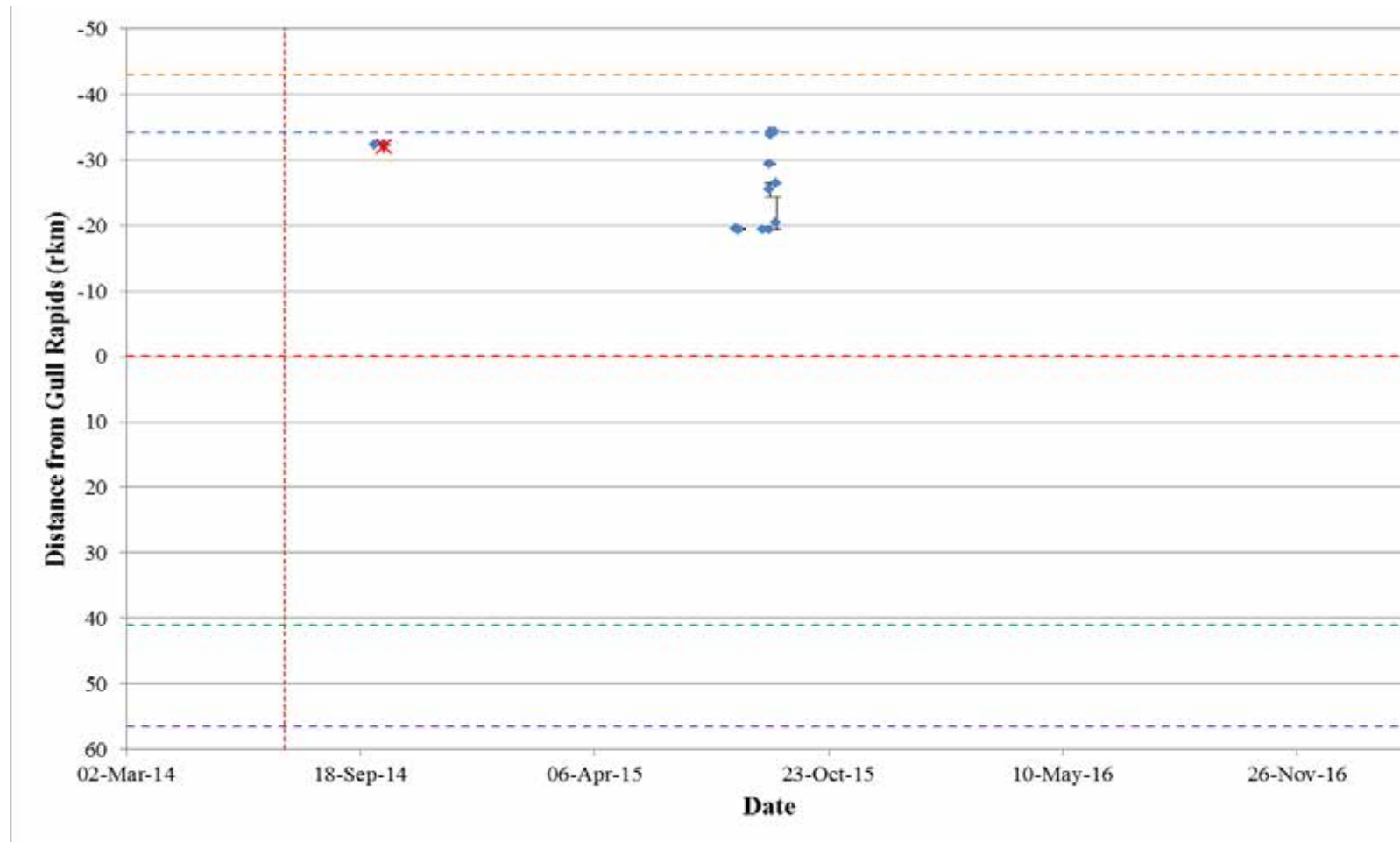
**Figure A2-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33807) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A2-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33808) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A2-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33809) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A2-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33812) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



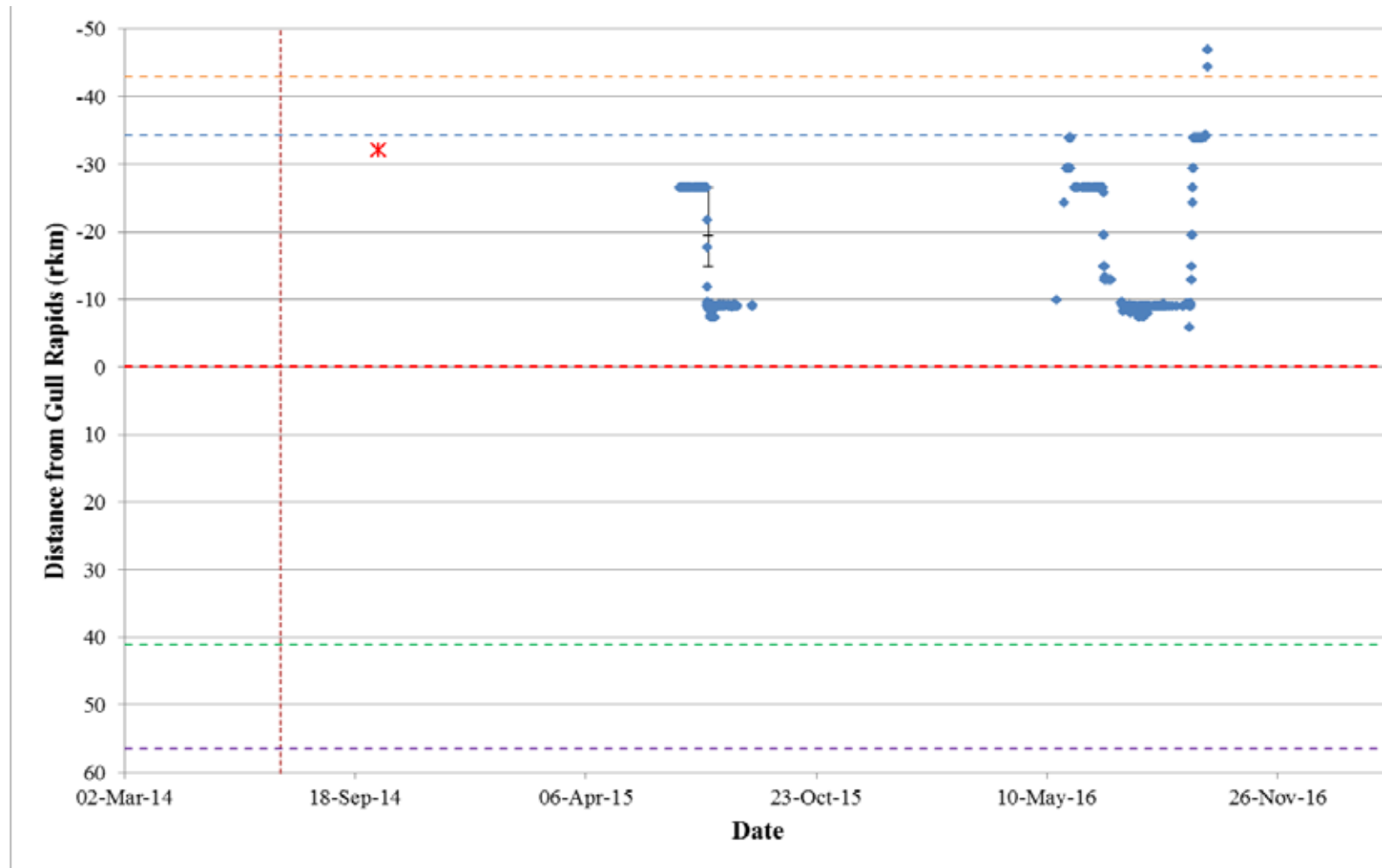


Figure A2-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33813) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

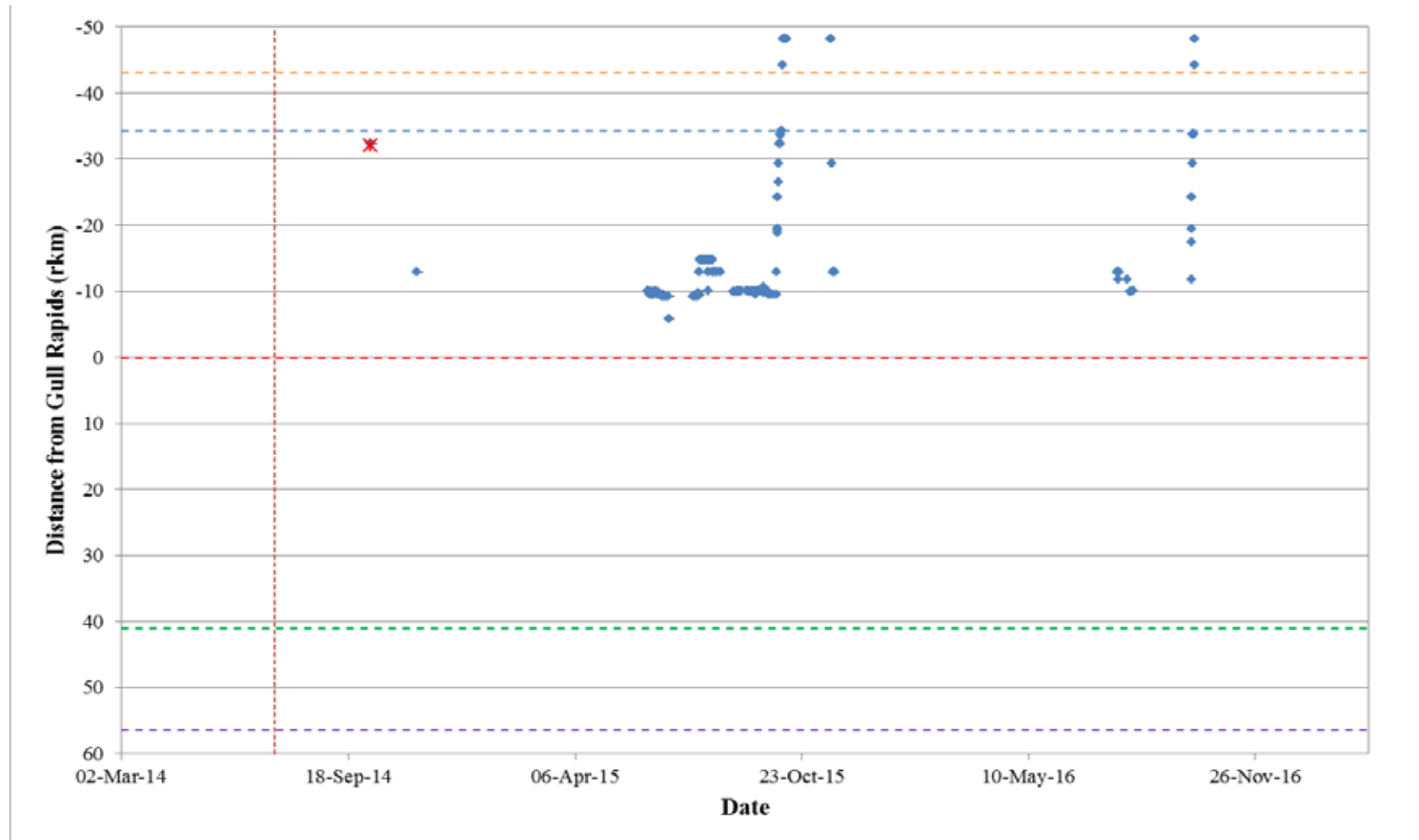
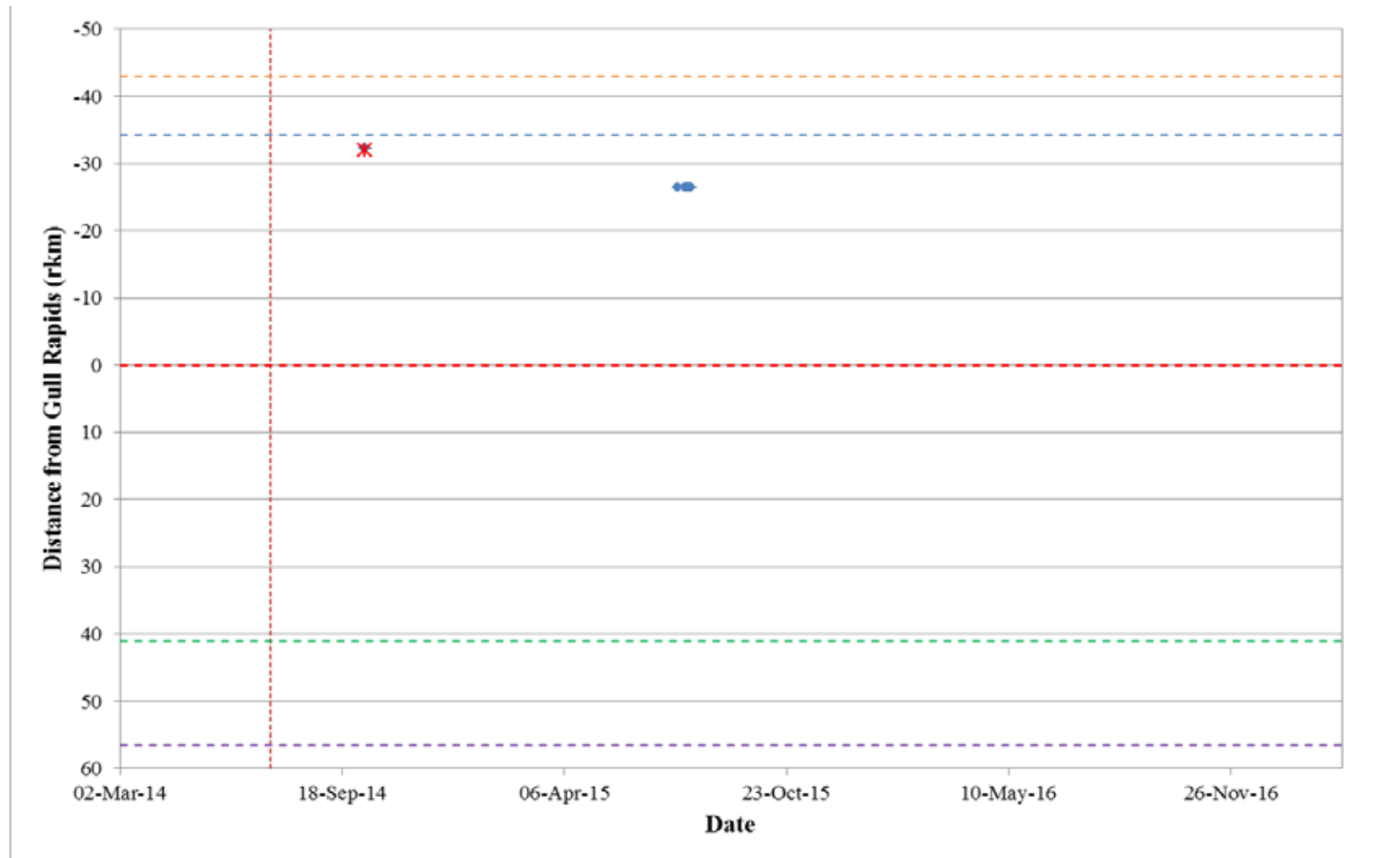


Figure A2-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33816) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A2-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33820) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

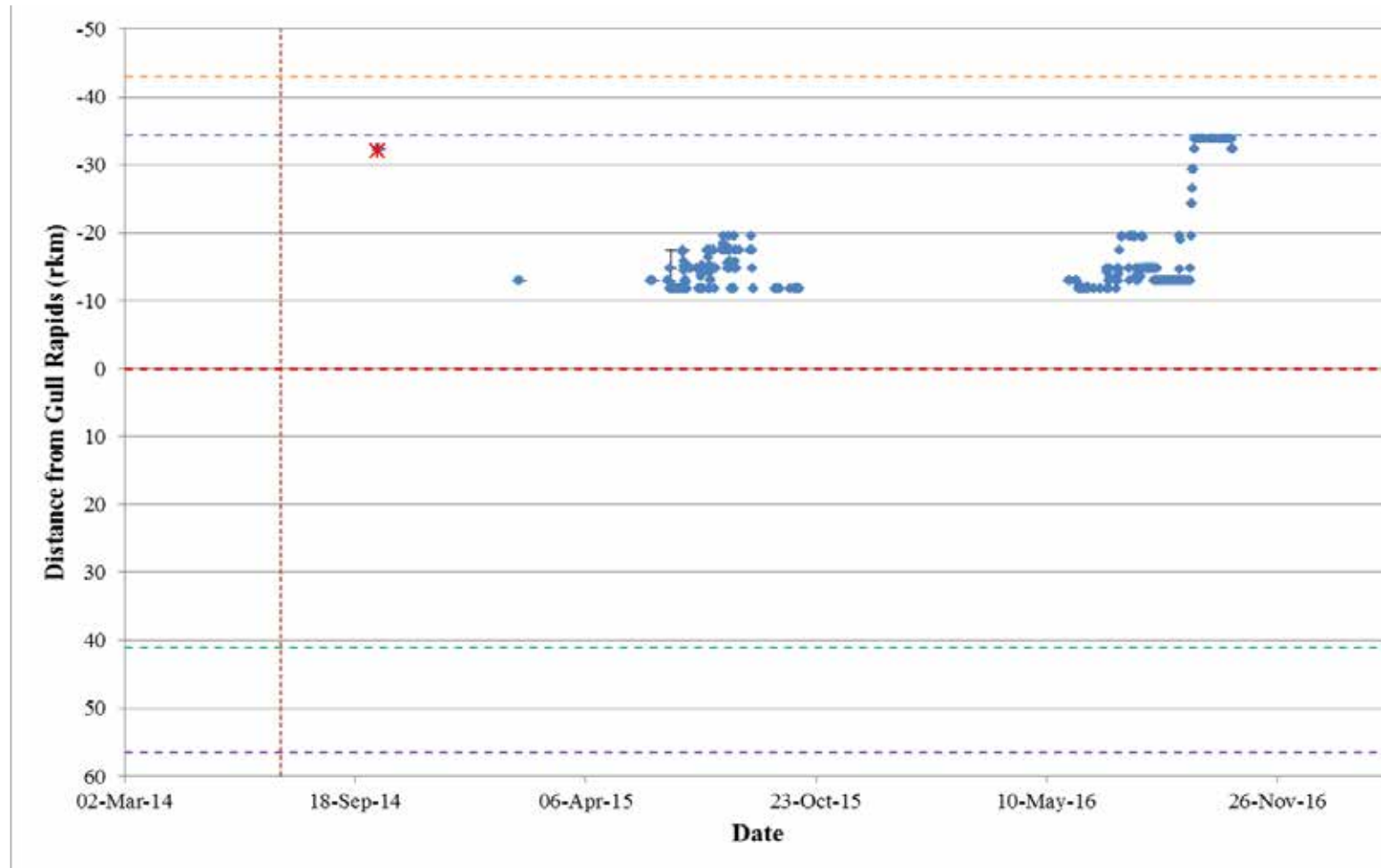


Figure A2-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33822) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

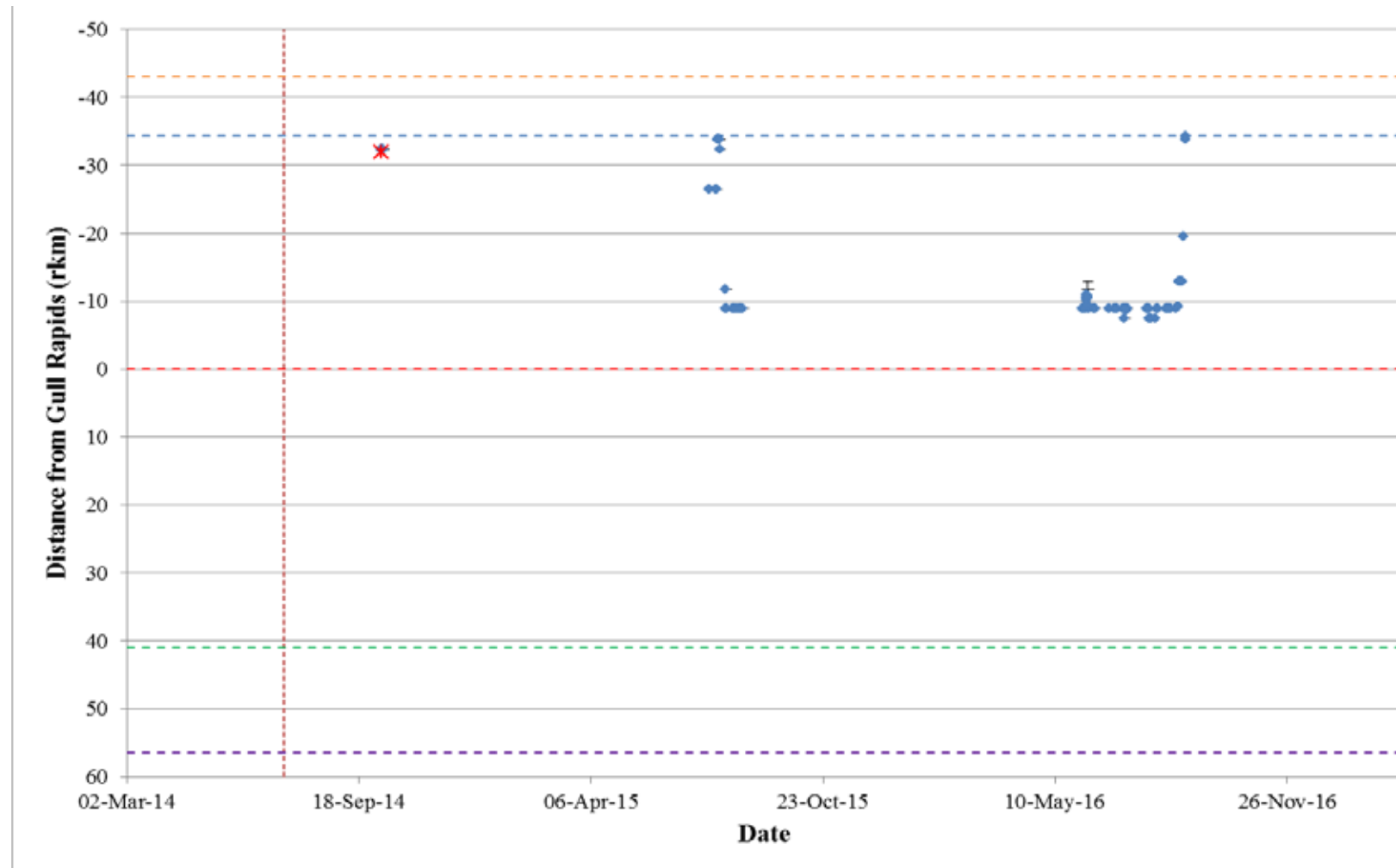


Figure A2-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33826) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

