Keeyask Generation Project

Aquatic Effects Monitoring Plan

Lake Whitefish Movement Monitoring Report

AEMP-2016-06

KEEYASK

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2015 - 2016

KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING REPORT

Report #AEMP–2016–06

LAKE WHITEFISH MOVEMENT MONITORING IN THE NELSON RIVER BETWEEN CLARK LAKE AND THE LONG SPRUCE GENERATING STATION, OCTOBER 2014 TO OCTOBER 2015: YEAR 2 CONSTRUCTION

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 August and September, the flow in the north and central channels of Gull Rapids was blocked off and all the flow was diverted to the south channel. Cofferdams were constructed in the north and central channels and these channels were dewatered by fall (see construction site map below). The combination of high natural flows in the Nelson River and diversion of flow resulted in water levels on Gull Lake increasing about 1.3 m at the water level monitoring site at Caribou Island. The rise in water levels resulted in flooding along the shoreline and in low-lying areas. During the winter, a cofferdam was constructed extending into the south channel. During the spring of 2015, flows in the Nelson River decreased and water level on Gull Lake went down to pre-construction high water levels.

Lake Whitefish movements observed during construction (*i.e.*, from October 15, 2014 to October 11, 2015) are discussed in this report. Monitoring fish movements is an important component of the overall plan to monitor the impacts of construction and operation of the Keeyask Generating Station (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.

Results from monitoring will be used to better understand fish movements in the study area and to address the potential impacts impacts of construction of the Keeyask GS on Lake Whitefish populations.

DATA SOURCE:
Orthophoto: Manitoba Hydro - June 21, 2015

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-FEB-10	30-MAY-16
0 0.15 0.3 Kilometres / 0 0.15 0.3 Miles	VERSION NO: 2.0	QA/QC: PMC/FSV/MWZ

KEEYASK

Construction Site

Map of instream structures at the Keeyask Generating Station site, June 2015.

Why is the monitoring being done?

The monitoring is being done to address several questions:

How many of the Lake Whitefish that are near Gull Rapids move through the rapids each year and when are they moving?

Movement studies tell us how many Lake Whitefish are moving through Gull Rapids (upstream and downstream) between Gull and Stephens lakes, and when the fish are making these movements. Recording where fish move during construction tells us how close the fish are to construction activities, which is important because fish moving past the construction site may be harmed.

Do Lake Whitefish move up and down over Gull Rapids to reach habitat that they need to complete their life cycle?

If Lake Whitefish can't reach spawning sites because their movements are blocked by the GS, then it would harm their overall population. This study will help determine whether or not Lake Whitefish need to cross Gull Rapids to spawn.

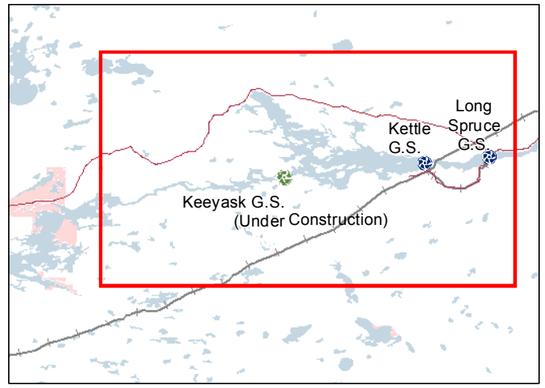
Do Lake Whitefish stay near or move away from the construction area and, if so, how far?

If Lake Whitefish are in the river right where a cofferdam is being built, they could be harmed by higher than normal concentrations of mud in the water or trapped inside an area that will be drained. Another possibility is that Lake Whitefish could move away from the construction site and be lost from the local population.

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 Long Spruce 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 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.

Lake Whitefish being implanted with an acoustic tag.



N

Sky Pilot Lake
Sky Pilot
Ferris Bay
Wilson Channel
STEPHENS LAKE
River
Moswakot
South
North Access Road
Looking Back Creek
Kettle Rapids
Kettle G.S.
Long Spruce Rapids
Long Spruce G.S.
Creek
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Gillam
Boots Creek
Cache Lake
Butnau River
Morris Point
Keeyask G.S.
(Under Construction)
Gull Rapids
Gillrat Lake
GULL LAKE
RIVER
Clark Lake
NELSON
Birthday Rapids
Carscadden Lake
Joslin Lake
SPLIT LAKE
Wapikopaw Lake
Butnau Lake
Little Kettle Lake
Kettle Lake
North Angling Lakes
Angling River

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-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
- Winter 2014/2015
- Winter 2014/2015 lost
- Open-water 2015
- Winter 2014/2015 and Open-water 2015
- Winter 2014/2015 and Open-water 2015 lost

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

2015 Acoustic Receivers
Clark Lake to Long Spruce G.S.

Map showing the 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?

Where Lake Whitefish moved and how far depended on the individual fish, whether they lived upstream of Gull Rapids (in Gull Lake) or downstream of Gull Rapids (in Stephens Lake), and on the season.

For the majority of the year, Lake Whitefish tagged upstream of Gull Rapids tended to stay in open areas of Gull Lake at locations adjacent to the main flow of the Nelson River. During fall, nearly half the tagged whitefish moved upstream at least as far as Birthday Rapids, presumably to spawn. Other whitefish detected during the fall season remained in the Gull Lake area. One whitefish detected in Gull Lake moved below Gull Rapids into Stephens Lake sometime between June and October, 2015.

Downstream of Gull Rapids, Lake Whitefish were present in the southern channel of Stephens Lake throughout much of the year. O'Neil Bay in Stephens Lake was also used regularly by whitefish during the spring and summer months. More than half the tagged whitefish migrated upstream towards the base of Gull Rapids during fall to spawn. No whitefish were detected moving upstream through Gull Rapids and into Gull Lake.

What does it mean?

Based on the information collected so far and the fact that construction has just begun, it is too early to know whether or not Lake Whitefish movements or habitat use have been affected by construction of the Keeyask GS. After one year of study, one Lake Whitefish was observed to move past the location where the generating station will be built.

What will be done next?

Tags were implanted in Lake Whitefish in fall 2014 and will last until 2017, which will provide three years of movement data during the construction phase of the generating station. Tracking individual fish over this period of time will give us a better idea of where the fish are going, 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 Michael John Garson of Tataskweyak Cree Nation, Jimmy Lockhart of Fox Lake Cree Nation, and Tim Flett of War Lake First Nation are thanked for their assistance in conducting the field work.

The collection of biological samples described in this report was authorized by Manitoba Conservation and Water Stewardship, Fisheries Branch, under terms of the Scientific Collection Permit #18-14 and #17-15.

STUDY TEAM

Data Collection

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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 Walleye (*Sander vitreus*), Northern Pike (*Esox lucius*), and Lake Whitefish were monitored from 2001 to 2005 (Barth *et al.* 2003; Murray *et al.* 2005; Murray and Barth 2007). Long-term acoustic telemetry studies were initiated in 2011 to assess adult Lake Sturgeon (*Acipenser fulvescens*) movements in the Keeyask Study Area (Hrenchuk and McDougall 2012; Hrenchuk and Barth 2013a). In that study, 60 adult Lake Sturgeon were tagged with 10-year acoustic transmitters to monitor their movements during the pre-construction, construction, and operation phases of the Keeyask GS Project. In 2013, 40 subadult Lake Sturgeon and 80 Walleye were tagged with acoustic transmitters to assess their frequency of movement through Gull Rapids and to monitor the potential impact construction of the Keeyask GS had on these movements (Hrenchuk and Barth 2014a,b). In fall 2014, 60 adult Lake Whitefish were tagged with three-year acoustic transmitters to provide information on the movements of this species in the Keeyask Study Area. Movements of these whitefish during fall 2014 (from September 25 to October 25) are provided in Hrenchuk and Barth (2015b), and their movements over a one-year period (from October 15, 2014 to October 11, 2015) are presented in this report.

Construction of the Project may affect Lake Whitefish movements in the main flow of the Nelson River near the construction site by blocking movements through the placement of cofferdams, altering flow patterns, and creating disturbances (*e.g.*, 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 in the Keeyask Study Area during generating station construction, with particular focus on movements in the vicinity of Gull Rapids.

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

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

2.0 THE KEEYASK STUDY SETTING

The Keeyask Study Area encompasses an approximately 95-km long reach of the Nelson River from Clark Lake to the upstream end of the Long Spruce GS Forebay. This section of river offers a diversity of physical habitat conditions, including a variety of substrate types, and variable water depths (ranging from 0 to 30 m) and velocities. Water velocities were classified as low (0.2–0.5 m/s), moderate (0.5–1.5 m/s), or high (>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 that is 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 (Map 1). 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, and extends to the downstream end of Caribou Island, approximately 3 km upstream of Gull Rapids (Map 1). 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.

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 length. Gull Rapids is the site of the Keeyask Generation Project. A summary of 2014/2015 construction activities 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 Generating Station. 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 Moosenose 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 6). 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). The Kettle GS is located approximately 40 km downstream of Gull Rapids.

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

2.1 2014/2015 CONSTRUCTION SUMMARY

Construction of the Keeyask GS began in mid-July 2014 with the construction of the Quarry Cofferdam in the north channel of Gull Rapids. In August, the North Channel Rock Groin and North Channel Cofferdam were constructed to diverted flow from the north and central channels of Gull Rapids to the south channel. The north and central channels were gradually dewatered by late fall 2014. The Stage 1 Powerhouse Cofferdam was constructed in the fall to permit excavation of the powerhouse. Construction of the Central Dam Cofferdam rock groins began the fall of 2014 and was completed the summer of 2015. During the winter of 2014/15 high flows in the Nelson River and partial failure of the ice boom resulted in high water levels in Gull Rapids which required some cofferdams to be raised. The North Channel Rock Groin was extended into the south channel of Gull Rapids during the winter 2014/15 to raise the water level on Gull Lake to promote the formation of a stable ice cover. The groin extension was partially removed in 2015. Construction of the spillway cofferdam, which extends into the south channel of Gull Rapids, began in early winter 2015 and was completed by late summer. Dewatering of the spillway cofferdam occurred in summer/fall 2015. The configuration of cofferdams as of mid-summer 2015 is shown on Map 2.

During July and August 2015, additional ice booms were installed in Gull Lake so that a stable ice cover would develop upstream of the construction site (as noted above, the previous ice boom had partially failed during the winter of 2014/2015). Map 3 illustrates the location of the new ice booms, which are held in place by anchors drilled into the bedrock below the river bottom.

Due to high flows in the Nelson River (almost a 1:20 year flow event) and the construction of the North Channel Rock Groin, water levels in Gull Lake rose to between 155 m ASL and 156 m ASL during late summer 2014. This resulted in water levels above the existing environment 95th percentile water level for open-water (154.2 m ASL) until the following spring (Manitoba Hydro 2015). Open water levels on Gull Lake in the existing environment were as high as 155 m and surpassed 156 m during winter on occasion. The amount of land inundated during the 2014-2015 period is not known, but based on estimates of flooded areas expected in the later stages

of construction (as presented in the Environmental Impact Statement), this area likely included the nearshore areas of much of Gull Lake and some localized areas in and around Gull Rapids, as well as low-lying areas that extended further inland. Water levels during the open-water season of 2015 declined due to lower discharge in the Nelson River. Water levels on Gull Lake ranged from 154 m ASL to 155 m ASL in 2015, and inundated areas were likely confined to localized sections of low-lying areas around Gull Lake.

Blasting at quarries within the north channel cofferdam has been on-going throughout the construction period, with blasts occurring every one to two weeks.

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.

3.1.1 ACOUSTIC TRANSMITTER APPLICATION

Lake Whitefish, measuring 372–565 mm fork length, were tagged with Vemco V13 acoustic transmitters (1141-day battery life) between September 25 and October 8, 2014. Due to difficulty in capturing 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). Whitefish were captured using boat electrofishing to decrease potential stress and mortality. All Lake Whitefish tagged upstream of Gull Rapids were captured immediately downstream of Birthday Rapids [32 river kilometres (rkm) upstream of Gull Rapids] (Map 4). In Stephens Lake, fish were captured along the north shore, 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 AND DEPLOYMENT

During the open-water season, 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 (see Hrenchuk and Barth 2014; Murray *et al.* 2015). At constrictions within the river channel, a series of receivers were deployed to create "gates" with the intent of recording any fish that passed by the river cross-section. In Stephens Lake, receivers were placed at locations within pre-flood river channels, based on the observation that fish tend to stay within channels, even in flooded environments.

An additional nine receivers (two upstream and seven downstream of Gull Rapids) were left in until October 25, 2014, when ice cover began to form. The seven receivers set immediately downstream of Gull Rapids were intended to collect as much data as possible on Lake Whitefish usage of this area, when spawning could be occurring.

The retrieval of receivers deployed during winter has proven challenging and several were lost in previous winters that were believed to have been moved by ice (Hrenchuk and Barth 2013b). Because it appears that receivers will only remain safe from ice if deployed at depths > 10 m, the number of possible receiver locations during winter, especially in Gull Lake, was limited.

3.1.2.1 WINTER 2014/2015

Twenty stationary acoustic receivers (VEMCO model VR2 and VR2W, Shad Bay, Nova Scotia) were placed between Clark Lake and the Long Spruce GS during the winter 2014/2015 period (13 October, 2014 to 30 April, 2015). Four were set upstream of Gull Rapids (Map 5), 15 throughout Stephens Lake (Map 6), and one in the Long Spruce Forebay (Map 7).

From January 14 to 21, acoustic tracking was conducted to assess the abundance of tagged fish in the vicinity of two potential ice blasting locations in Gull Lake (Manitoba Hydro 2015). Additional movement information acquired during this tracking event are discussed in Section 5.0, and a full summary of results are provided in Hrenchuk and Barth (2016).

3.1.2.2 OPEN-WATER 2015

During the 2015 open-water period (from May 1 to October 11, 2015), an array of 56 stationary acoustic receivers was used. Twenty-five were set between Clark Lake and Gull Rapids (Map 8), 27 in Stephens Lake (Map 9), and four in the Long Spruce Forebay (Map 10).

Receiver “gates” were deployed in several key areas: four between Clark Lake and Gull Rapids (44, 34, 19, and 10 rkm upstream of Gull Rapids); and two in Stephens Lake (4.5 and 40 rkm downstream of Gull Rapids) (Maps 8 and 9). 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. The area upstream of Gull Rapids was divided into five zones (Map 8), while Stephens Lake was divided into two zones (Map 9). Gate locations were consistent with 2013 and 2014 baseline open-water studies that focused on Lake Sturgeon (Hrenchuk and Barth 2015b; Hrenchuk *et al.* 2014) and Walleye (Hrenchuk and Barth 2014b; Murray *et al.* 2015), and divided the river into the same zones. On October 11, 2015, the majority of receivers were removed and a subset (n = 21) were redeployed to monitor movements during winter 2015/2016.

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 a different behaviour or movement pattern for monitored fish.

Movements were described in terms of rkm distance, with the base of Gull Rapids representing a distance of 0 rkm. Detections in the area downstream of Gull Rapids (*i.e.*, Stephens Lake and the Long Spruce Forebay) were given positive (+) distance values from Gull Rapids, while detections made in the area upstream (*i.e.*, Gull and Clark lakes) were given negative (-) distance values (Figures 2 and 3). The average rkm distance from Gull Rapids was calculated over a 4-hour interval and plotted versus time for each fish. Total relocation ranges were calculated by subtracting the furthest downstream detection location from the location of the furthest upstream detection. Proportion of time all fish spent within each river zone was calculated and plotted.

4.0 RESULTS

The location of all acoustic receivers set in the Nelson River upstream of Gull Rapids, in Stephens Lake, and in the Long Spruce Forebay during both the 2014/2015 winter season and the 2015 open-water season are displayed in Maps 5 to 10 and in Figures 2 and 3. Seasonal movement summaries of individual Lake Whitefish, and proportional distribution analyses for individual fish and for all fish grouped upstream and downstream of Gull Rapids, are provided in Figures 4 to 9. A detection summary by season and year, including the farthest upstream and downstream detection locations for each tagged whitefish, are tabulated in appendices A1-1 and A1-2. Individual movement summaries are provided for each whitefish tagged upstream of Gull Rapids in appendices A2-1 to A2-18, and downstream of Gull Rapids in appendices A3-1 to A3-31.

4.1 UPSTREAM OF GULL RAPIDS

4.1.1 WINTER 2014/2015

Two of four receivers deployed upstream of Gull Rapids during winter 2014/2015 (at rkm -48.2 and -12.9) were retrieved (Map 5). The remaining two receivers (at rkm -9.9 and -29.4) could not be located, and were likely moved by ice. Six of 20 tagged Lake Whitefish were detected (Figure 4, Appendix A1-1). All six whitefish were located at rkm -12.9 for individual totals of 1-14 days of the 200-day study period.

4.1.2 OPEN-WATER 2015

All 25 acoustic receivers deployed upstream of Gull Rapids during the 2015 open-water period were retrieved (Map 8). Seventeen of 20 tagged Lake Whitefish were located during this period for a total of 38,296 detections (range of 48–8,810) (Appendix A1-1). Individual fish were detected between 4 and 72 days of the 164-day study period. One fish (5%) was located as far upstream as rkm -48.2 (the inlet of Clark Lake), while another (5%) was located as far downstream as rkm 2.9 (in Stephens Lake) (Figure 4, Appendix A1-1). The overall average movement range was 15.6 rkm (StDev = 11.1; range of 0–38.9). Throughout much of the open-water study period, the highest proportion of Lake Whitefish was found in Zone 4 (Figures 5 and 6, Map 8). During the fall spawning period, however, most fish had moved farther upstream into Zone 3.

Eight of the 17 Lake Whitefish detected during the 2015 open-water period (#s 33793, 33798, 33803, 33806, 33807, 33809, 33812, and 33816) were located in the Gull Lake area between rkm -7.4 and -26.5 during spring and/or summer before moving upstream to at least rkm -33.8

(the base of Birthday Rapids), and as far upstream as rkm -48.2 (the inlet of Clark Lake), during fall (Figure 4, Appendix A1-1).

- Seven of the eight whitefish remained upstream of Gull Lake by the end of the 2015 open-water study period:
    - #s 33793, 33803, 33806, 33807, and 33809 were last located at rkm -33.8 (below Birthday Rapids) for 2 to 22 detection days (appendices A2-1, -5, -8, -9, and -11).
    - #33798 was last located at rkm -34.3 (directly above Birthday Rapids) for one day (Appendix A2-2).
    - #33816 was last located at rkm -48.2 (upstream end of Clark Lake) for four consecutive days (Appendix A2-14).
- One whitefish (#33812) moved as far upstream as rkm -34.3 by September 4 before moving back downstream to rkm -19.4 (upstream end of Gull Lake) by September 8 for one day (Appendix A2-12).

Another four Lake Whitefish (#s 33804, 33813, 33822, and 33826) were located between rkm -19.5 and -33.8 during spring and/or summer before moving downstream to rkm -9.0 and -11.8 during mid to late summer (Figure 4, Appendix A1-1).

- Three of the four whitefish (#s 33804, 33813, and 33826) moved downstream between July 21 and 26 and remained at rkm -9.0 to -11.8 for 8 to 21 detection days (appendices A2-6, -13, and -17).
- #33822 moved repeatedly between rkm -11.8 and -19.8 from June to August before remaining at rkm -11.8 (upstream of Hydro Island) by 30 August for a total of 11 detection days (Appendix A2-16).

One (#33805) was located between rkm -5.8 and -11.8 from June 20 to 29 (a total of ten detection days) before moving downstream and being located again below Gull Rapids in Stephens Lake on October 5 (Figure 4, Appendix A2-7).

The remaining four Lake Whitefish were located infrequently upstream of Gull Rapids (4 to 22 detection days). No obvious patterns of movement were evident for these fish.

- #33801 was located between rkm -17.4 and -19.5 (upstream end of Gull Lake) for four detection days, two in July and two in August (Appendix A2-3).
- #33808 was located between rkm -17.4 and -19.5 (upstream end of Gull Lake) for a total of 14 detection days between June and August (Appendix A2-10).
- #33820 was located at rkm -26.0 for eight detection days in July (Appendix A2-15); was an incidental gillnet mortality near rkm -26.0 on August 13 (Lavergne, *in prep*.)
- #33830 also was located at rkm -26.0 for 22 detection days in July and August (Appendix A2-18).

4.2 DOWNSTREAM OF GULL RAPIDS

4.2.1 WINTER 2014/2015

Ten of the 15 acoustic receivers deployed in Stephens Lake during winter 2014/2015 were retrieved. Receivers deployed at rkm 6.1, 6.3, 26.0, 32.0, and 40.8 could not be retrieved (Map 6). The two receivers set closest to Gull Rapids could not be located and were likely moved by ice. Three other receivers set in the lower (*i.e.*, downstream) half of Stephens Lake were snagged and could not be pulled to the surface.

Seventeen of the 40 tagged Lake Whitefish were located for a total of 105,942 detections (range: 15 – 29,858) (Appendix A1-2). Whitefish were located between 1 and 153 days of the 200-day study period. Twelve (71%) were detected as far upstream as rkm 7.7, while one (6%) was detected as far downstream as rkm 40.8 (upstream side of the Kettle GS) (Appendix A1-2). The overall average movement range was 7.5 rkm (StDev = 7.9 rkm; range: 0.0 – 33.1 rkm).

Ten (#s 6358, 6360, 6363, 6364, 6366, 6372, 33794, 33795, 33819, and 33823) were located only at the beginning of the winter period between one and 22 detection days (Figure 7, Appendix A1-2).

- Five were detected only in the upper 10.5 rkm of Stephens Lake:
    - #6358 was located only at rkm 10.2 for a total of three detection days (Appendix A3-2).
    - #6363 was located between rkm 7.7 and 7.9 (in the former channel of the Moosenose River) for a total of ten detection days (Appendix A3-6).
    - #33794 moved between rkm 7.7 and 10.5 (in the former channel of the Moosenose River) for nine detection days (Appendix A3-15).
    - #33795 was located at rkm 7.9 for four days (Appendix A3-16).
    - #33823 was located at rkm 7.7 for two detection days (Appendix A3-25).
- Five were detected in Stephens Lake at greater distances from Gull Rapids:
    - Three fish (#s 6360, 6366, and 6372) were located as far downstream as rkm 16.8, each for one detection day (appendices A3-4, -8, and -11).
    - #6364 was located as far downstream as rkm 14.9 for 22 detection days (Appendix A3-7).
    - #33819 was located as far downstream as rkm 40.8 (directly upstream of the Kettle GS) (Appendix A3-23).

The remaining seven Lake Whitefish were detected for the majority of the study period (42 to 153 detection days). No obvious patterns of movement were evident for these fish.

- Three (#s 6357, 6376, and 33821) were detected consistently throughout the study period:
    - #6357 moved between rkm 7.9 and 16.8 in the early portion of winter 2014/2015. It moved to rkm 10.5 on 12 February, 2015, and remained there until 21 April, 2015 (Appendix A3-1).
    - #6376 moved between rkm 7.7 and 13.4. It was detected mainly at rkm 10.5 from 15 October to 21 December, 2014, and again from 1 to 30 April, 2015, and at rkm 7.9 from 6 January to 30 March, 2015 (Appendix A3-14).
    - #33821 was detected at rkm 10.5 from 18 November, 2014, to 19 January, 2015, and then moved to rkm 7.9 from 27 January to 30 April, 2015 (Appendix A3-24).
- Four (#s 6370, 33796, 33815, and 33818) were detected only at the beginning of the study period (for 33 to 65 detection days):
    - #6370 was located between rkm 7.7 and 14.9 until 22 December, 2014. On 24 December, 2014, it moved downstream to rkm 21.6 (middle section of Stephens Lake) (Appendix A3-10).
    - #33796 was located at rkm 13.4 (in the former channel of the Moosenose River) for the majority of the study period. It was last detected at that location on 10 January, 2015 (Appendix A3-17).
    - #33815 moved betweem recievers corresponding to the former channel of the Moosenose River (#114227 [rkm 7.9], #122776 [10.5], and #4638 [13.4]) until it was last detected on 27 December, 2014 (Map 6; Appendix A3-20).
    - #33818 moved throughout the southern channel of Stephens Lake (rkm 7.7, 10.2, 14.9, and 18.7) where it was last detected on 19 January, 2015 (Appendix A3-22).

4.2.2 OPEN-WATER 2015

All 27 acoustic receivers deployed in Stephens Lake during the 2015 open-water season were retrieved (Map 9). However, during the last download on October 11, 2015, two receivers in Stephens Lake (#122778 at rkm 28.3 and #108003 at rkm 39.9) were caught on submerged trees and could not be retrieved.

Twenty-seven of 40 tagged Lake Whitefish were detected for a total of 47,713 detections (range of 52 – 11,658) (Appendix A1-2). Individual whitefish were located between 2 and 67 days of the 163-day study period. Nine (33%) were detected as far upstream as rkm 1.3, while one (4%) was detected as far downstream as rkm 28.3 (Figure 7, Appendix A1-2). The overall average movement range was 6.6 rkm (StDev = 6.3; range of 0 – 26.1). Throughout the entire open-water study period, the largest proportion of Lake Whitefish tagged in Stephens Lake was located in Zone 1 (Figures 8 and 9, Map 9).

Twenty-five of the 27 Lake Whitefish detected during the 2015 open-water period (#s 6357, 6358, 6359, 6361, 6363, 6364, 6367, 6372, 6374, 6375, 33794, 33795, 33810, 33814, 33815, 33817, 33818, 33819, 33821, 33824, 33825, 33827, 33829, 33831, and 33832) were located between rkm 1.3 and 7.9 during fall (September 1 to October 11) (Figure 7), Appendix A1-2).

- Seventeen were only located in upper Stephens Lake during fall for 2-17 detection days (appendices A3-3, -5, -7, -9, -12, -13, -15, -16, -18, -19, -21, -23, -26, -28, -29, -30, and -31).
    - Eight (#s 6357, 6358, 6363, 6372, 33815, 33818, 33821, and 33825) were also detected during spring and/or summer:
    - #6357 was located in the southern channel of Stephens Lake at rkm 14.9 from May 24 to June 20 for a total of 30 detection days (Appendix A3-1).
    - #6358 moved throughout the southern channel of Stephens Lake (rkm 7.7, 10.2, 11.0, 13.4, 14.9, 16.8, and 18.7) from June 18 to 20 (Appendix A3-2).
    - #6363 was located at rkm 3.6 (O'Neil Bay) during July and August for a total of 14 detection days (Map 9; Appendix A3-6).
    - #6372 was located by receivers corresponding to the former channel of the Moosenose River (#4548 [rkm 3.6], #114227 [rkm 7.9], #122776 [rkm 10.5], and #4638 [rkm 14.0]) from June 15 to 23 for a total of six detention days (Map 9; Appendix A3-11).
    - #33815 was located primarily in the former channel of the Moosenose River (rkm 7.9, 10.5, and 13.4) for 13 detection days between May 12 and 31; moved to the southern channel of Stephens Lake (rkm 4.4, 7.7, 14.9, 17.4, 19.0, and 21.0) for 18 detection days between June 3 and 20; located downstream at rkm 24.7 on August 17, then back upstream to the former Moosenose River channel between August 29 and 30 (Appendix A3-20).
    - #33818 was located in the southern channel of Stephens Lake (rkm 10.2, 14.9, 17.4, 19.0, and 28.3) from June 1 to August 2 for a total of 27 detection days; moved upstream to below Gull Rapids (rkm 2.2, 3.8, 4.4, 4.7, and 5.8) on August 13; moved back to the southern channel of Stephens Lake from August 14 to 28 for a total of six detection days (Appendix A3-22).
    - #33821 was located in the former channel of the Moosenose River (rkm 7.9, 10.5, 13.4, and 16.8) from May 1 to June 15 for a total of 21 detection days; moved upstream to below Gull Rapids (rkm 2.2, 2.9, 3.8, 4.4, 4.7, and 6.2) from August 19 to 29, all days consecutively (Appendix A3-24).
    - #33825 was located at rkm 3.6 (O'Neil Bay) on August 12 (Appendix A3-27).

Two Lake Whitefish were detected in the former channel of the Moosenose River only at the beginning of the 2015 open-water study period (Map 9).

- #6376 was located at rkm 10.5 and 16.8 from May 1 to 12 June for a total of 20 detection days (Appendix A3-14).

- #33796 was located at rkm 10.5, 13.4, and 16.8 from 13 to 20 June, all day consecutively (Appendix A3-17).

5.0 DISCUSSION

This report presents results of the first year (October 2014 to October 2015) of a three-year Lake Whitefish movement monitoring study initiated in September 2014. Given that the acoustic transmitters will last at least until November 2017, the movement data collected to date are considered preliminary, and in-depth analyses will be not be conducted until the study is completed.

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); however, relative to similar studies on adult and juvenile Lake Sturgeon (Hrenchuk and Barth 2015b; Lacho *et al.* 2015), results are more difficult to interpret. This is because Lake Whitefish (as well as Walleye) do not utilize the thalweg of the Nelson River as frequently as Lake Sturgeon, and alternatively use tributaries, shallow water habitats, habitat in off-current embayments or areas such as the north arm of Stephens Lake where there is no receiver coverage. 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, 36 (or 60%) were not detected during the 2014/2015 winter period, and 16 (or 27%) were not detected during the 2015 open-water period. Analyses of these data becomes complicated as it is difficult to account for missing fish in the analysis; questions arise as to the number of missing fish that should be accounted for as mortalities. To improve the detection frequency of Lake Whitefish in 2016, additional tags (to account for potential mortality) and receivers will be added. Receivers will be placed at the mouths of tributaries and in the northern arm of Stephens Lake to account for Lake Whitefish that may be leaving the study area.

5.2 MOVEMENTS UPSTREAM OF GULL RAPIDS

Despite the finding that a sizeable proportion of Lake Whitefish went undetected during the 2014/15 winter and 2015 open-water study periods, a large quantity of data were collected to provide information on Lake Whitefish movements. Upstream of Gull Rapids, six whitefish were detected during the winter period, all at rkm -12.9 in the upper basin of Gull Lake. One of these fish, first detected at rkm -12.9 in November 2014, was later located at rkm -7.5 (near the upstream end of Caribou Island) for six detection days in January 2015, as part of a separate winter fish tracking study (described in full in Hrenchuk and Barth 2016). This individual later moved downstream into Stephens Lake sometime between June and October, 2015.

During the open-water period, two basic movement patterns have become apparent upstream of Gull Rapids. First, most whitefish detected during spring and summer (12 of 17; 71%) spent the majority or all of their time in the Gull Lake area (*i.e.*, zones 4 and 5), including two that moved downstream to the Gull Lake area during late July and were last detected there. Second, nearly half the Lake Whitefish detected during the 2015 open-water period (8 of 17; 47%) moved upstream to at least the base of Birthday Rapids during fall, presumably to spawn. One such fish continued moving upstream as far as the inlet of Clark Lake, while another moved back downstream to the inlet of Gull Lake soon after reaching Birthday Rapids in early September. These two movement patterns are likely related to spawning, as Lake Whitefish are known to spawn in the riverine section of the Nelson River between Birthday Rapids and the inlet of Gull Lake (Keeyask Hydropower Limited Partnership 2014).

5.3 MOVEMENTS DOWNTREAM OF GULL RAPIDS

All 40 Lake Whitefish tagged downstream of Gull Rapids have remained in Stephens Lake after the first year of study; none moved upstream past Gull Rapids. During the 2014/15 winter period, a total of 17 whitefish were detected. All but one fish were located between 6.1 and 21.0 rkm downstream of Gull Rapids in the southern channel of Stephens Lake and in the former channel of the Moosenose River (*i.e.*, in Zone 2). A single fish moved downstream to rkm 40.8 (upstream of the Kettle GS) then back upstream to rkm 7.7 during October 2014.

During spring and summer of the 2015 open-water period, Lake Whitefish utilized the same areas as in winter, as close to half the fish detected (11 of 27; 41%) were found in both the southern Stephens Lake channel and the former Moosenose River channel in Zone 2. Close to two-thirds of whitefish detected during the open-water period (17 of 27; 63%) also were located in O'Neil Bay (Map 9). This bay is relatively shallow compared to other areas of the lake (Larter and Cooley 2010) and may be attractive to whitefish as feeding habitat.

Twenty-three of 27 Lake Whitefish (or 85%) detected during fall 2015 were located near the base of Gull Rapids. These movements are likely related to spawning as the rapids are known to provide important spawning habitat for whitefish in Stephens Lake (Keeyask Hydropower Limited Partnership 2014). The spawning run in 2015 (September/October) would have occurred during construction at the Keeyask GS site.

5.4 KEY QUESTIONS

In the discussion below, the key questions/objectives of Lake Whitefish movement monitoring during construction, as described in the AEMP, and presented in the introduction of this report, are addressed:

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

Although preliminary, results 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 into Stephens Lake sometime between June and October, 2015. This finding is consistent with baseline movement studies, where only four of 30 (or 13%) of whitefish tagged in the Keeyask Study Area in 2001 (*i.e.*, 15 in each of Gull and Stephens lakes) moved through Gull Rapids between 2001 and 2004; two fish moved upstream and two downstream (Murray and Barth 2007).