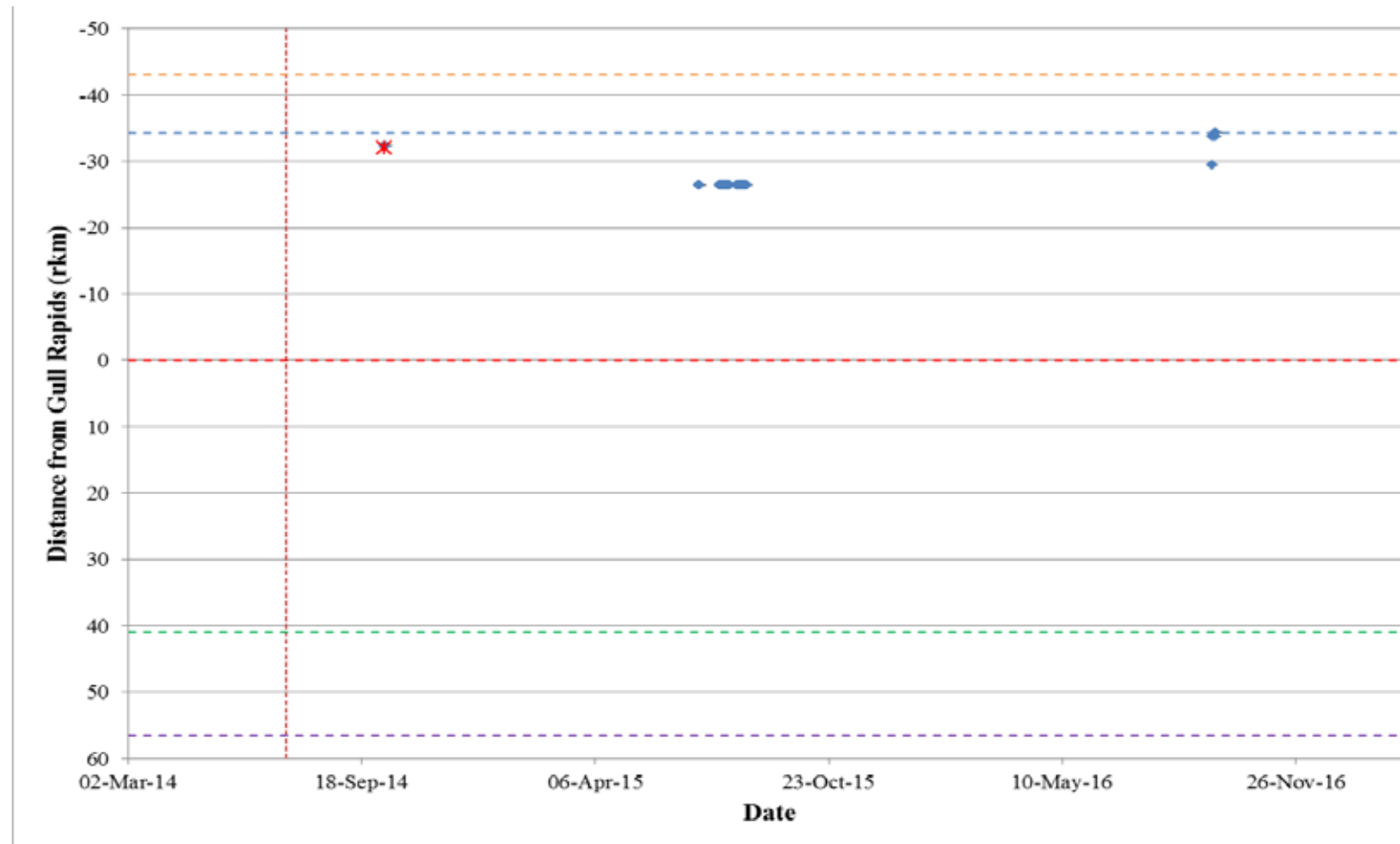


Figure A2-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33830) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



## APPENDIX 3:

# LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC-TAGGED LAKE WHITEFISH IN STEPHENS LAKE, OCTOBER 2015 TO OCTOBER 2016

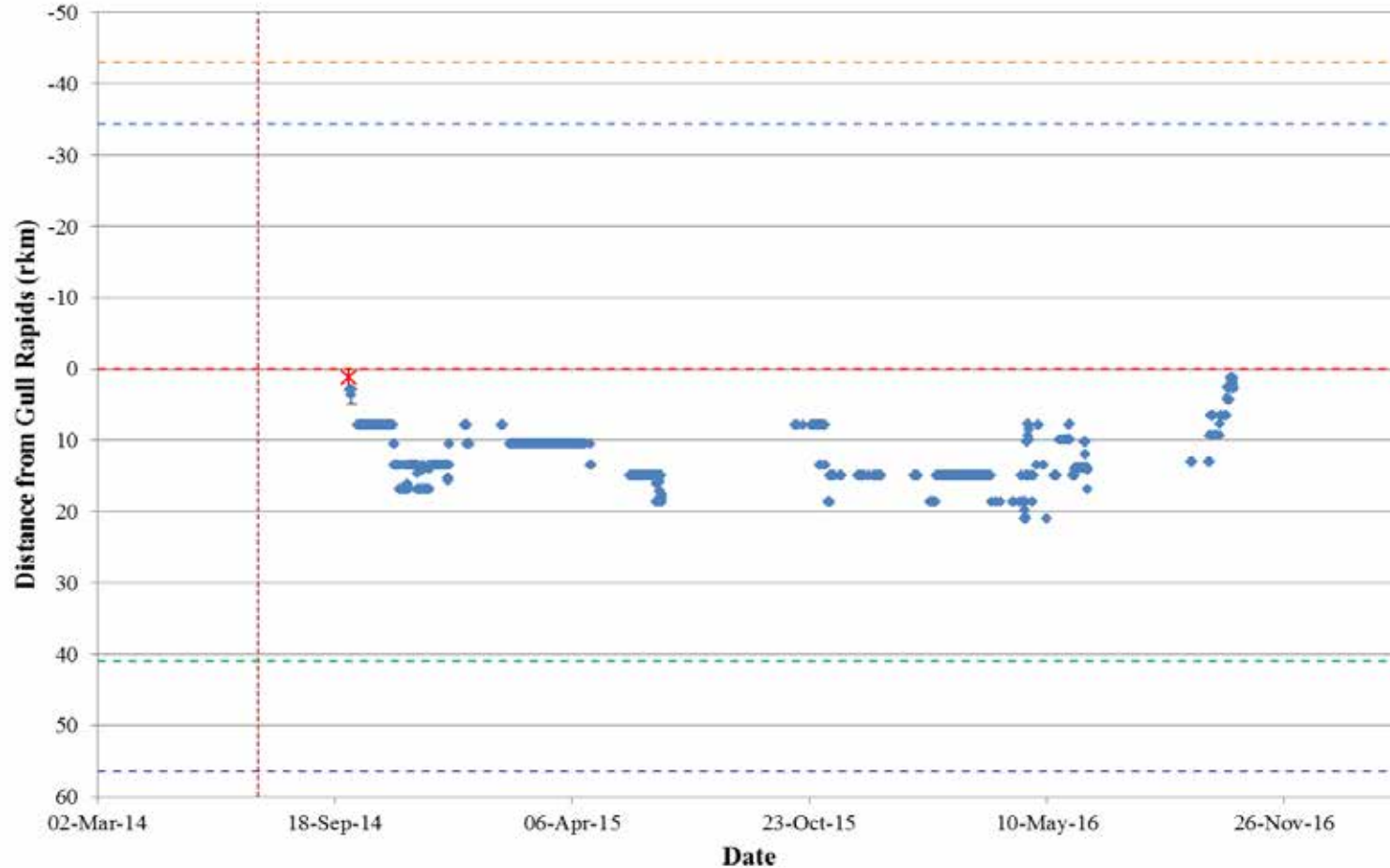
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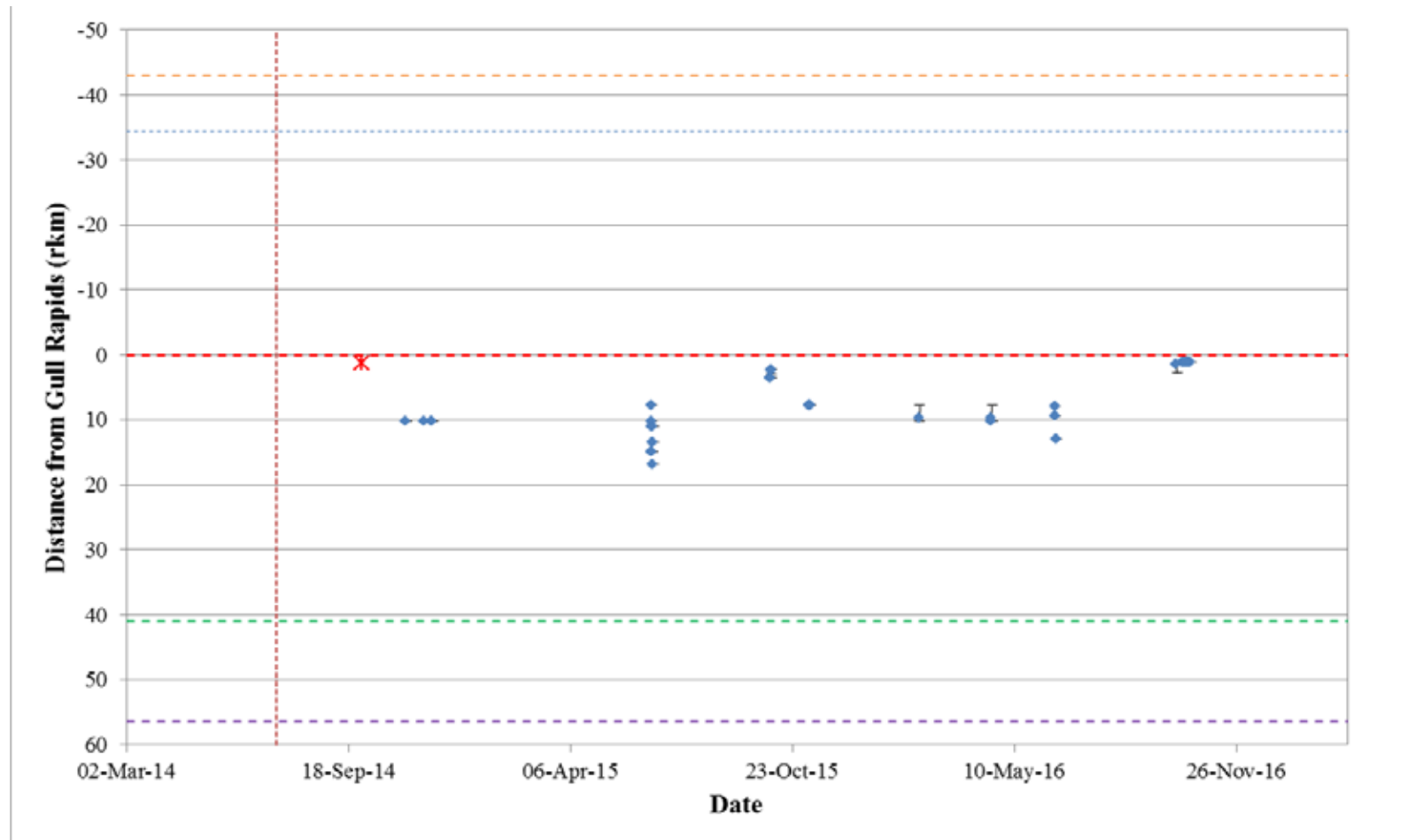
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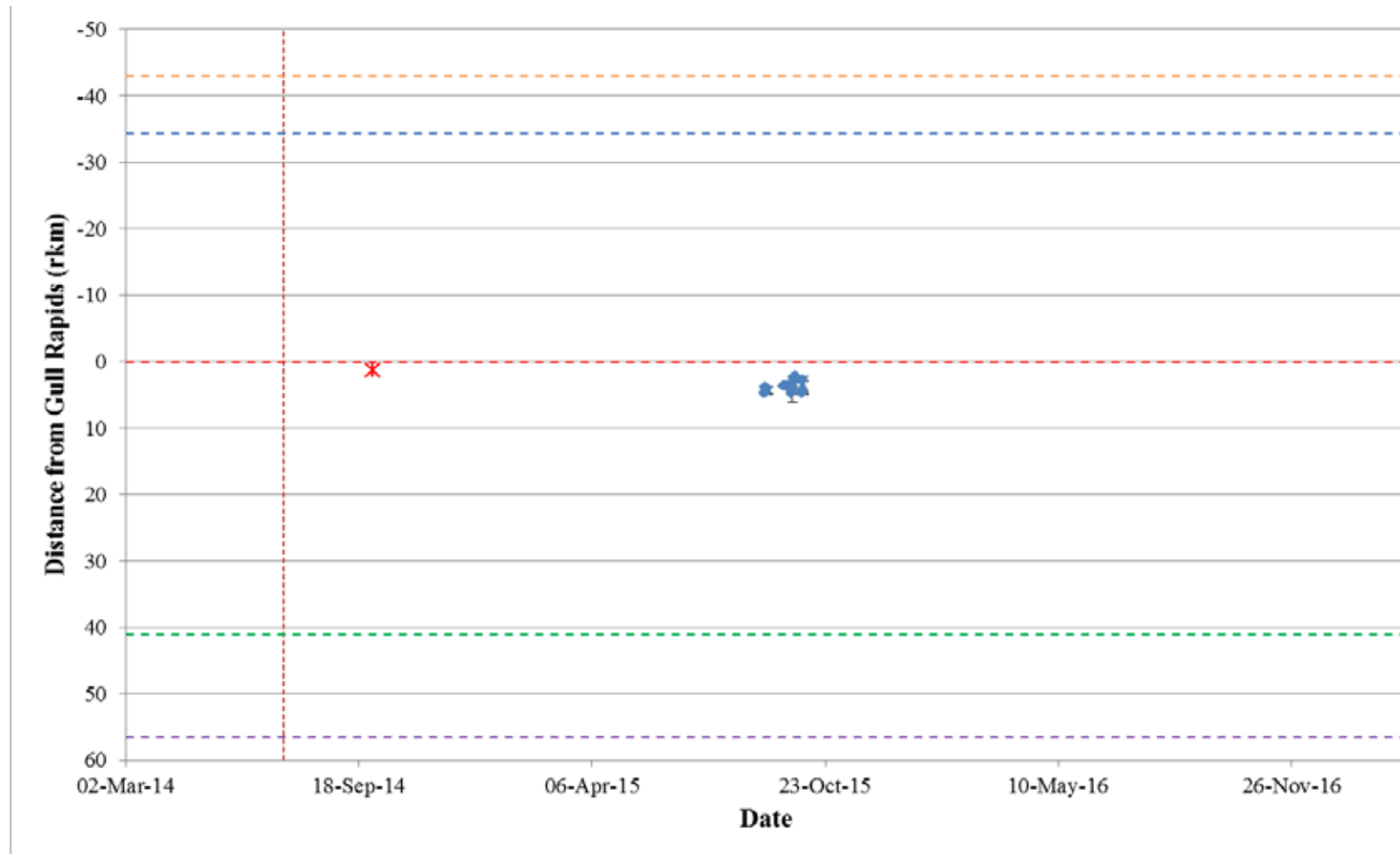


**Figure A3-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6357) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**





**Figure A3-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6358) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A3-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6359) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

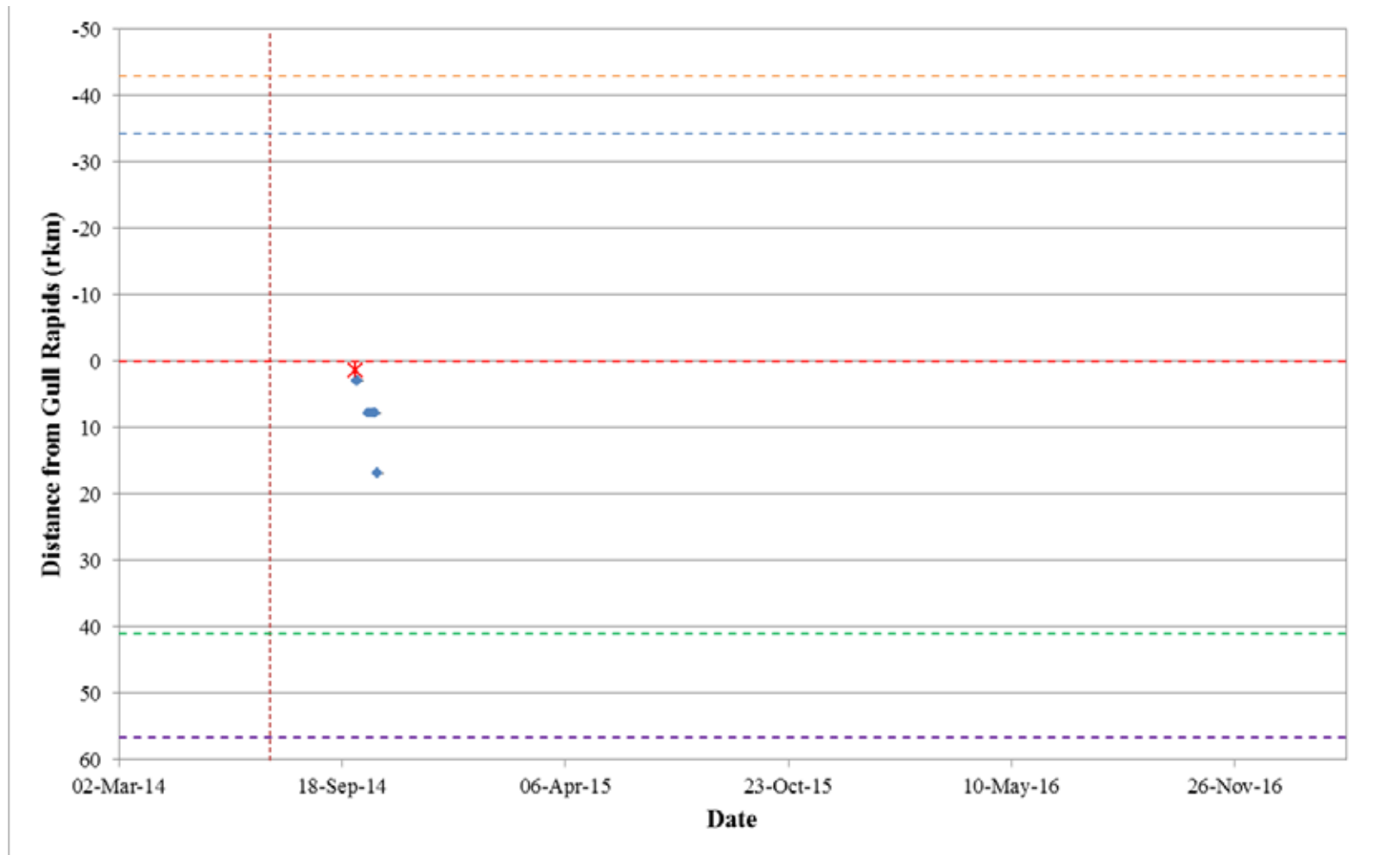
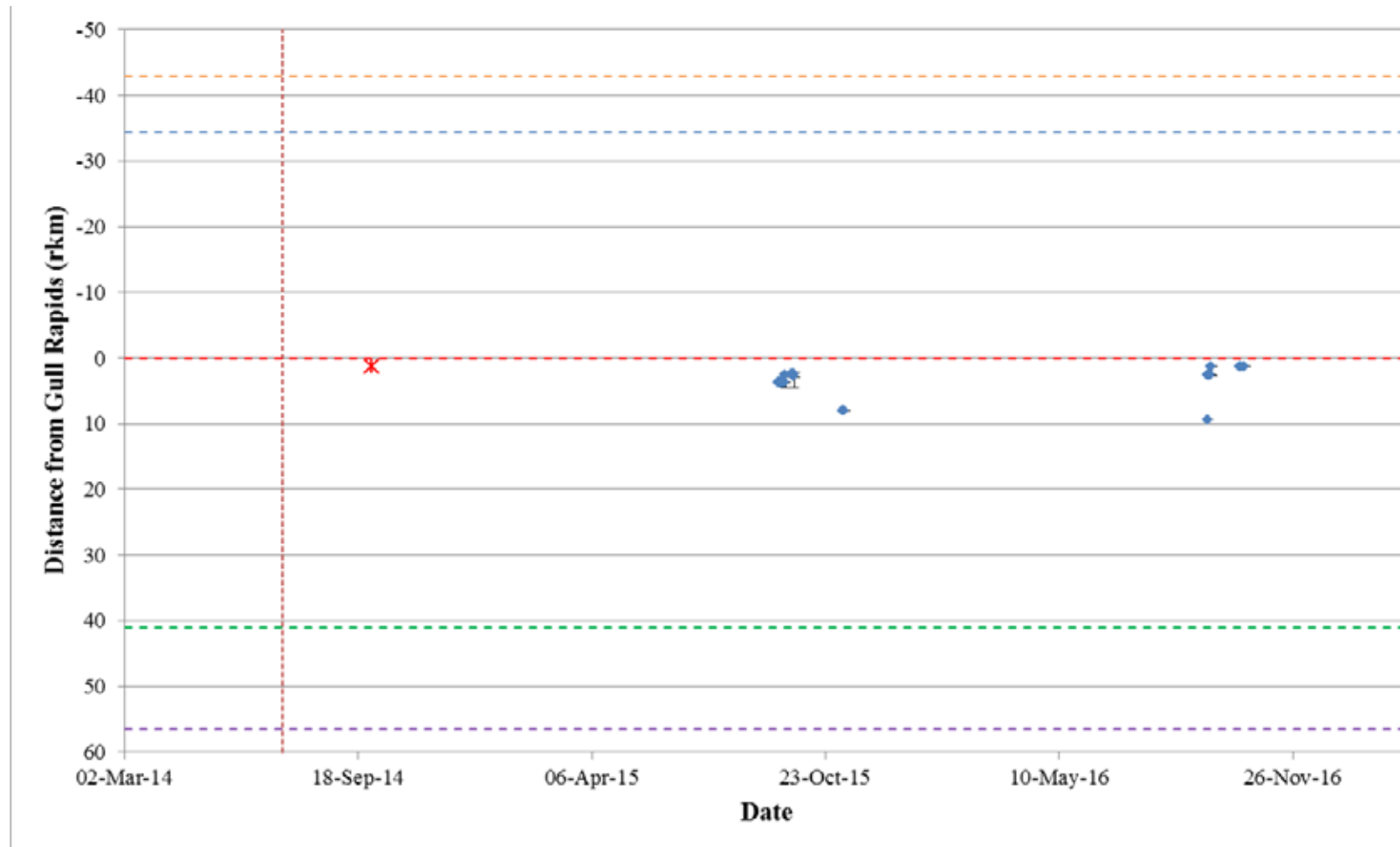
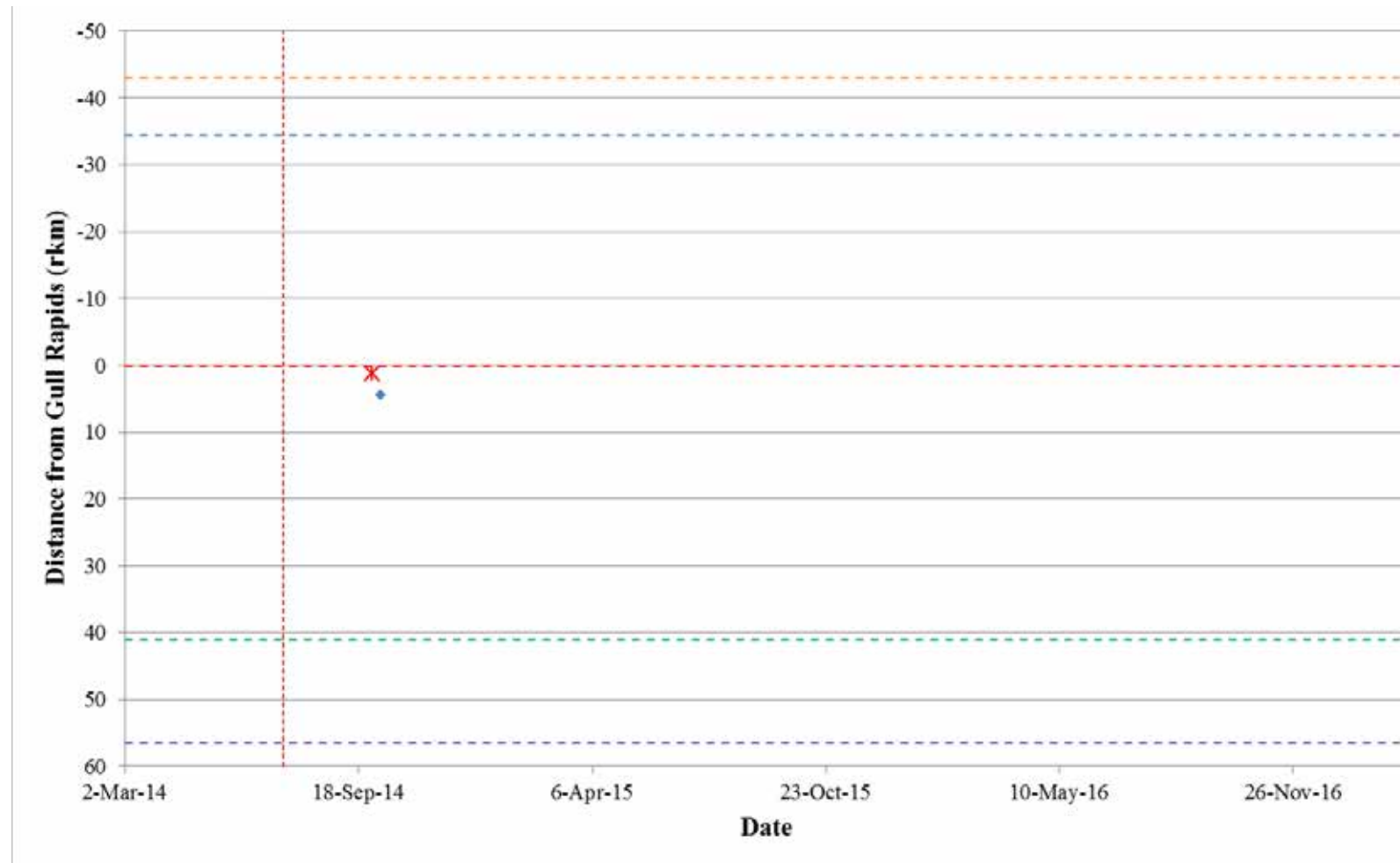


Figure A3-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6360) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

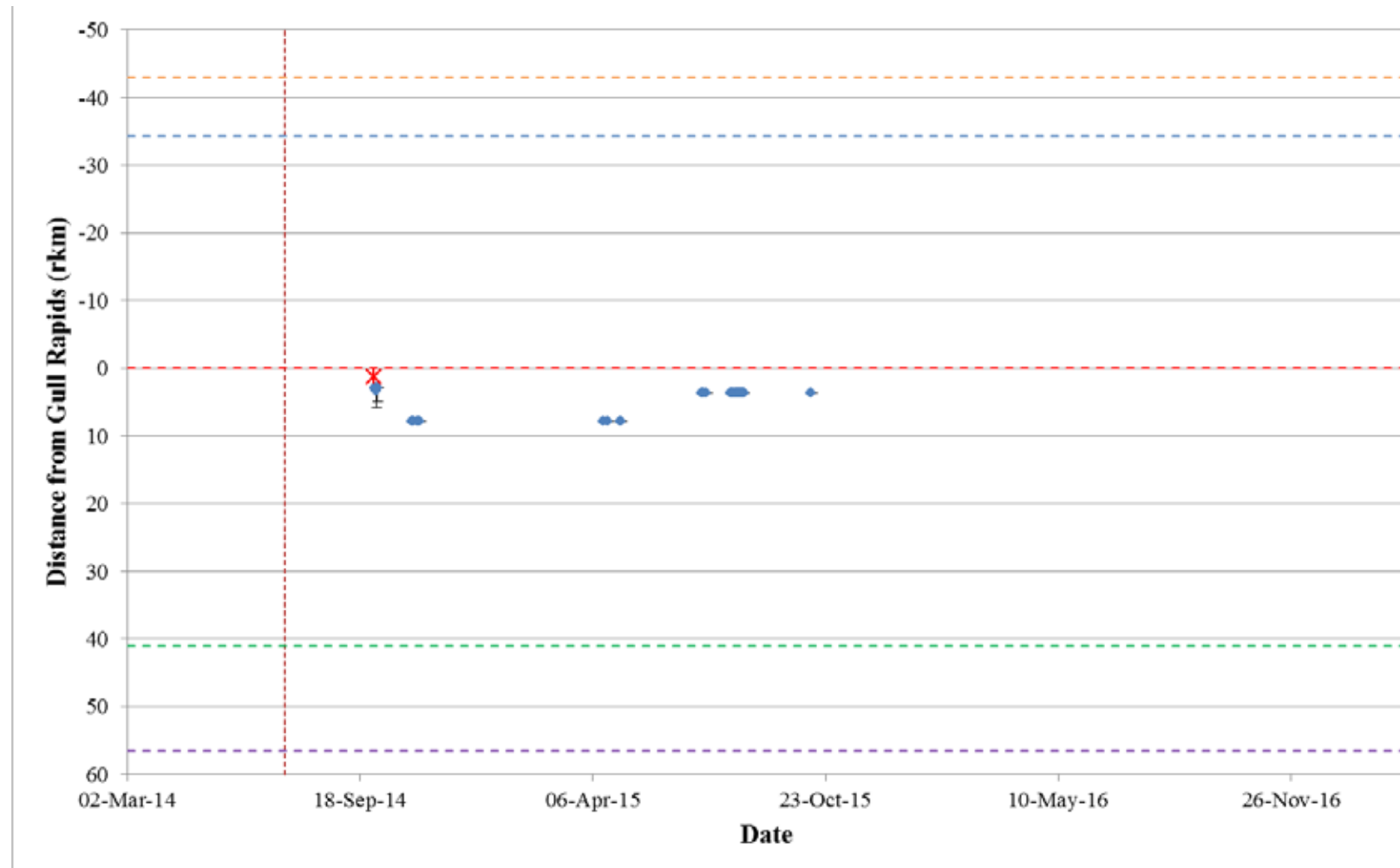


**Figure A3-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6361) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

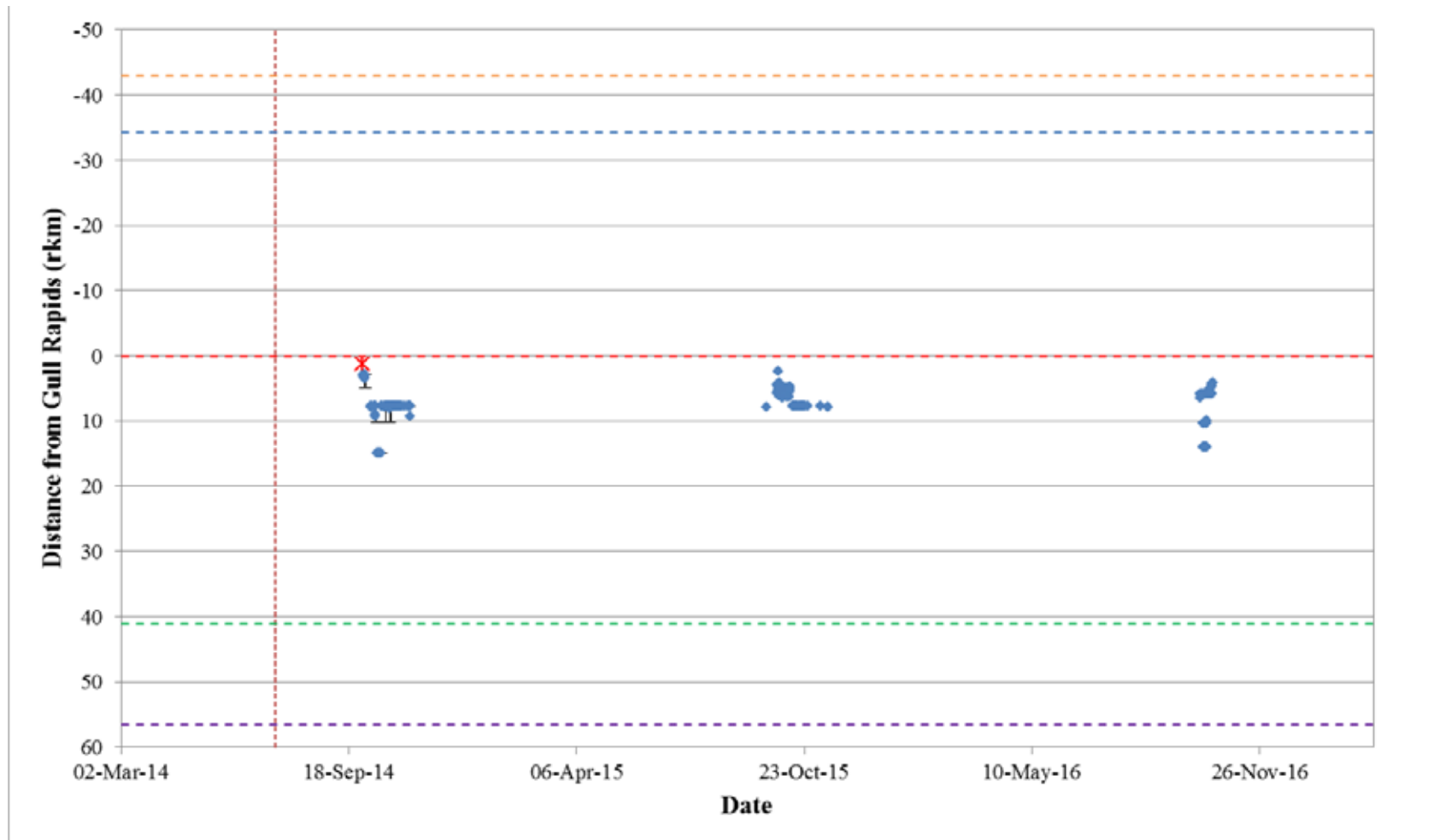


**Figure A3-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6362) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**





**Figure A3-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6363) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A3-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6364) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

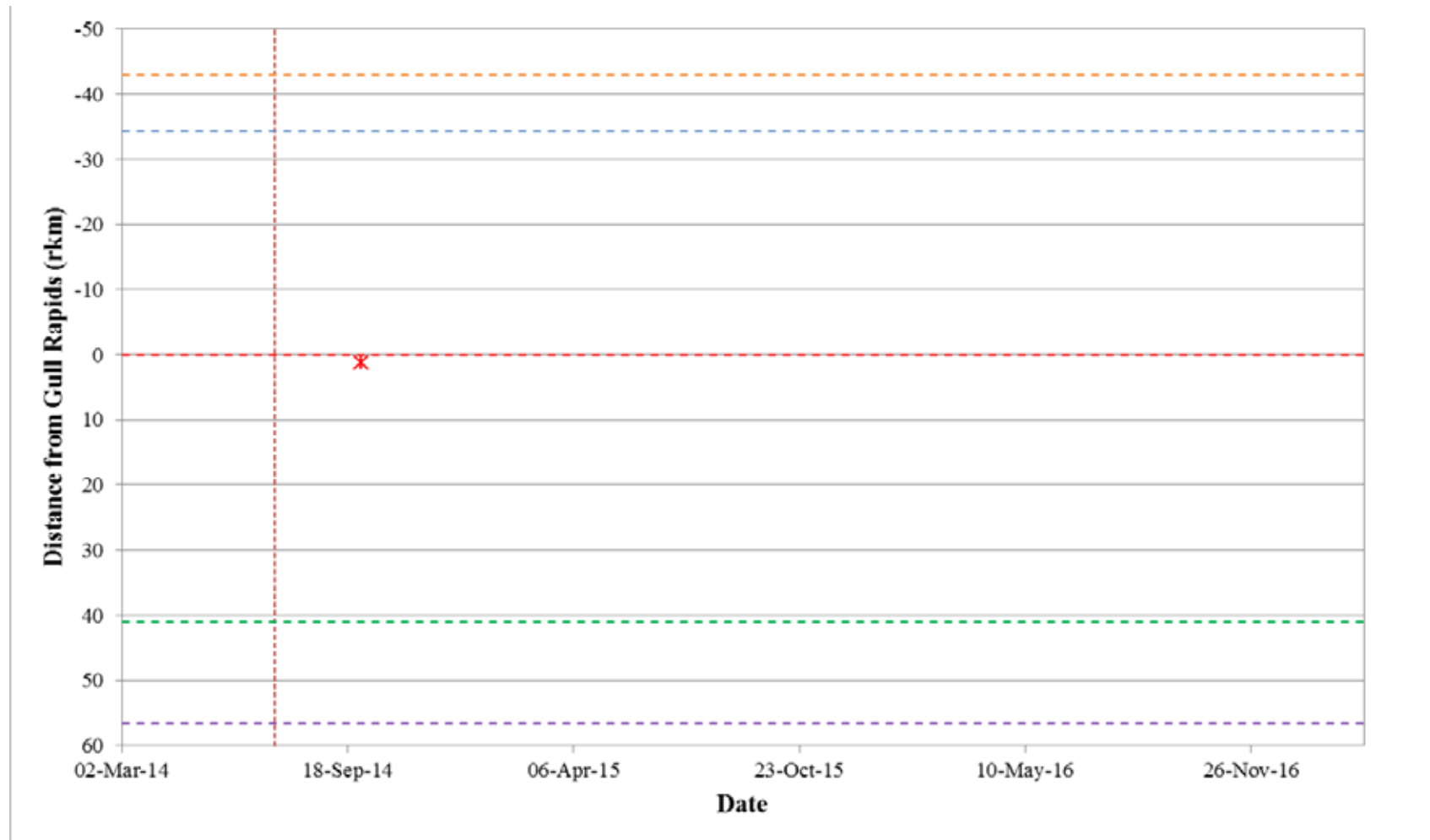


Figure A3-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6365) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

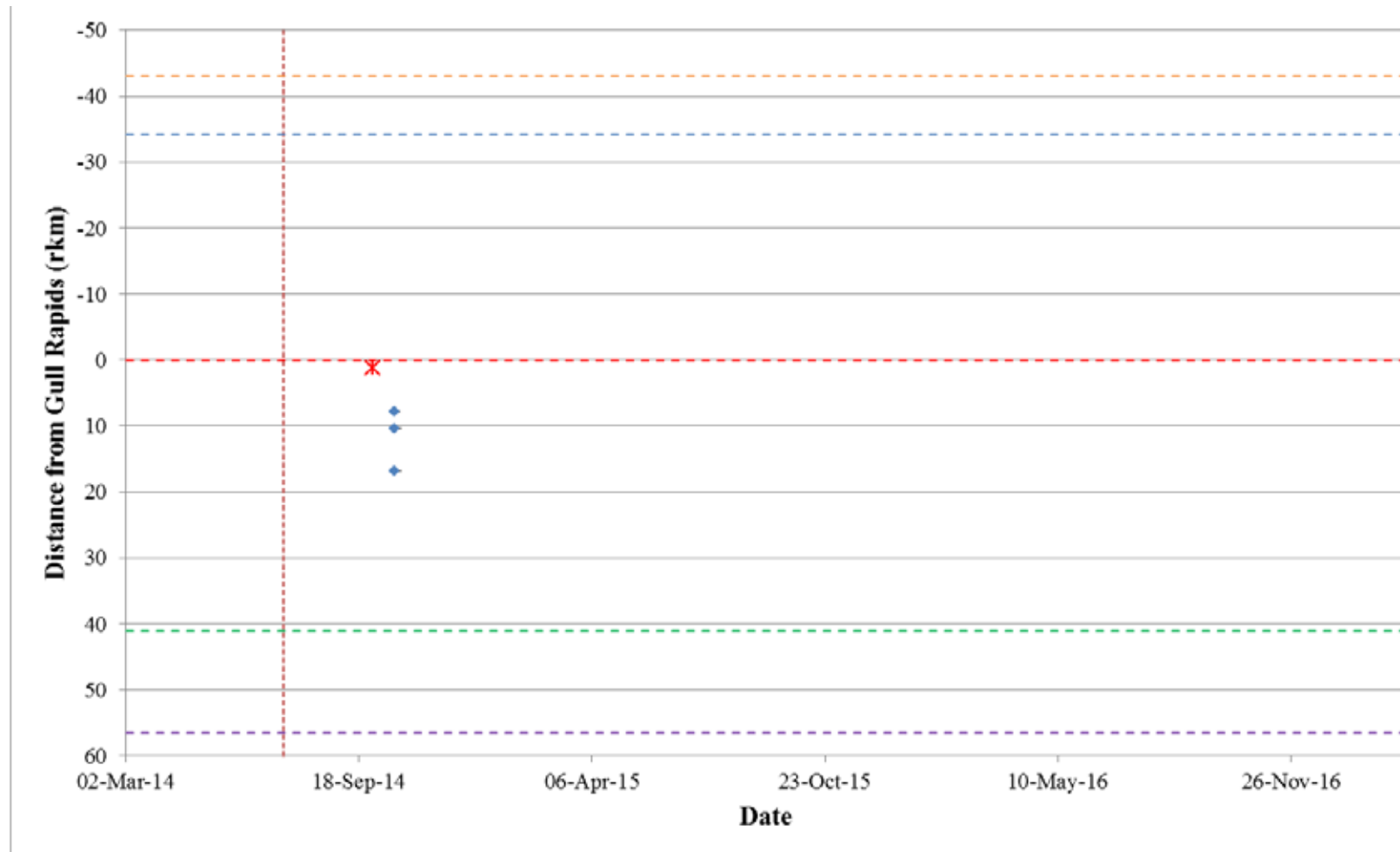


Figure A3-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6366) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