No Lake Whitefish were detected moving upstream through Gull Rapids to Gull Lake for the reporting period.

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

During the 2015 fall spawning season, nearly half the Lake Whitefish detected upstream of Gull Rapids moved upstream to at least the base of Birthday Rapids, presumably to spawn. Preliminary results indicate that Lake Whitefish tagged upstream are not using habitat directly upstream of the Keeyask GS construction site, and are therefore less likely to be affected directly by construction-related activities such as blasting. In contrast, a considerable proportion of the whitefish population tagged downstream of Gull Rapids appear to inhabit the upper 6 km of Stephens Lake during the 2015 open-water period, particularly during fall, and thus may be directly impacted by construction activities at the Keeyask GS site. Also, spawning whitefish and incubating eggs could be affected by construction related disturbances during fall and winter, respectively.

6.0 SUMMARY AND CONCLUSIONS

- Acoustic telemetry was an effective method for monitoring Lake Whitefish movements in the Keeyask Study Area during the 2015 open-water period, as 44 of the 60 tagged whitefish (73%) were detected. Monitoring during winter, however (especially in Gull Lake), is more difficult and the quantity of data collected during this period is limited.
- During the 2015 fall spawning season, nearly half the Lake Whitefish detected upstream of Gull Rapids moved upstream to at least the base of Birthday Rapids, presumably to spawn. At the same time, the majority of whitefish detected downstream of Gull Rapids moved upstream towards the base of Gull Rapids. The upstream spawning migration observed in Stephens Lake coincided with on-going construction at the Keeyask Generating Station site.
- Tagged Lake Whitefish in Stephens Lake have not made any long-range movements after the first year of study. Three tagged fish moved downstream to lower Stephens Lake only briefly, one during winter and two during summer. In comparison, two Lake Whitefish tagged upstream of Gull Rapids showed some long range movement. One fish moved as far upstream as the inlet of Clark Lake, while another moved downstream past Gull Rapids into Stephens Lake sometime between June and October, 2015.
- Lake Whitefish tagged upstream of Gull Rapids are not using habitat directly upstream of the Keeyask GS construction site, and are therefore less likely to be affected directly by construction-related activities such as blasting. In contrast, a considerable proportion of the whitefish population tagged downstream of Gull Rapids appear to inhabit upper Stephens Lake year-round, and thus may be more directly impacted by construction activities at the Keeyask GS site. Also, spawning whitefish and incubating eggs could be affected by construction related disturbances during fall and winter, respectively.
- The key questions, as described in the AEMP, for Lake Whitefish movement monitoring during construction of the Keeyask GS are as follows:
    - *What is the number (or the proportion) of tagged Lake Whitefish that move past the construction site?*

      Although preliminary, results 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 into Stephens Lake sometime between June and October, 2015.
    - *Are tagged Lake Whitefish utilizing habitat in the vicinity of construction activities (particularly during spawning)?*

      Preliminary results indicate that Lake Whitefish tagged upstream are not using habitat directly upstream of the Keeyask GS construction site. A considerable proportion of the whitefish population tagged downstream of Gull Rapids appear to inhabit the upper 6 km of Stephens Lake during the 2015 open-water period,

particularly during fall, and thus may be directly impacted by construction activities at the Keeyask GS site.

- Additional tags (to account for mortality) and receivers (to extend the coverage area) will be added in 2016.

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TABLES

Table 1: Acoustic-tag and biological information for each Lake Whitefish sampled in the Nelson River upstream of Gull Rapids, fall 2014.

Tag ID	Date tagged	Tag life (days)	Expiry date	Fork length (mm)	Weight (g)
33822	7-Oct-14	1141	20-Nov-17	455	1825
33826	7-Oct-14	1141	20-Nov-17	433	1200
33830	7-Oct-14	1141	20-Nov-17	449	1500
33793	8-Oct-14	1141	21-Nov-17	425	2350
33797	8-Oct-14	1141	21-Nov-17	534	3350
33798	8-Oct-14	1141	21-Nov-17	464	1775
33800	8-Oct-14	1141	21-Nov-17	416	1025
33801	8-Oct-14	1141	21-Nov-17	529	2450
33802	8-Oct-14	1141	21-Nov-17	503	2300
33803	8-Oct-14	1141	21-Nov-17	500	2150
33804	8-Oct-14	1141	21-Nov-17	482	1625
33805	8-Oct-14	1141	21-Nov-17	434	1400
33806	8-Oct-14	1141	21-Nov-17	495	1925
33807	8-Oct-14	1141	21-Nov-17	461	1375
33808	8-Oct-14	1141	21-Nov-17	444	1850
33809	8-Oct-14	1141	21-Nov-17	482	1725
33812	8-Oct-14	1141	21-Nov-17	560	3425
33813	8-Oct-14	1141	21-Nov-17	438	1325
33816	8-Oct-14	1141	21-Nov-17	452	1650
33820	8-Oct-14	1141	21-Nov-17	493	1725

Table 2: Acoustic-tag and biological information for each Lake Whitefish sampled in Stephens Lake, fall 2014.

Tag ID	Date tagged	Tag life (days)	Expiry date	Fork length (mm)	Weight (g)
6367	25-Sep-14	1141	8-Nov-17	508	2100
6368	25-Sep-14	1141	8-Nov-17	495	2050
6372	25-Sep-14	1141	8-Nov-17	482	1800
6373	25-Sep-14	1141	8-Nov-17	541	2900
6374	25-Sep-14	1141	8-Nov-17	510	2300
6375	25-Sep-14	1141	8-Nov-17	492	1750
6376	25-Sep-14	1141	8-Nov-17	380	900
6357	30-Sep-14	1141	9-Nov-17	436	1500
6358	30-Sep-14	1141	9-Nov-17	503	2400
6359	30-Sep-14	1141	9-Nov-17	520	2300
6360	30-Sep-14	1141	9-Nov-17	460	1700
6361	30-Sep-14	1141	9-Nov-17	495	2300
6362	30-Sep-14	1141	9-Nov-17	514	2500
6363	30-Sep-14	1141	9-Nov-17	489	1900
6364	30-Sep-14	1141	9-Nov-17	445	1600
6365	30-Sep-14	1141	9-Nov-17	524	3000
6366	30-Sep-14	1141	9-Nov-17	440	1700
6369	30-Sep-14	1141	9-Nov-17	538	3000
6370	30-Sep-14	1141	9-Nov-17	560	3700
6371	30-Sep-14	1141	9-Nov-17	520	3500
33794	30-Sep-14	1141	9-Nov-17	552	2700
33795	30-Sep-14	1141	9-Nov-17	483	2200
33796	30-Sep-14	1141	9-Nov-17	372	950
33799	30-Sep-14	1141	9-Nov-17	549	2900
33810	30-Sep-14	1141	9-Nov-17	551	3250
33811	30-Sep-14	1141	9-Nov-17	448	1600
33814	30-Sep-14	1141	9-Nov-17	446	1600
33815	30-Sep-14	1141	9-Nov-17	538	2600
33817	30-Sep-14	1141	9-Nov-17	508	2400
33818	30-Sep-14	1141	9-Nov-17	456	1850
33819	30-Sep-14	1141	9-Nov-17	565	3150
33821	4-Oct-14	1141	17-Nov-17	459	1575
33823	4-Oct-14	1141	17-Nov-17	454	1750
33824	4-Oct-14	1141	17-Nov-17	519	2650
33825	4-Oct-14	1141	17-Nov-17	442	1325
33827	4-Oct-14	1141	17-Nov-17	410	1800
33828	4-Oct-14	1141	17-Nov-17	494	2150
33829	4-Oct-14	1141	17-Nov-17	506	2400
33831	4-Oct-14	1141	17-Nov-17	538	2700
33832	4-Oct-14	1141	17-Nov-17	549	2725

FIGURES

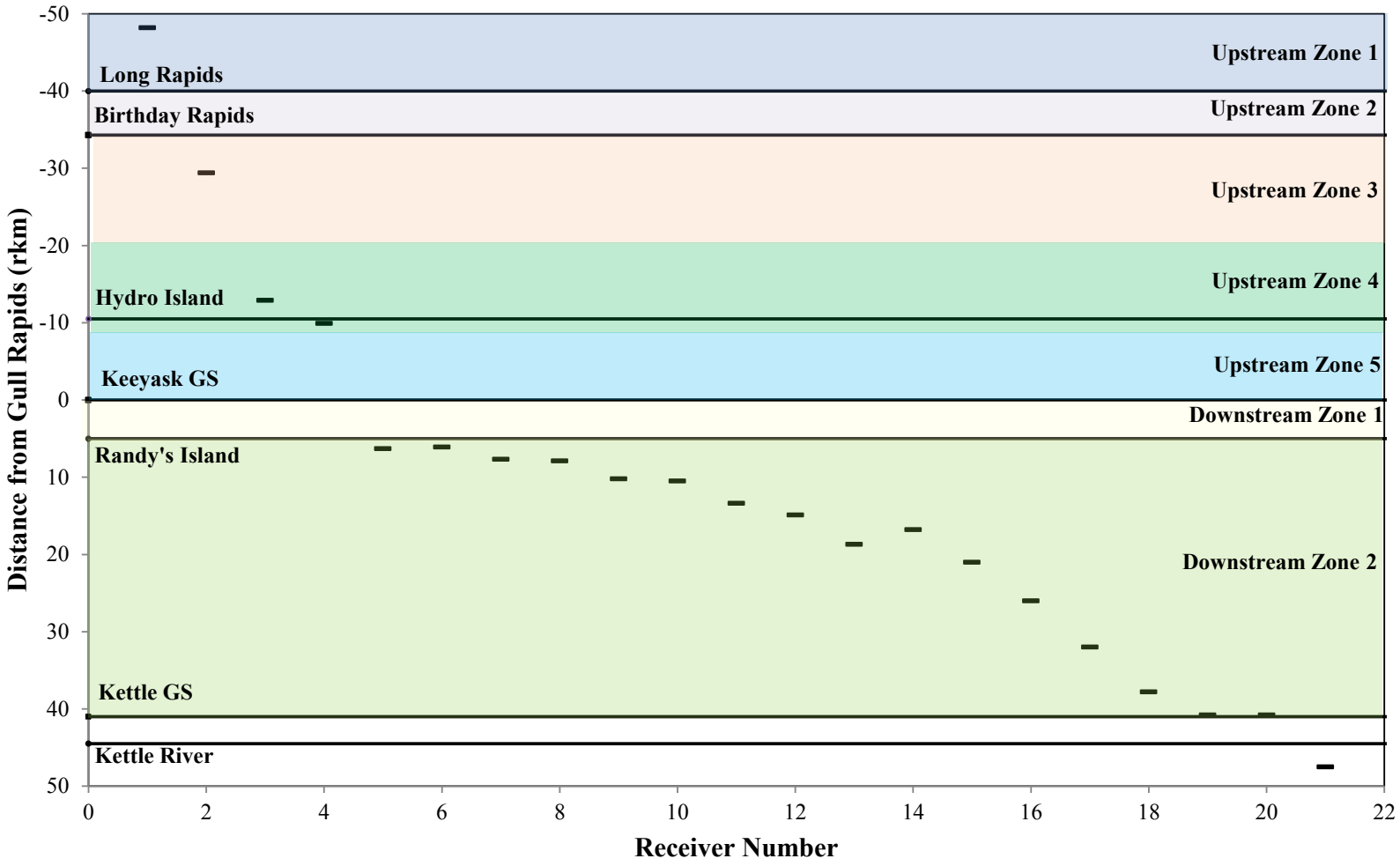


Figure 1: **Locations of stationary acoustic receivers (dashes) in relation to the base of Gull Rapids (*i.e.*, the Keeyask GS construction site) (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Long Spruce GS from 15 October, 2014 to 01 May, 2015. River zones upstream and downstream of Gull Rapids are indicated by shading.**

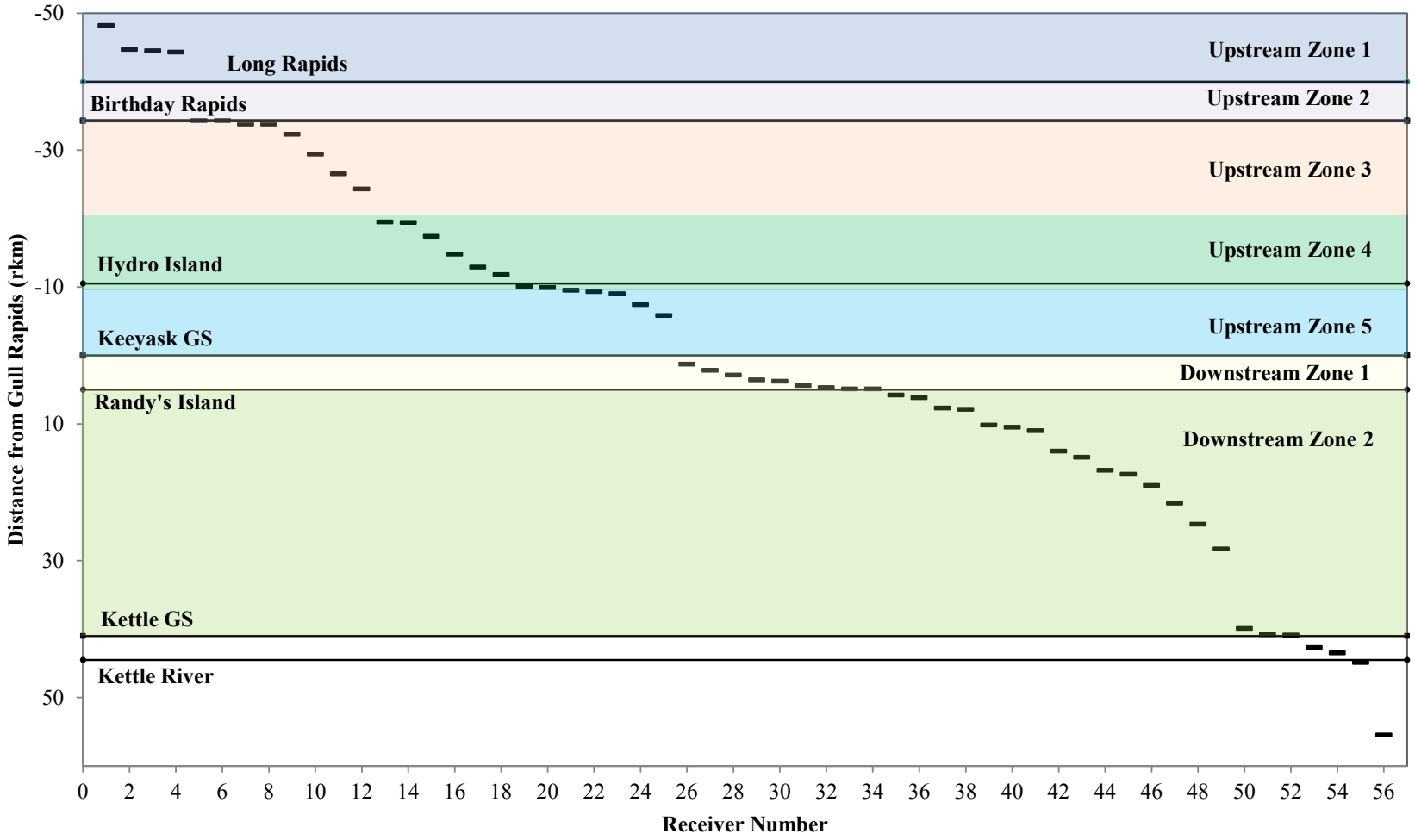


Figure 2: **Locations of stationary acoustic receivers (dashes) in relation to the base of Gull Rapids (*i.e.*, the Keeyask GS construction site) (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Long Spruce GS from June to October, 2015. River zones upstream and downstream of Gull Rapids are indicated by shading.**

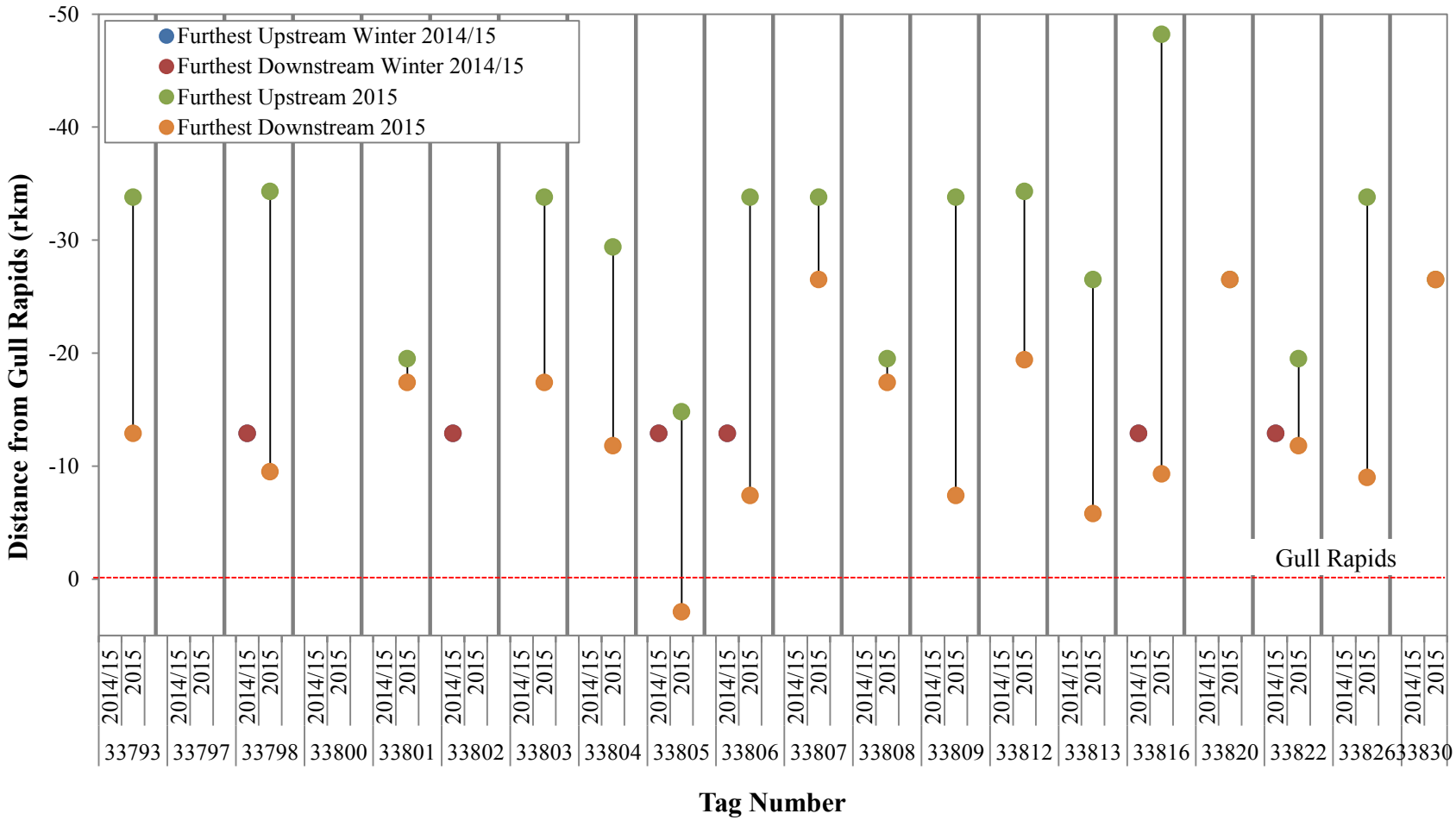


Figure 3: **Detection ranges for individual Lake Whitefish (n = 20) tagged with acoustic transmitters upstream of Gull Rapids during the 2014/2015 winter period (15 October, 2014 to 30 April, 2015) and the 2015 open-water period (01 May to 11 October).**

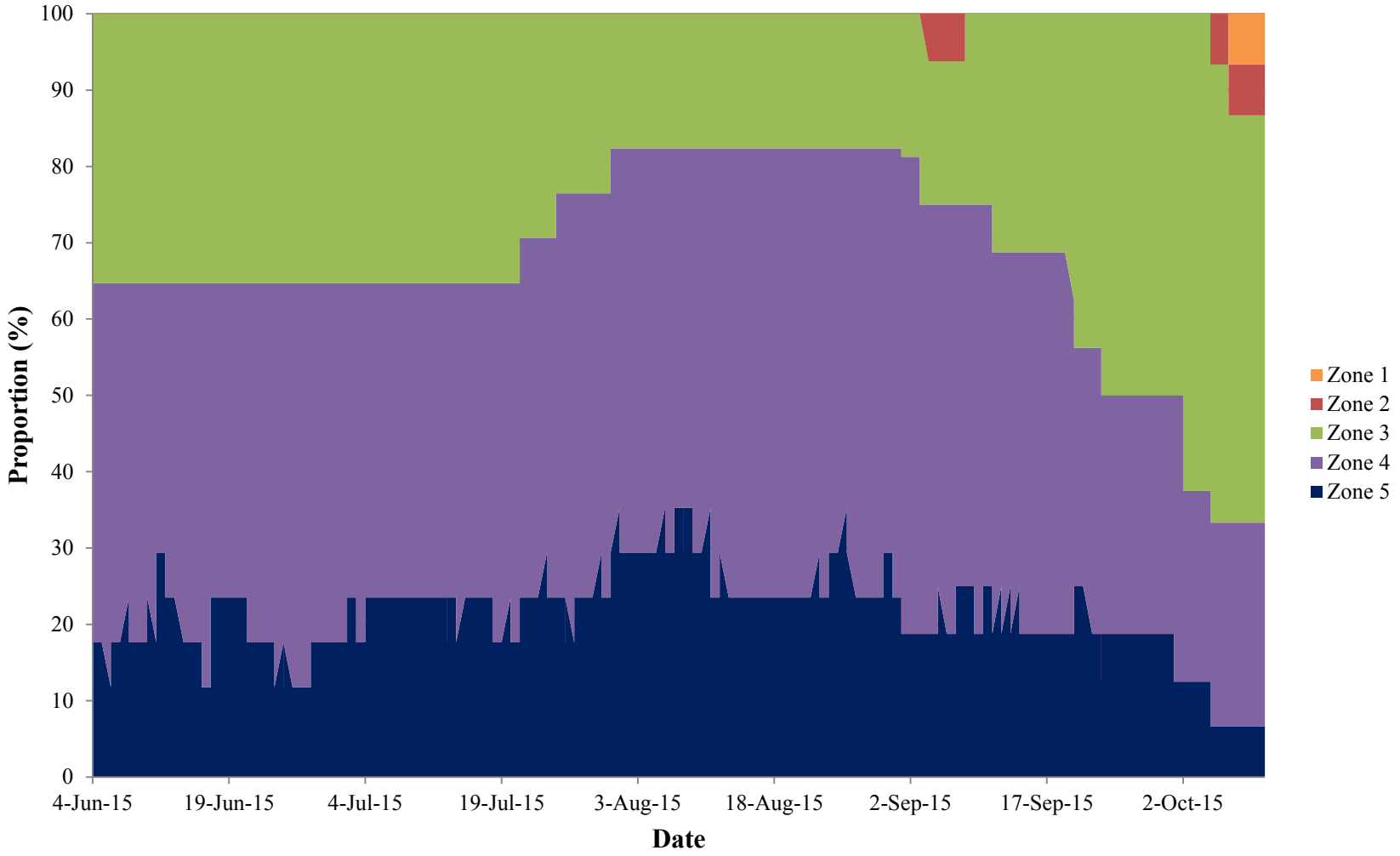


Figure 4: Proportional distribution of acoustic-tagged Lake Whitefish within five river zones between Clark Lake and Gull Rapids during the 2015 open-water period (04 June to 11 October).

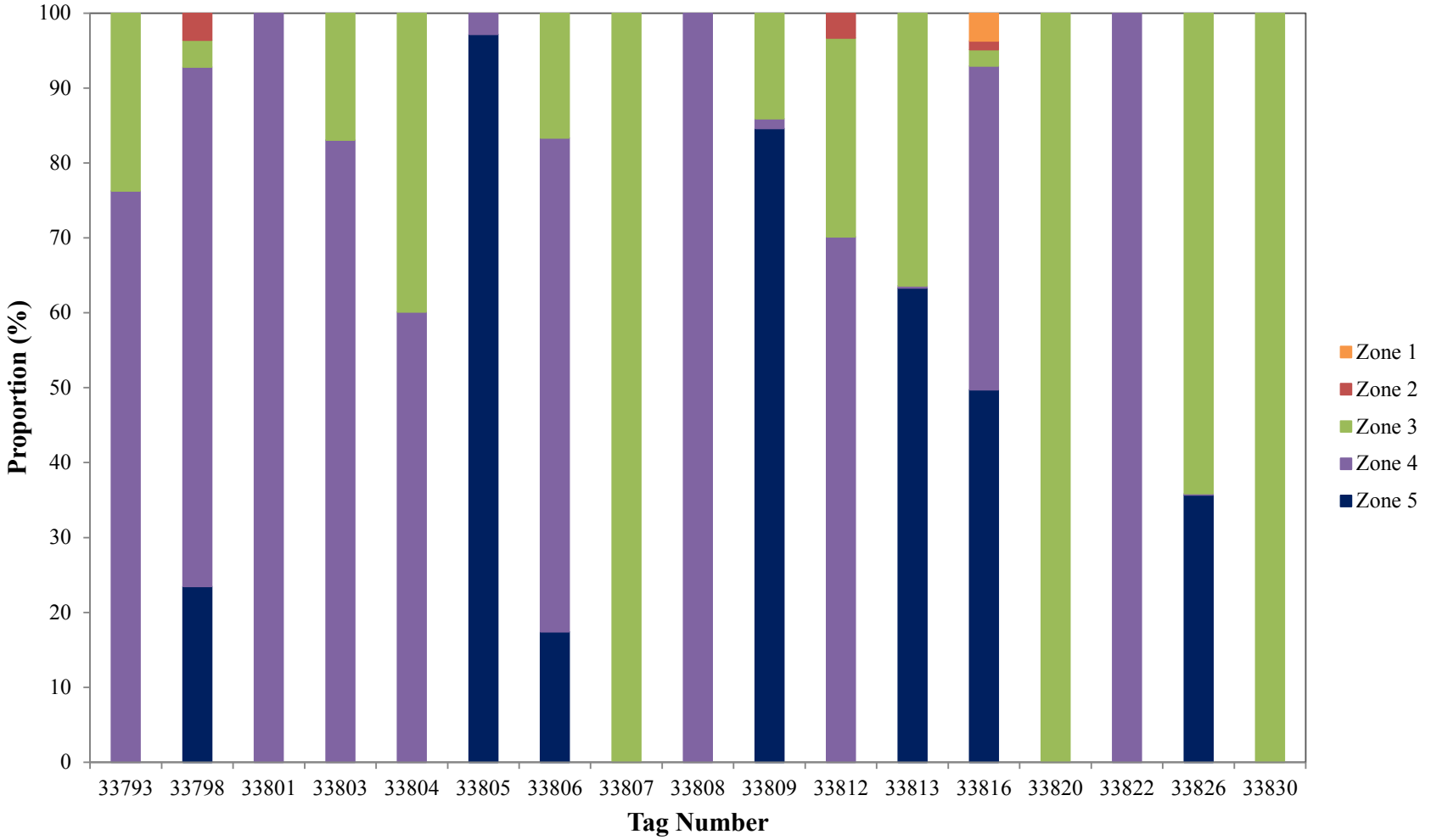


Figure 5: Proportion of time spent within five river zones between Clark Lake and Gull Rapids by individual acoustic-tagged Lake Whitefish during the 2015 open-water period (04 June to 11 October).

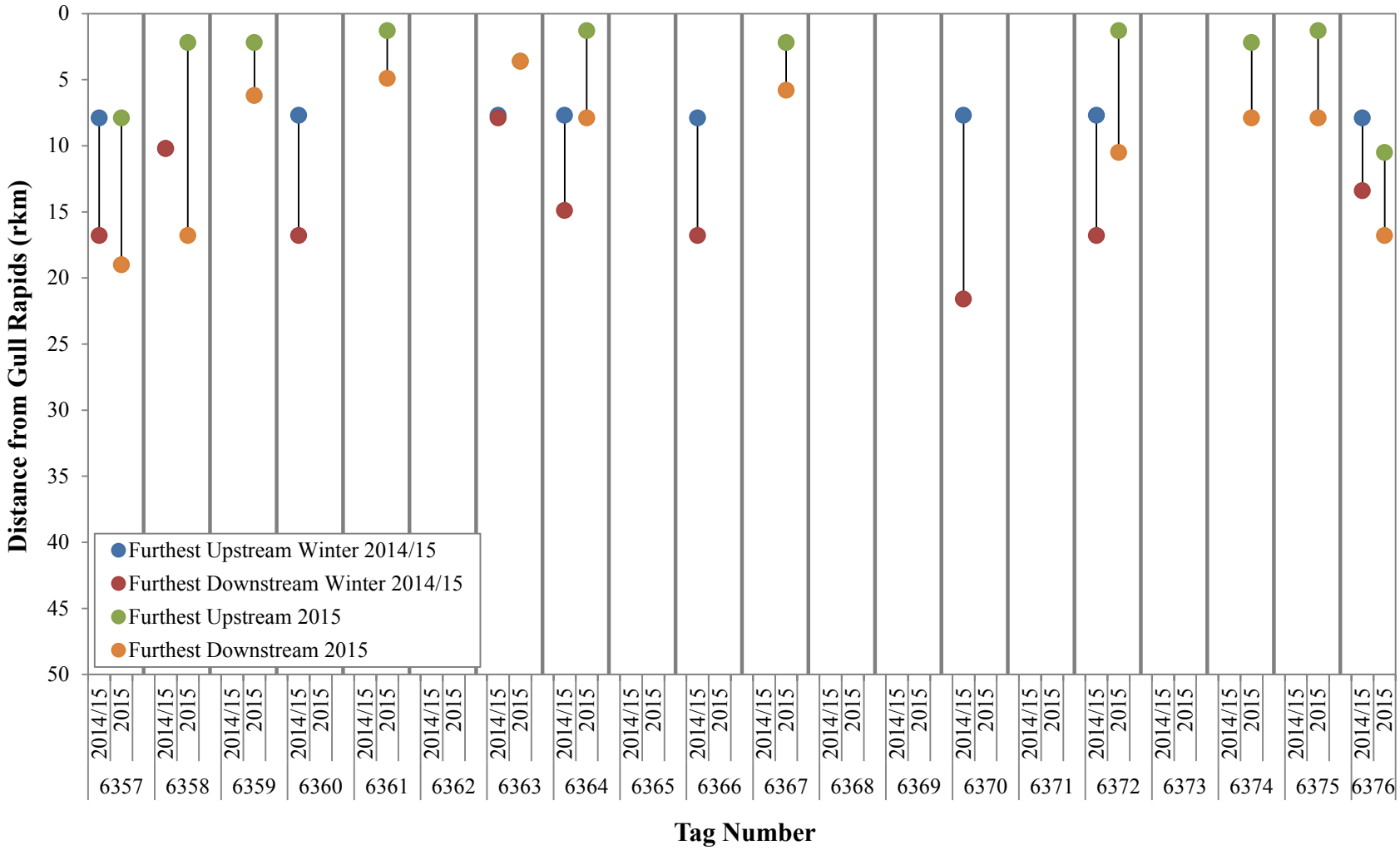


Figure 6: **Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2014/2015 winter period (15 October, 2014 to 30 April, 2015) and the 2015 open-water period (01 May to 11 October).**

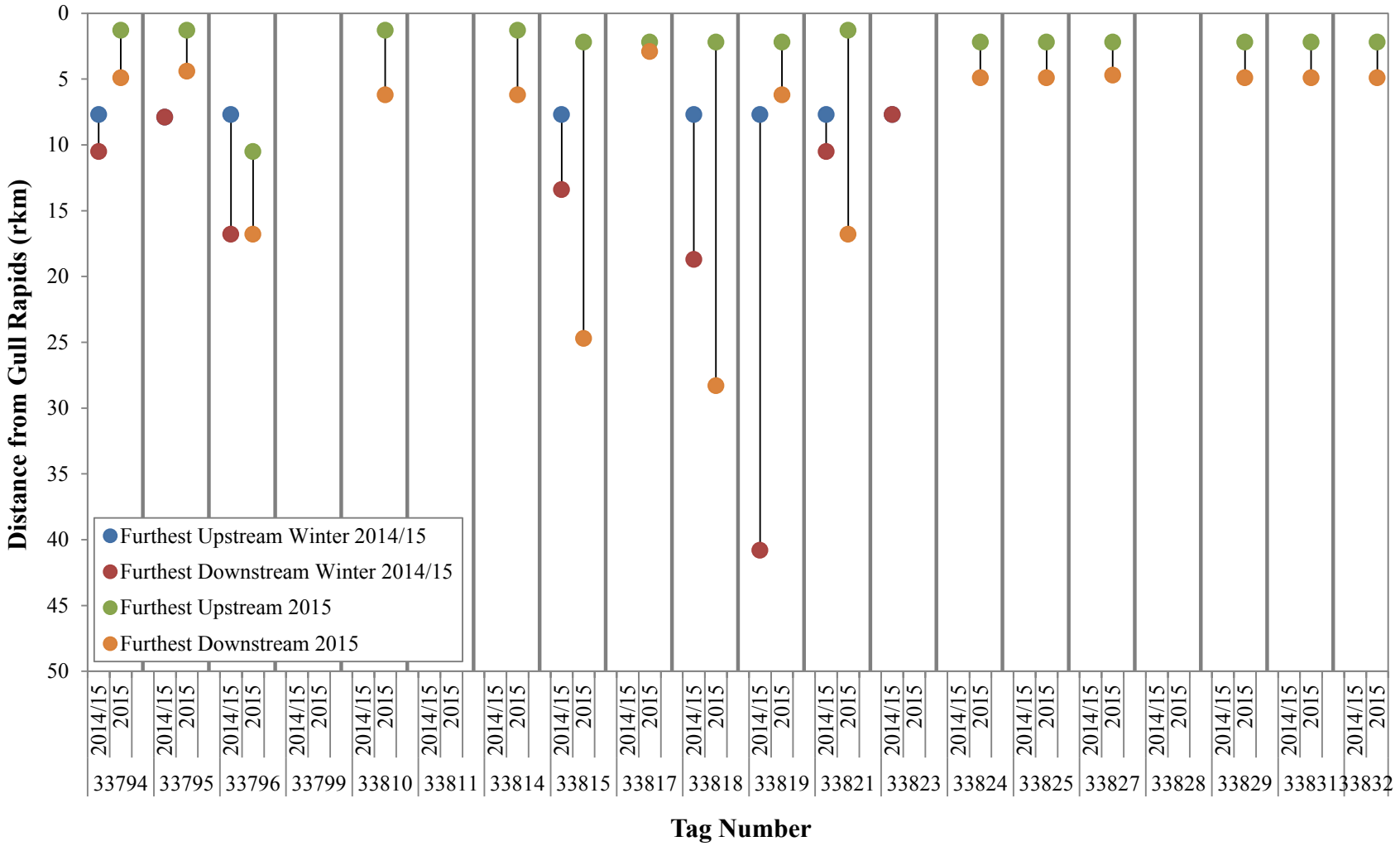


Figure 6: Detection ranges for individual Lake Whitefish (n = 40) tagged with acoustic transmitters in Stephens Lake during the 2014/2015 winter period (15 October, 2014 to 30 April, 2015) and the 2015 open-water period (01 May to 11 October) (continued).