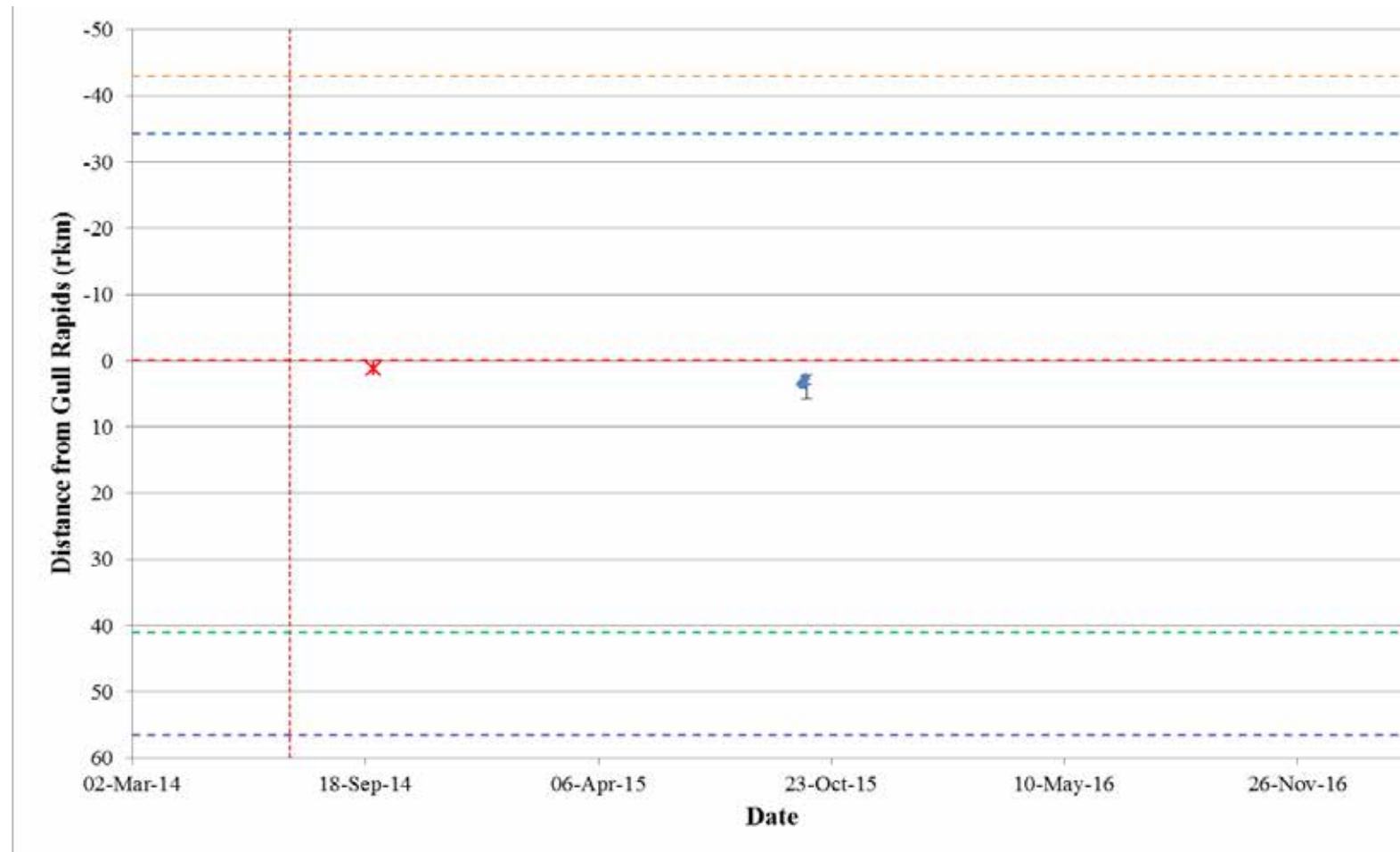
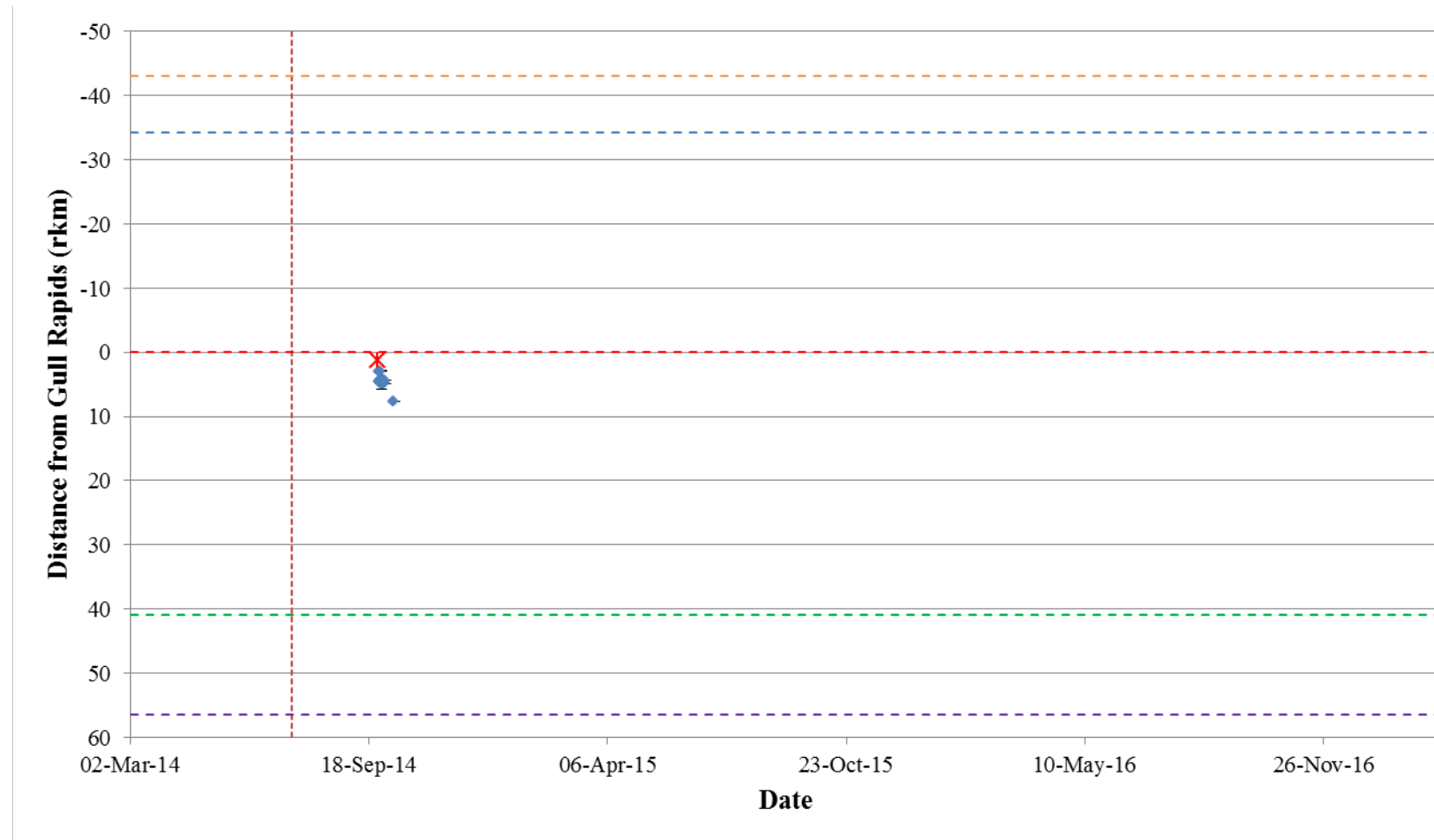
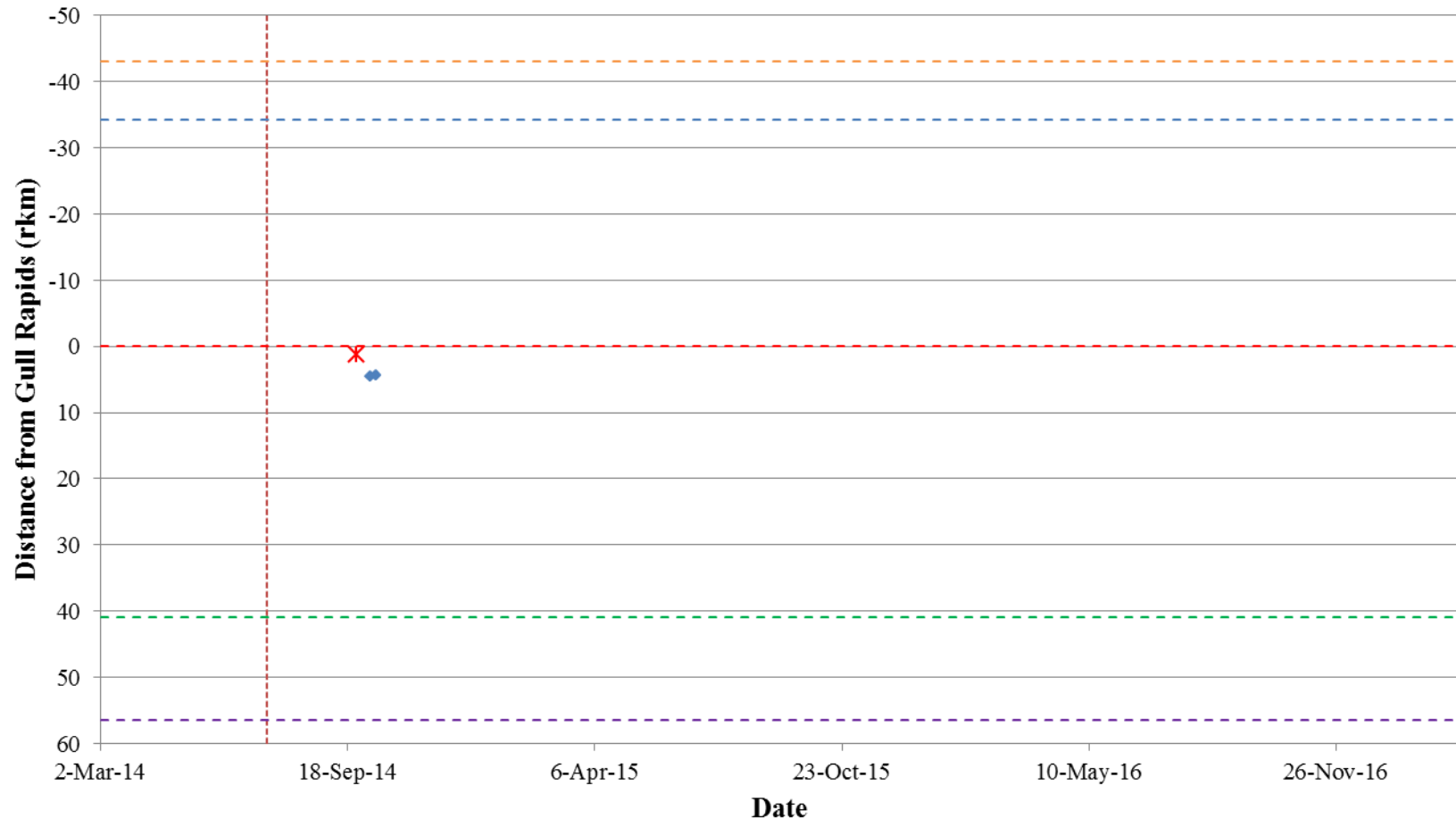


Figure A3-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6367) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6368) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**





**Figure A3-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6369) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

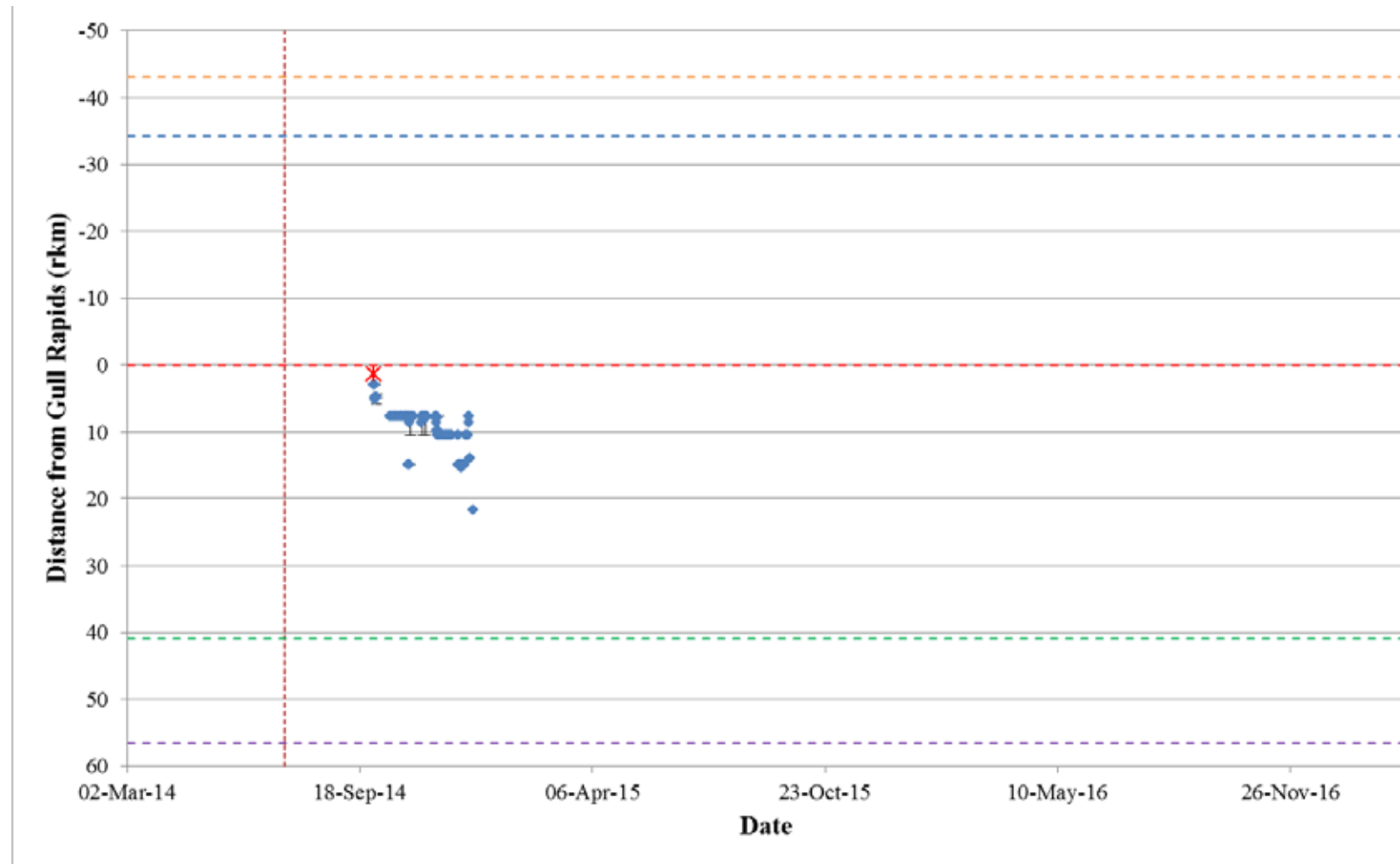
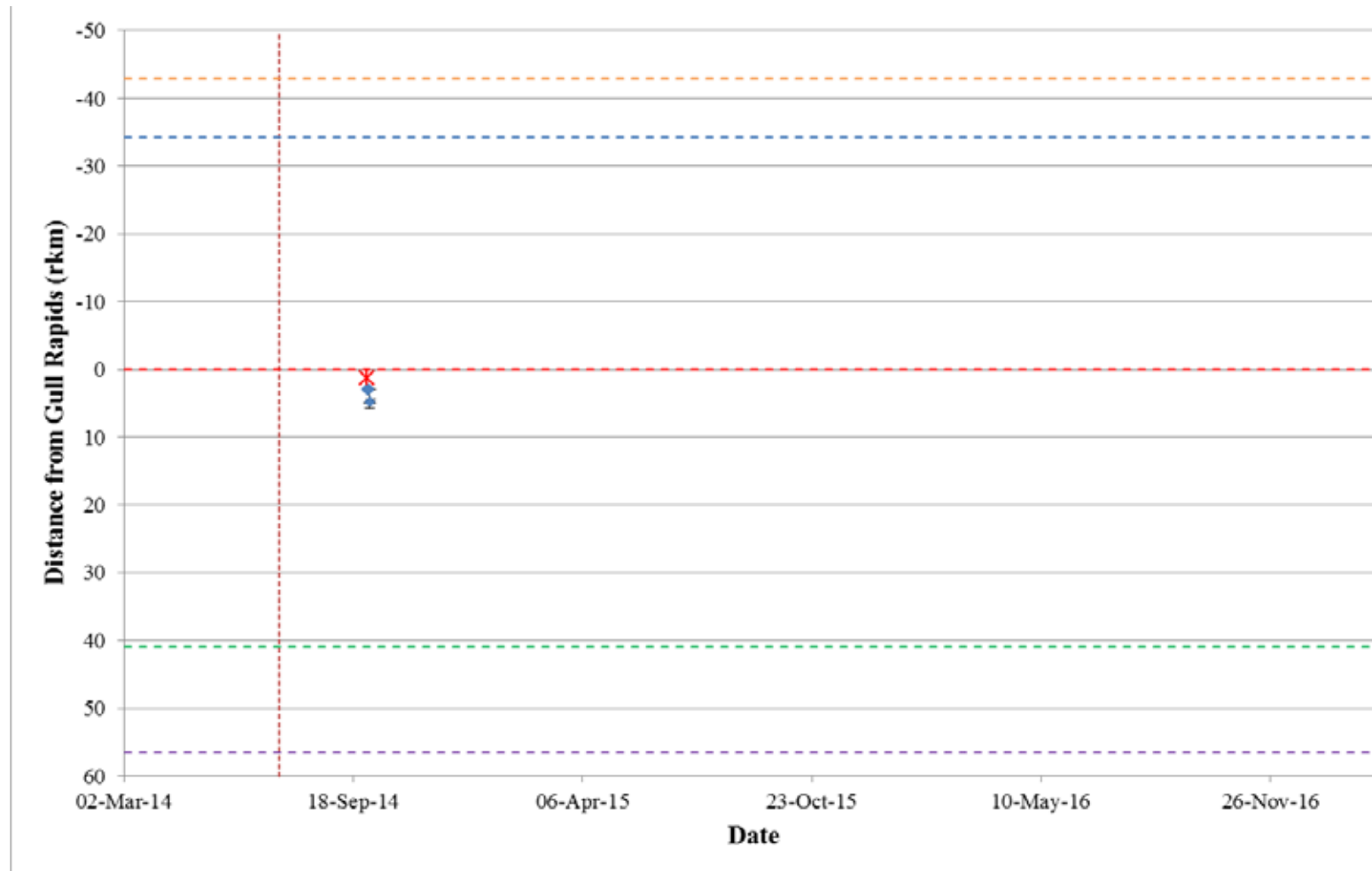


Figure A3-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6370) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6371) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

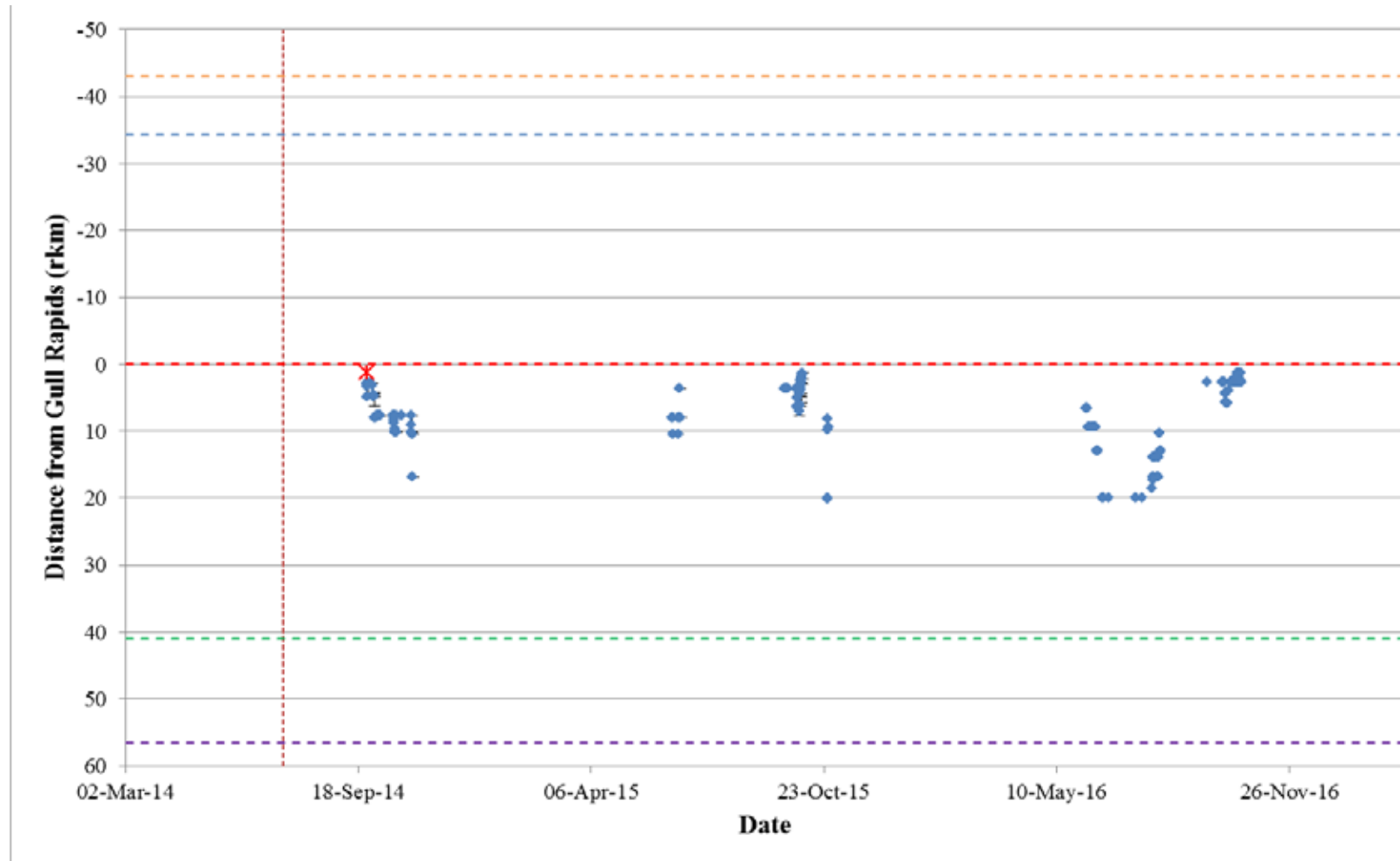


Figure A3-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6372) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

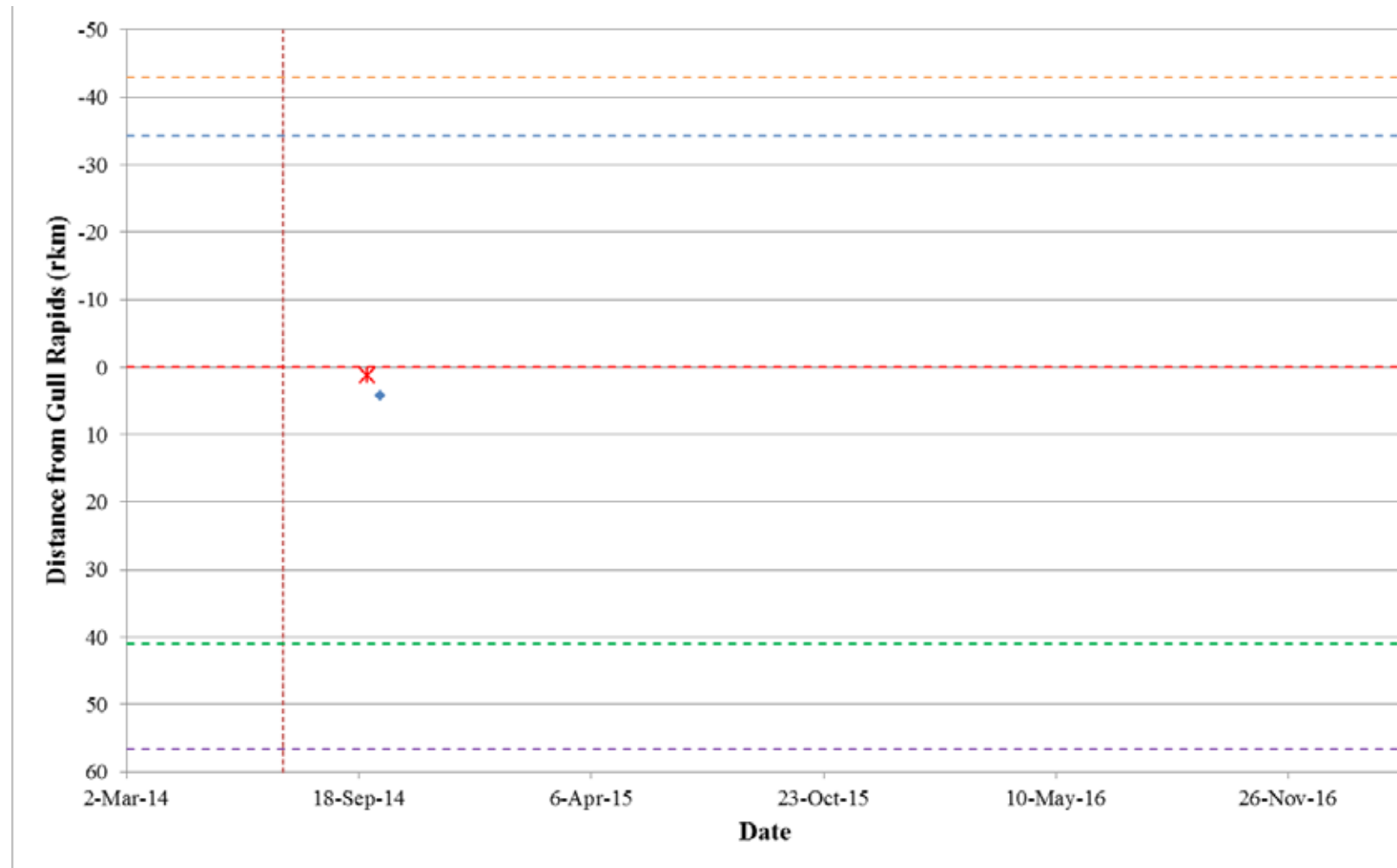
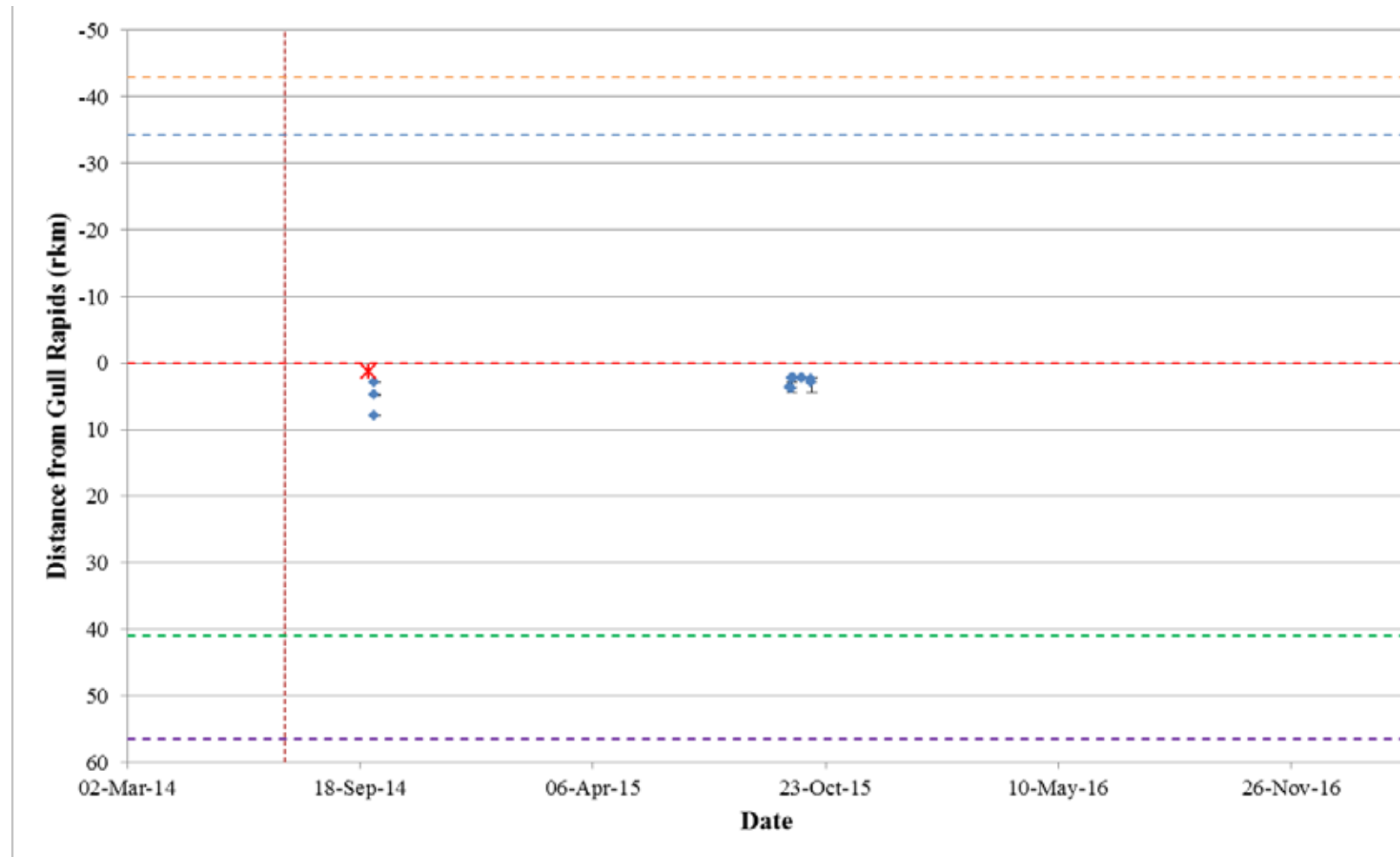


Figure A3-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6373) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6374) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



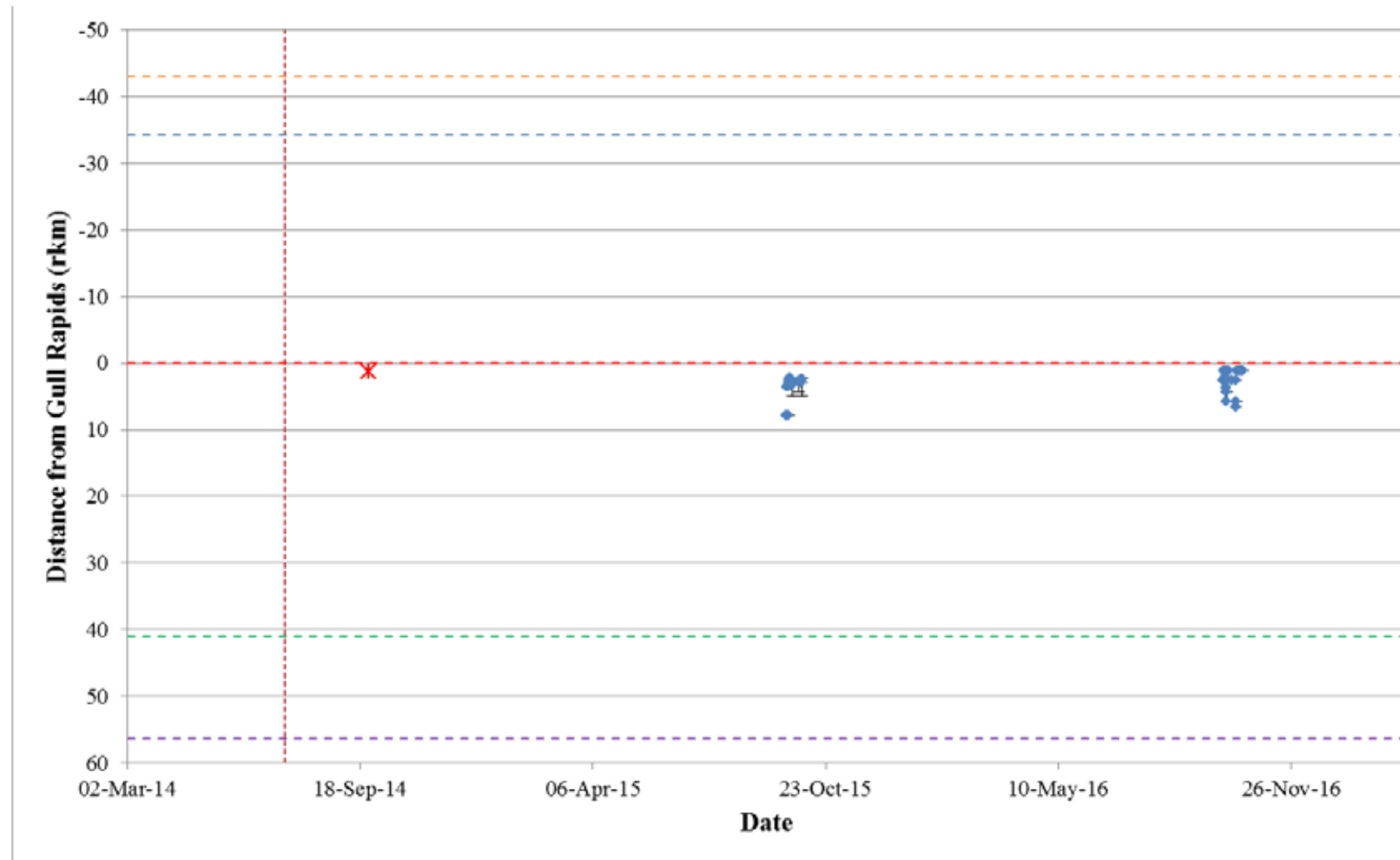


Figure A3-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6375) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

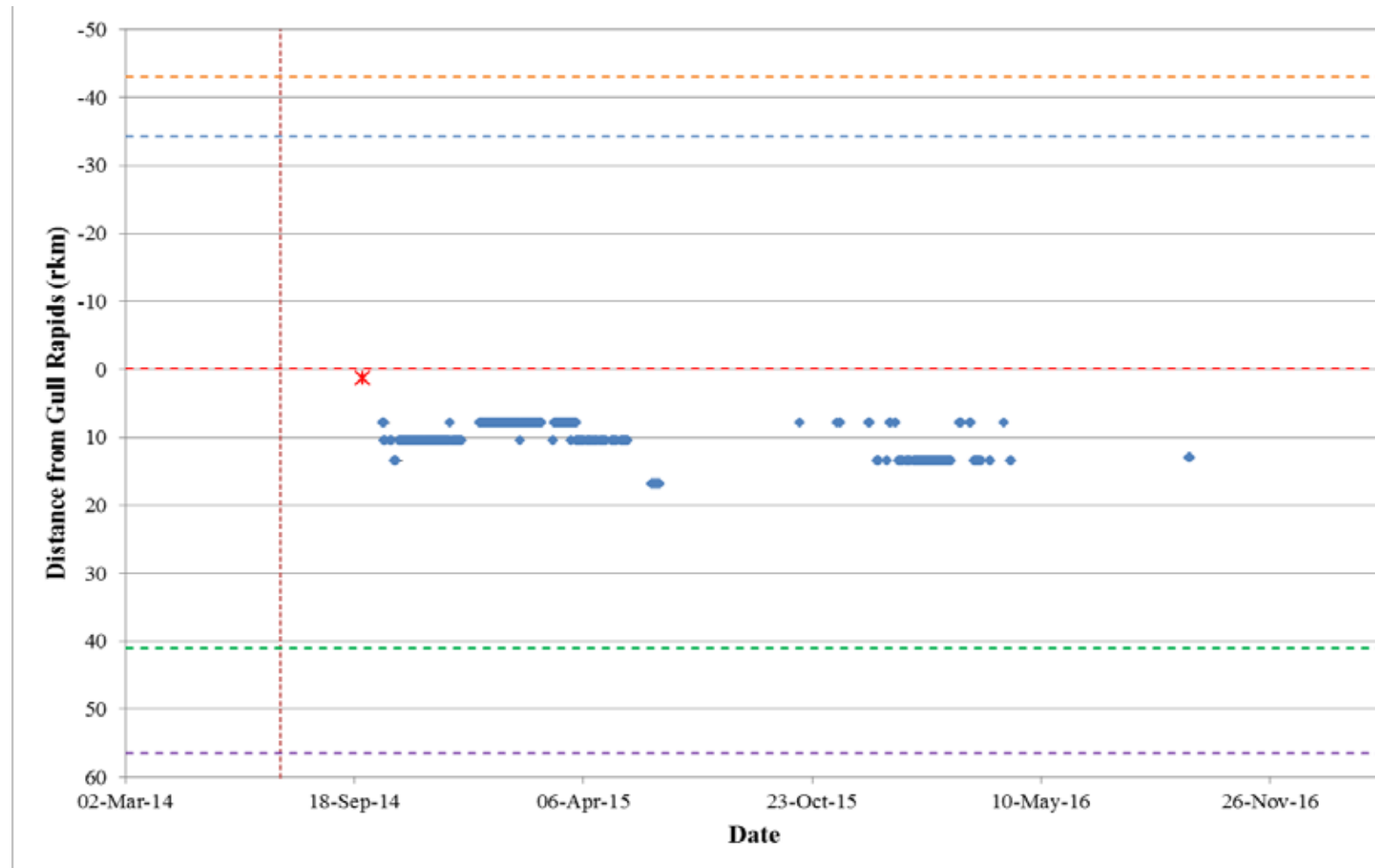
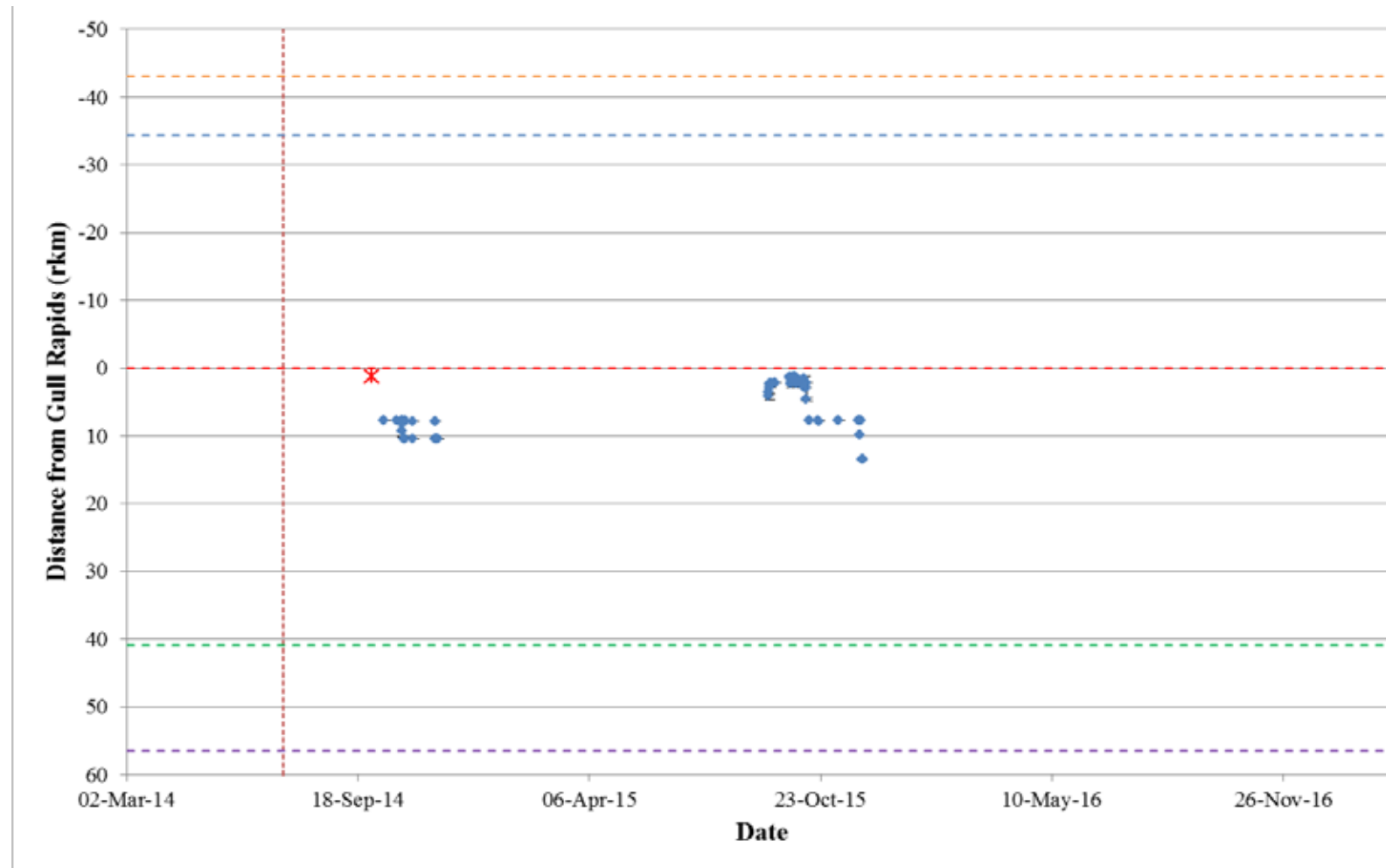
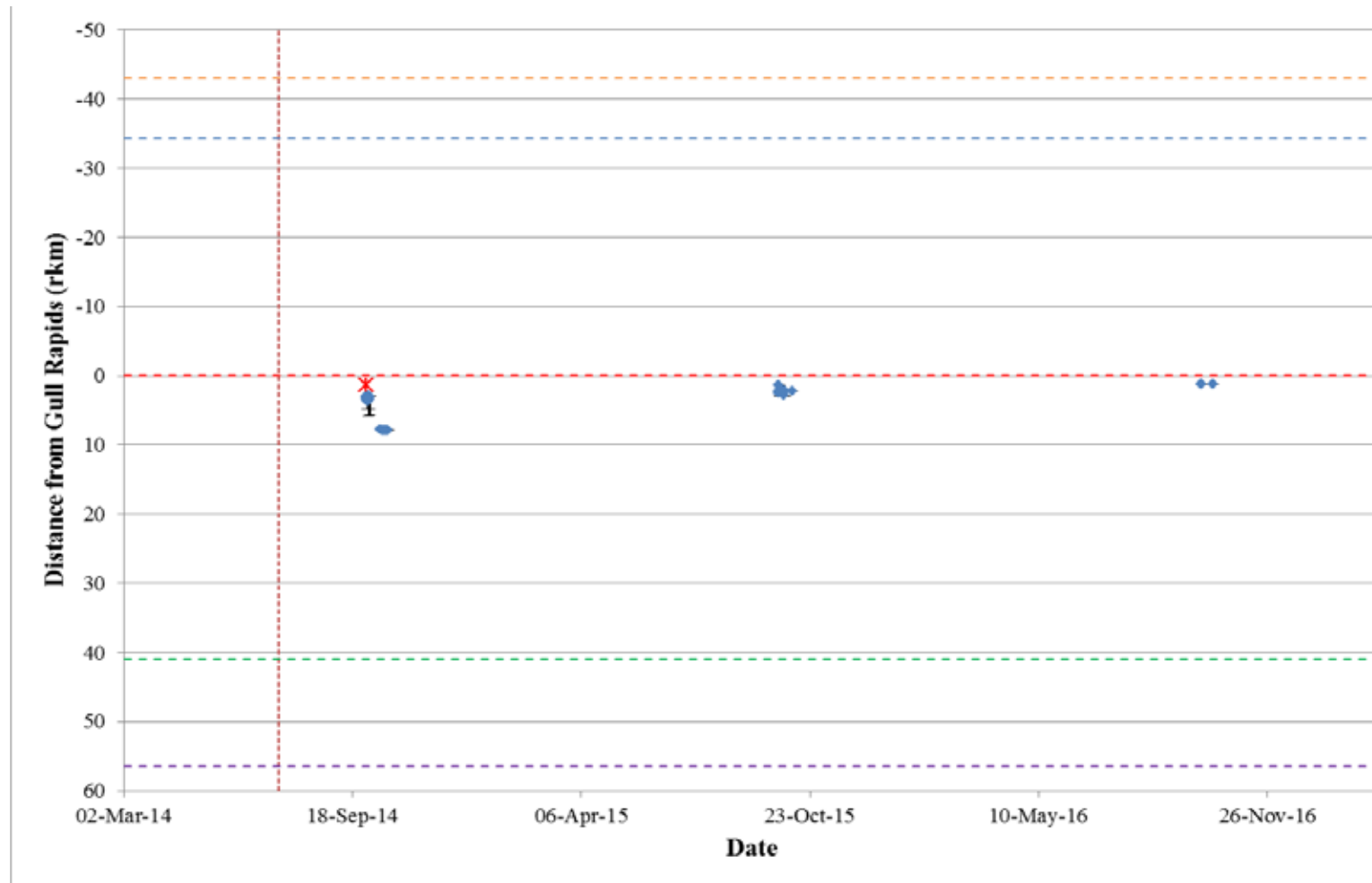


Figure A3-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6376) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33794) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A3-22: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33795) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