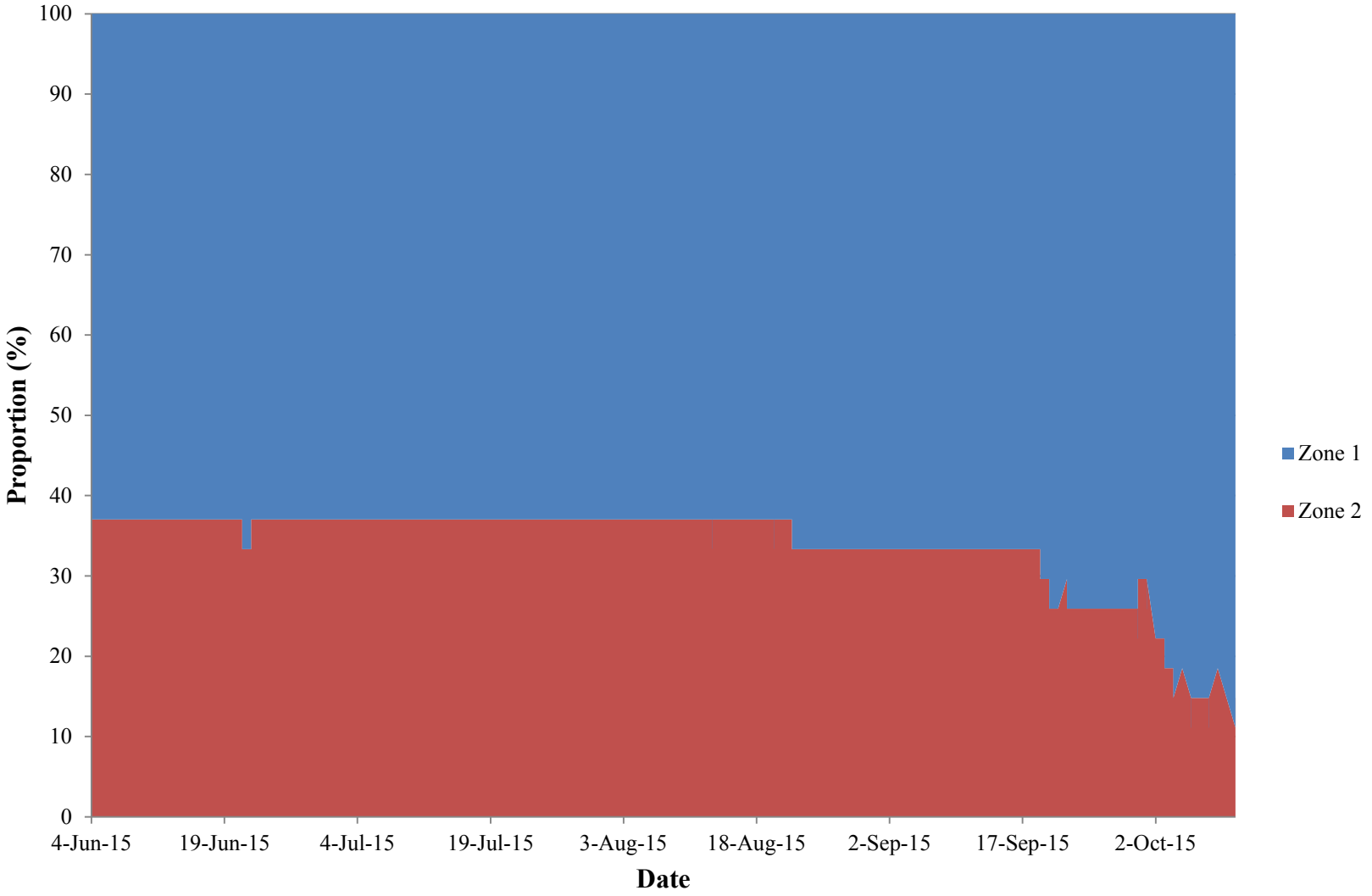


Figure 7: Proportional distribution of acoustic-tagged Lake Whitefish within two zones between Gull Rapids and the Kettle GS during the 2015 open-water period (04 June to 11 October).

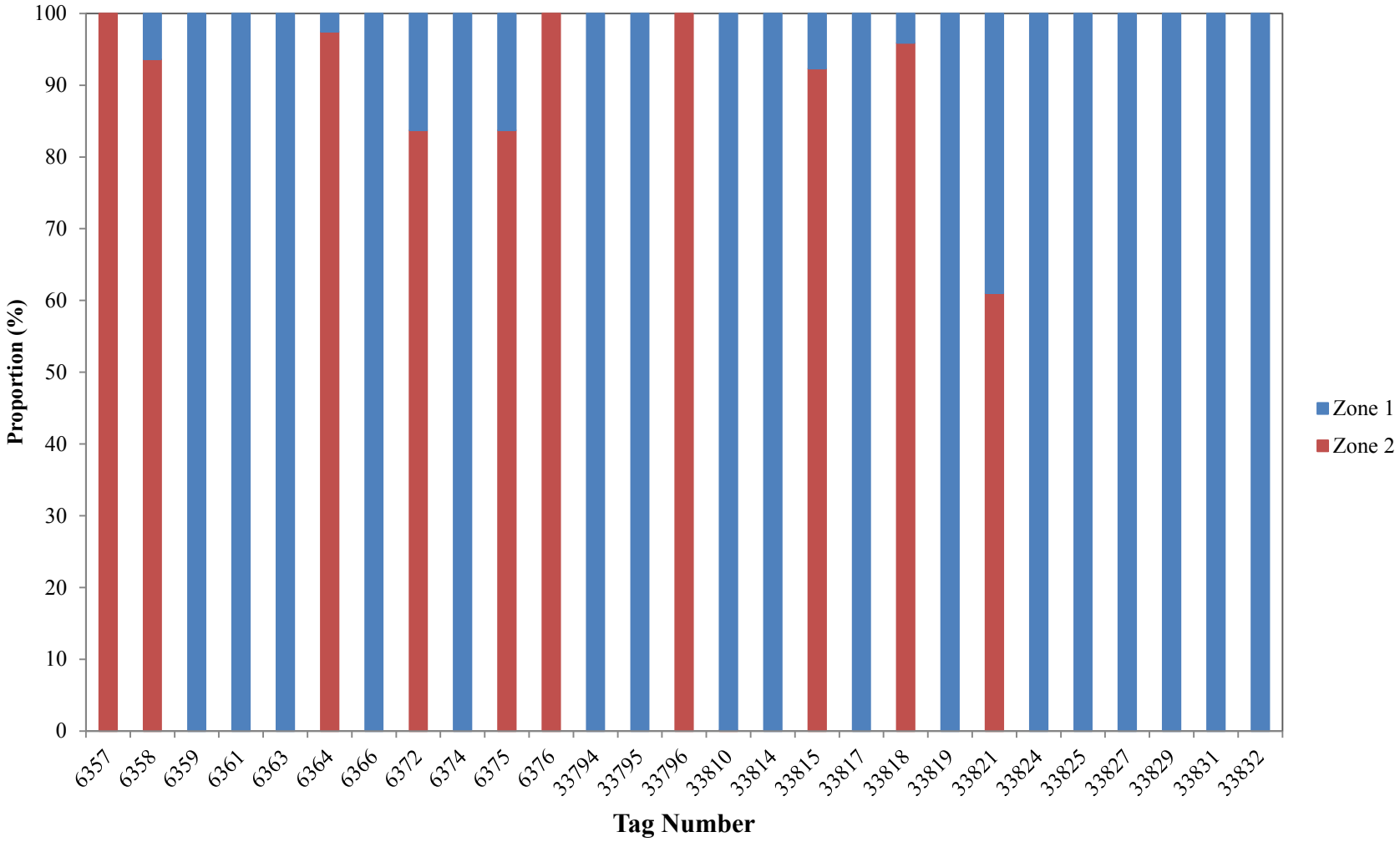


Figure 8: Proportion of time spent within two river zones between Gull Rapids and the Kettle GS by individual acoustic-tagged Lake Whitefish during the 2015 open-water period (04 June to 11 October).

MAPS

KEEYASK

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

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	09-FEB-15	02-JUN-16
0 6 12 Kilometres 0 5 10 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

Legend

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

Keeyask Study Area

Map 1: Map of the Nelson River showing the site of the Keeyask Generating Station.

DATA SOURCE:
Orthophoto: Manitoba Hydro - June 21, 2015

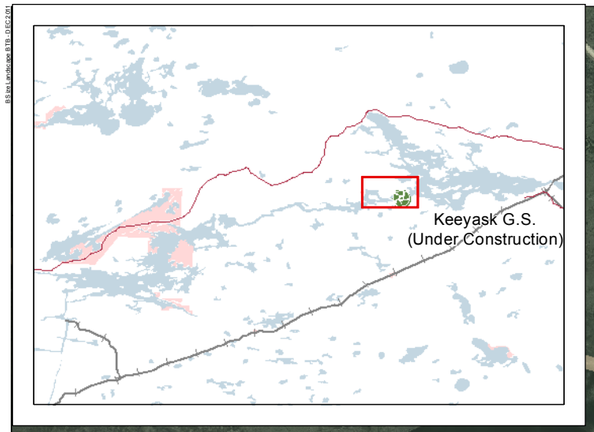
CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	26-FEB-10	30-MAY-16
0 0.15 0.3 Kilometres / 0 0.15 0.3 Miles	VERSION NO: 2.0	QA/QC: PMC/FSV/MWZ

KEEYASK

Construction Site

Map 2: Map of instream structures at the Keeyask Generating Station site, June 2015.



KEEYASK

DATA SOURCE:
Manitoba Hydro; Government of Manitoba; Government of Canada:
Imagery - 2010 Keeyask 10cm and 1999 Gull 1m (Black an White)

CREATED BY:
Manitoba Hydro - GIS Studies

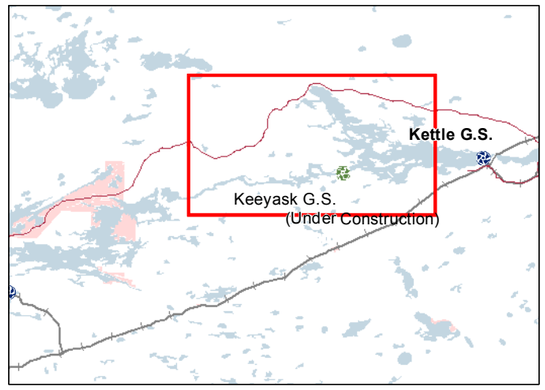
COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	22-MAY-15	06-JAN-16
0 0.4 0.8 Kilometres 0 0.3 0.6 Miles	VERSION NO: 1.0	QA/QC:

Legend

- Ice Boom
- Infrastructure

Keeyask G.S.
Ice Boom Locations

Map 3: Locations where ice booms were installed, July to August 2015.



N

Sky Pilot Lake

Ferris Bay

Wilson Channel

Moswakot River

South

280

North Access Road

Looking Back Creek

STEPHENS LAKE

Callan Island

Randy's Island

n = 40

Keeyask G.S.
(Under Construction)

n = 40

Caribou Island

Gull Rapids

GULL LAKE

South Access Road

Gillrat Lake

n = 15

RIVER

n = 20

n = 5

Birthday Rapids

NELSON

Carscadden Lake

Joslin 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:
06-JUN-16

0 0.45 0.9 Kilometres
0 0.35 0.7 Miles

VERSION NO:
1.0

QA/QC:
CMP/YYY/ZZZ

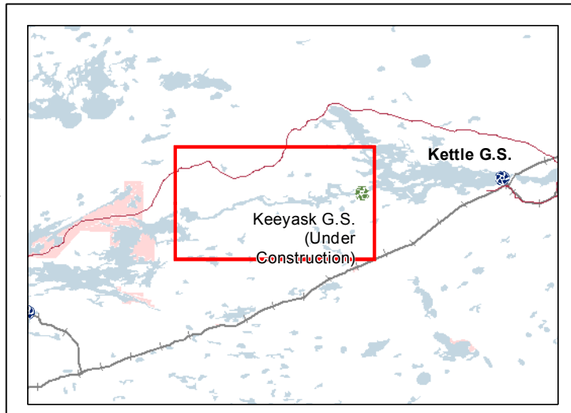
Legend

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

2014 Lake Whitefish Capture and Release Locations

Clark Lake to Kettle G.S.

Map 4: Release sites for Lake Whitefish marked with acoustic transmitters in the Keeyask study area during fall 2014.



Ross Wright Bay

North Access Road

Looking Back Creek

280

Effie Creek

Pond 13

Hidden Creek

Two Goose Creek

Trickle Creek

Caribou Island

Morris Point

Keeyask G.S.
(Under Construction)

Gull Rapids

South Access Road

NELSON RIVER

122777

114245

114228

Fork Creek

125105

Clark Lake

Long Rapids

Birthday Rapids

Nap Creek

Portage Creek

Rabbit Creek

Seebeesis Creek

Carscadden Lake

SPLIT LAKE

N

KEEYASK

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:
03-JUN-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

- Lost
- Retrieved
- Generating Station (Existing)
- Generating Station (Under Construction)

Highway

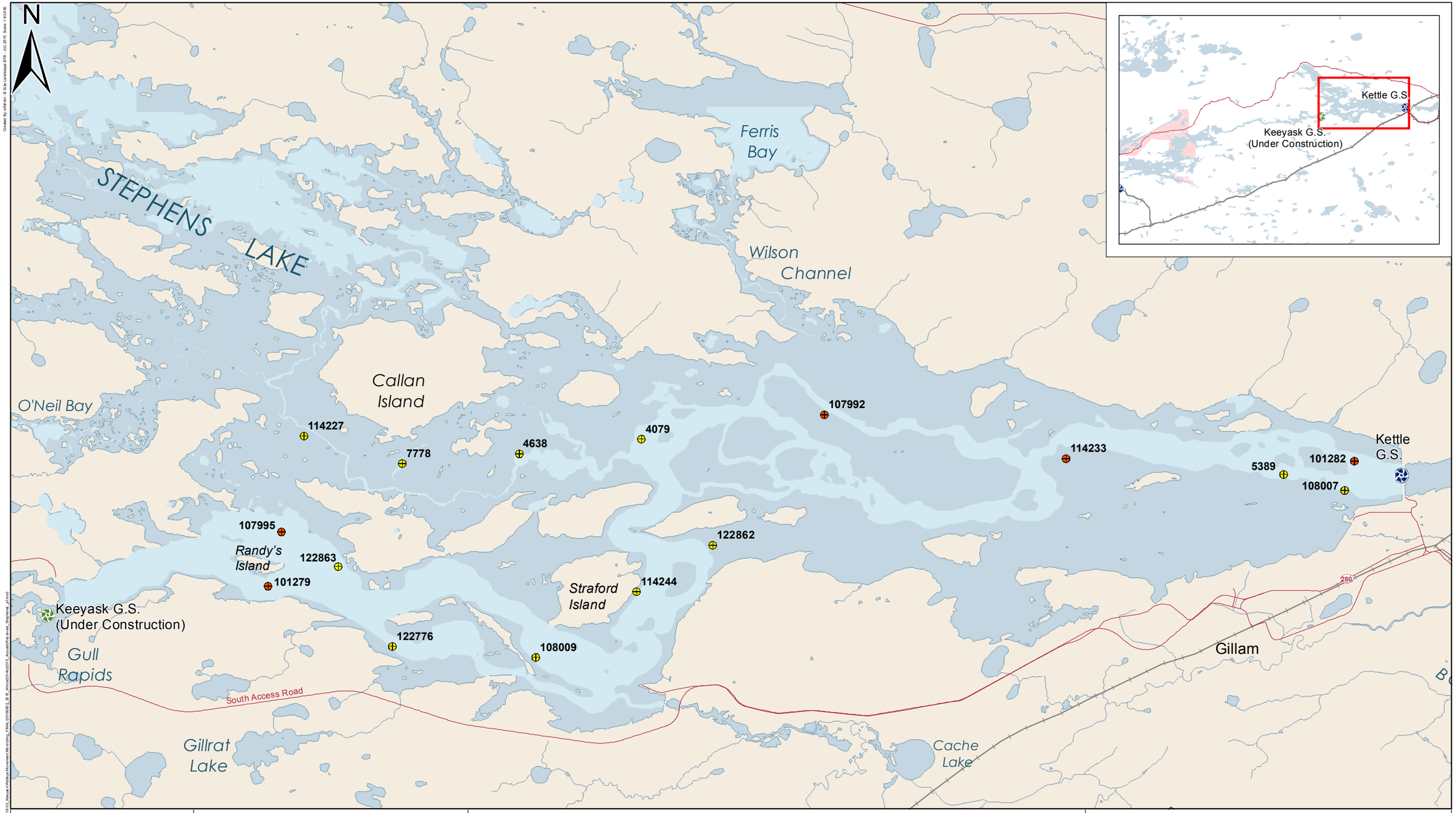
Rail

First Nation Reserve

Winter 2014/2015 Acoustic Receiver Locations

Clark Lake to Gull Rapids

Map 5: Locations of four stationary receivers set in the Nelson River, from Clark Lake to Gull Rapids, between October 2014 and June 2015.


N
STEPHENS LAKE
Ferris Bay
Wilson Channel
Callan Island
O'Neil Bay
114227
7778
4638
4079
107992
114233
101282
5389
108007
Kettle G.S.
107995
Randy's Island
122863
101279
122862
Straford Island
114244
Keeyask G.S.
(Under Construction)
122776
108009
Gull Rapids
South Access Road
Gillrat Lake
Cache Lake
Gillam
280
Kettle G.S.
Keeyask G.S.
(Under Construction)

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

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z14N	09-FEB-15	09-JUN-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

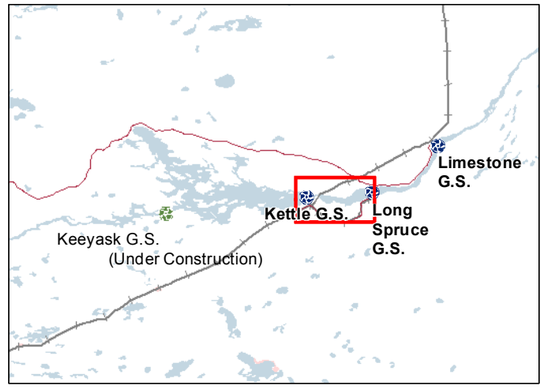
Legend

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

Highway
Rail
First Nation Reserve

Winter 2014/2015 Acoustic Receiver Locations
Stephens Lake

Map 6: Locations of 15 stationary receivers set in Stephens Lake, from Gull Rapids to the Kettle GS, between October 2014 and June 2015. The former (pre-impoundment) river channel is shown in light blue.



N

STEPHENS LAKE

Long Spruce Forebay

108000

Kettle River

Wilson Creek

Legend

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

KEEYASK

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: 03-JUN-16

0 0.45 0.9 Kilometres

0 0.35 0.7 Miles

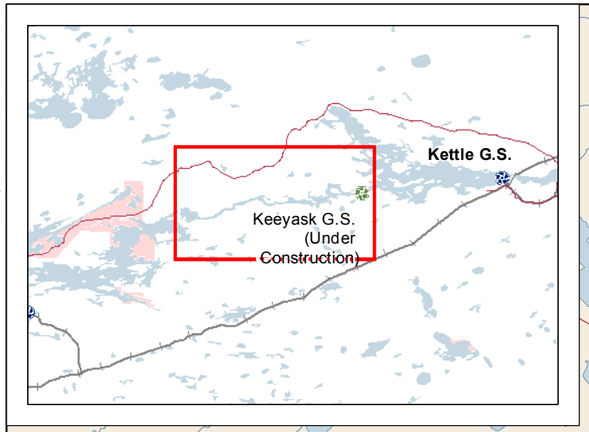
VERSION NO: 1.0

QA/QC: CMP/YYY/ZZZ

Winter 2014/2015 Acoustic Receiver Locations

Long Spruce G.S. Reservoir

Map 7: Location of one stationary recevier set in the Long Spruce Forebay between October 2014 and June 2015.



Ross Wright Bay

North Access Road

Looking Back Creek

280

Effie Creek

125552

114237

Pond 13

Hidden Creek

107993

Caribou Island

Morris Point

7779

5

Keeyask G.S.
(Under Construction)

Gull Rapids

South Access Road

Two Goose Creek

Trickle Creek

5507

122780

125553

114228

4495

127089

108002

101278

127075

3

127071

127095

NELSON RIVER

125557

Fork Creek

125555

122781

125556

108010

114243

Portage Creek

4

2

Birthday Rapids

Nap Creek

Rabbit Creek

Seebeesis Creek

125105

Clark Lake

7021

107998

5505

1

Long Rapids

Carscadden Lake

SPLIT LAKE

Legend

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

KEEYASK

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

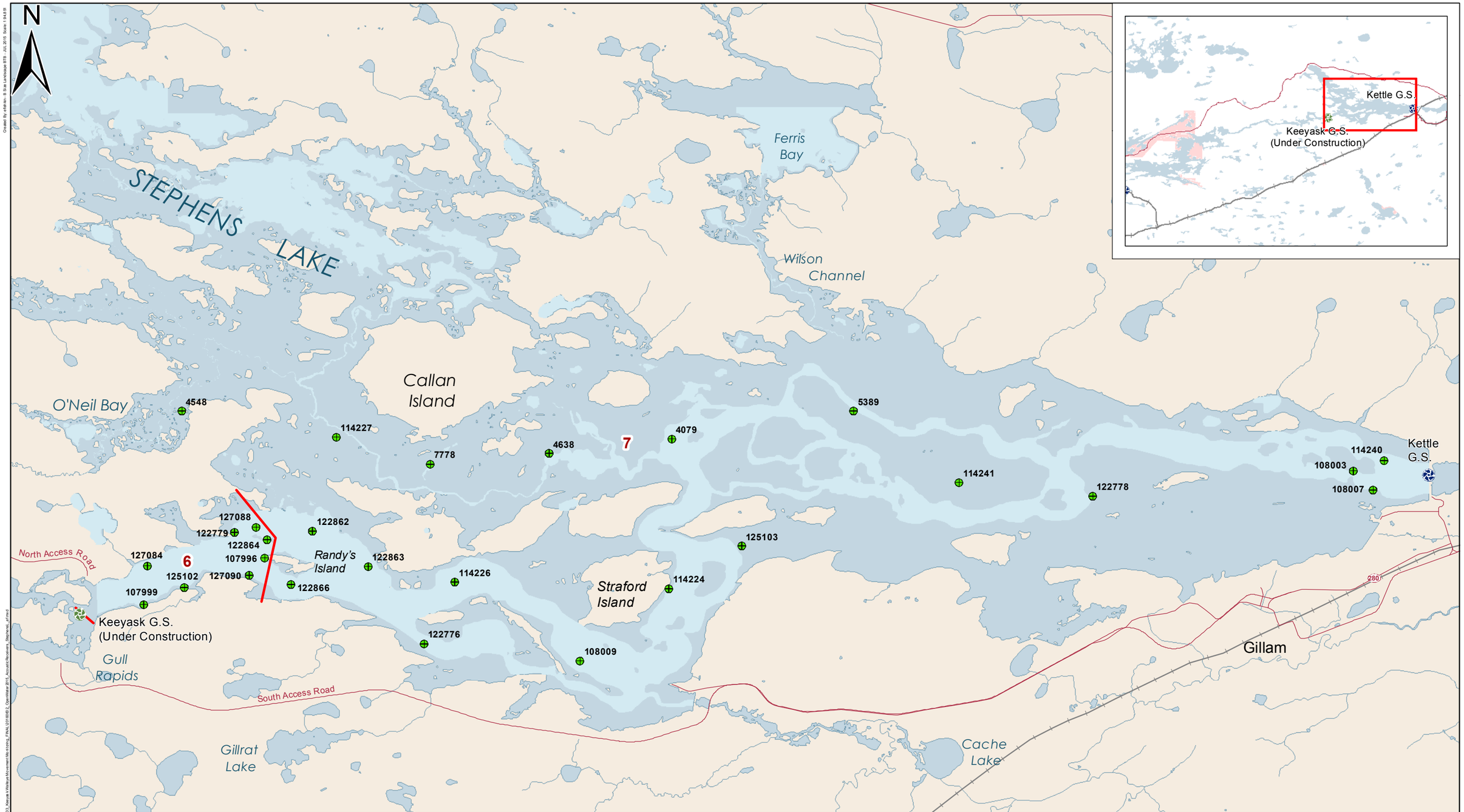
CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z14N	09-FEB-15	06-JUN-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

Open-water 2015 Acoustic Receiver Locations

Clark Lake to Gull Rapids

Map 8: Locations of 25 stationary receivers set in the Nelson River, from Clark Lake to Gull Rapids, between June and October 2015. The river is divided into five "zones" based on placement of receiver "gates".



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

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z14N	09-FEB-15	09-JUN-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

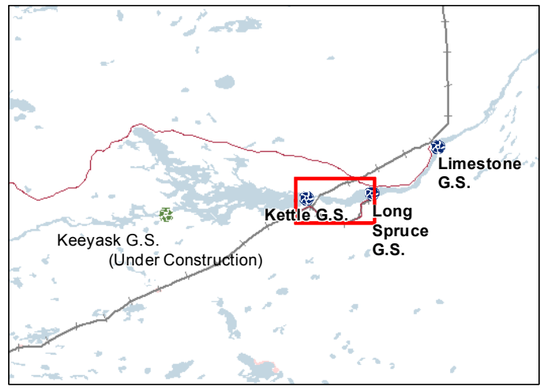
Legend

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

Open-water 2015 Acoustic Receiver Locations

Stephens Lake

Map 9: **Locations of 27 stationary receivers set in Stephens Lake, from Gull Rapids to the Kettle GS, between June and October 2015. The river is divided into two "zones" based on placement of receiver "gates". The pre-impoundment river channel is shown in light blue.**



N

STEPHENS LAKE

125101

122774

108000

Kettle River

Long Spruce Forebay

125104

Wilson Creek

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

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z14N	09-FEB-15	03-JUN-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 2015 Acoustic Receiver Locations

Long Spruce G.S. Reservoir

Map 10: Locations of four stationary receivers set in the Long Spruce Forebay between June and October 2015.

APPENDICES

APPENDIX 1:
DETECTION SUMMARIES FOR LAKE WHITEFISH TAGGED AND MONITORED IN THE KEEYASK STUDY AREA BETWEEN SEPTEMBER 2014 AND OCTOBER 2015

Table A1-1: Detection summary for Lake Whitefish tagged upstream of Gull Rapids from October 2014 to October 2015. Movements of fish not detected since being tagged are highlighted in yellow and those not detected in open-water of 2015 are highlighted in red.

Tag ID	Fall 2014					Winter 2014-2015					Open-water 2015				
	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)
33793	0	-	-	-	-	0	-	-	-	-	4121	45	-33.8	-12.9	20.9
33797	0	-	-	-	-	0					0	-	-	-	-
33798	476	2	-32.3	-32.3	0	37	1	-12.9	-12.9	0	8810	67	-34.3	-9.5	24.8
33800	581	2	-32.3	-32.3	0	0	-	-	-		0	-	-	-	-
33801	96	2	-32.3	-32.3	0	0	-	-	-	-	72	4	-19.5	-17.4	2.1
33802	222	2	-32.3	-32.3	0	137	2	-12.9	-12.9	0	0	-	-	-	-
33803	255	2	-32.3	-29.4	2.9	0	-	-	-	-	1462	43	-33.8	-17.4	16.4
33804	329	2	-32.3	-32.3	0	0	-	-	-	-	3832	60	-29.4	-11.8	17.6
33805	60	2	-32.3	-32.3	0	902	14	-12.9	-12.9	0	522	12	-11.8	2.9	14.7
33806	14	1	-32.3	-26.5	5.8	208	7	-12.9	-12.9	0	2839	43	-33.8	-7.4	26.4
33807	0	-	-	-	-	0	-	-	-	-	48	4	-33.8	-26.5	7.3
33808	0	-	-	-	-	0	-	-	-	-	149	14	-19.5	-17.4	2.1
33809	0	-	-	-	-	0	-	-	-	-	2274	30	-33.8	-7.4	26.4
33812	288	3	-32.3	-32.3	0	0	-	-	-	-	184	9	-34.3	-19.4	14.9
33813	0	-	-	-	-	0	-	-	-	-	4248	50	-26.5	-5.8	20.7
33816	26	2	-32.3	-32.3	0	8	1	-12.9	-12.9	0	3743	72	-48.2	-9.3	38.9
33820	409	2	-32.3	-32.3	0	0	-	-	-	-	487	8	-26.5	-26.5	0
33822	1427	2	-32.3	-32.3	0	43	2	-12.9	-12.9	0	4656	68	-19.5	-11.8	7.7
33826	1268	2	-32.3	-32.3	0	0	-	-	-	-	276	14	-33.8	-9.0	24.8
33830	692	2	-32.3	-32.3	0	0	-	-	-	-	573	22	-26.5	-26.5	0

Note: U/S = upstream, D/S = downstream.

Table A1-2: Detection summary for Lake Whitefish tagged downstream of Gull Rapids from September 2014 to October 2015. Movements of fish not detected since being tagged are highlighted in yellow and those not detected in open-water of 2015 are highlighted in red.

Tag ID	Fall 2014					Winter 2014-2015					Open-water 2015				
	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)
6357	263	6	2.9	4.9	2.0	21618	139	7.9	16.8	8.9	11658	30	7.9	19.0	11.1
6358	0	-	-	-	-	56	3	10.2	10.2	0.0	297	5	2.2	16.8	14.6
6359	3	1	2.9	2.9	0	0	-	-	-	-	1278	17	2.2	6.2	4.0
6360	164	7	1.3	5.8	4.5	132	2	7.7	16.8	9.1	0	-	-	-	-
6361	0	-	-	-	-	0	-	-	-	-	606	8	1.3	4.9	3.6
6362	41	1	2.9	4.9	2.0	0	-	-	-	-	0	-	-	-	-
6363	200	3	2.9	5.8	2.9	153	10	7.7	7.9	0.2	685	16	3.6	3.6	0.0
6364	199	7	2.9	5.8	2.9	994	22	7.7	14.9	7.2	5070	13	1.3	7.9	6.6
6365	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
6366	0	-	-	-	-	37	1	7.9	16.8	8.9	0	-	-	-	-
6367	1	1	2.9	2.9	0	0	-	-	-	-	148	4	2.2	5.8	3.6
6368	390	6	2.9	5.8	2.9	0	-	-	-	-	0	-	-	-	-
6369	189	2	1.3	4.9	3.6	0	-	-	-	-	0	-	-	-	-
6370	217	3	2.9	5.8	2.9	3616	49	7.7	21.6	13.9	0	-	-	-	-
6371	161	3	2.9	5.8	2.9	0	-	-	-	-	0	-	-	-	-
6372	588	12	1.3	7.9	6.6	590	7	7.7	16.8	9.1	1210	15	1.3	10.5	9.2
6373	16	1	2.9	4.9	2.0	0	-	-	-	-	0	-	-	-	-
6374	22	3	2.9	7.9	5.0	0	-	-	-	-	165	9	2.2	7.9	5.7
6375	0	-	-	-	-	0	-	-	-	-	1034	10	1.3	7.9	6.6
6376	0	-	-	-	-	29858	153	7.9	13.4	5.5	1477	20	10.5	16.8	6.3

Table A1-2: Detection summary for Lake Whitefish tagged downstream of Gull Rapids from September 2014 to October 2015. Movements of fish not detected since being tagged are highlighted in yellow and those not detected in open-water of 2015 are highlighted in red (continued).