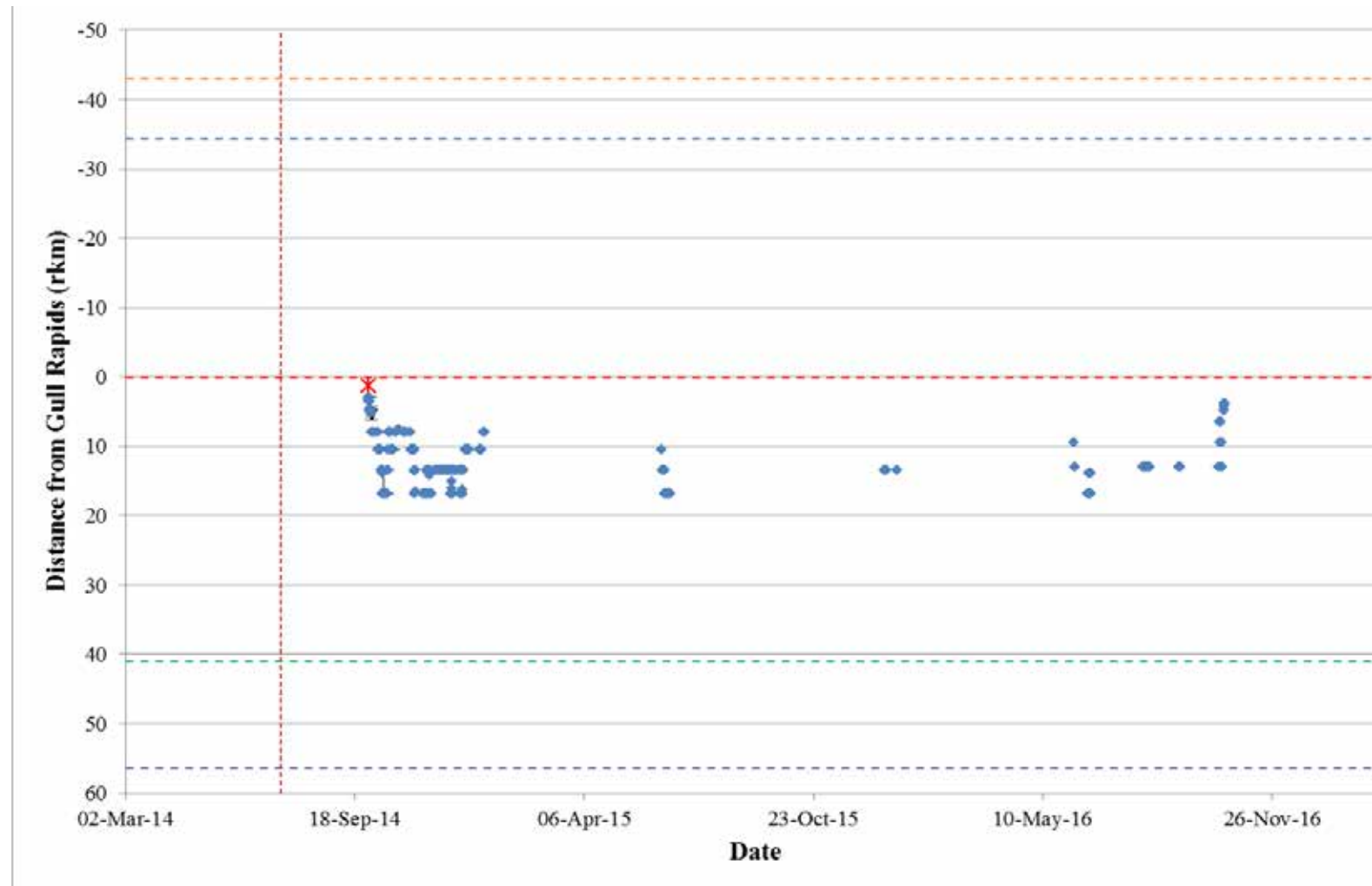


Figure A3-23: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33796) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

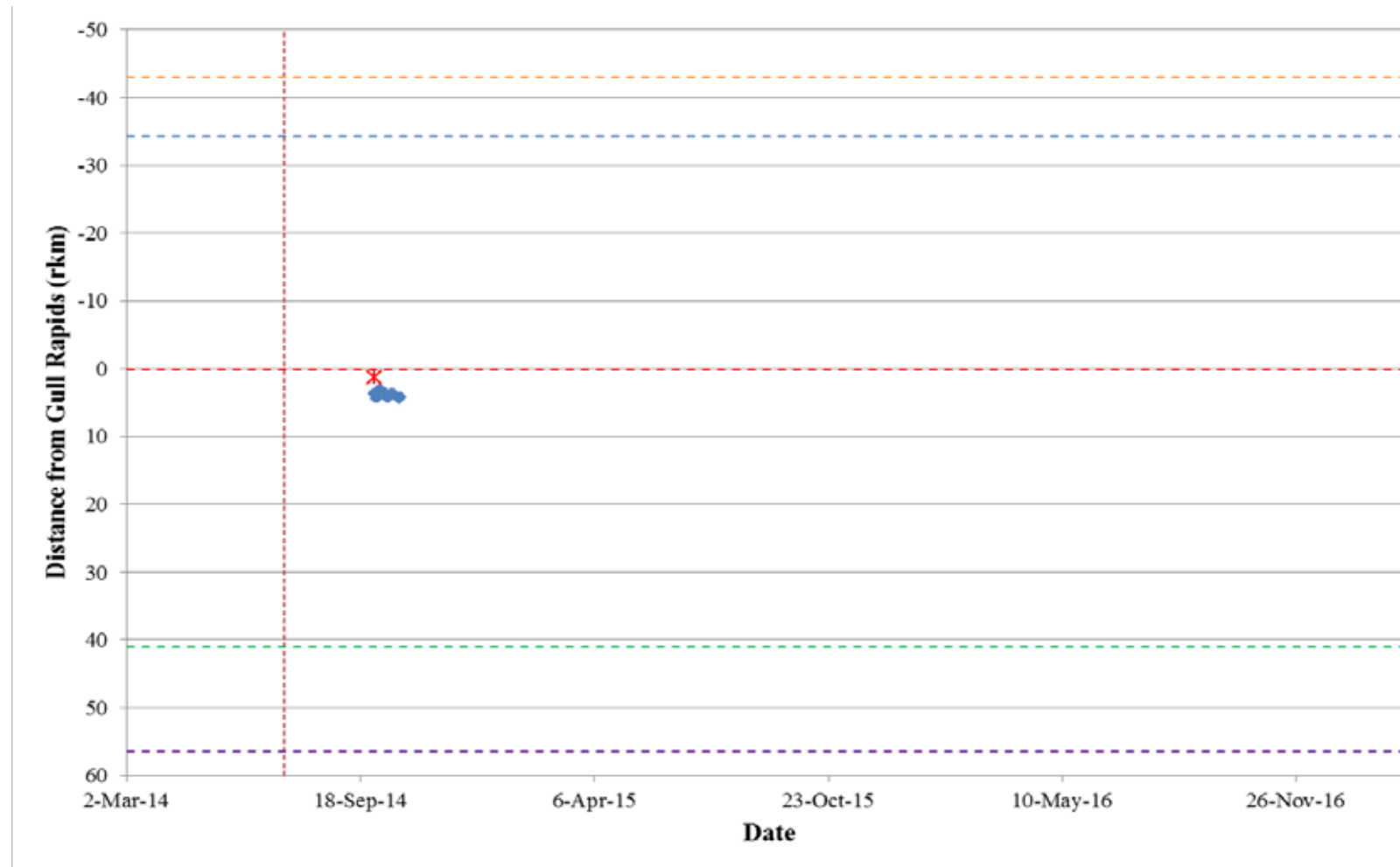


Figure A3-24: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33799) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



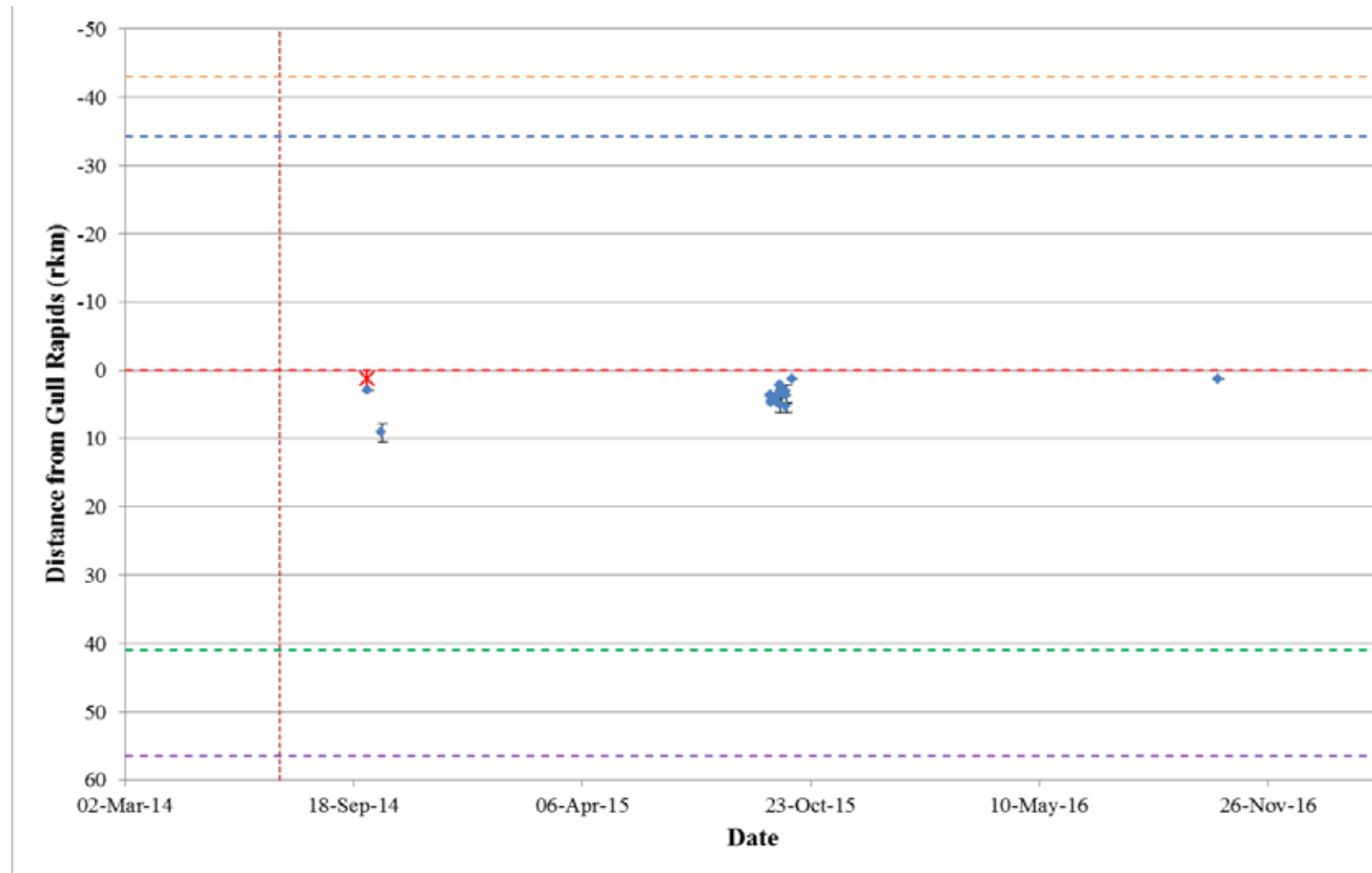


Figure A3-25: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33810) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

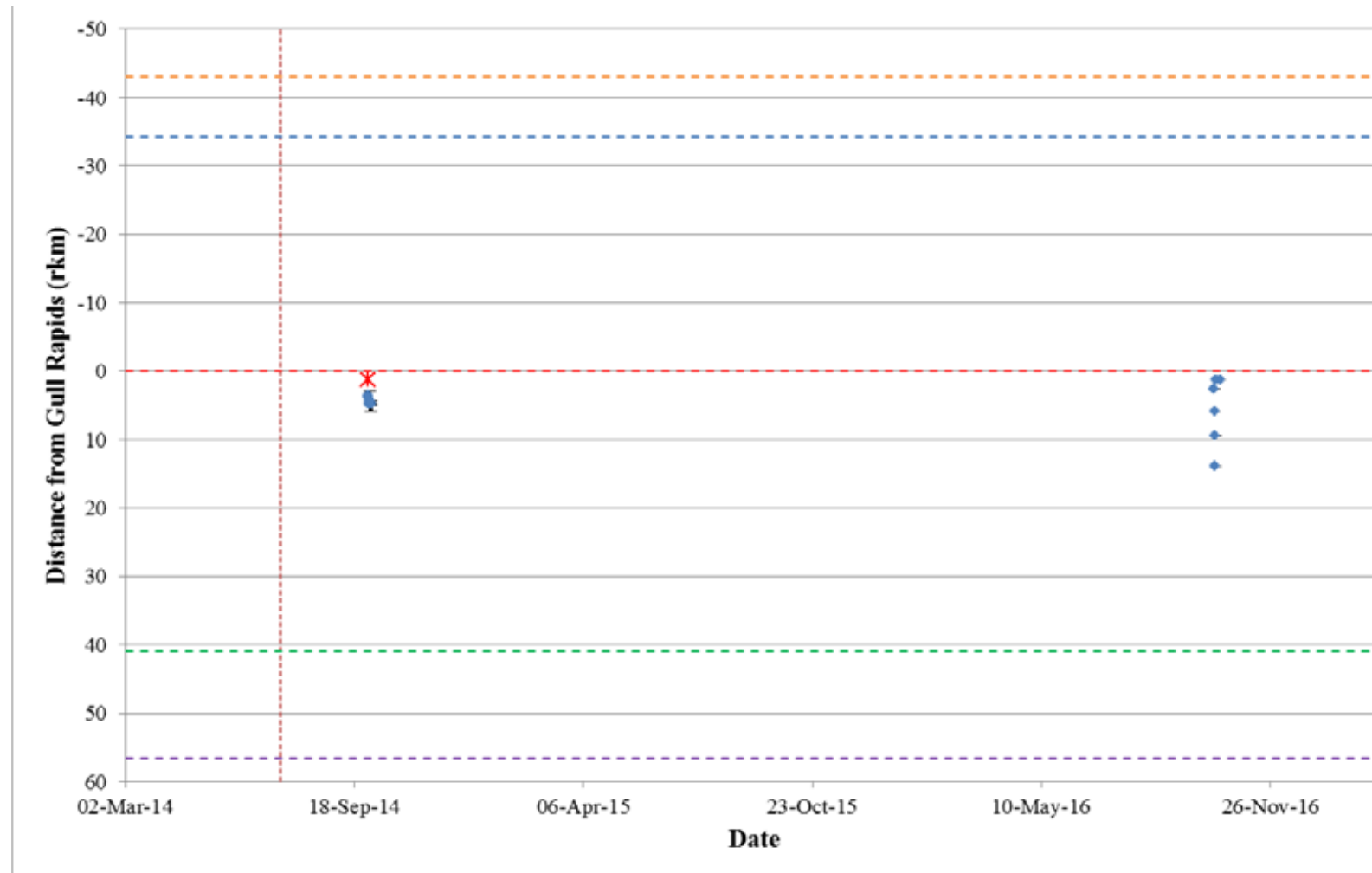


Figure A3-26: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33811) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).

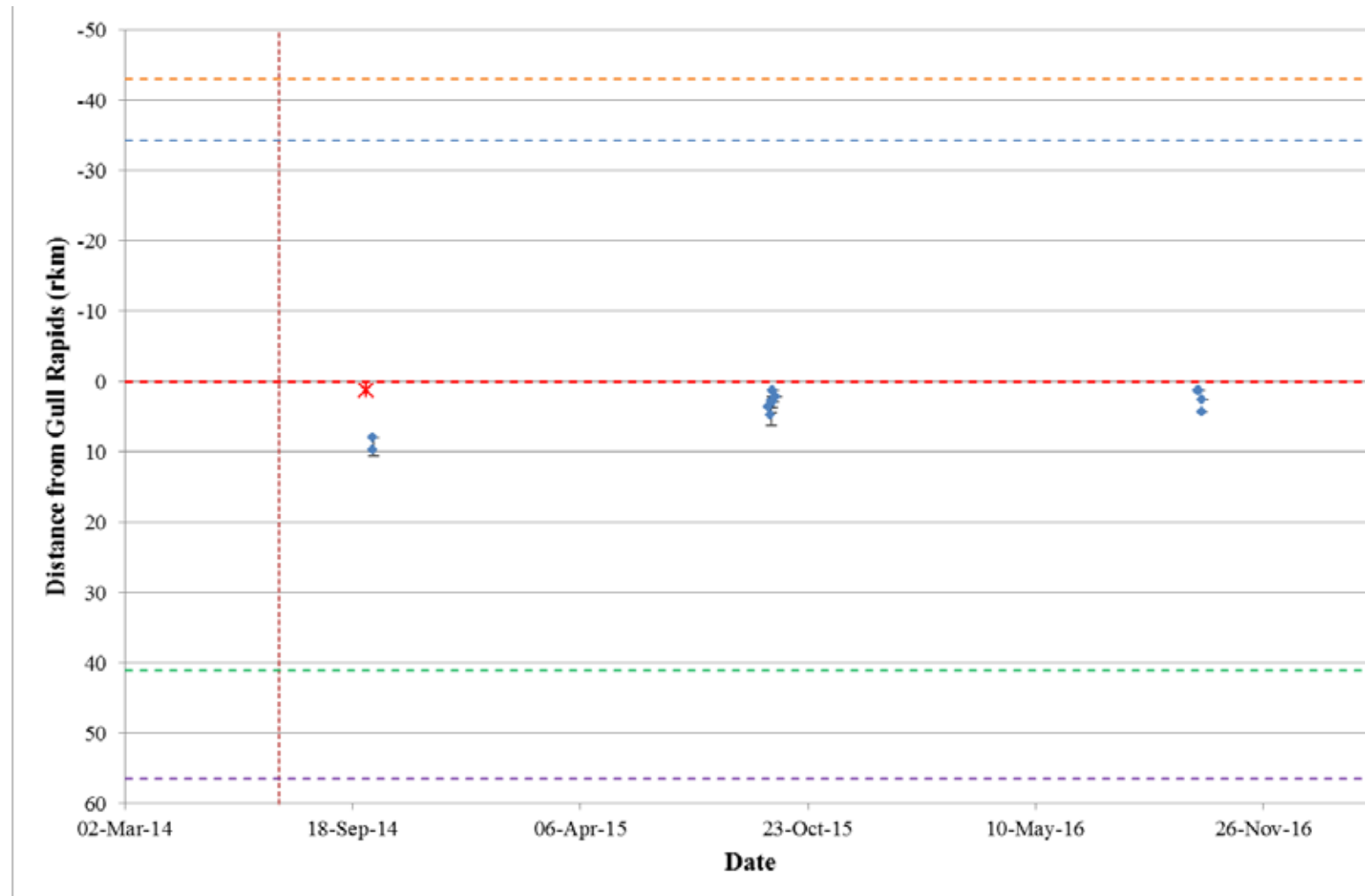
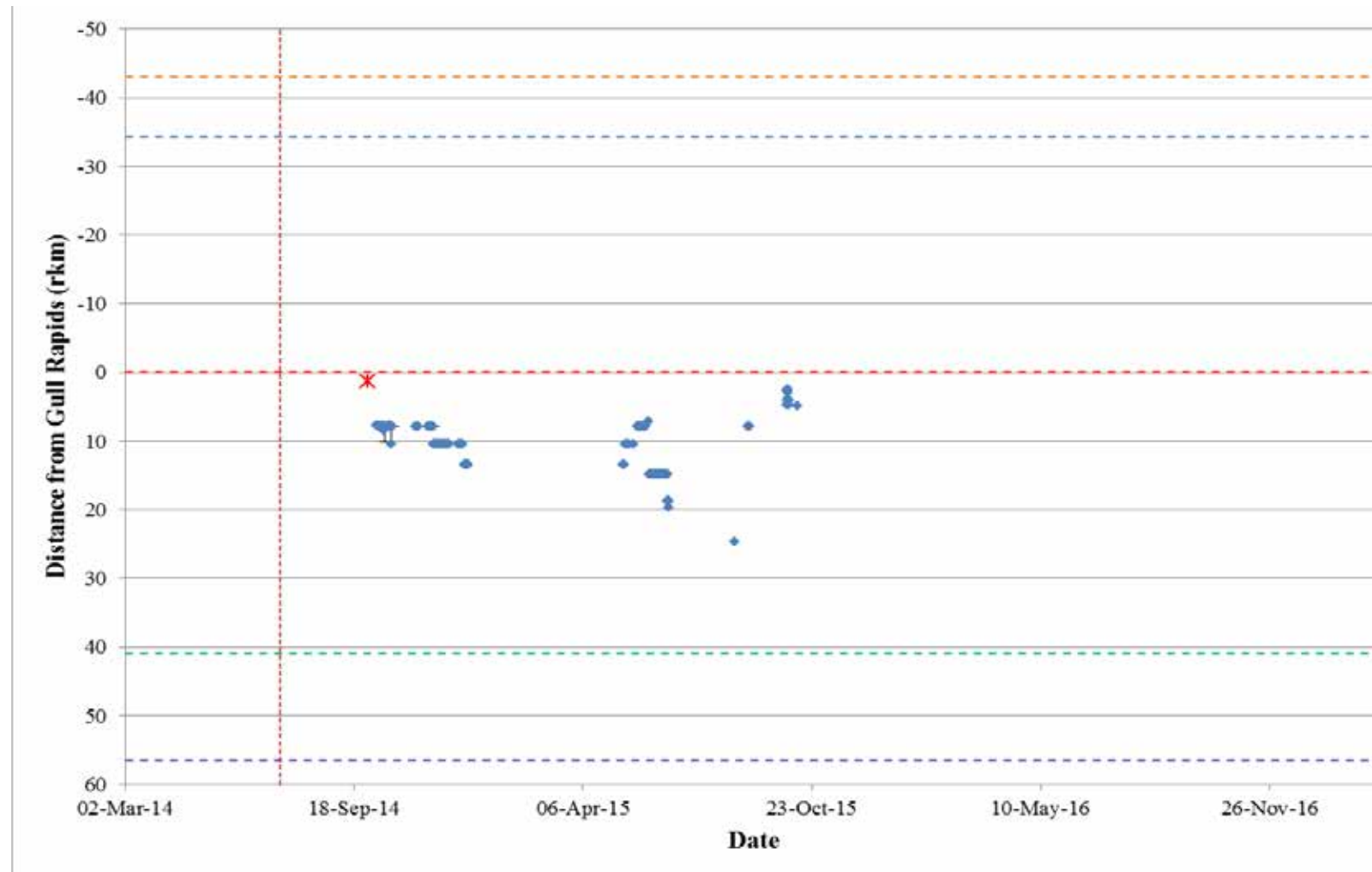


Figure A3-27: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33814) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-28: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33815) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