Tag ID	Fall 2014					Winter 2014-2015					Open-water 2015				
	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)	# of Detections	# of Detection Days	Farthest U/S (rkm)	Farthest D/S (rkm)	Movement Range (rkm)
33794	43	1	1.3	4.9	3.6	703	9	7.7	10.5	2.8	1804	17	1.3	4.9	3.6
33795	1696	6	1.3	7.9	6.6	501	4	7.9	7.9	0.0	498	6	1.3	4.4	3.1
33796	8299	11	2.9	7.9	5.0	8573	59	7.7	16.8	9.1	882	8	10.5	16.8	6.3
33799	183	6	2.9	4.9	2.0	0	-	-	-	-	0	-	-	-	-
33810	7	1	1.3	4.9	3.6	0	-	-	-	-	334	10	1.3	6.2	4.9
33811	1673	4	1.3	5.8	4.5	0	-	-	-	-	0	-	-	-	-
33814	46	1	7.9	10.5	2.6	0	-	-	-	-	85	5	1.3	6.2	4.9
33815	104	5	4.3	4.9	0.6	5238	33	7.7	13.4	5.7	4974	38	2.2	24.7	22.5
33817	0	-	-	-	-	0	-	-	-	-	98	4	2.2	2.9	0.7
33818	2916	9	2.9	5.8	2.9	9928	65	7.7	18.7	11.0	6568	67	2.2	28.3	26.1
33819	228	2	1.3	4.9	3.6	302	6	7.7	40.8	33.1	292	5	2.2	6.2	4.0
33821	28	1	1.3	4.9	3.6	23628	119	7.7	10.5	2.8	6240	39	1.3	16.8	15.5
33823	83	1	2.9	4.9	2.0	15	2	7.7	7.7	0.0	0	-	-	-	-
33824	0	-	-	-	-	0	-	-	-	-	701	10	2.2	4.9	2.7
33825	0	-	-	-	-	0	-	-	-	-	413	12	2.2	4.9	2.7
33827	0	-	-	-	-	0	-	-	-	-	285	7	2.2	4.7	2.5
33828	170	4	1.3	4.9	3.6	0	-	-	-	-	0	-	-	-	-
33829	0	-	-	-	-	0	-	-	-	-	52	2	2.2	4.9	2.7
33831	0	-	-	-	-	0	-	-	-	-	227	8	2.2	4.9	2.7
33832	0	-	-	-	-	0	-	-	-	-	632	4	2.2	4.9	2.7

Note: U/S = upstream, D/S = downstream.

APPENDIX 2:
LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC-TAGGED LAKE WHITEFISH IN THE NELSON RIVER UPSTREAM OF GULL RAPIDS, OCTOBER 2014 TO OCTOBER 2015

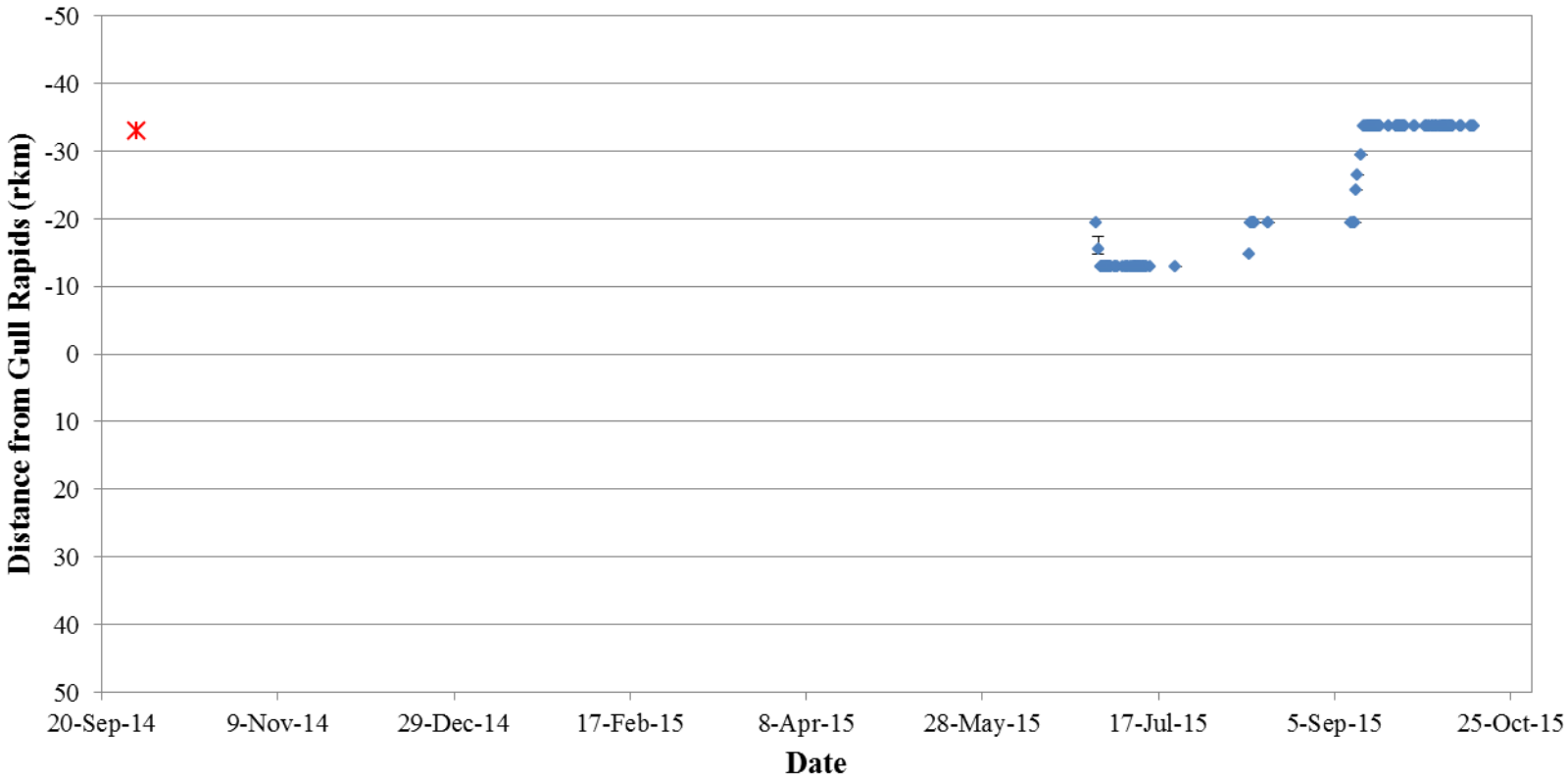


Figure A2-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33793) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

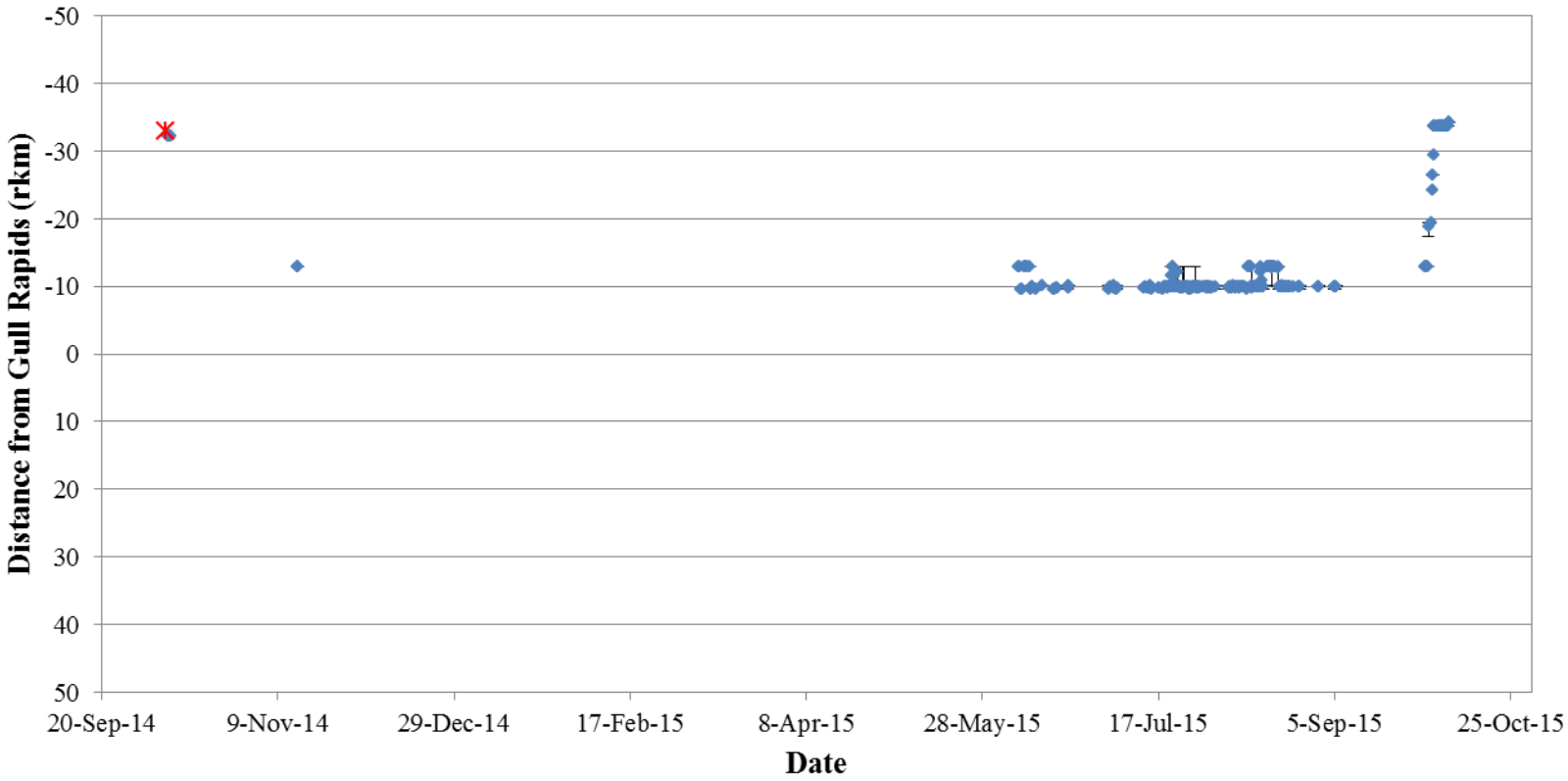


Figure A2-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33798) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

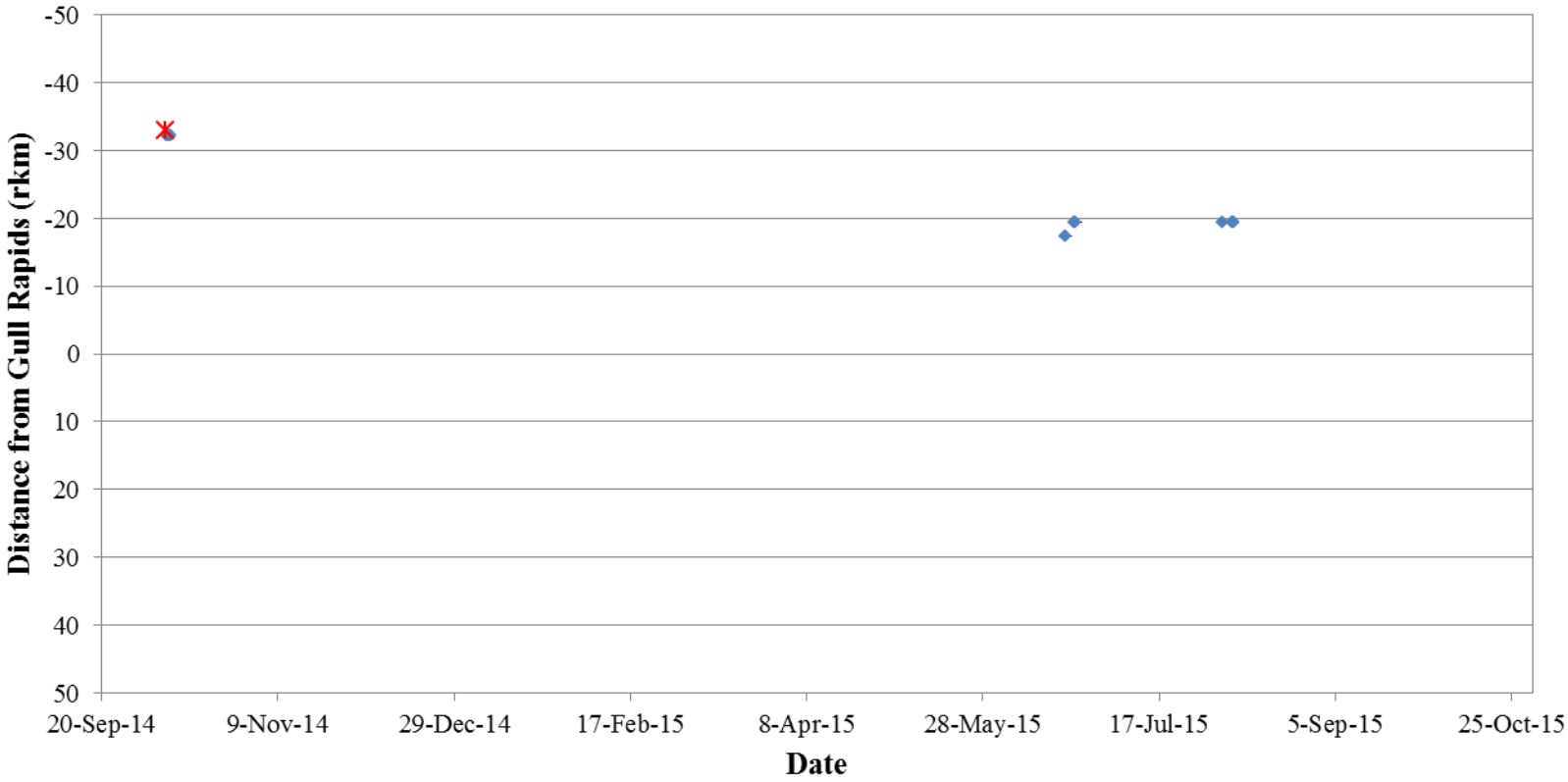


Figure A2-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33801) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

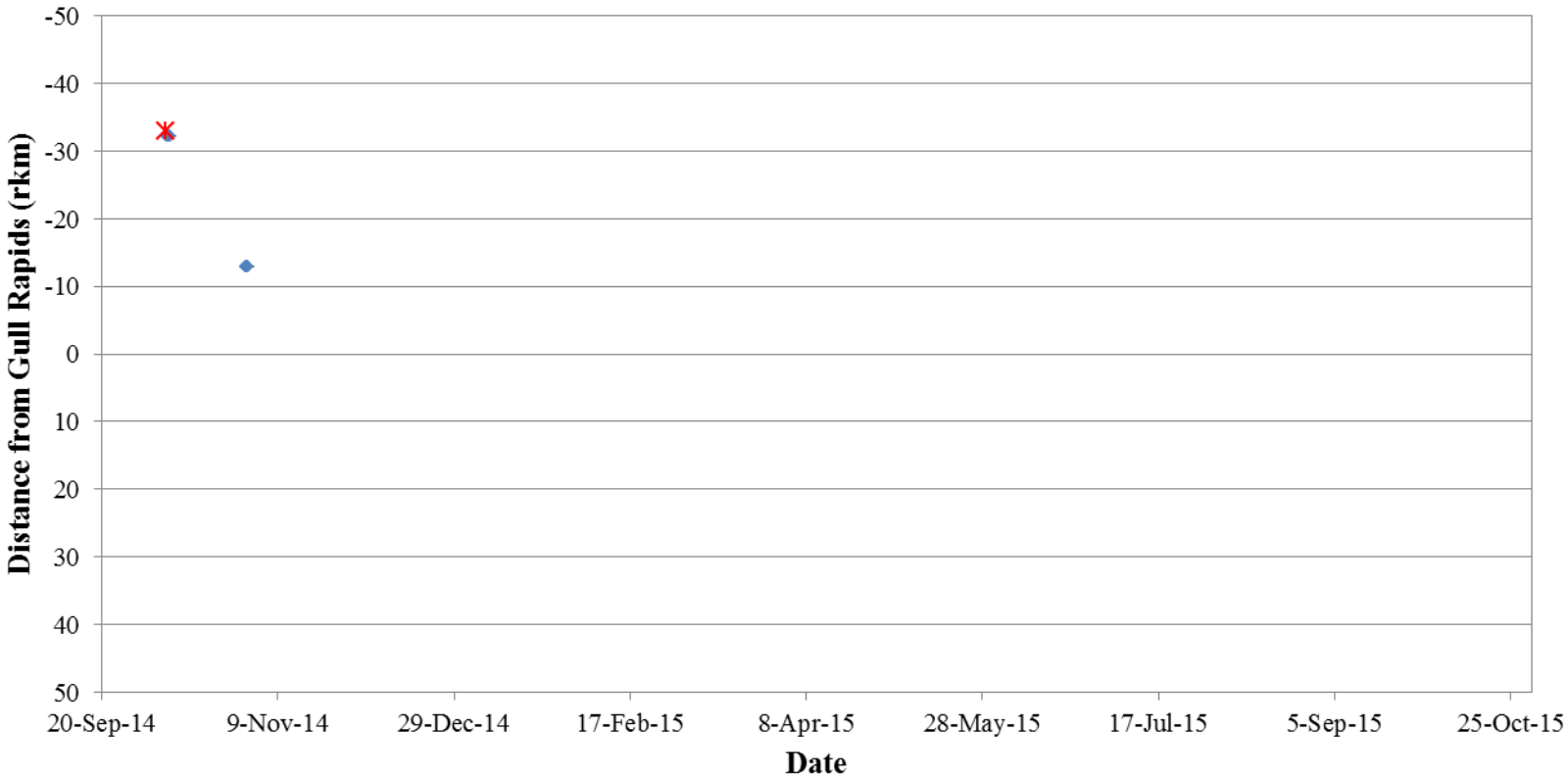


Figure A2-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33802) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

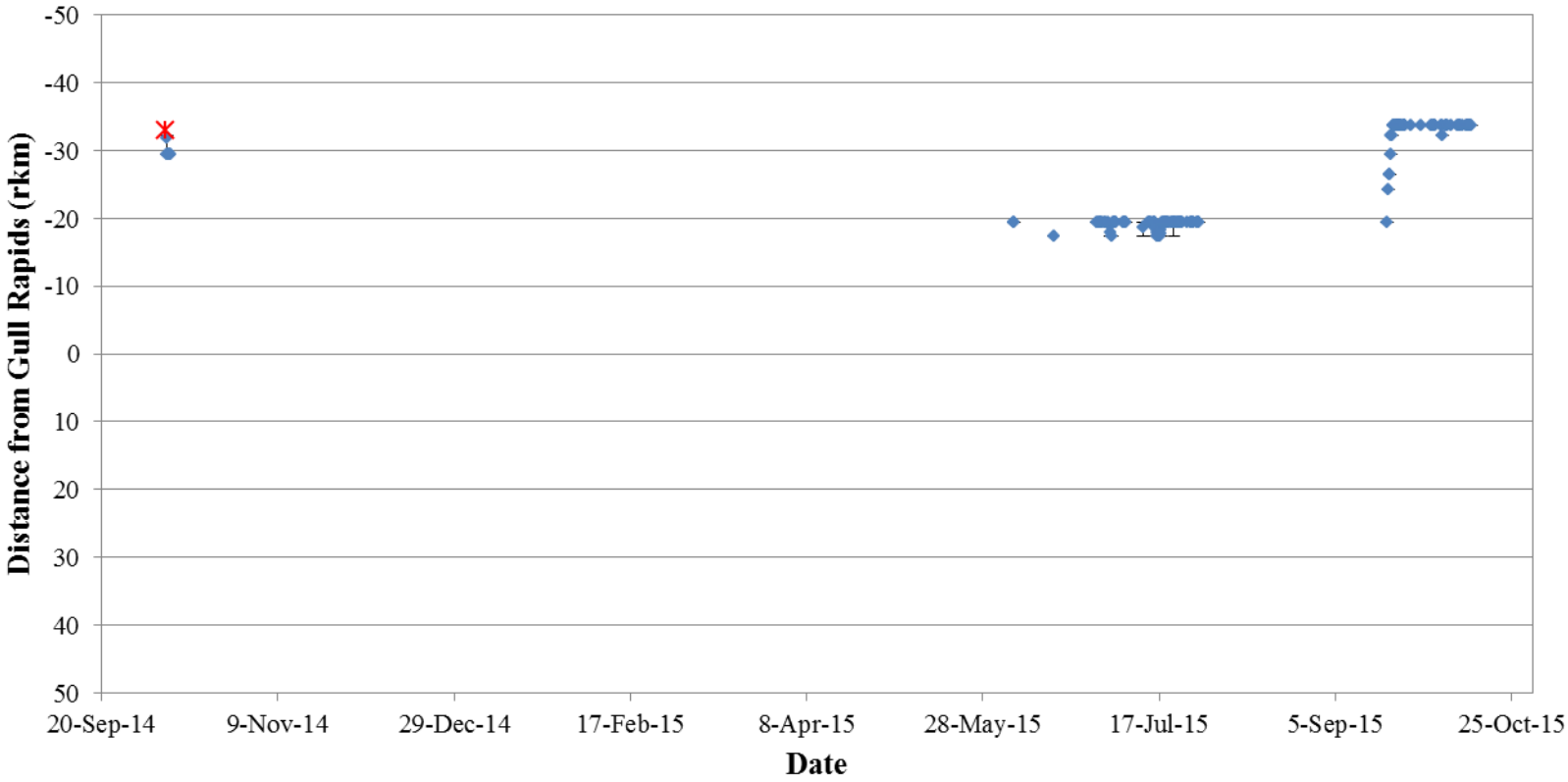


Figure A2-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33803) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

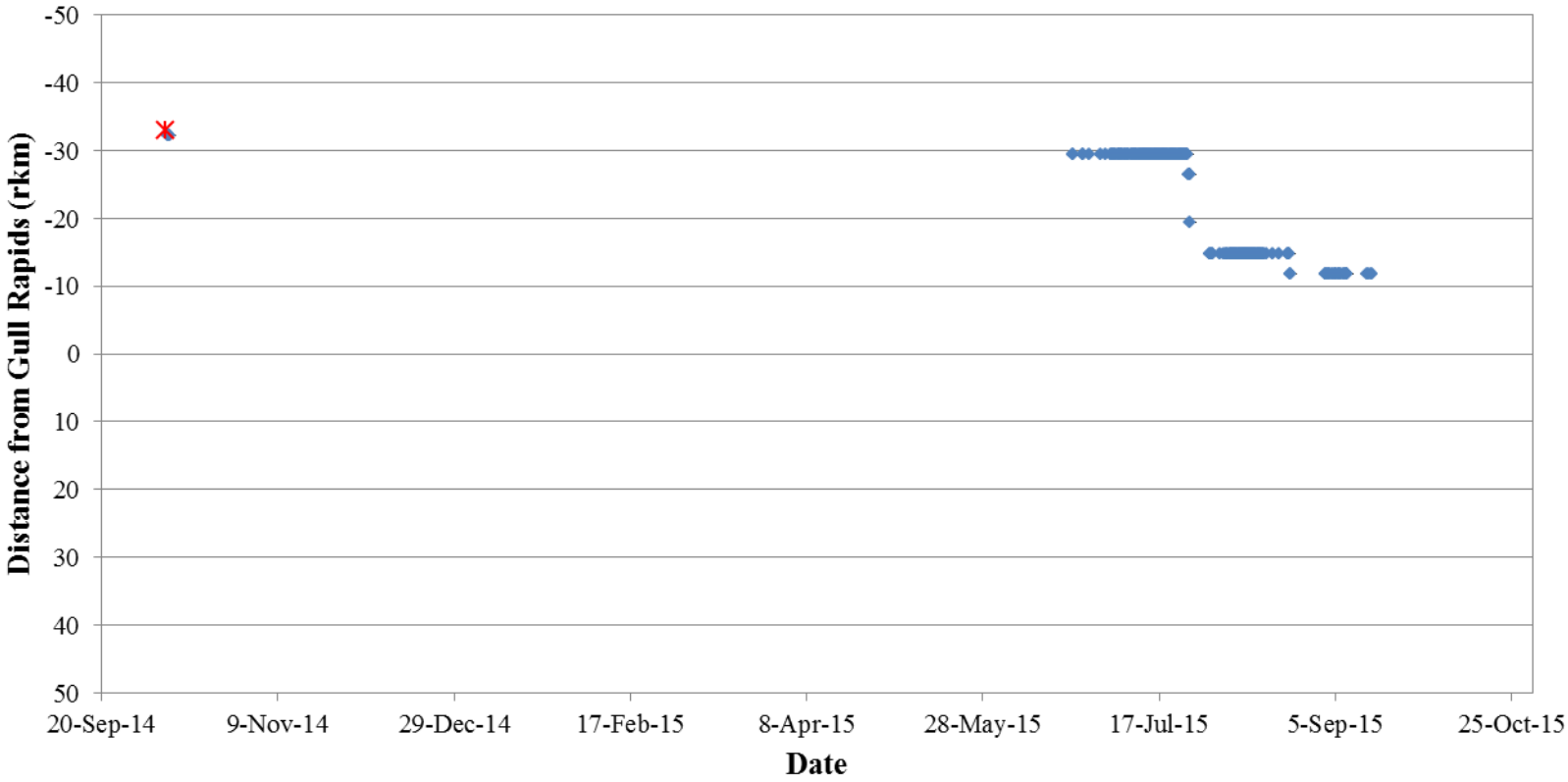


Figure A2-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33804) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

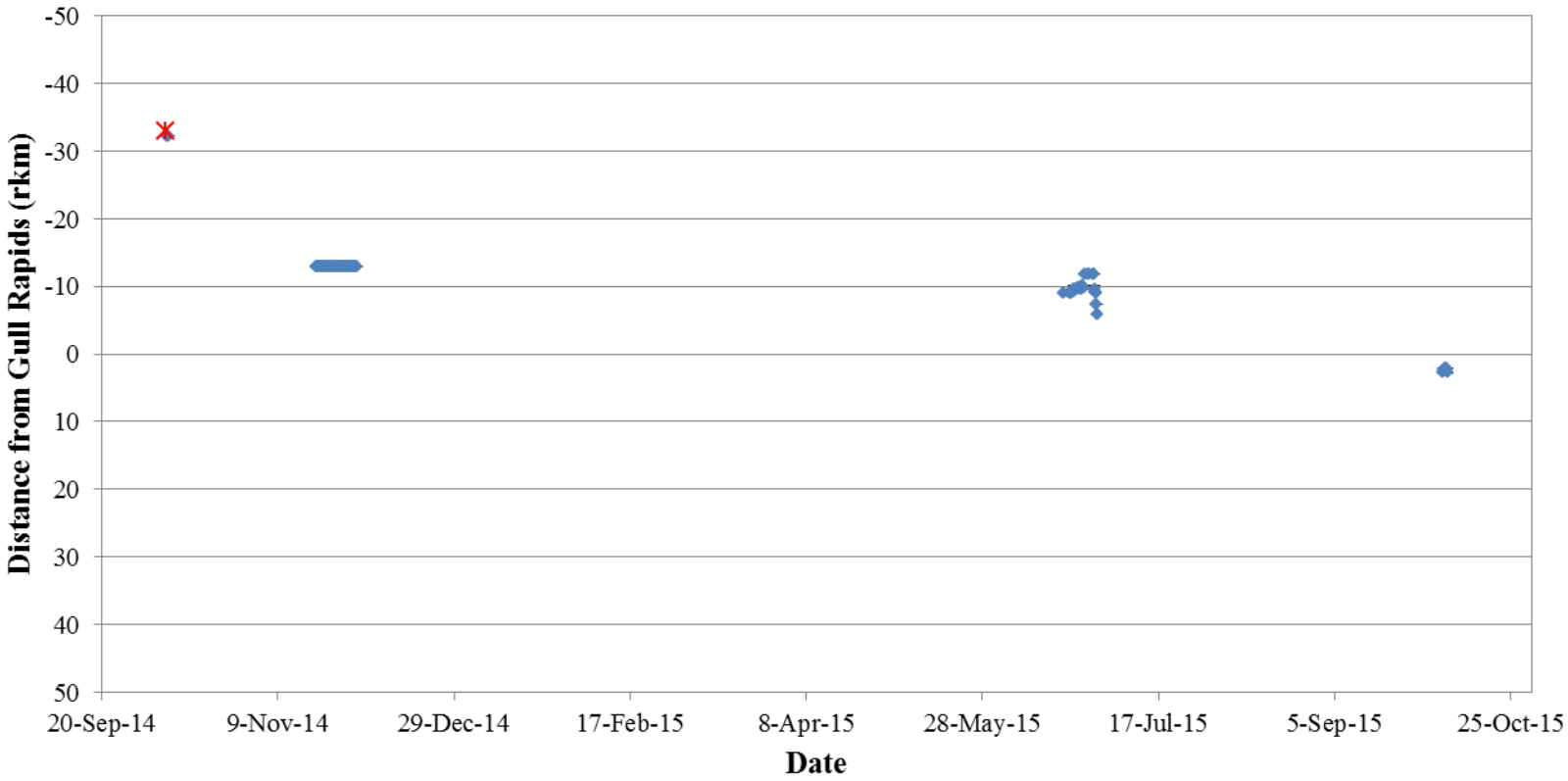


Figure A2-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33805) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

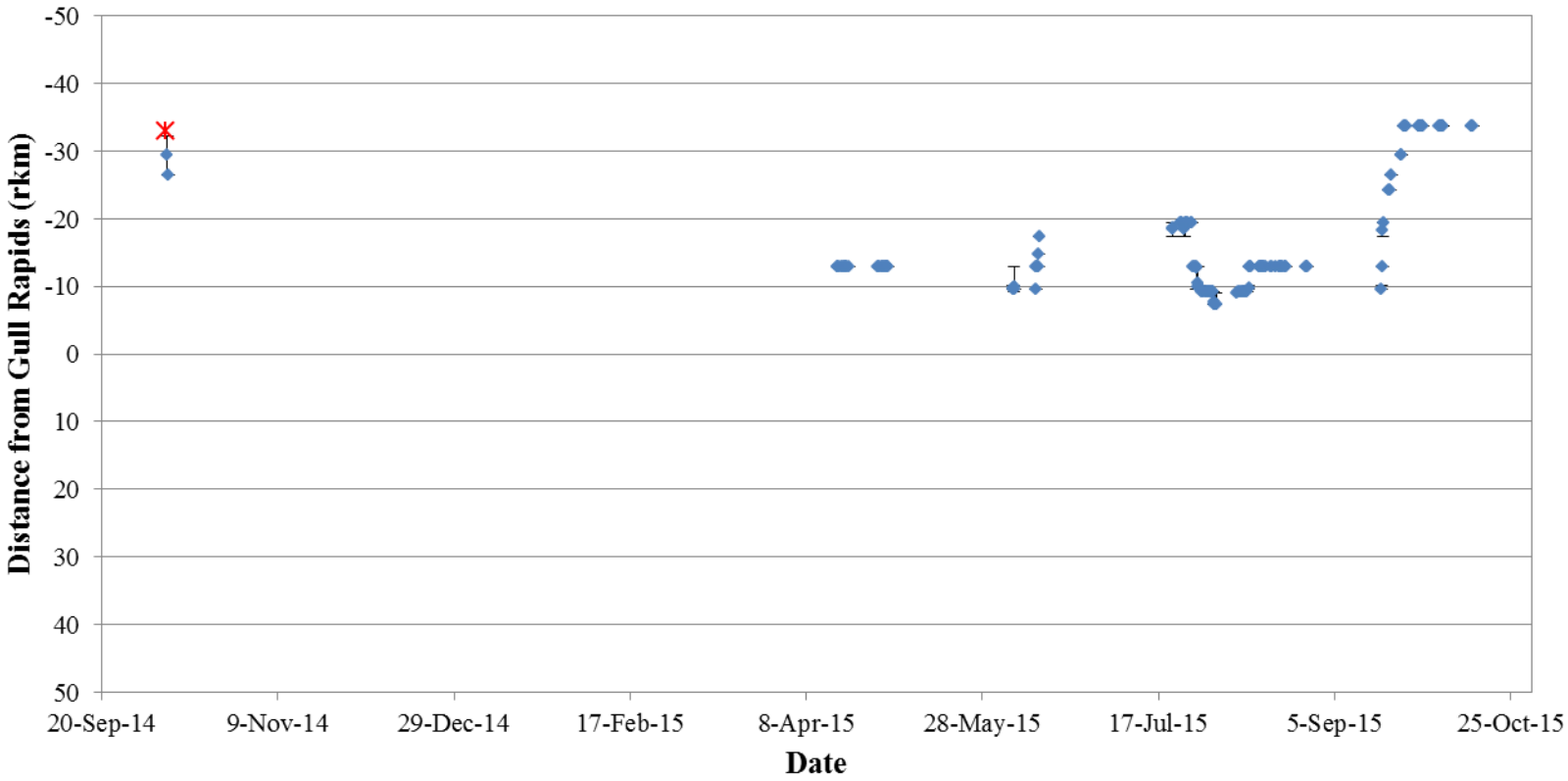


Figure A2-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33806) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