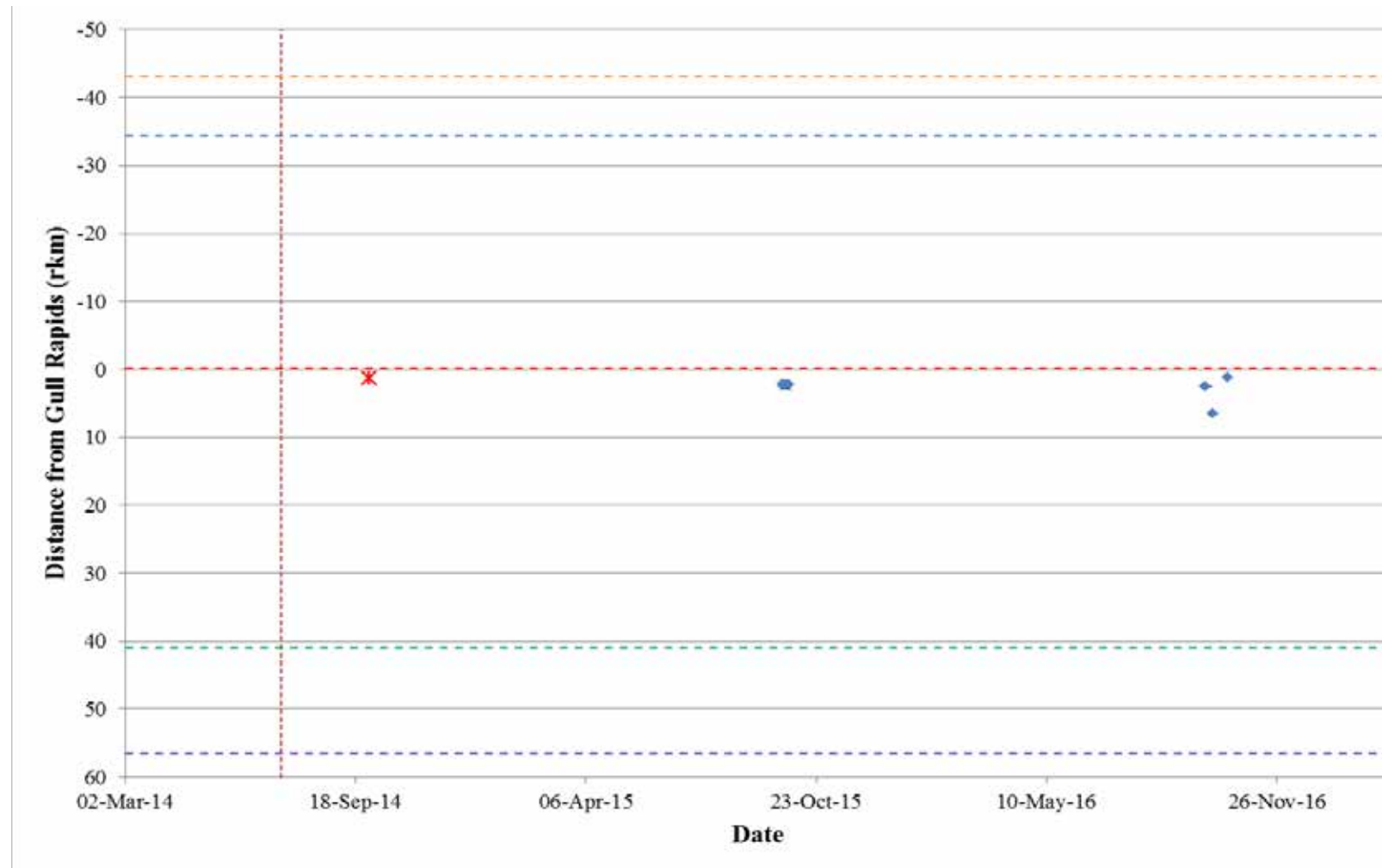
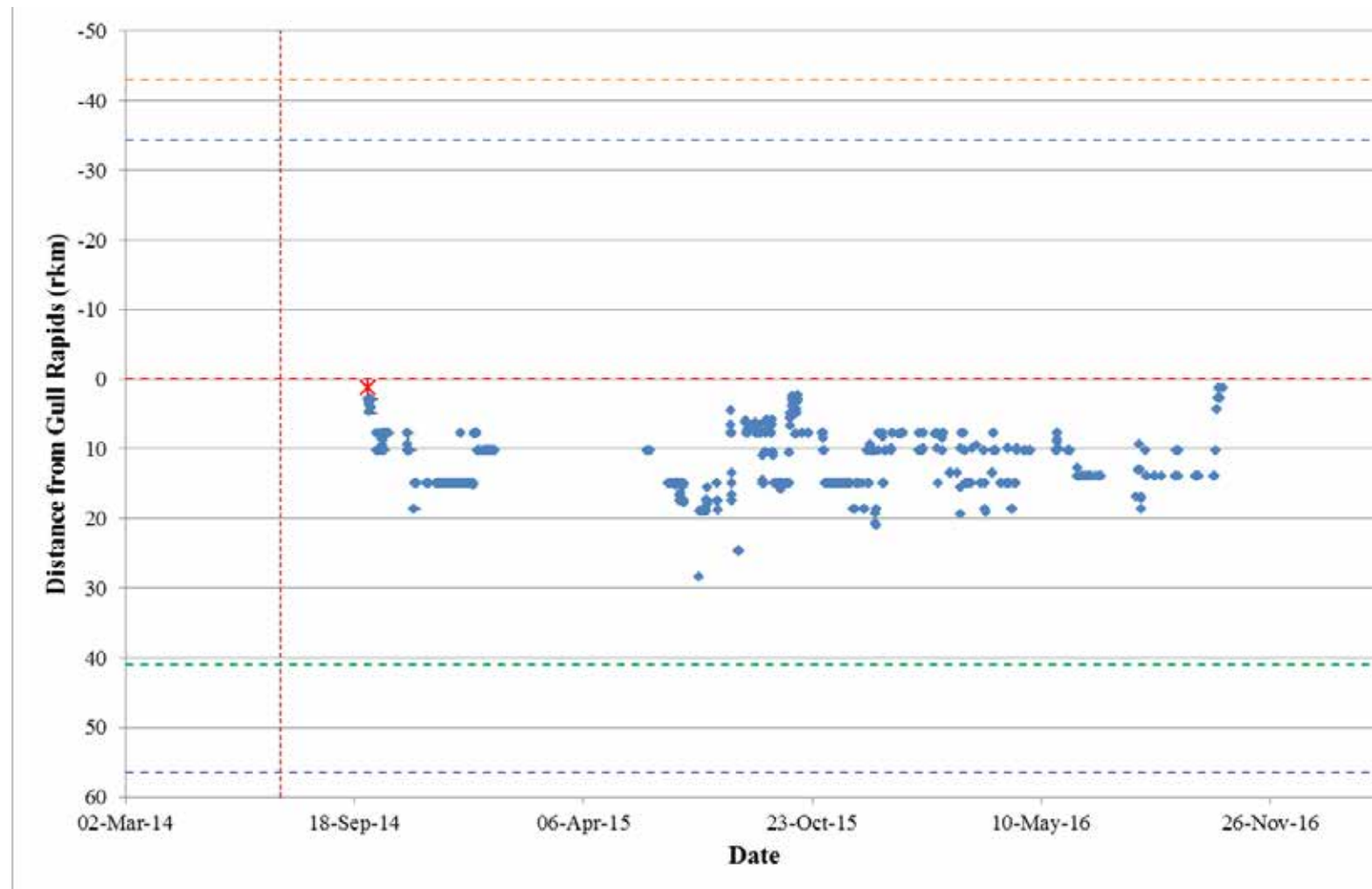
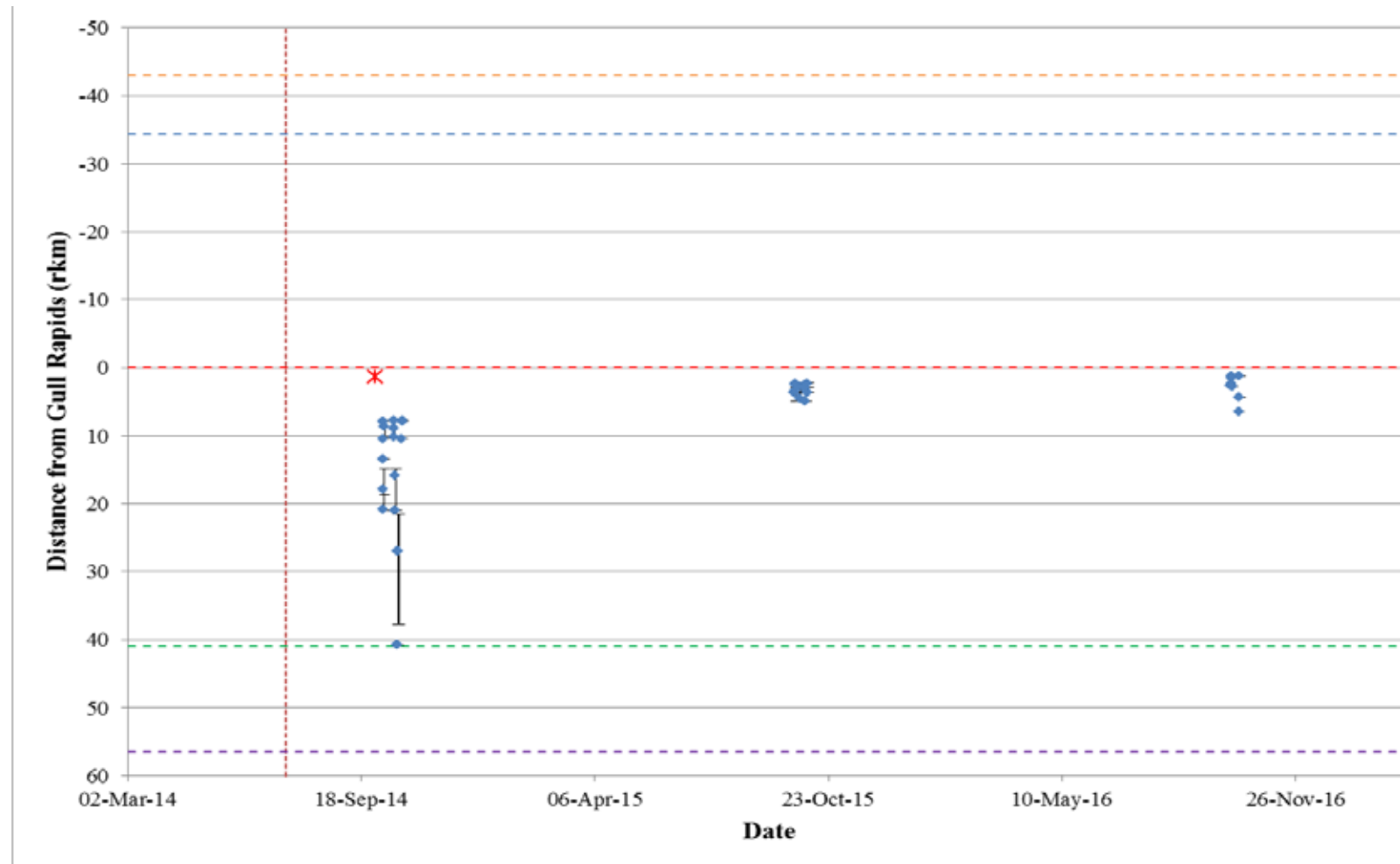


Figure A3-29: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33817) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-30: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33818) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**





**Figure A3-31: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33819) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

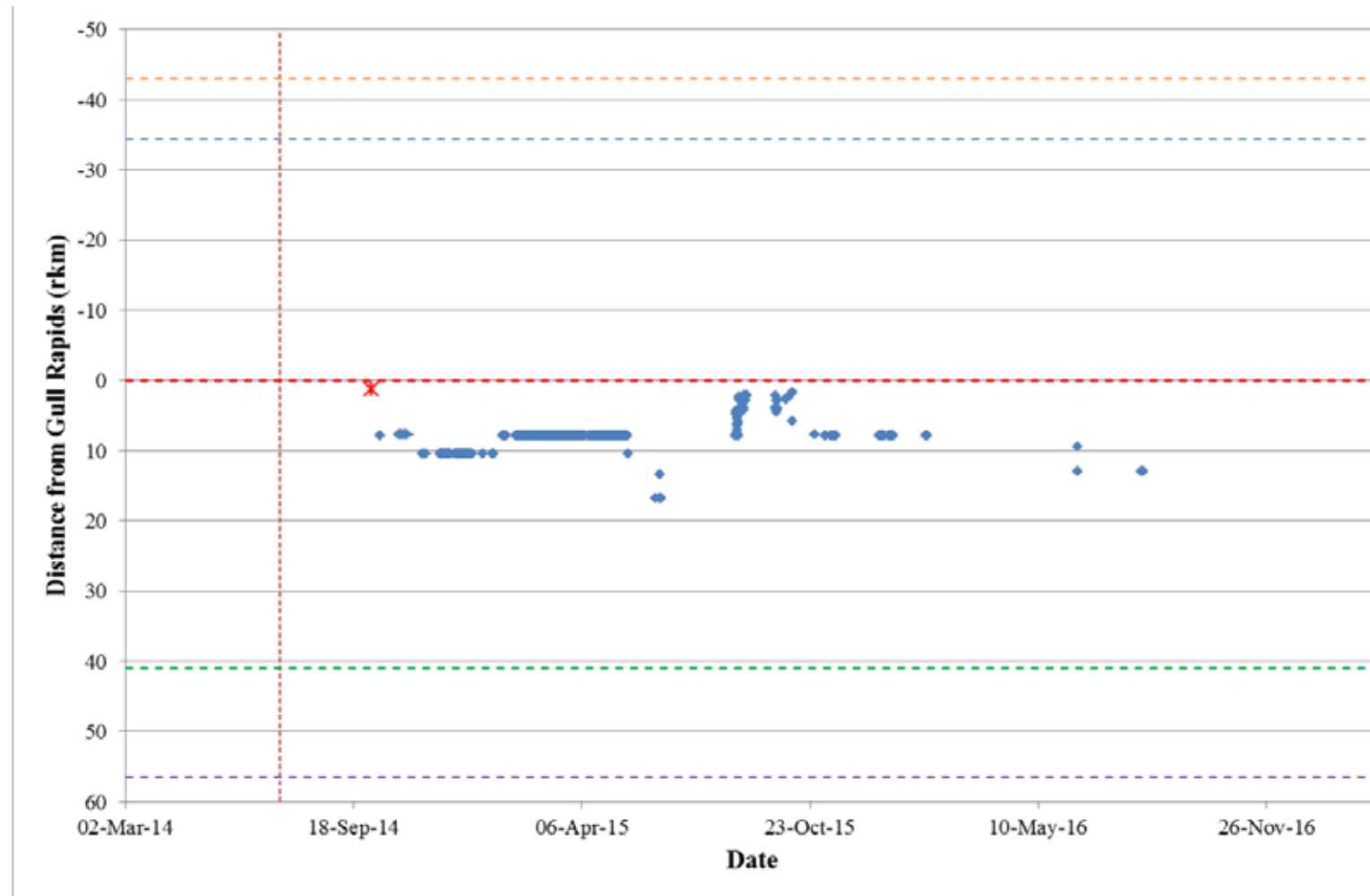
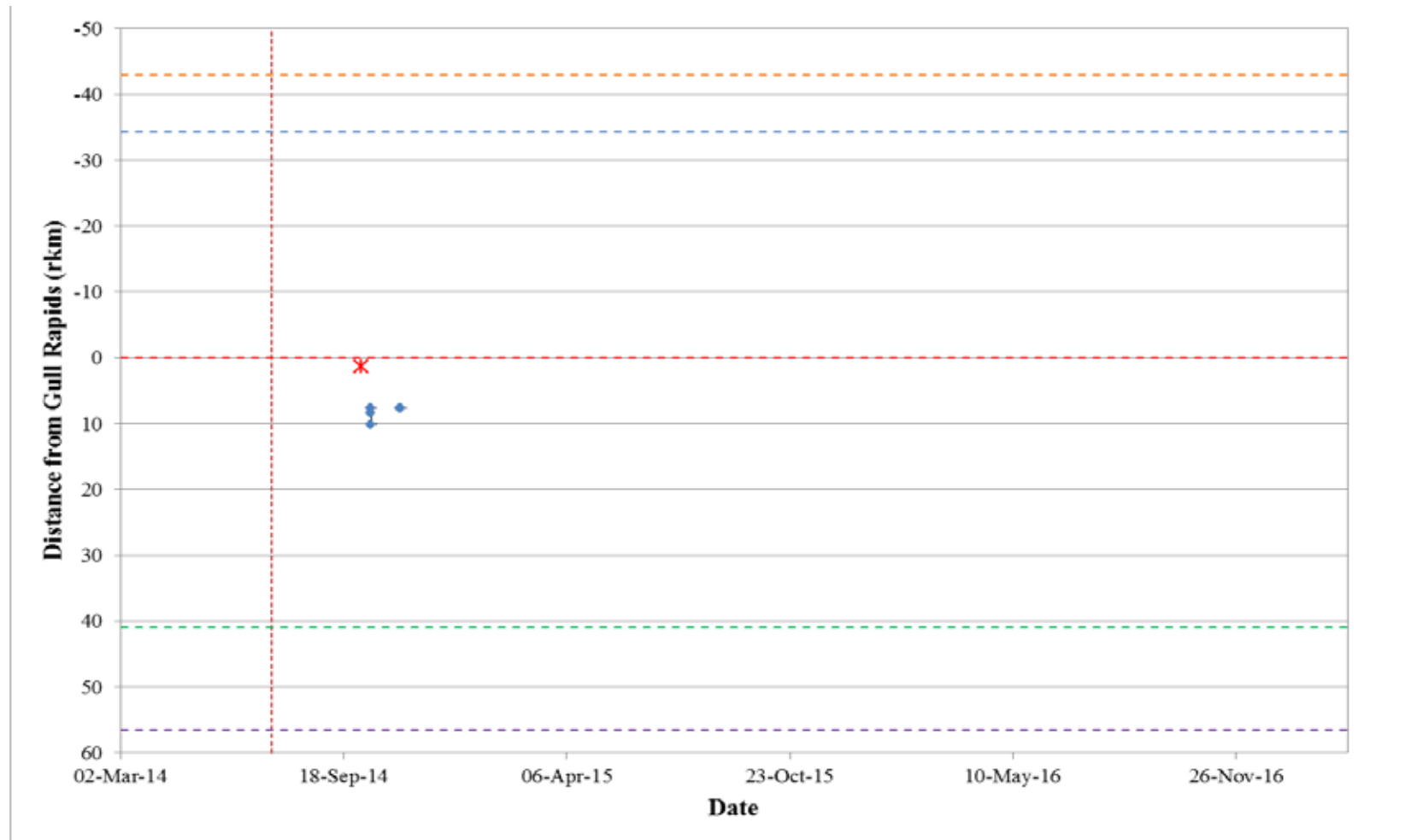


Figure A3-32: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33821) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-33: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33823) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

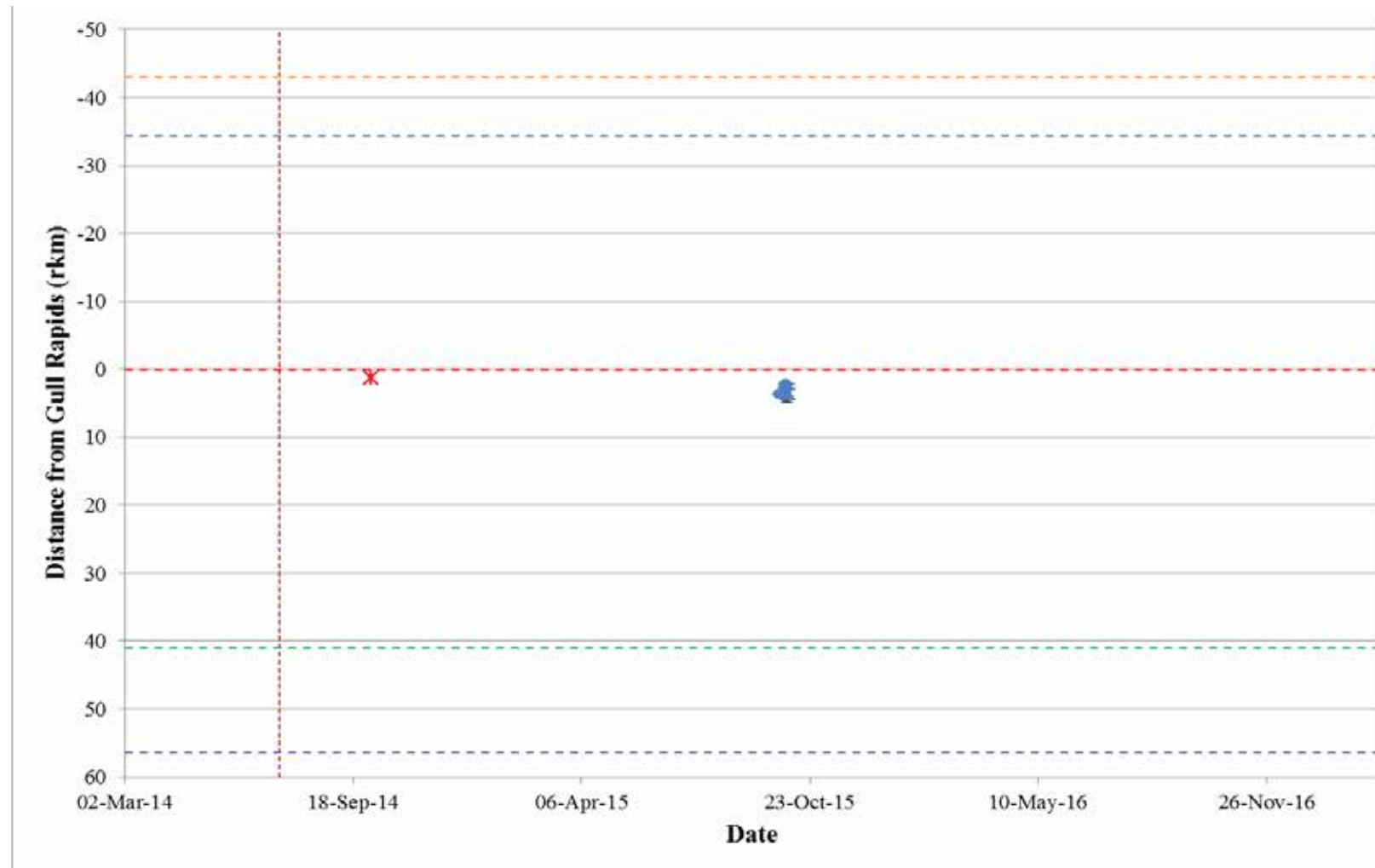
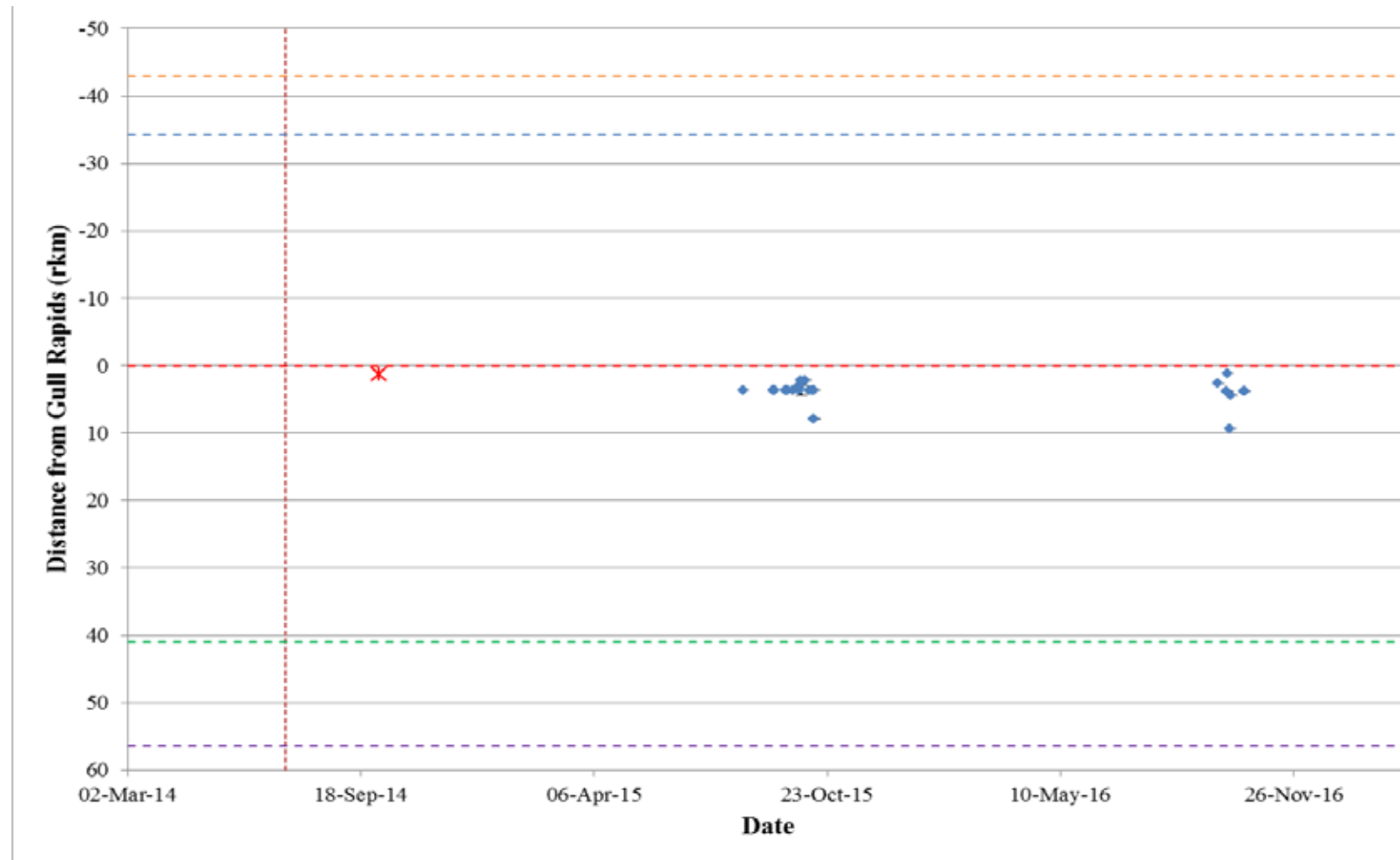