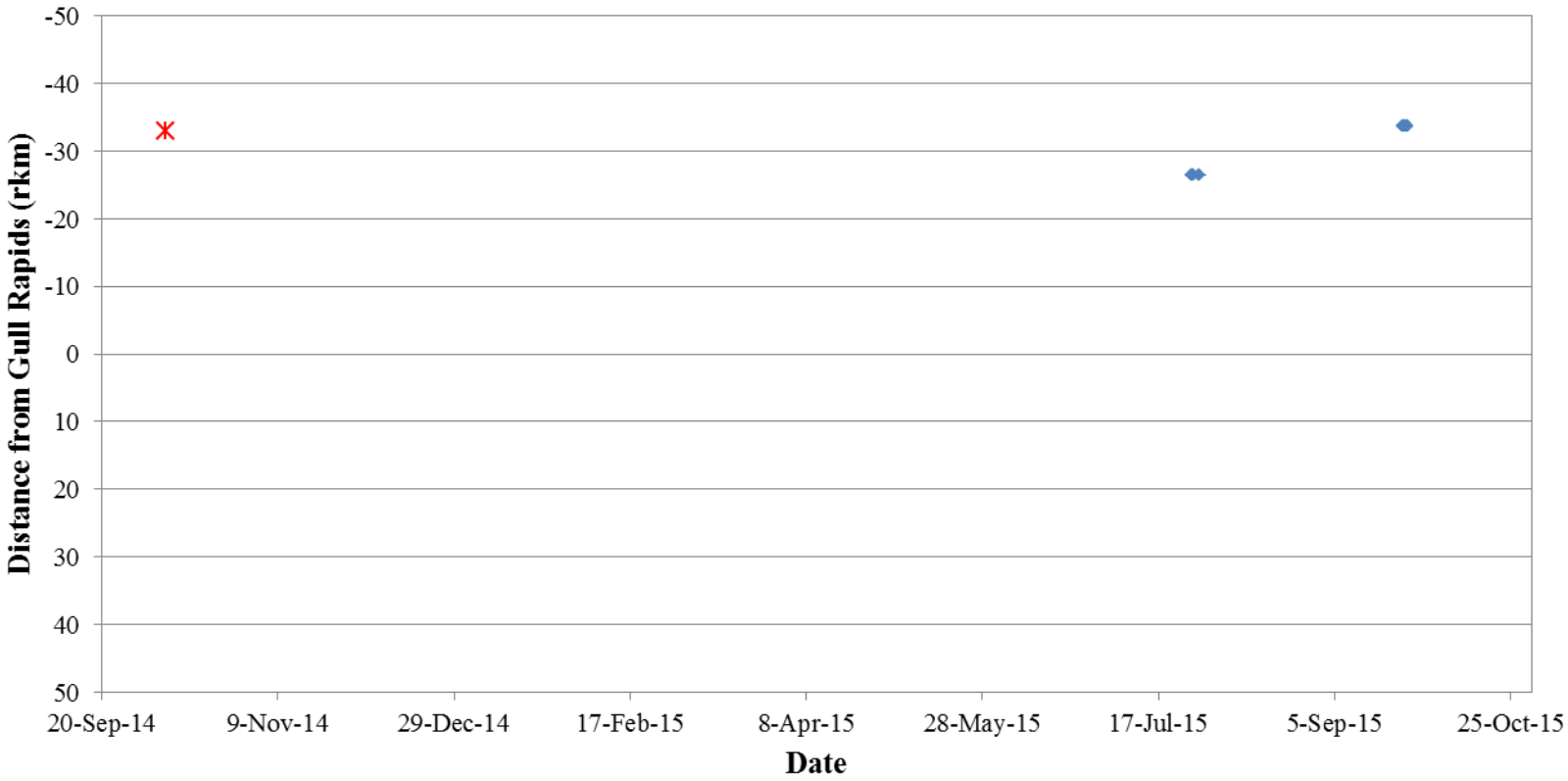


Figure A2-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33807) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

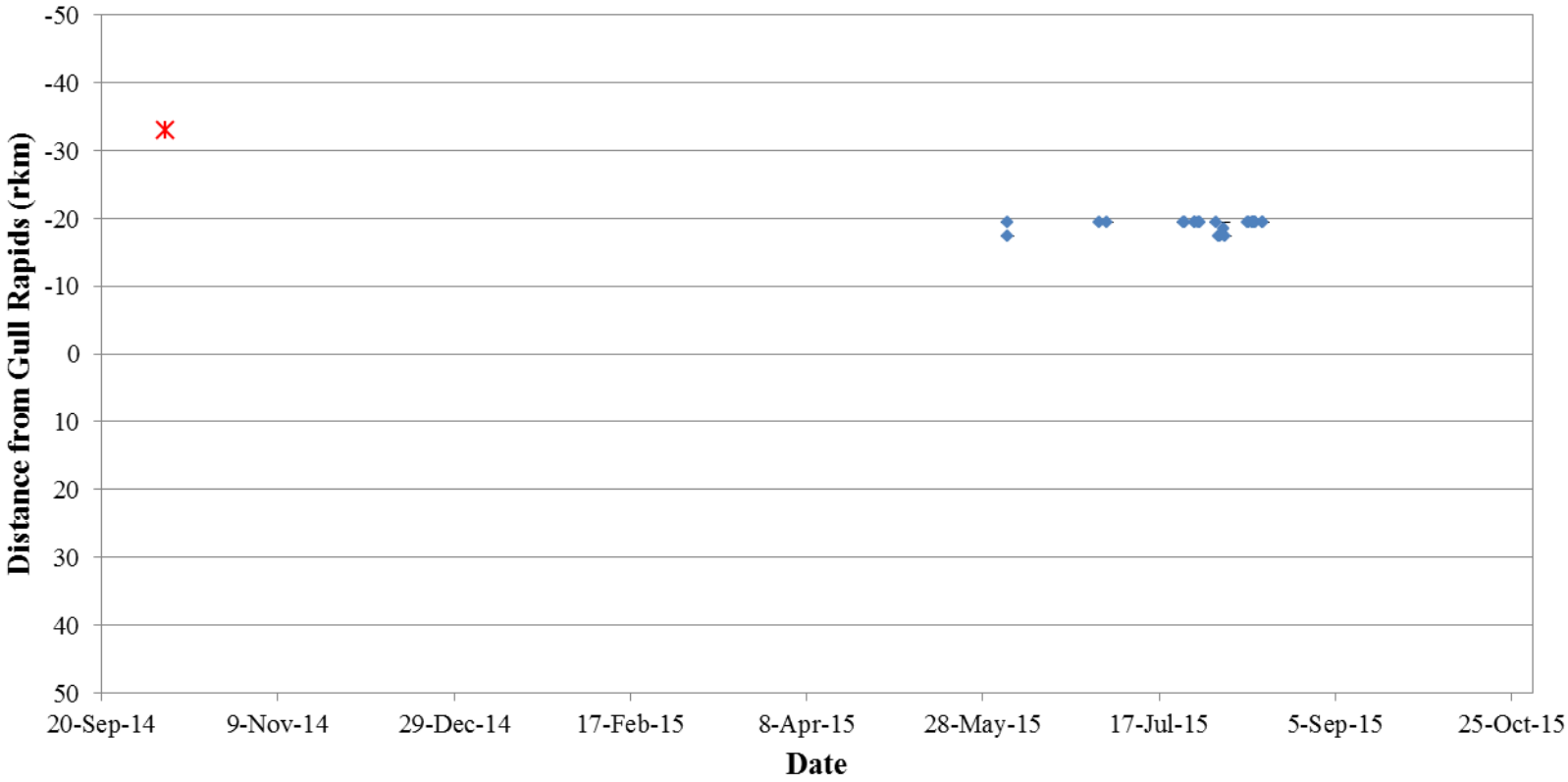


Figure A2-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33808) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

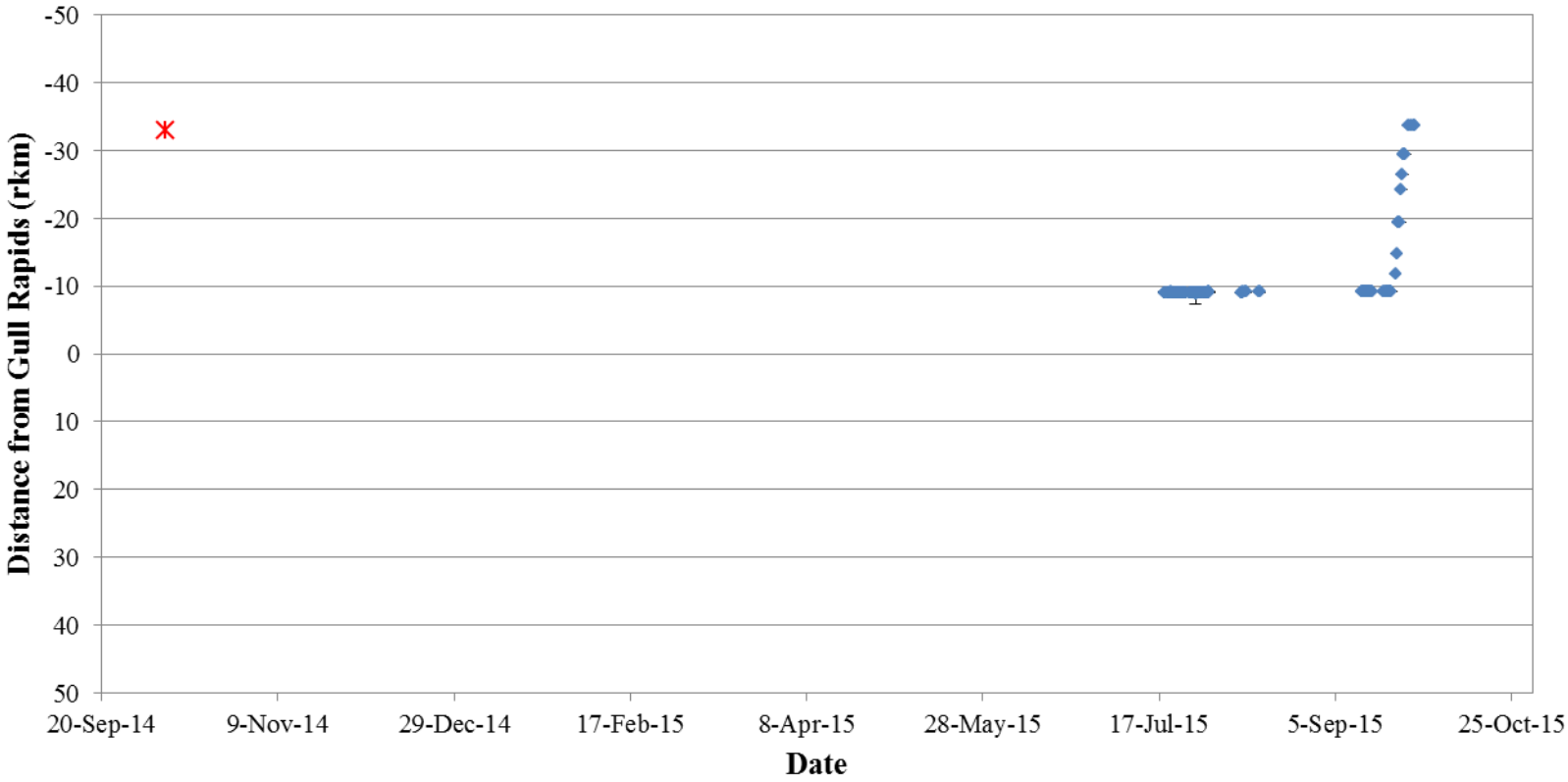


Figure A2-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33809) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

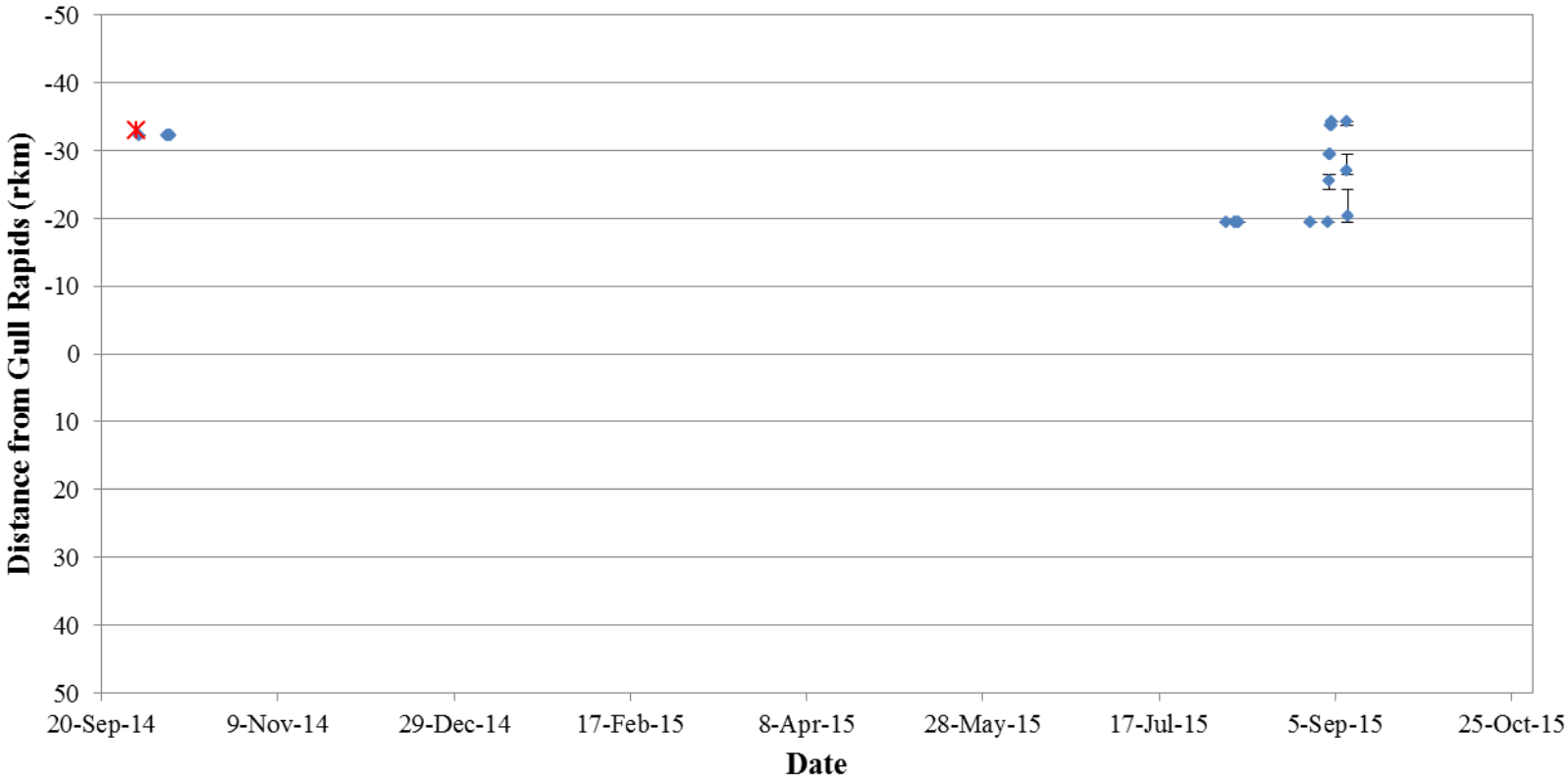


Figure A2-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33812) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

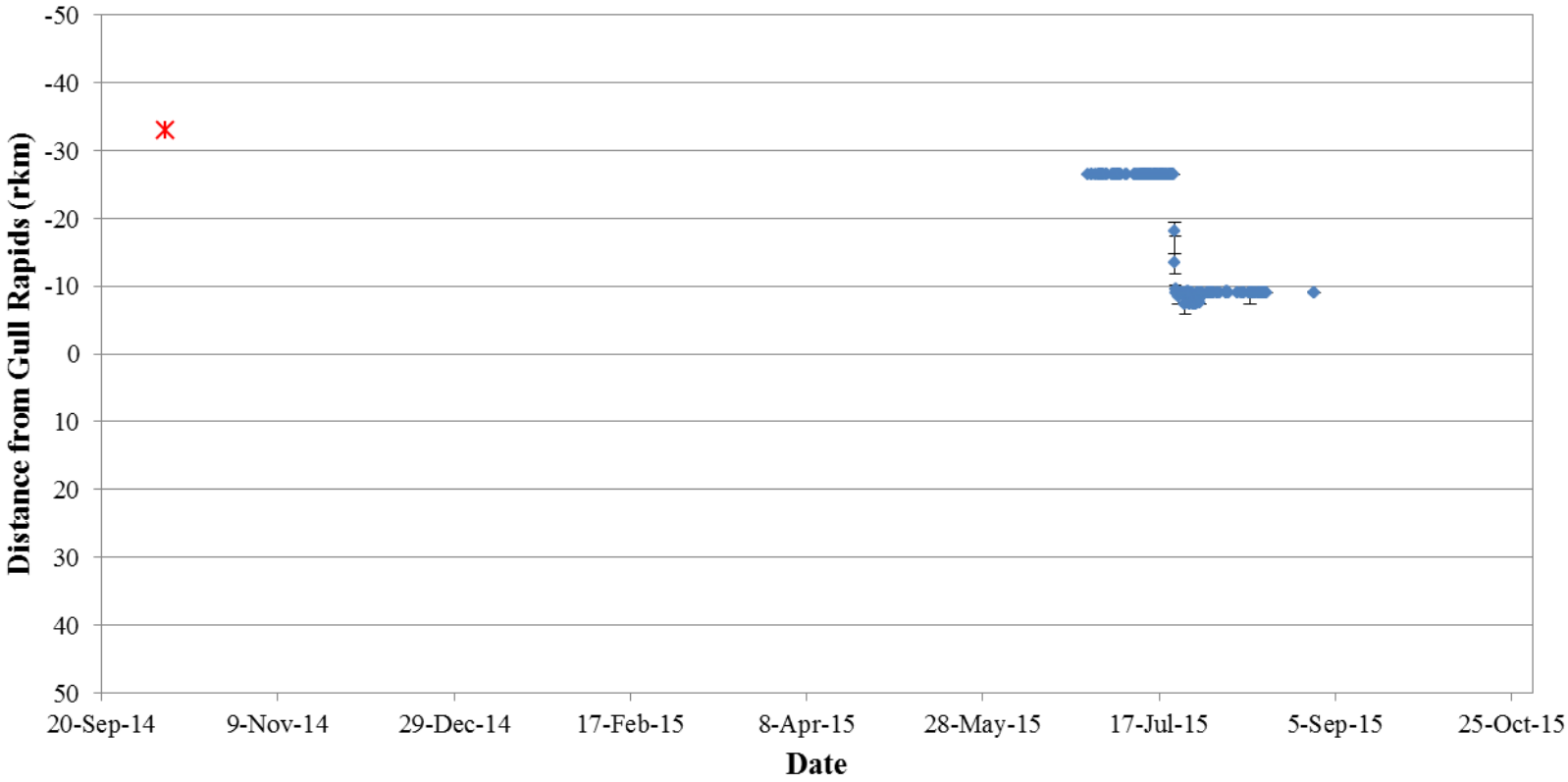


Figure A2-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33813) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

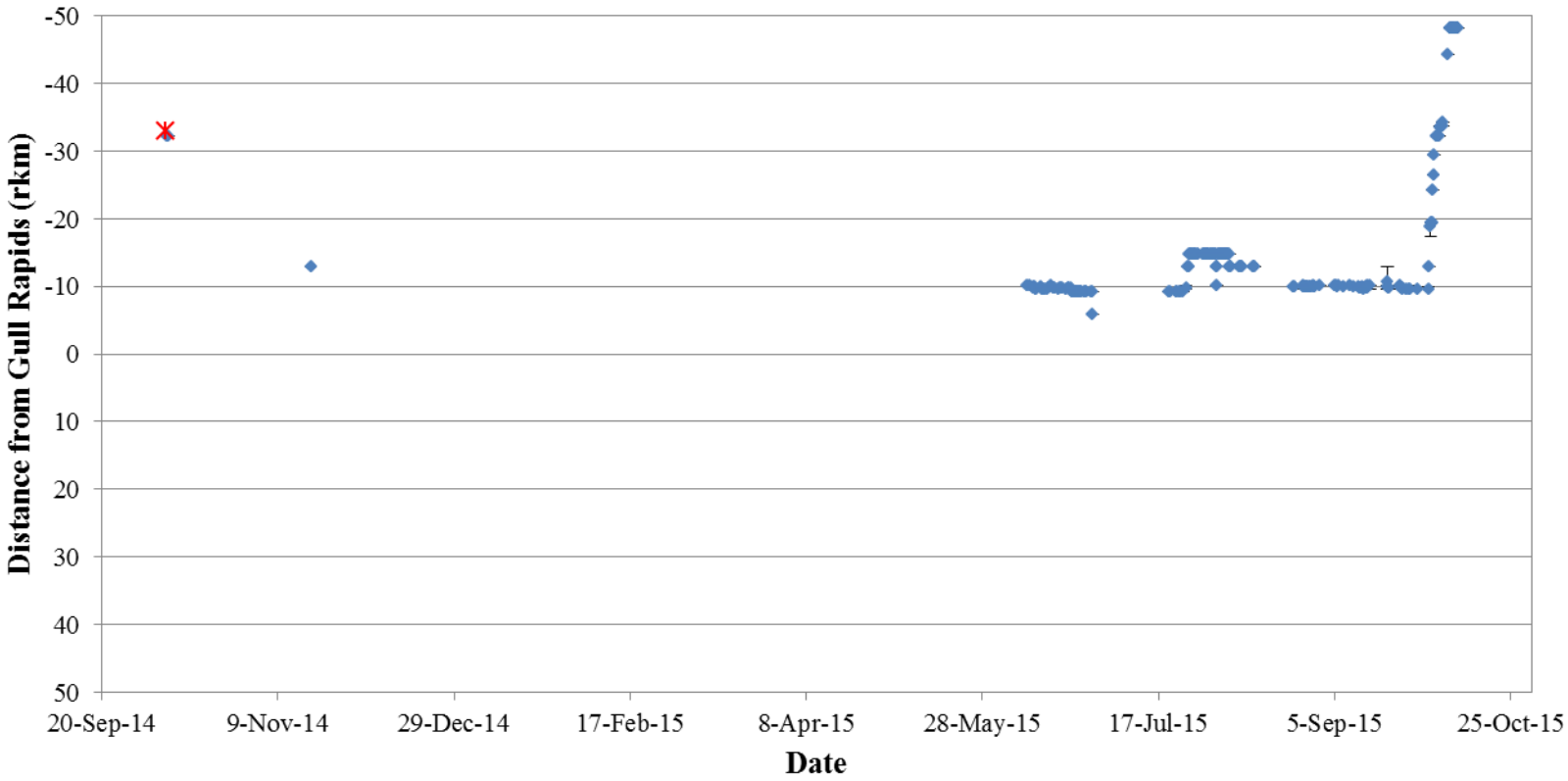


Figure A2-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33816) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

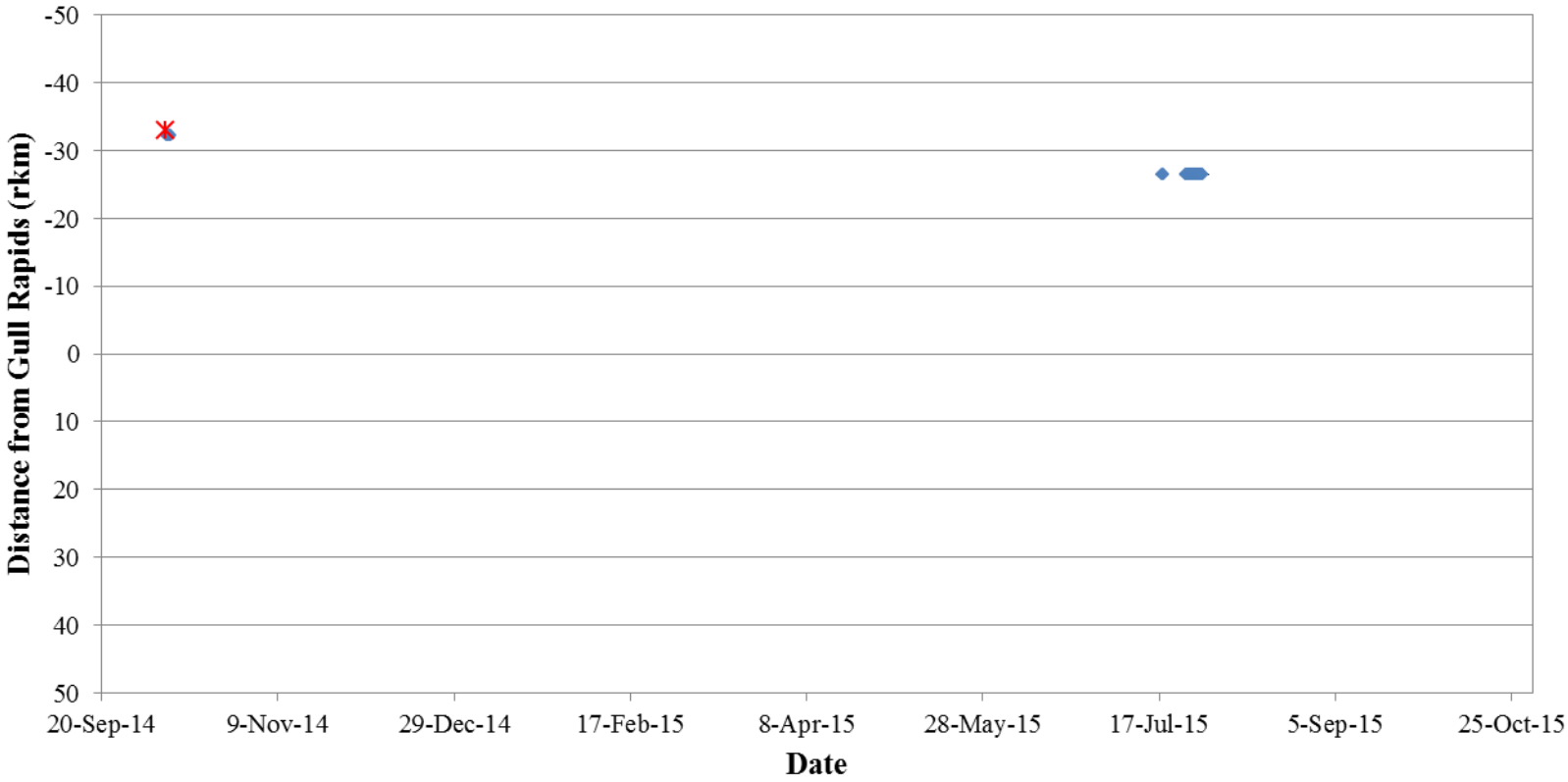


Figure A2-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33820) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

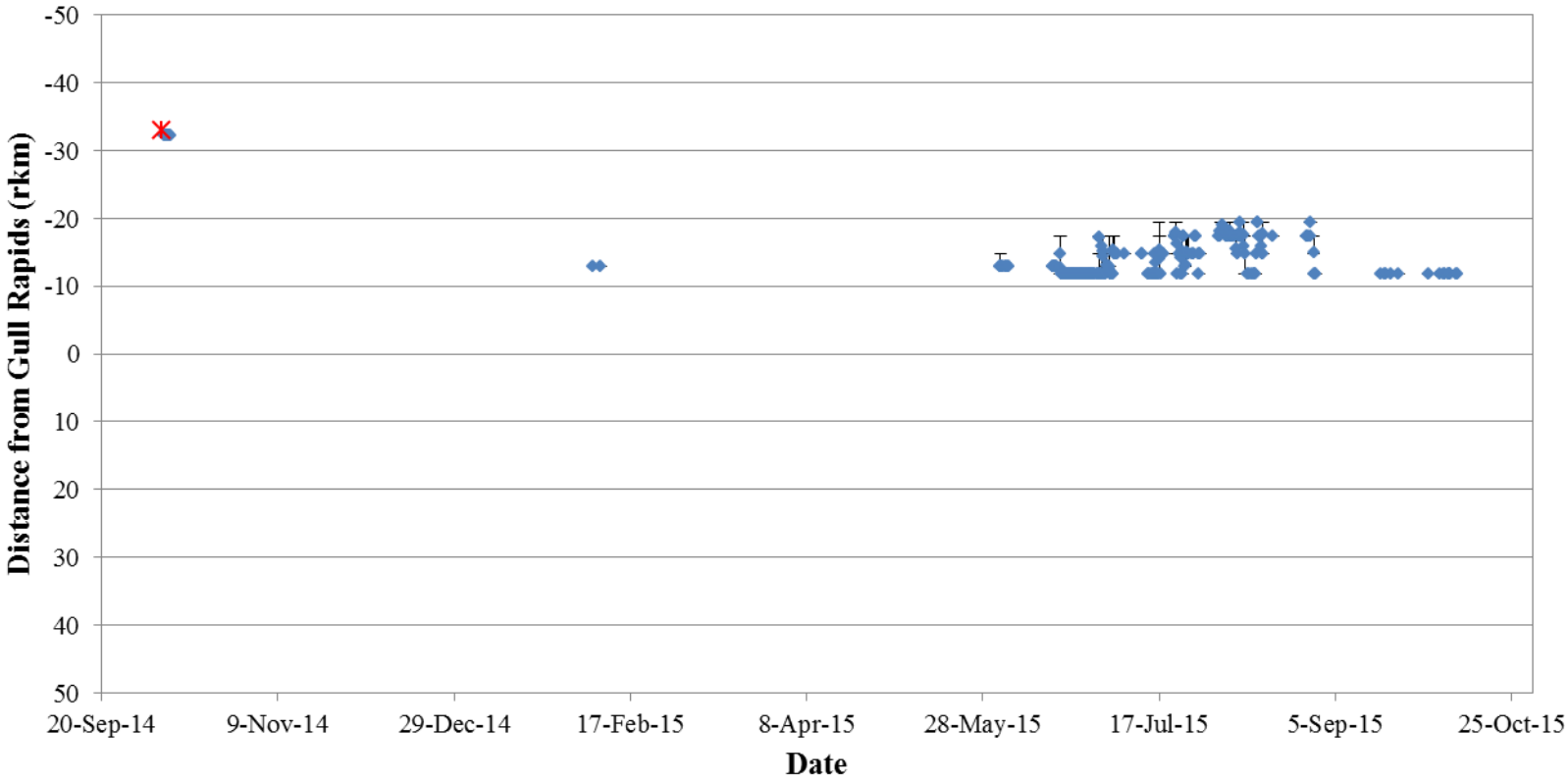


Figure A2-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33822) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

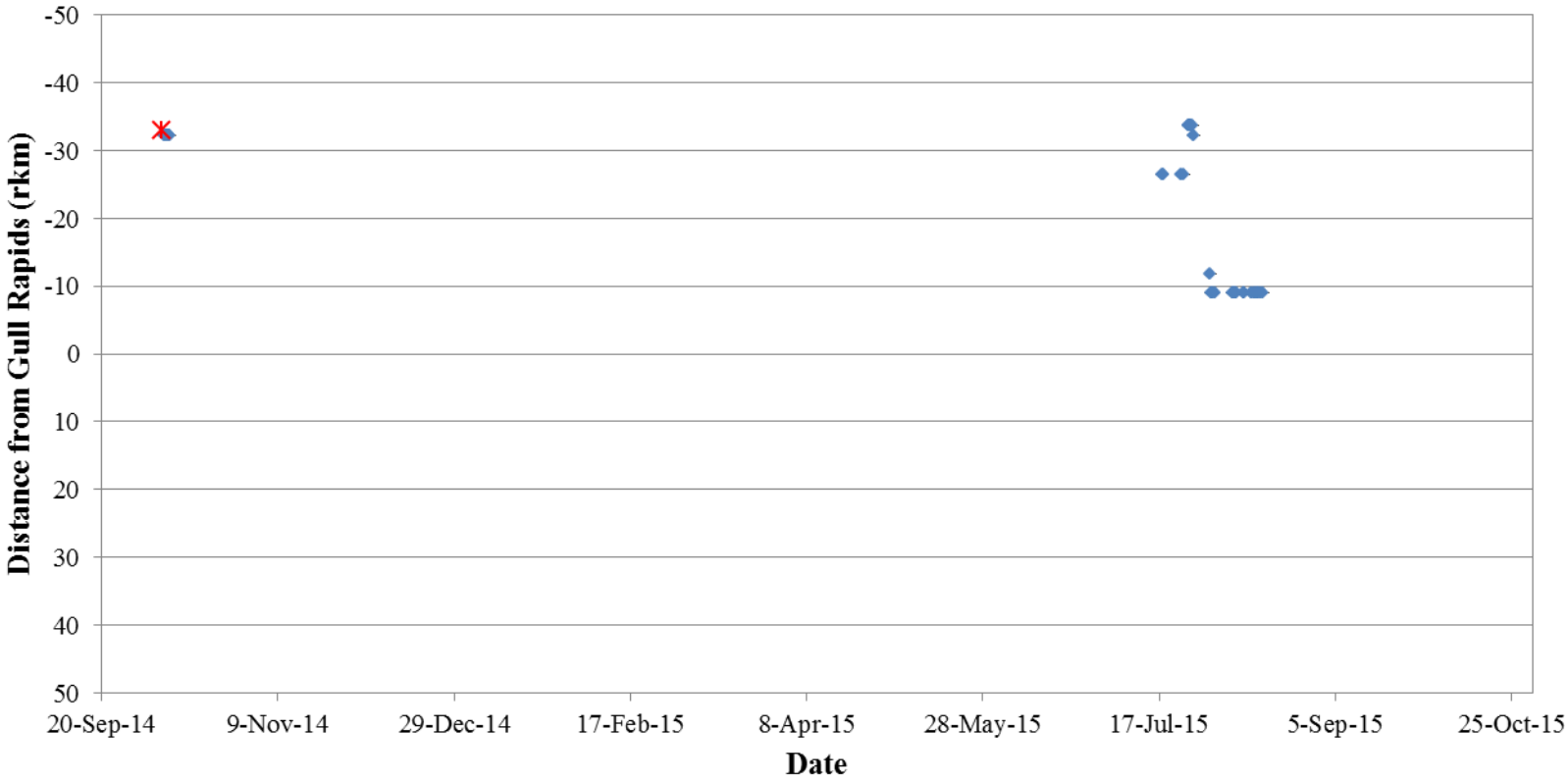


Figure A2-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33826) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

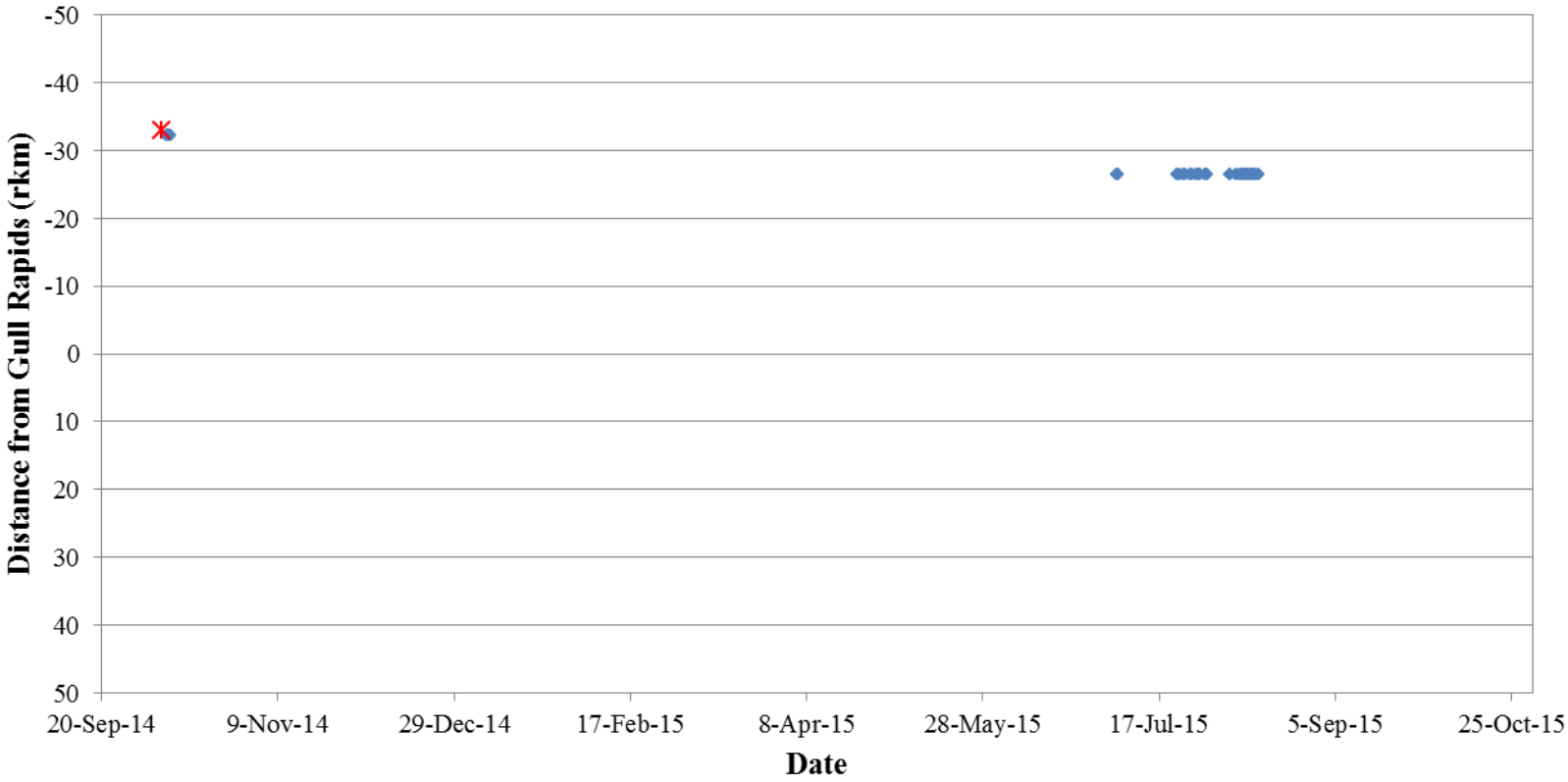


Figure A2-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33830) in the Nelson River between Clark Lake and Gull Rapids, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

APPENDIX 3:
LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC-TAGGED LAKE WHITEFISH IN STEPHENS LAKE, SEPTEMBER 2014 TO OCTOBER 2015

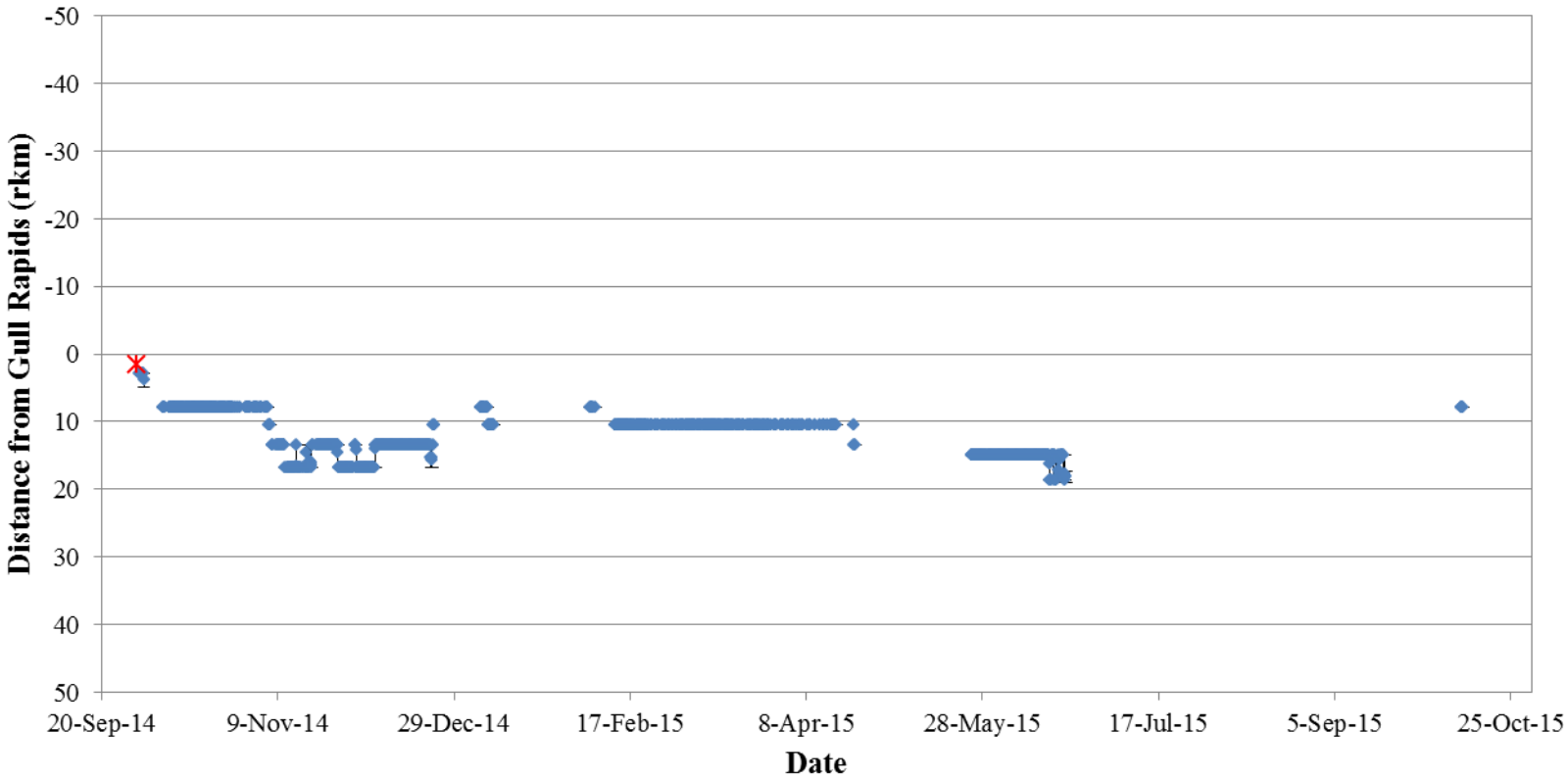


Figure A3-1: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6357) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

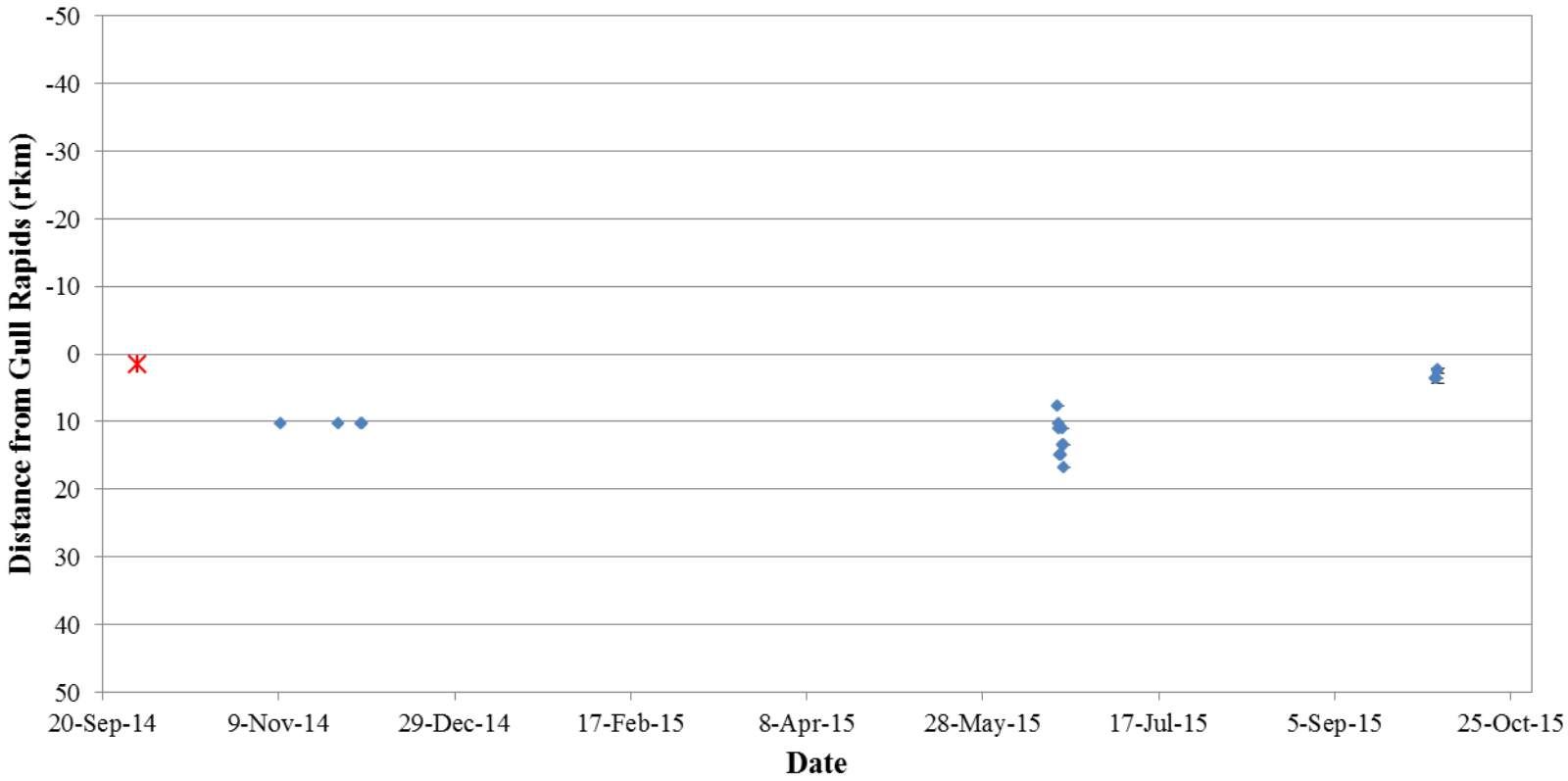


Figure A3-2: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6358) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

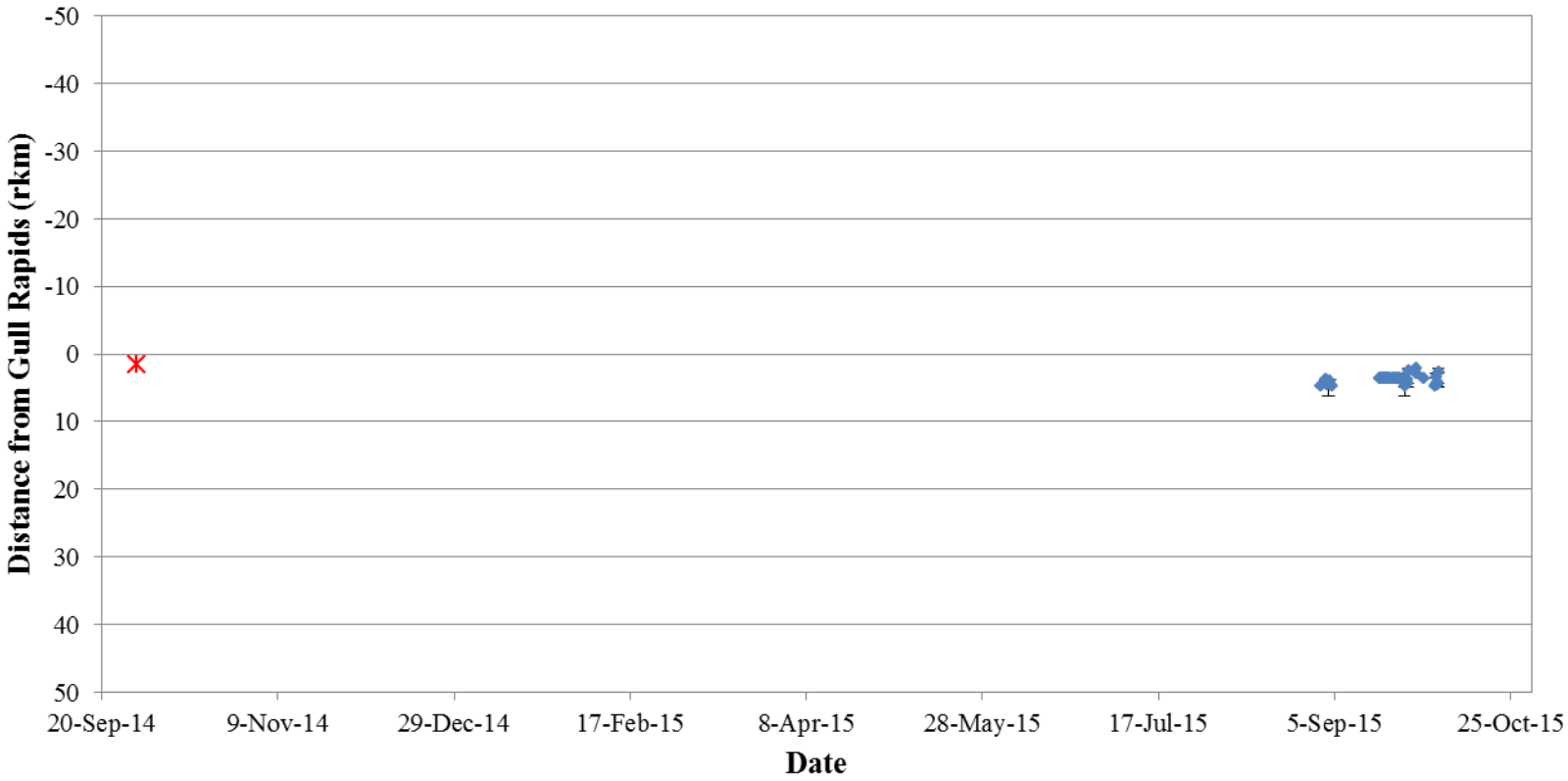


Figure A3-3: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6359) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

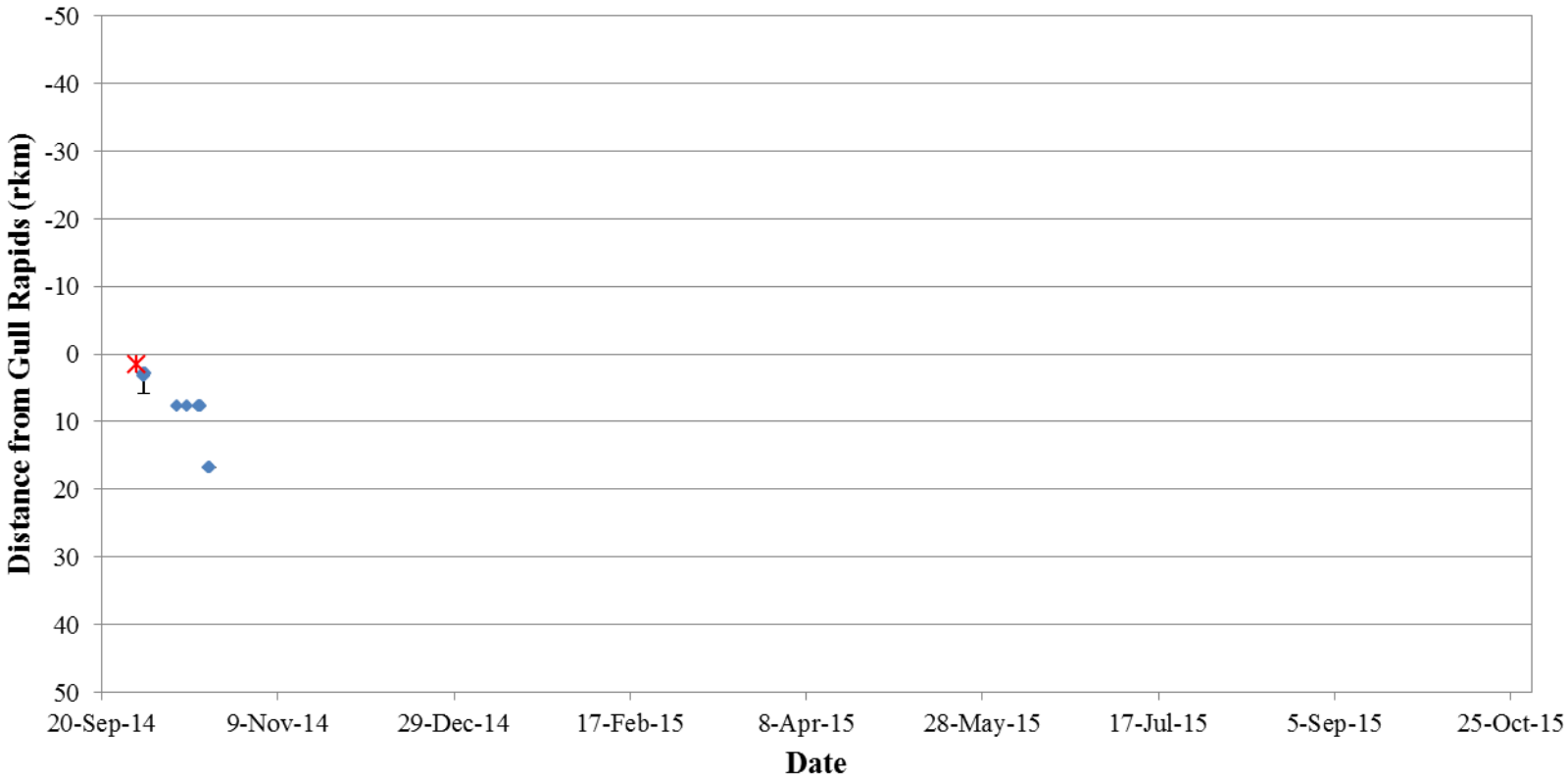


Figure A3-4: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6360) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

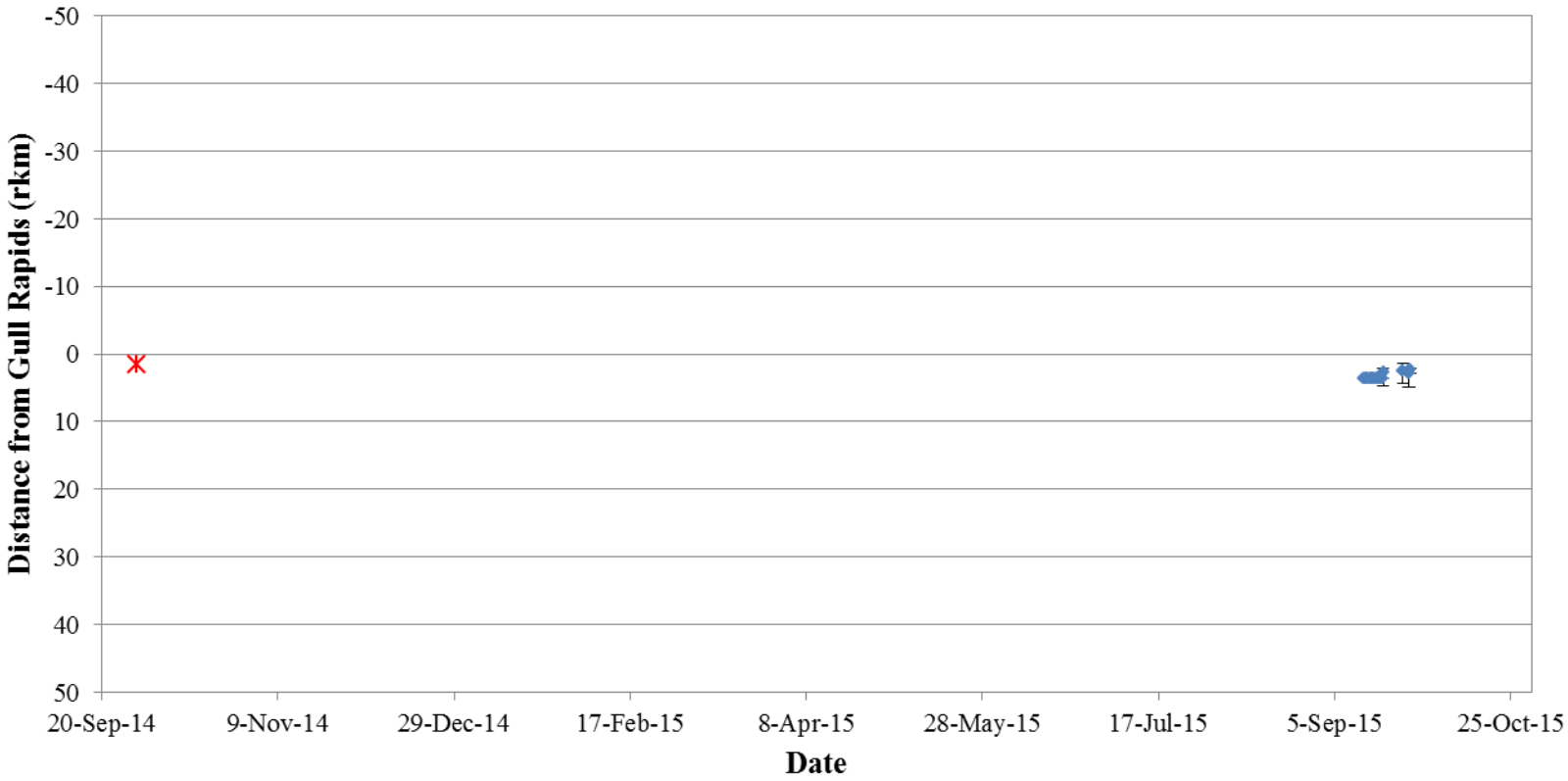


Figure A3-5: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6361) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

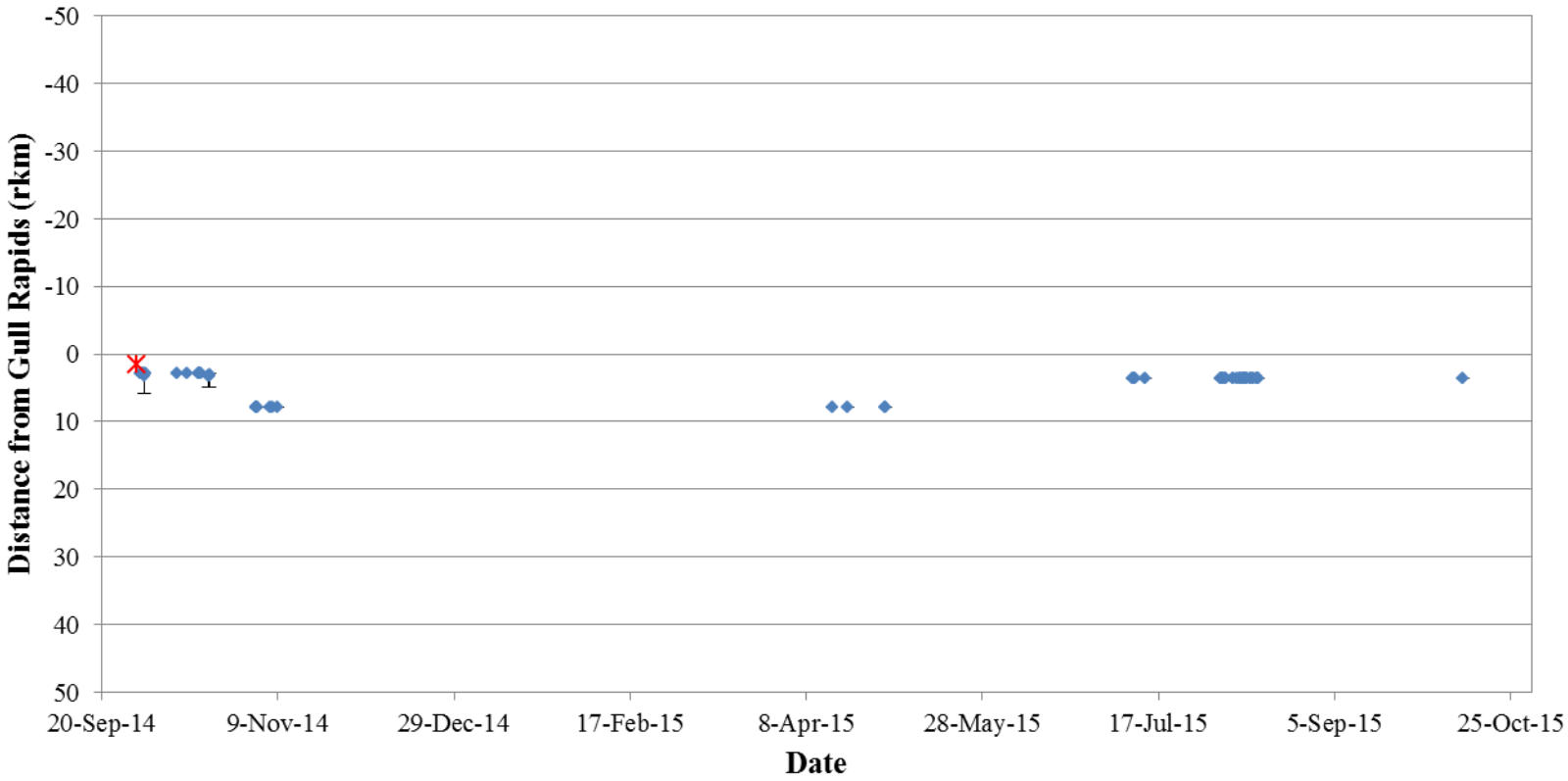


Figure A3-6: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6363) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

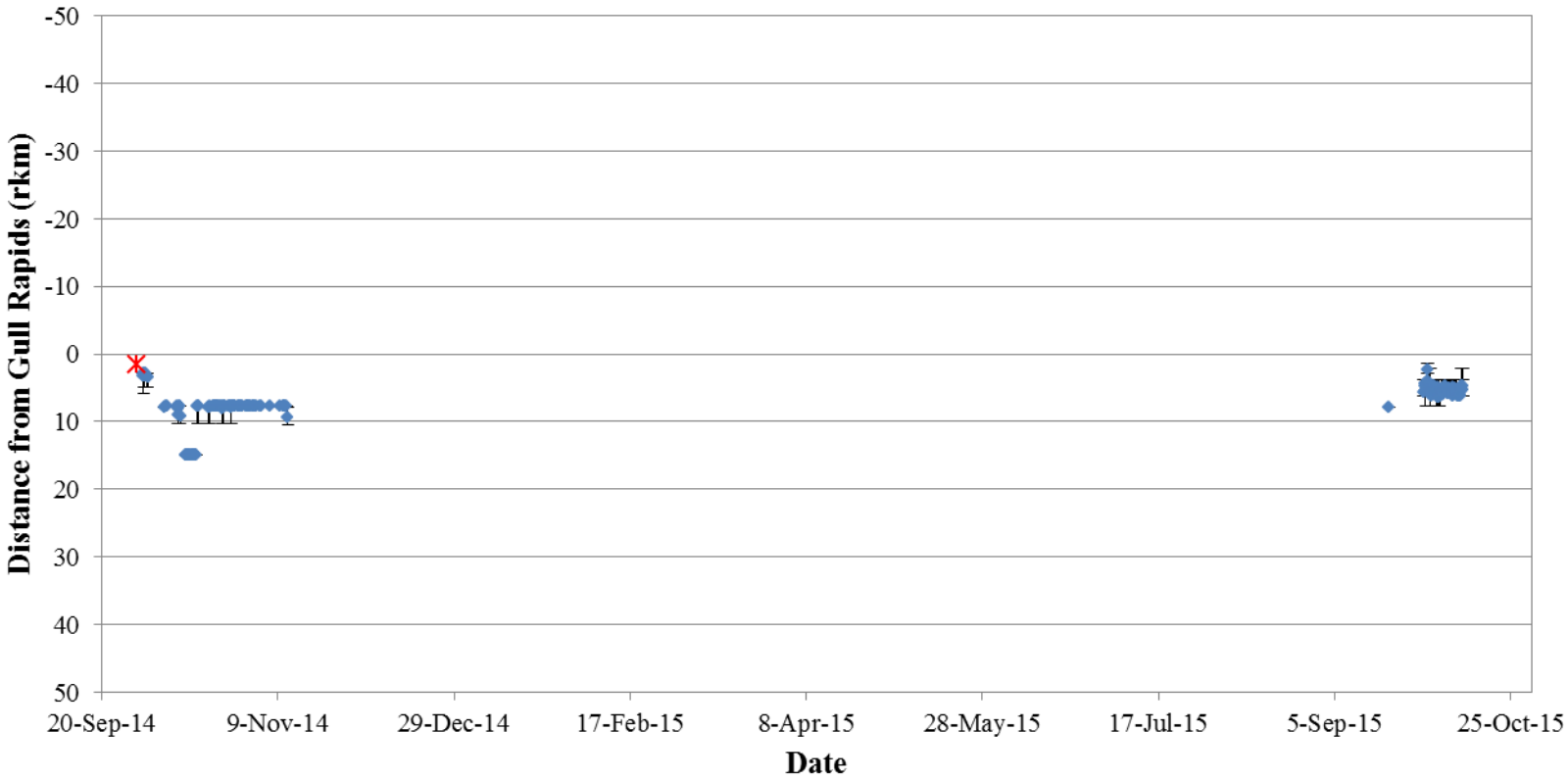


Figure A3-7: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6364) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