Figure A3-34: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33824) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-35: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33825) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

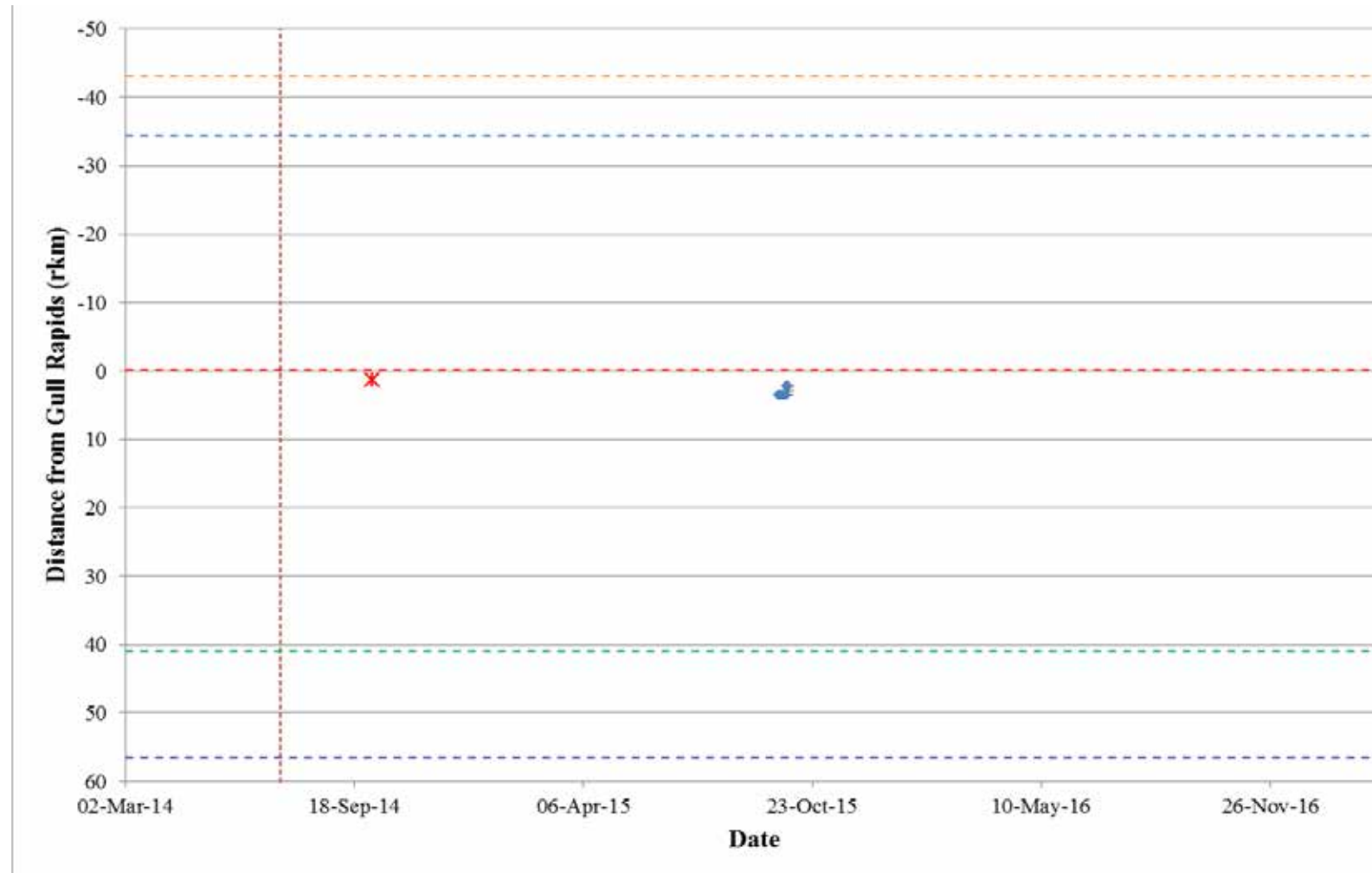


Figure A3-36: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33827) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



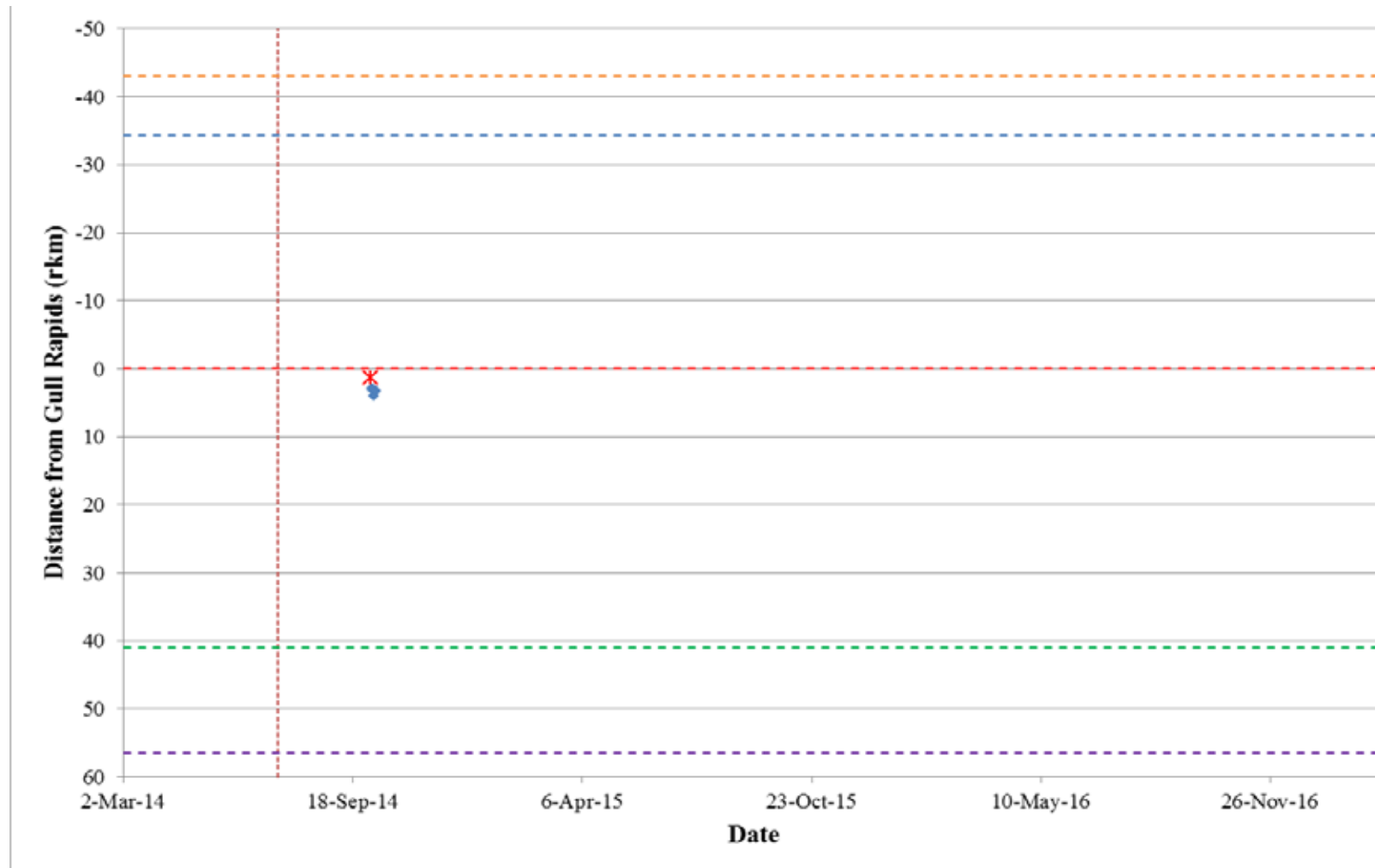
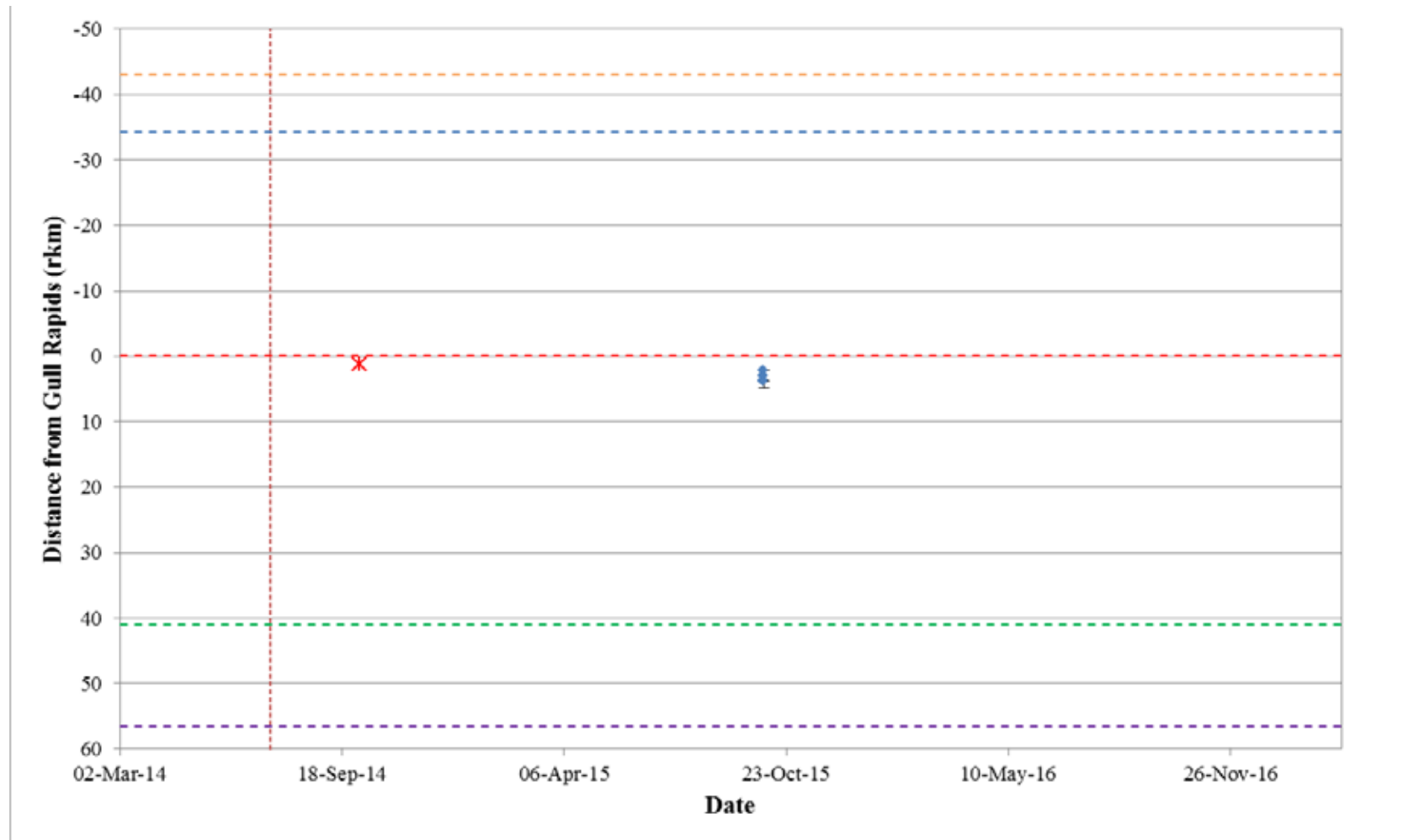
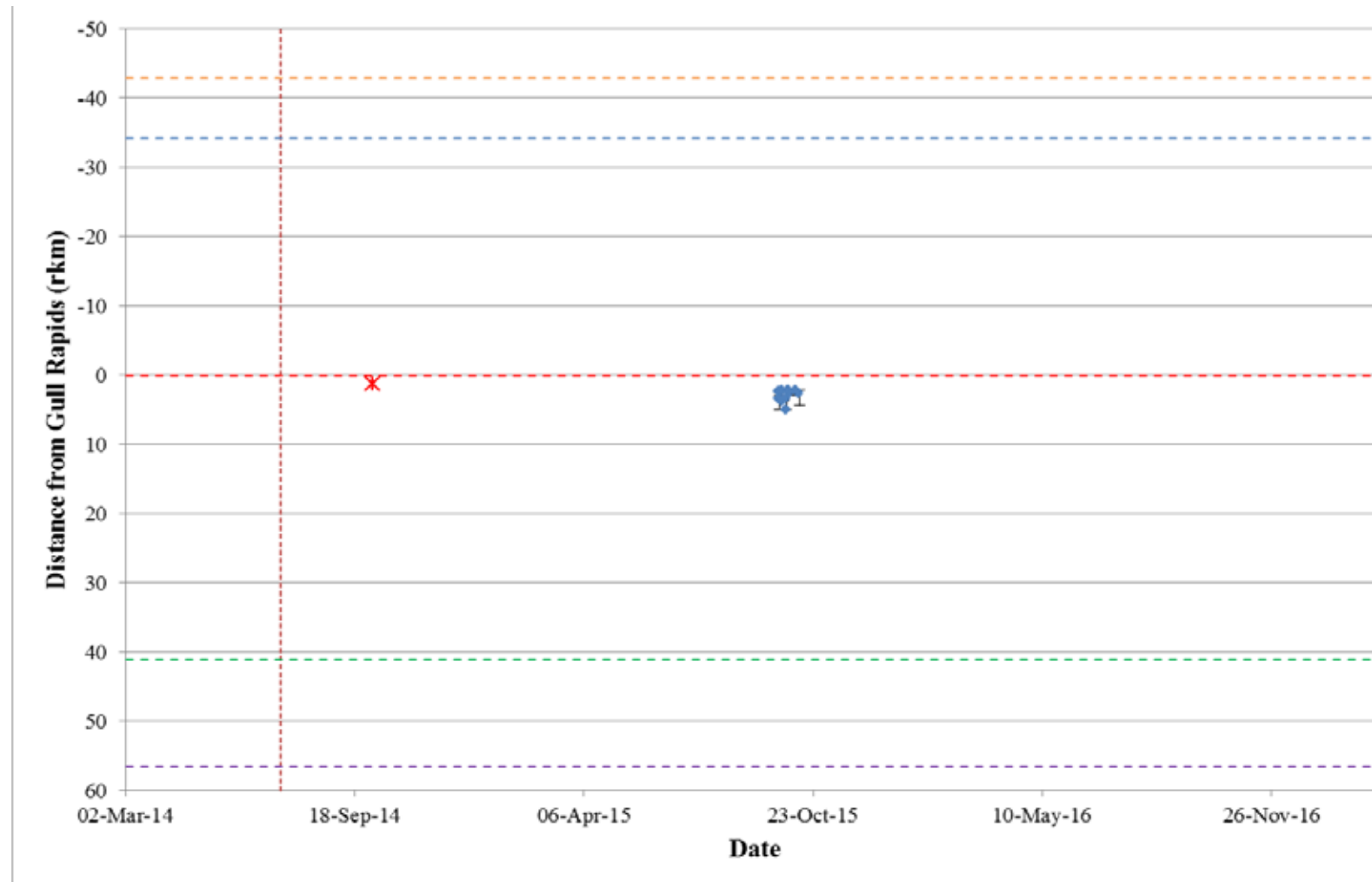


Figure A3-37: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33828) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).



**Figure A3-38: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33829) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**



**Figure A3-39: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33831) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. 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 = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).**

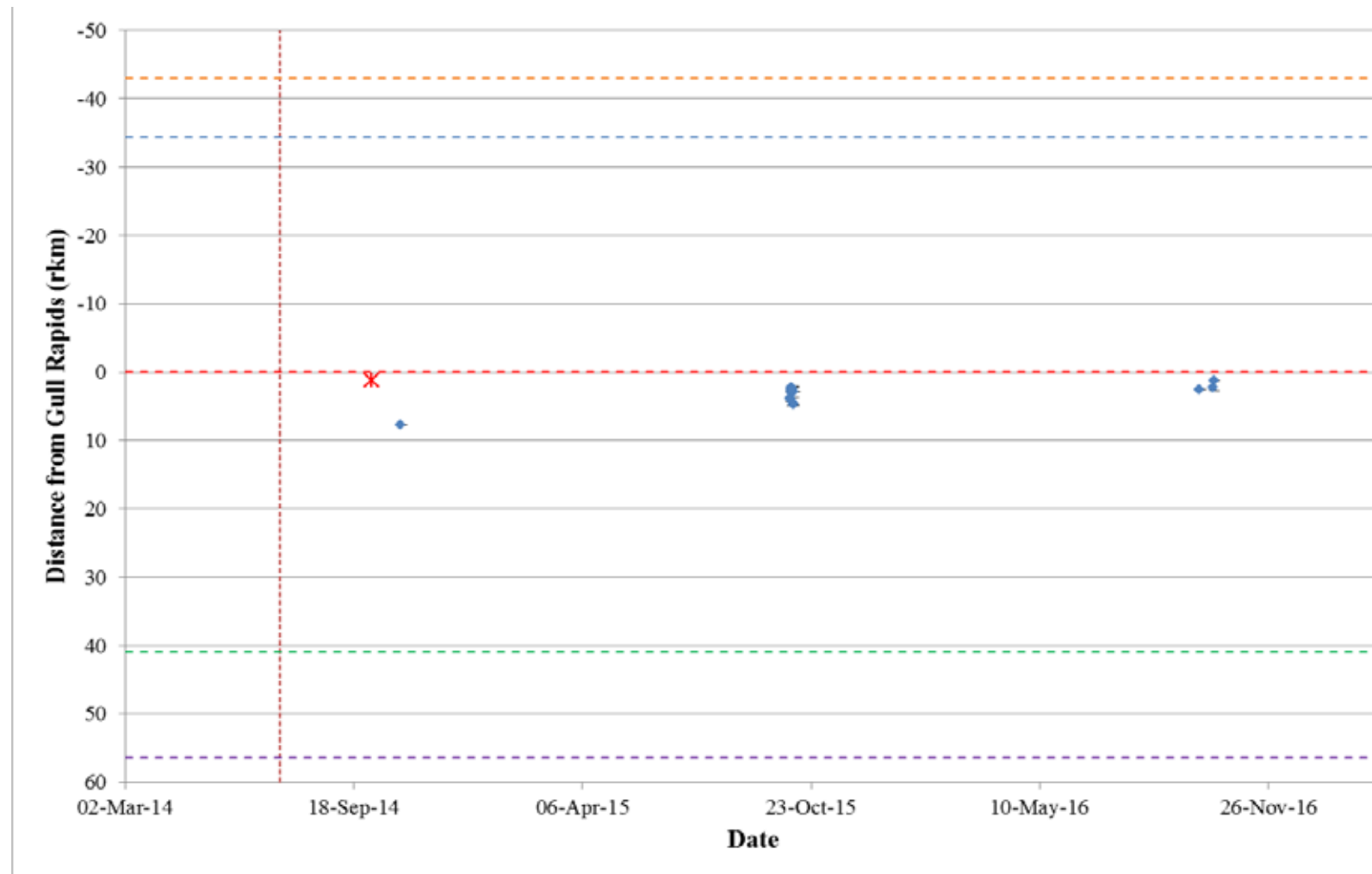


Figure A3-40: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33832) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2016. The date and location of tagging are indicated by a red star. Horizontal dotted lines indicate locations of landmarks (orange = Clark Lake outlet; blue = Birthday Rapids, red = Gull Rapids; green = Kettle GS, purple = Long Spruce GS).