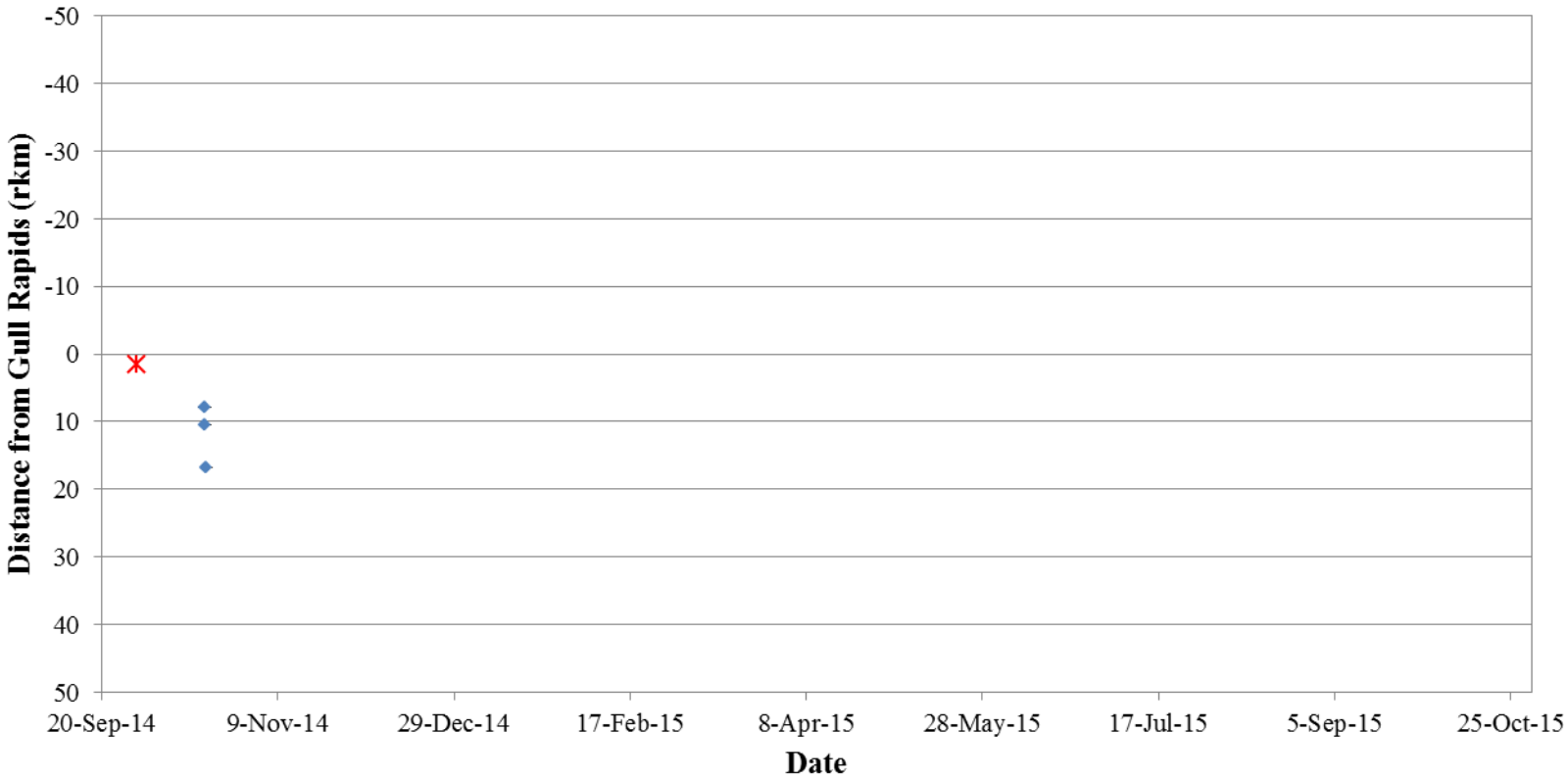


Figure A3-8: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6366) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

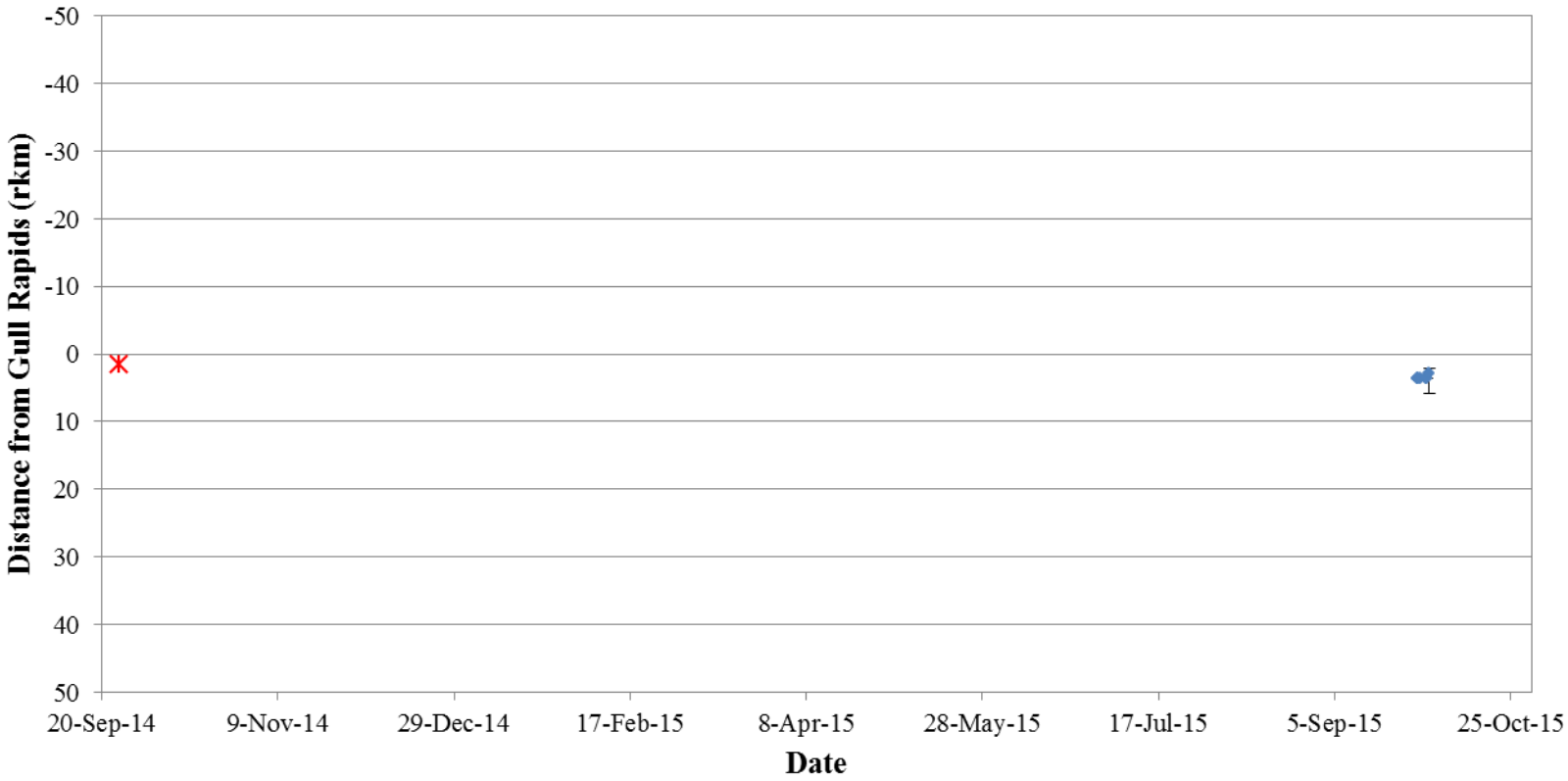


Figure A3-9: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6367) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

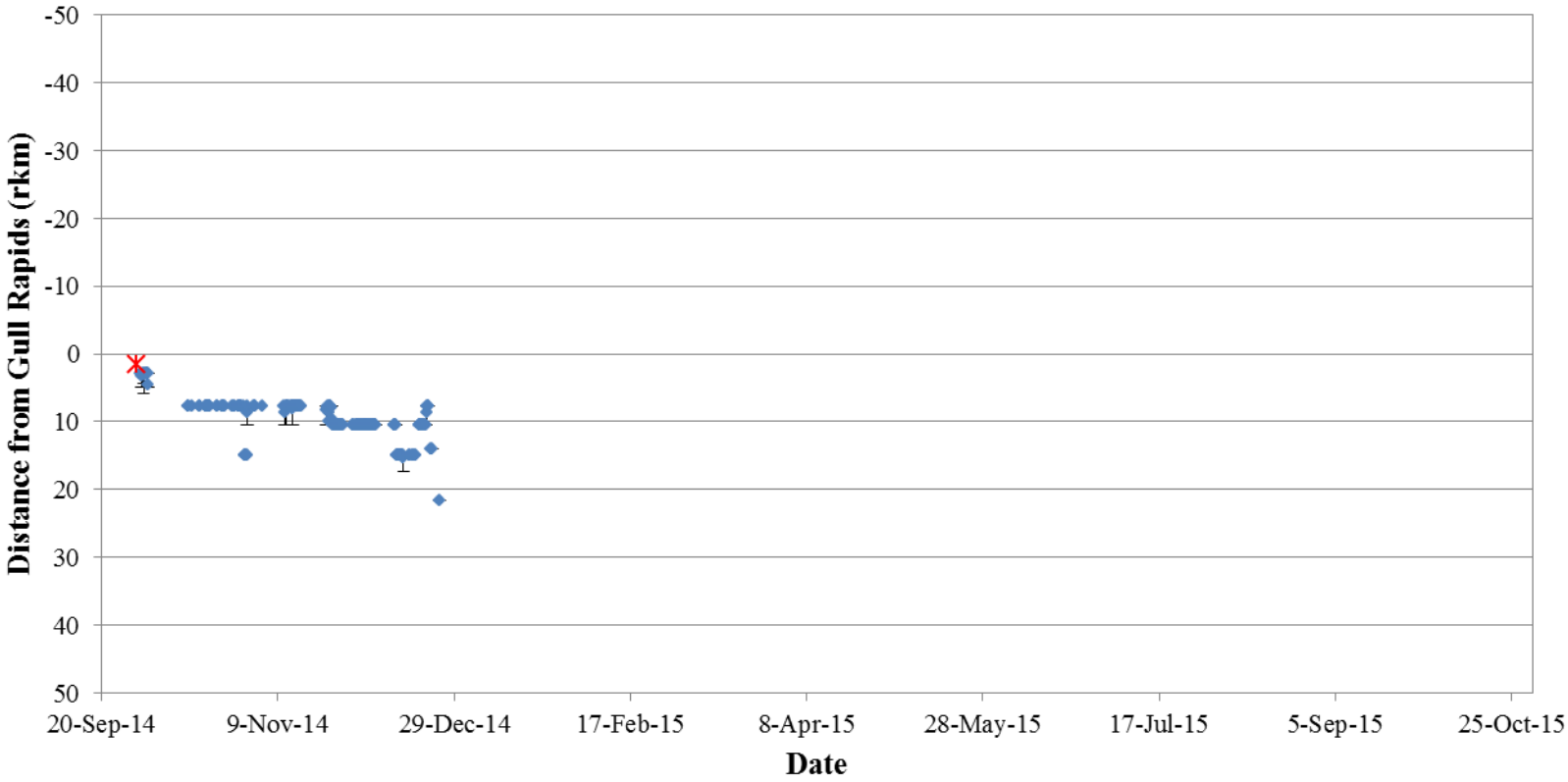


Figure A3-10: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6370) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

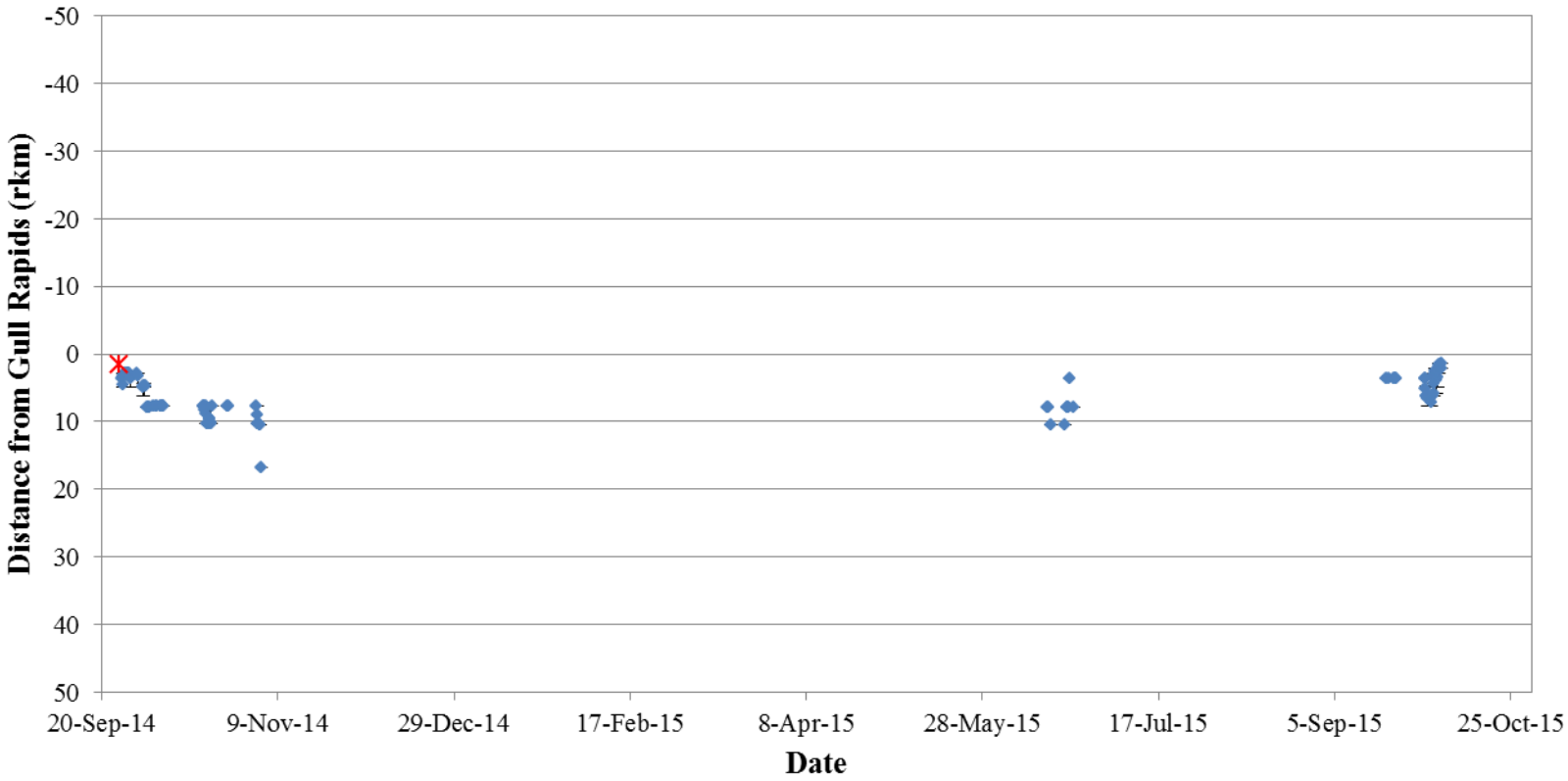


Figure A3-11: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6372) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

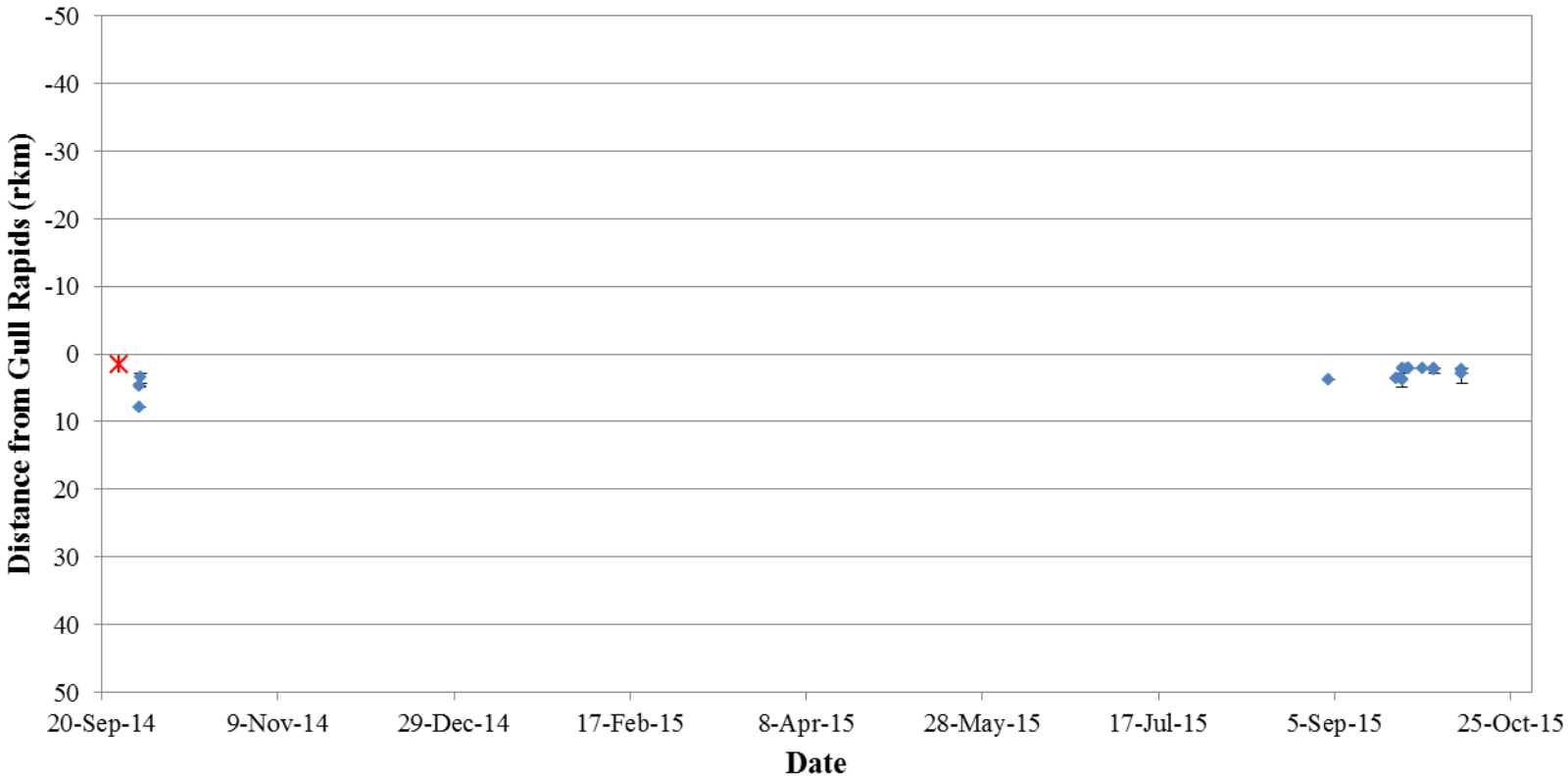


Figure A3-12: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6374) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

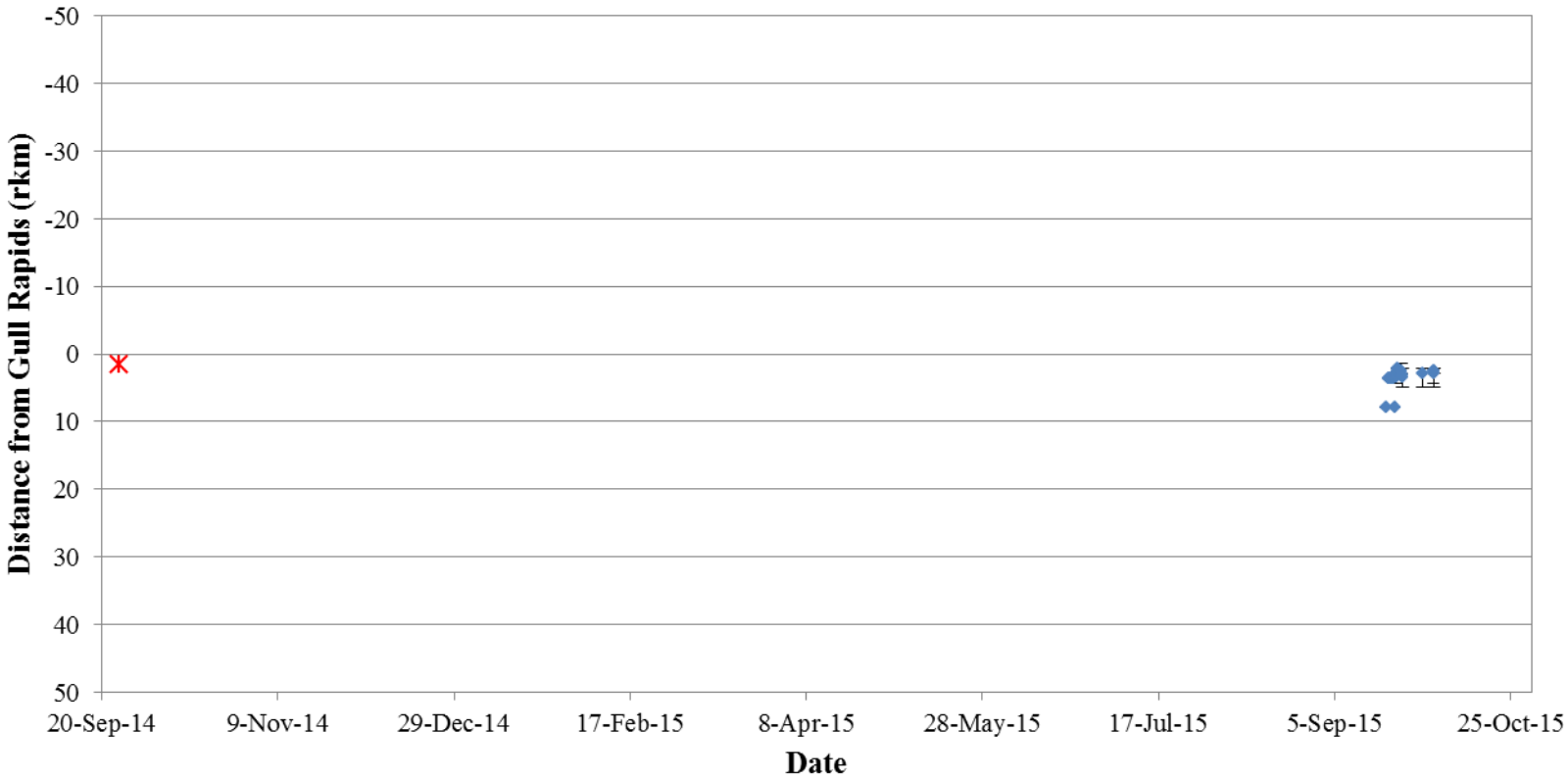


Figure A3-13: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6375) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

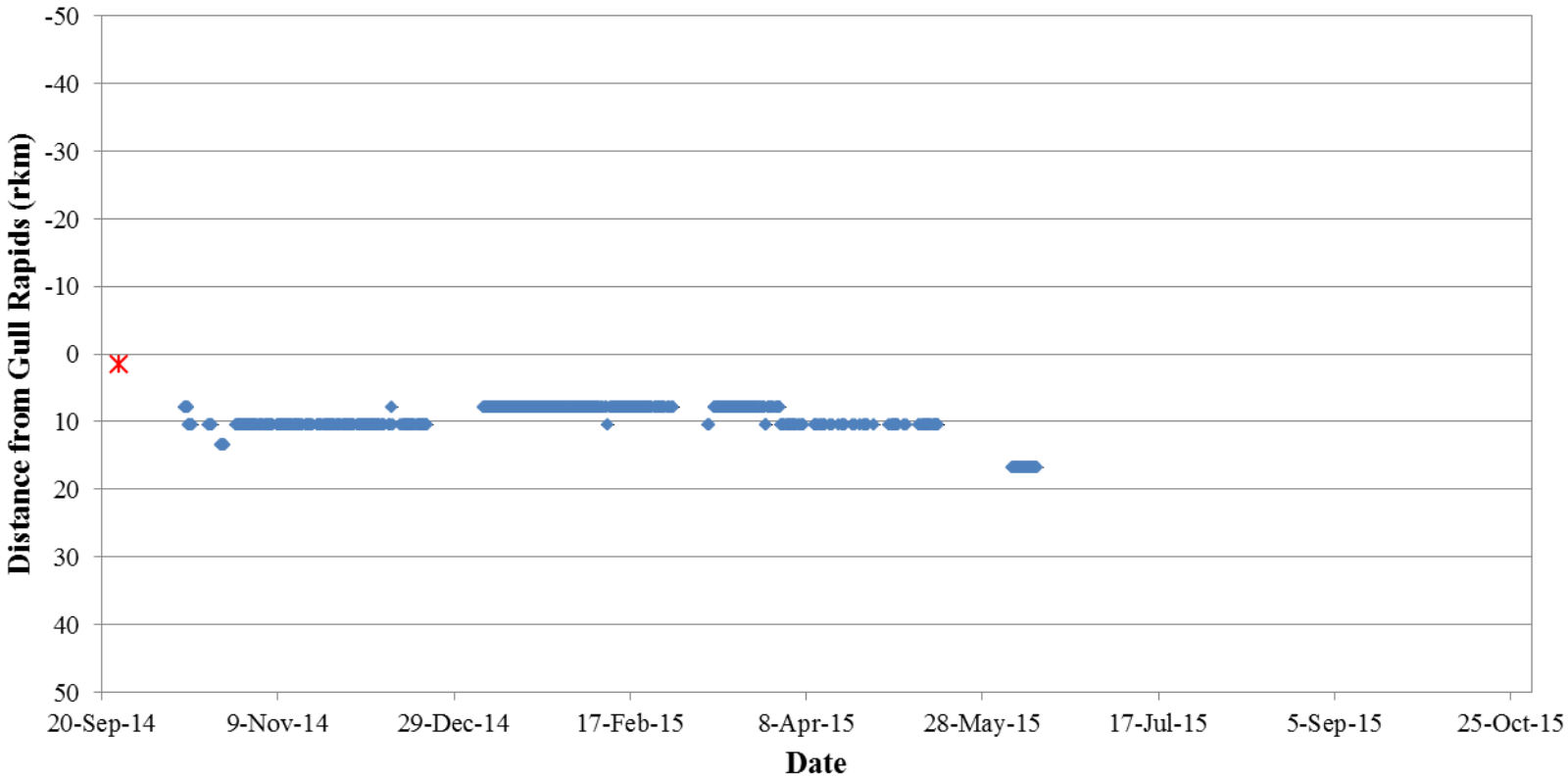


Figure A3-14: Position of a Lake Whitefish tagged with an acoustic transmitter (code #6376) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

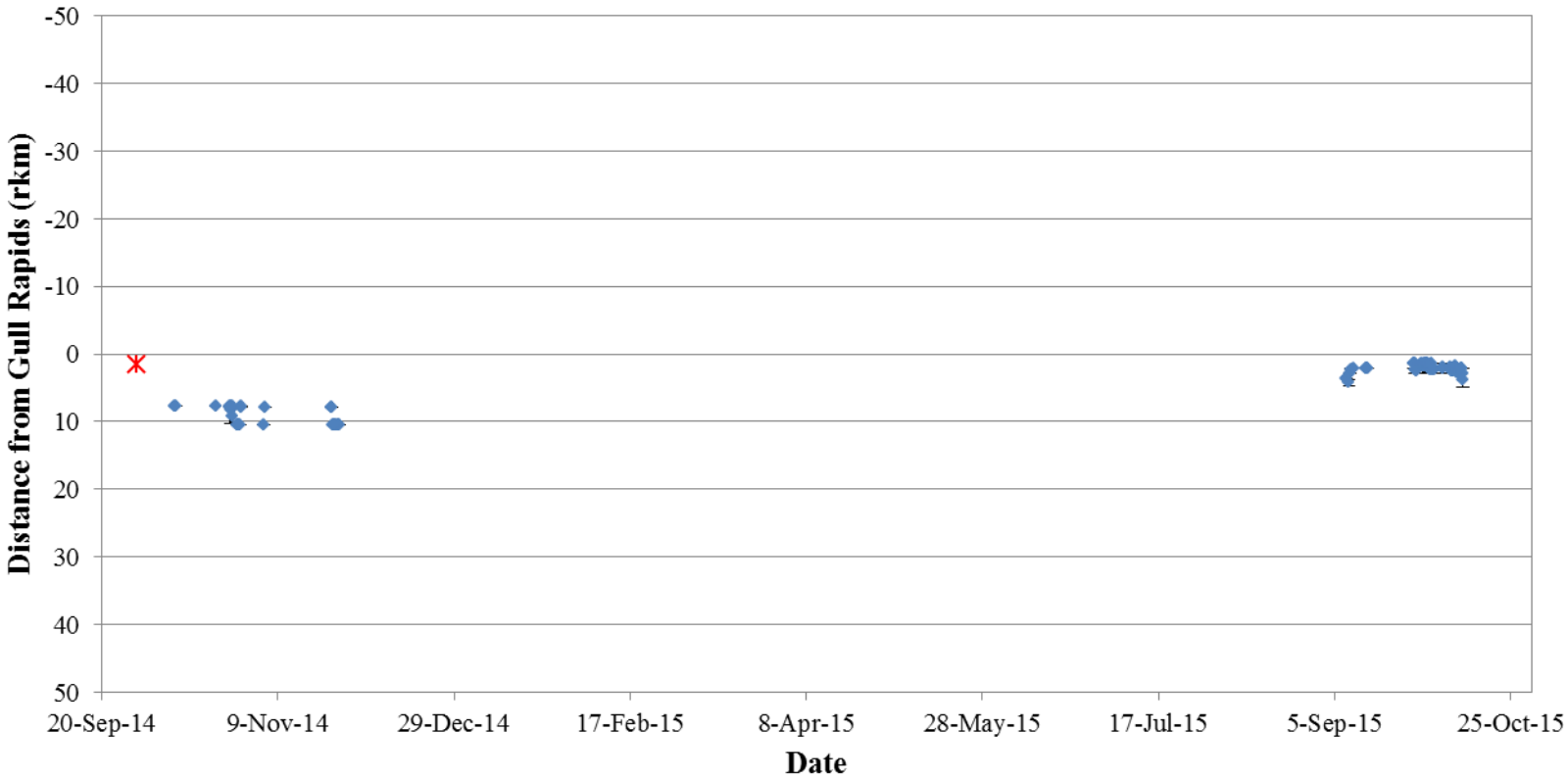


Figure A3-15: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33794) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

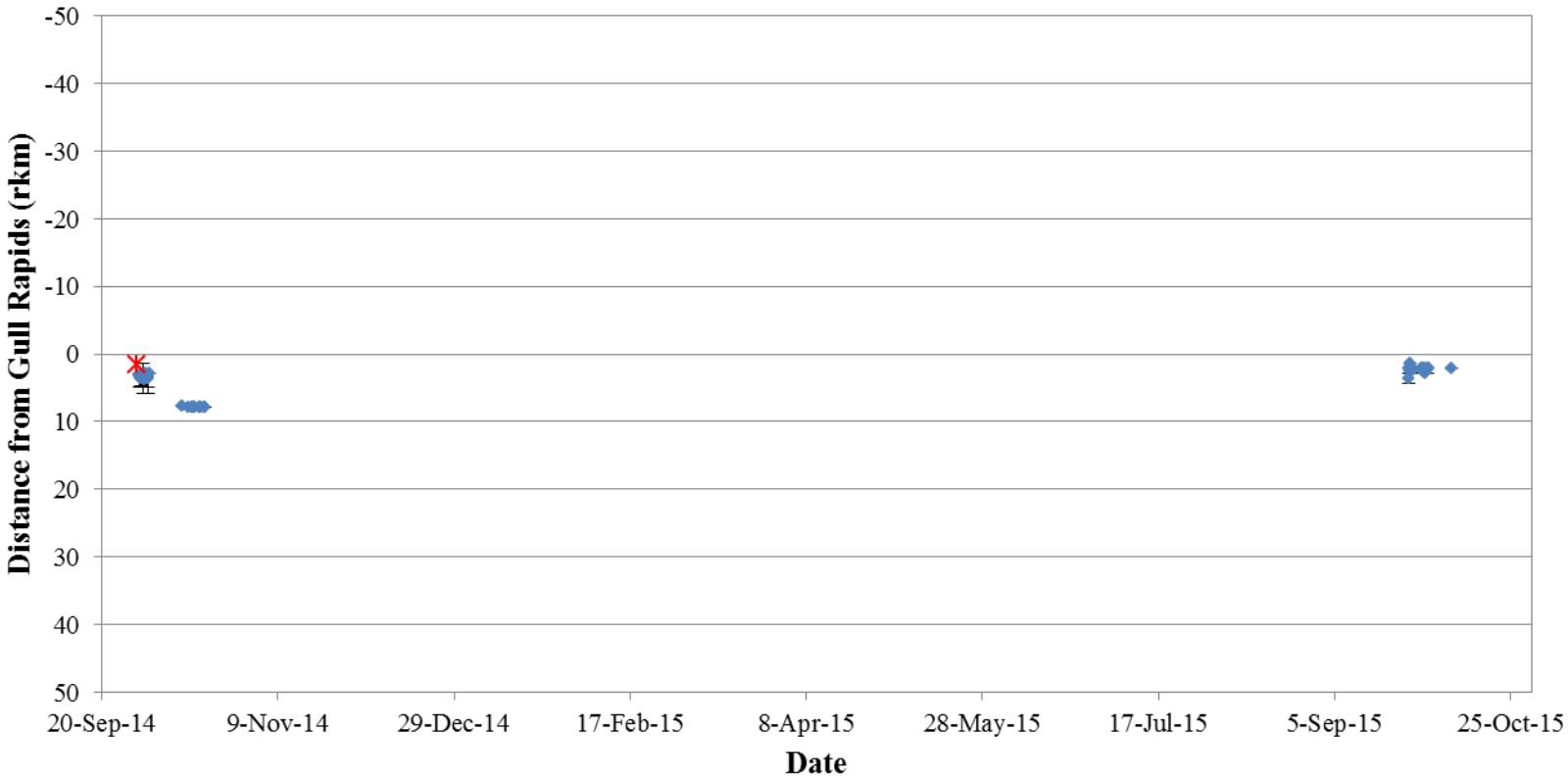


Figure A3-16: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33795) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

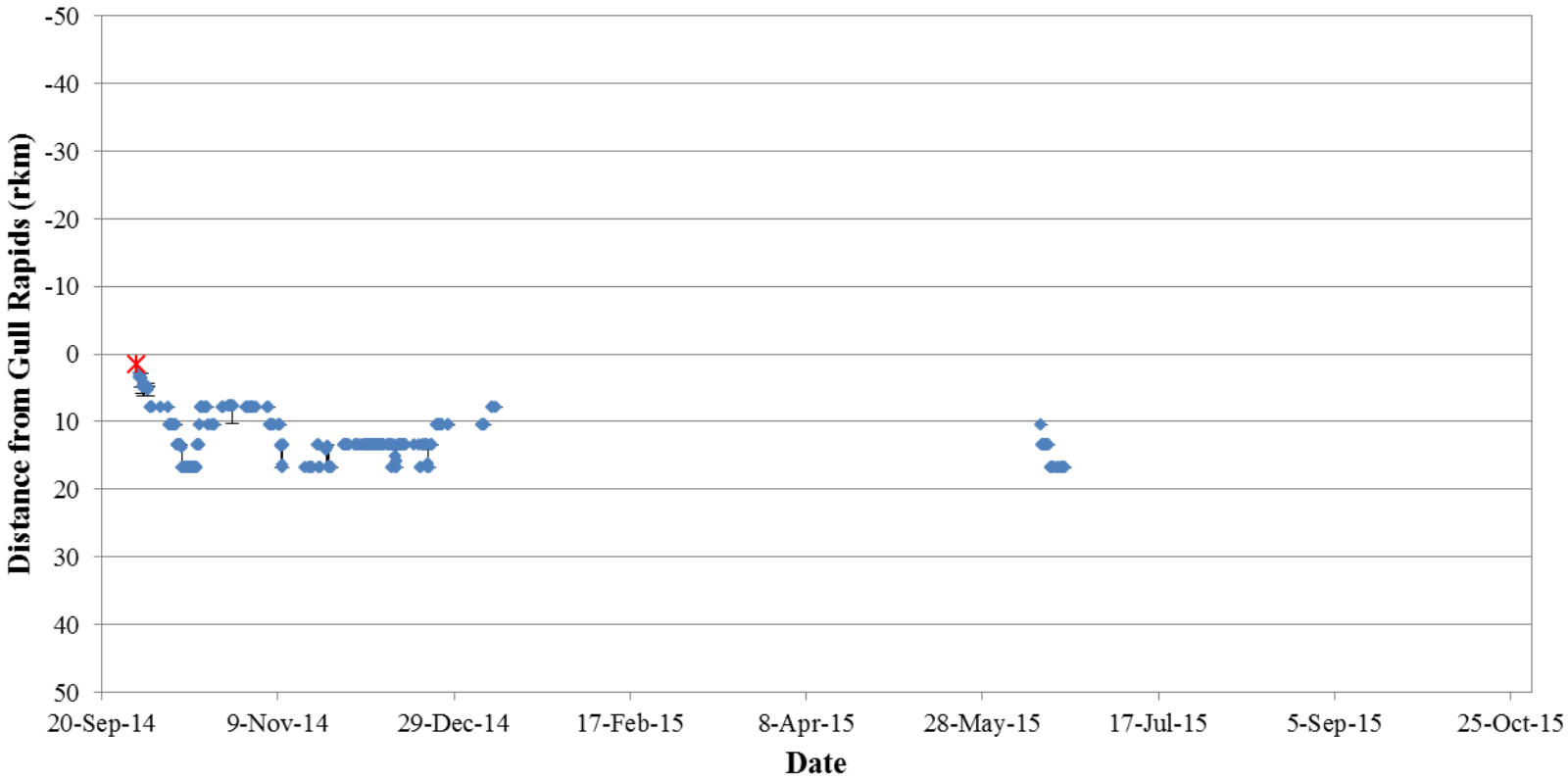


Figure A3-17: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33796) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

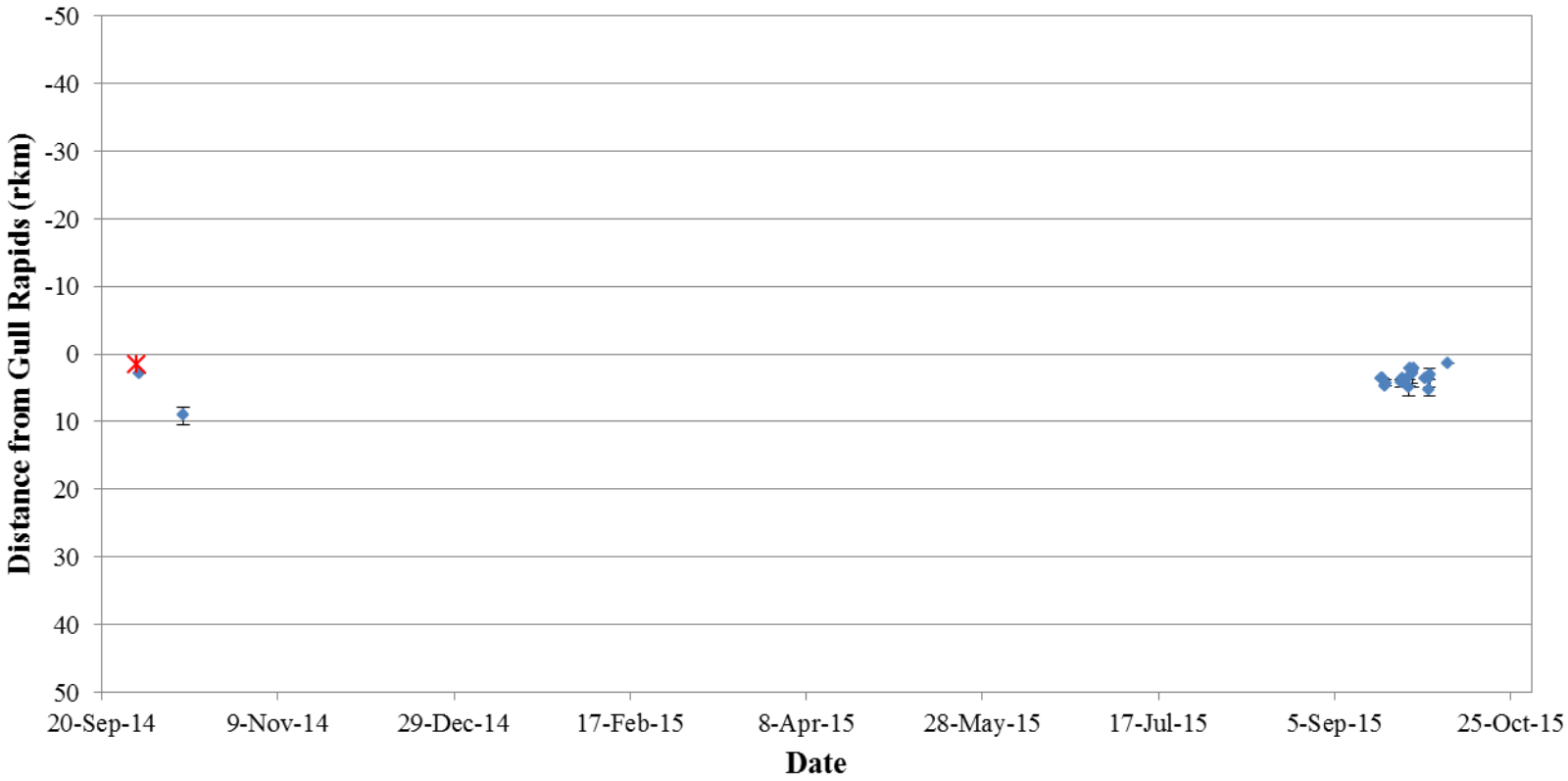


Figure A3-18: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33810) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

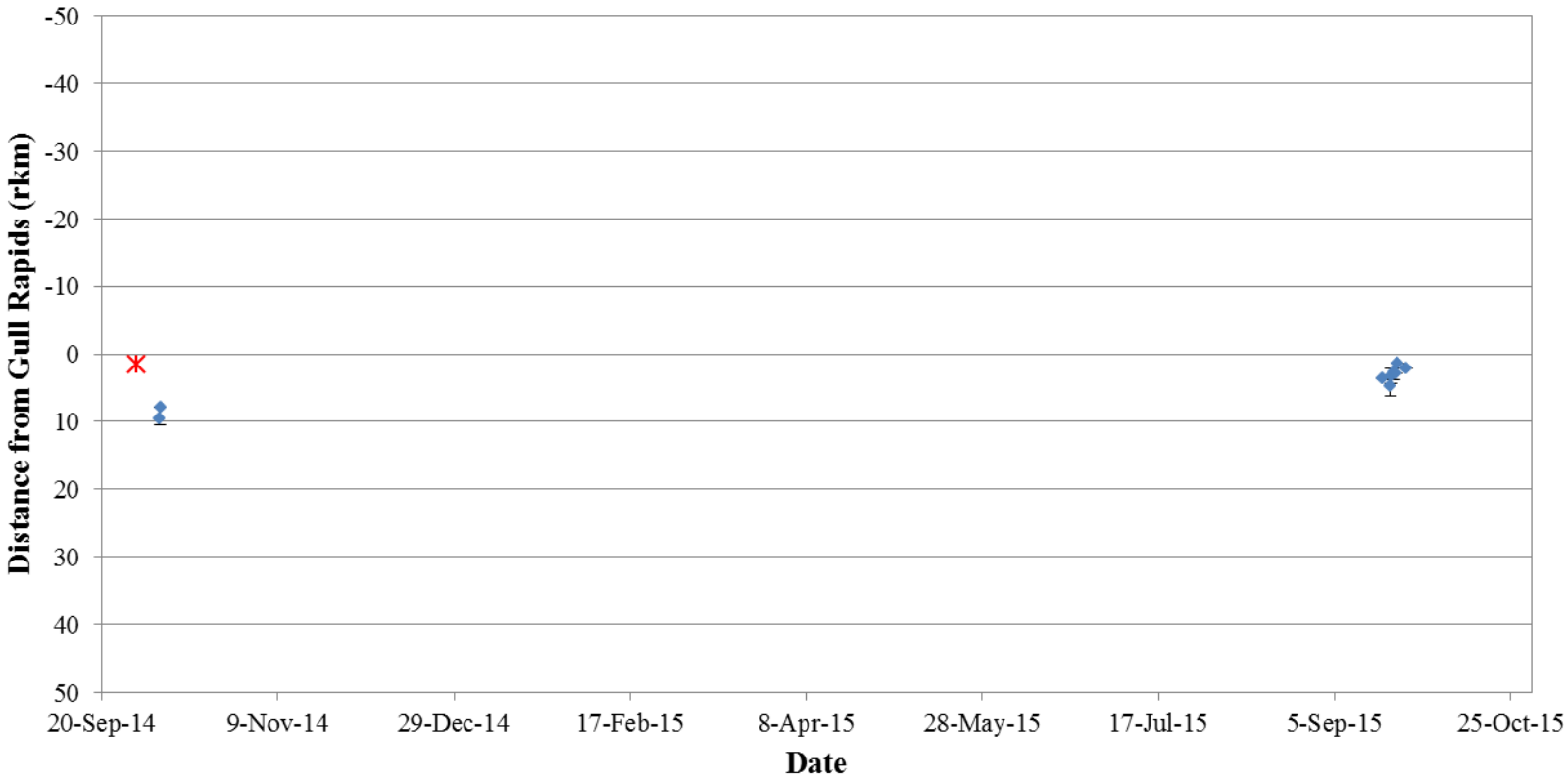


Figure A3-19: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33814) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

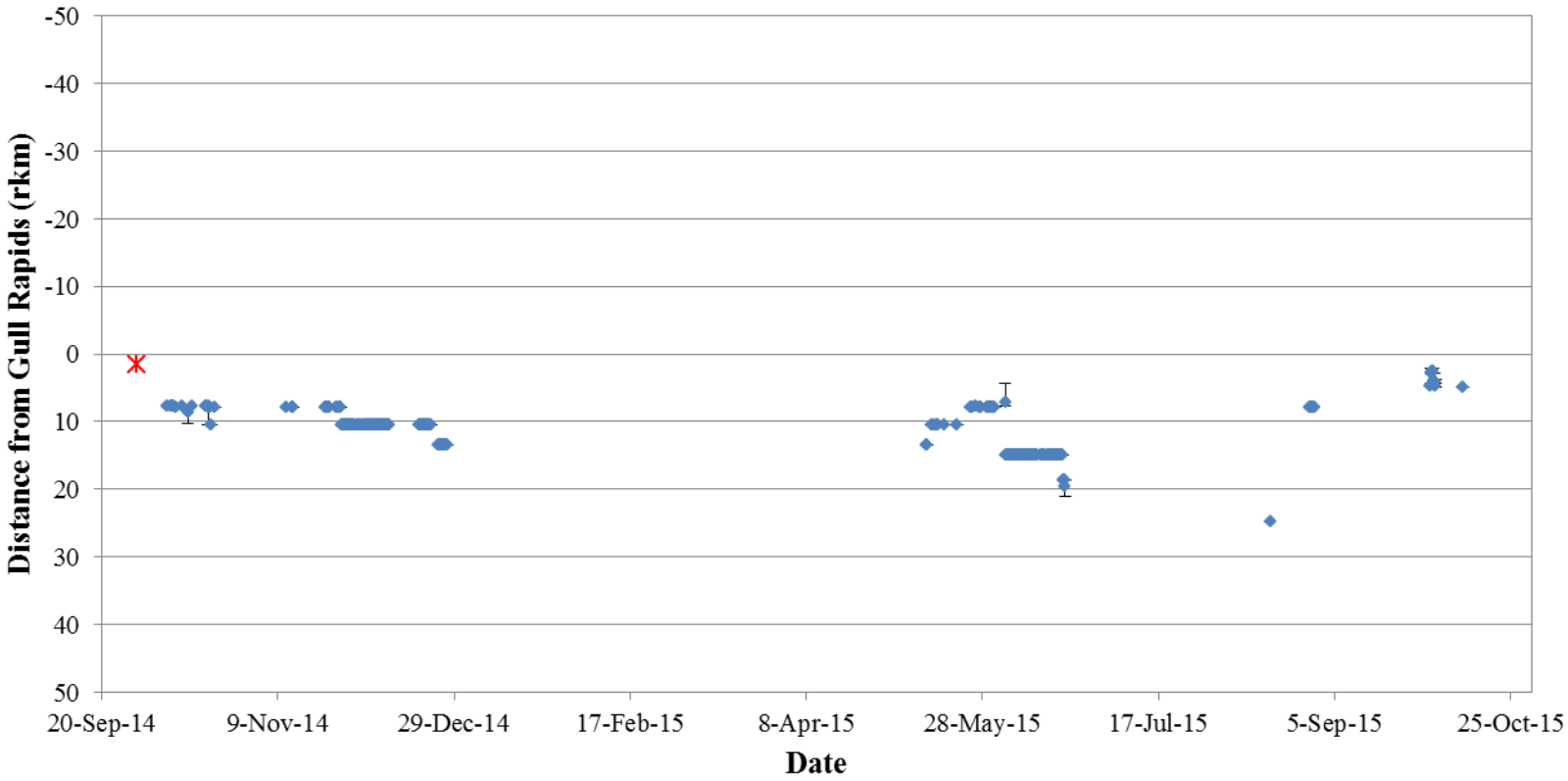


Figure A3-20: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33815) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

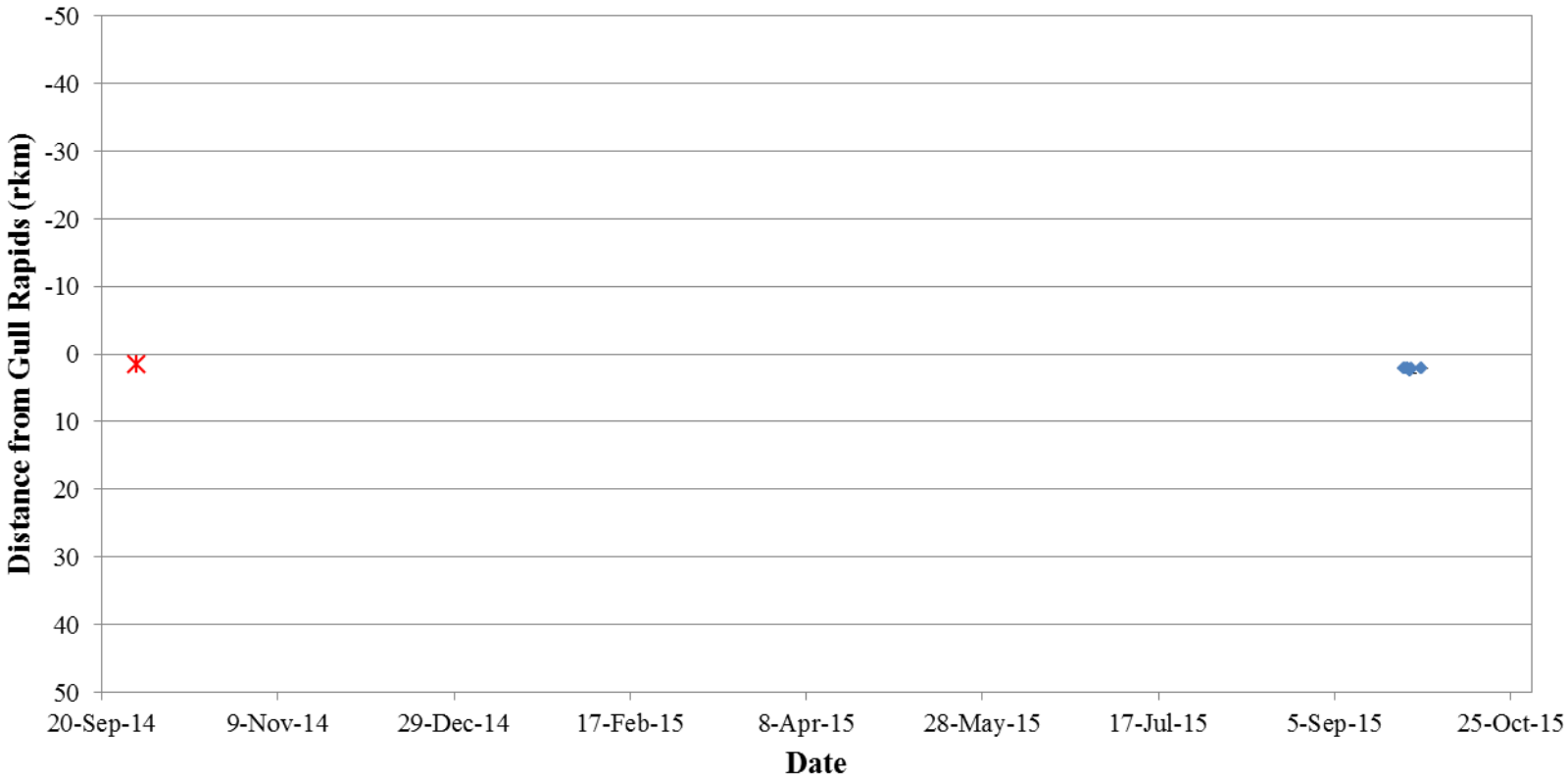


Figure A3-21: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33817) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

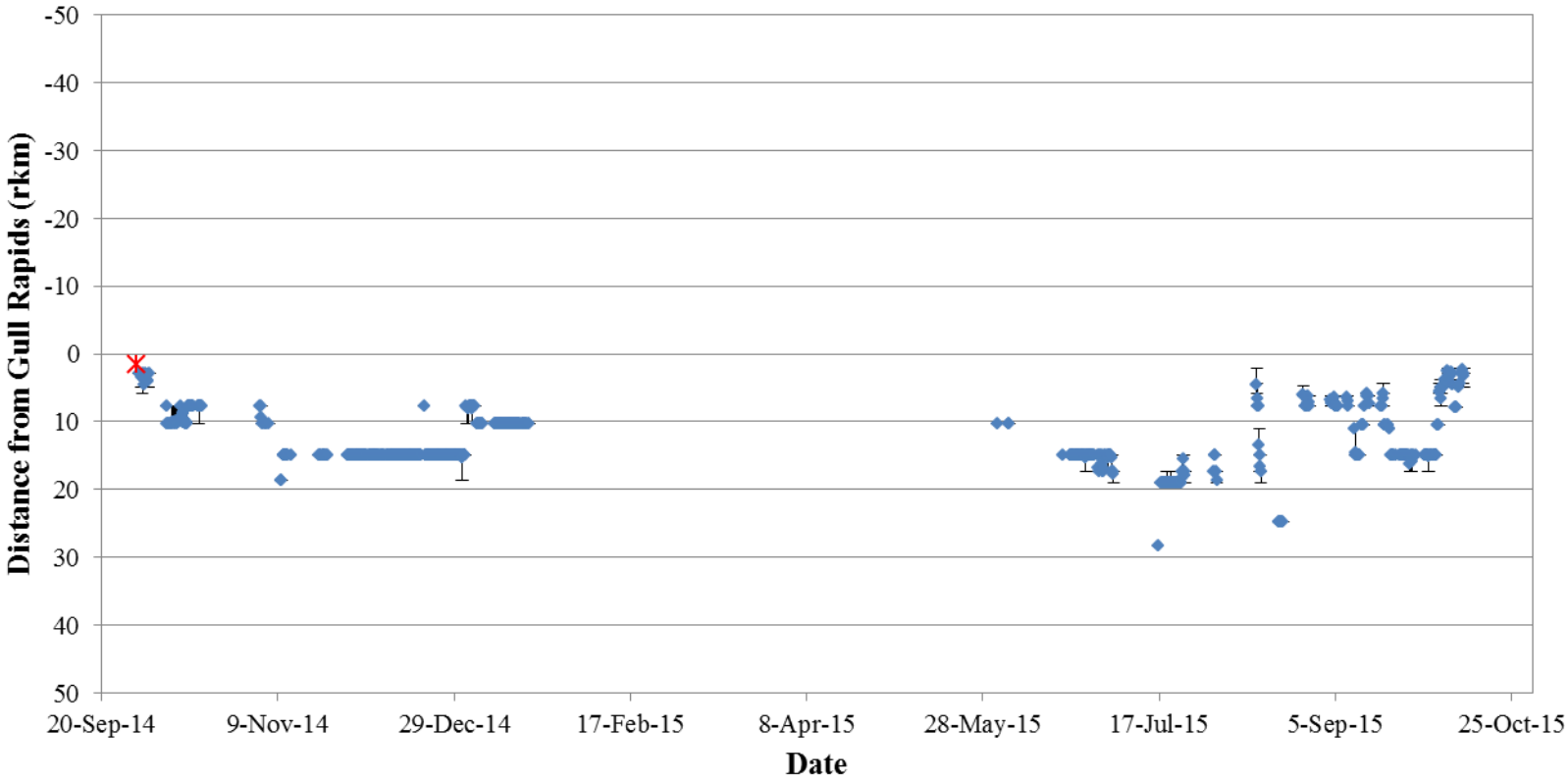


Figure A3-22: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33818) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

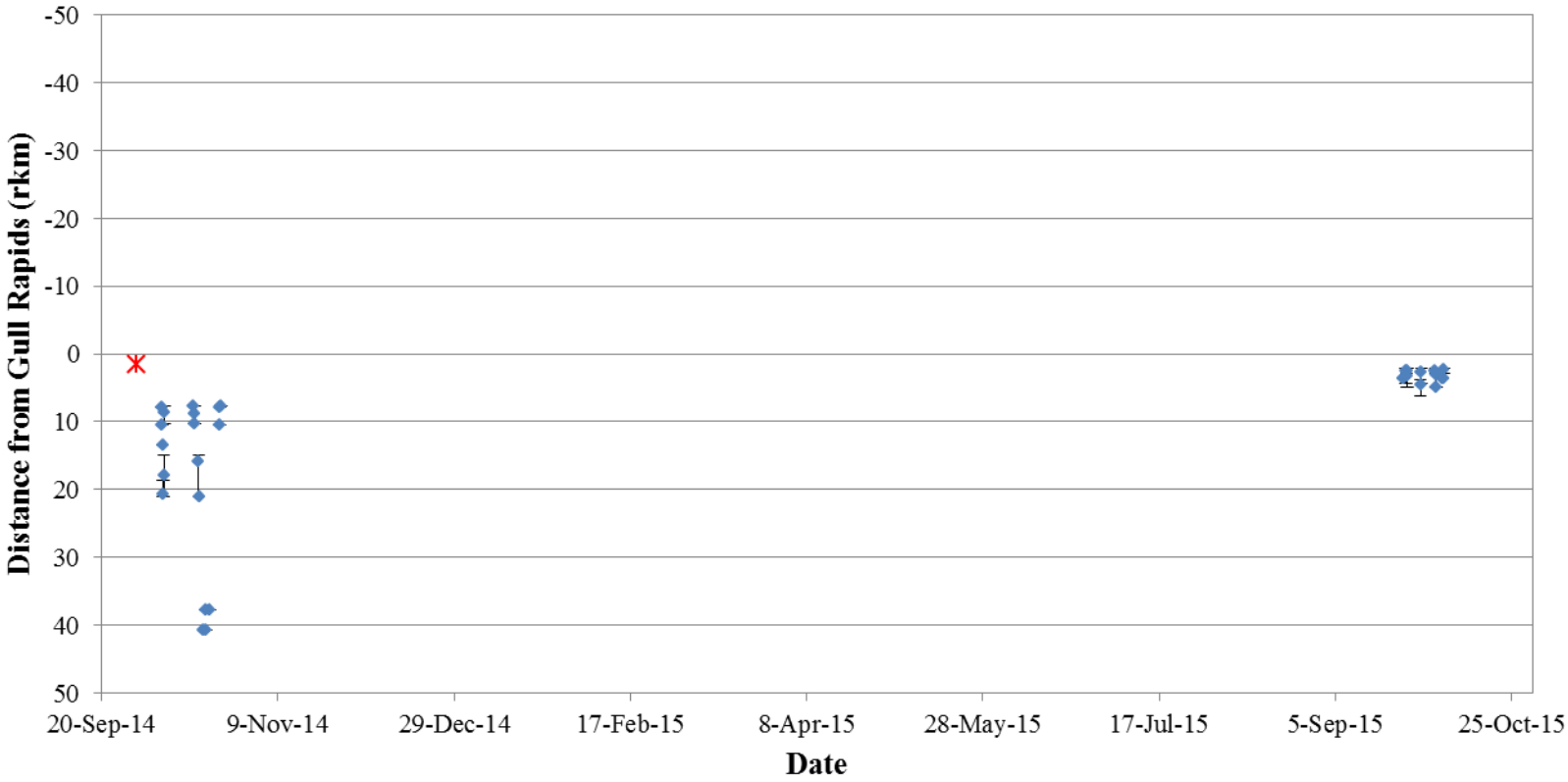


Figure A3-23: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33819) in Stephens Lake, in relation to Gull Rapids (rkm 0), from September 2014 to October 2015. The date and location of tagging are indicated by a red star.

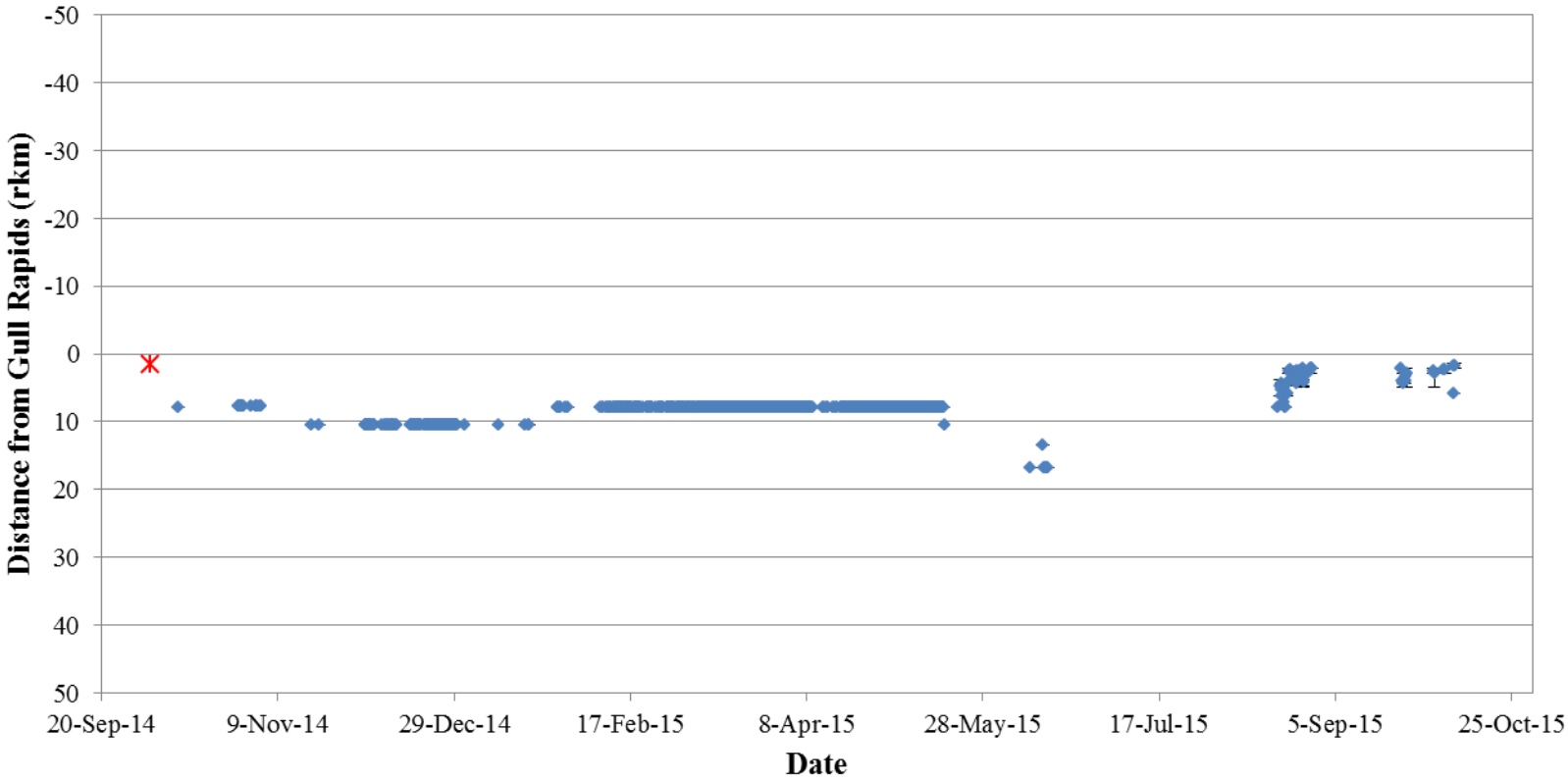


Figure A3-24: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33821) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

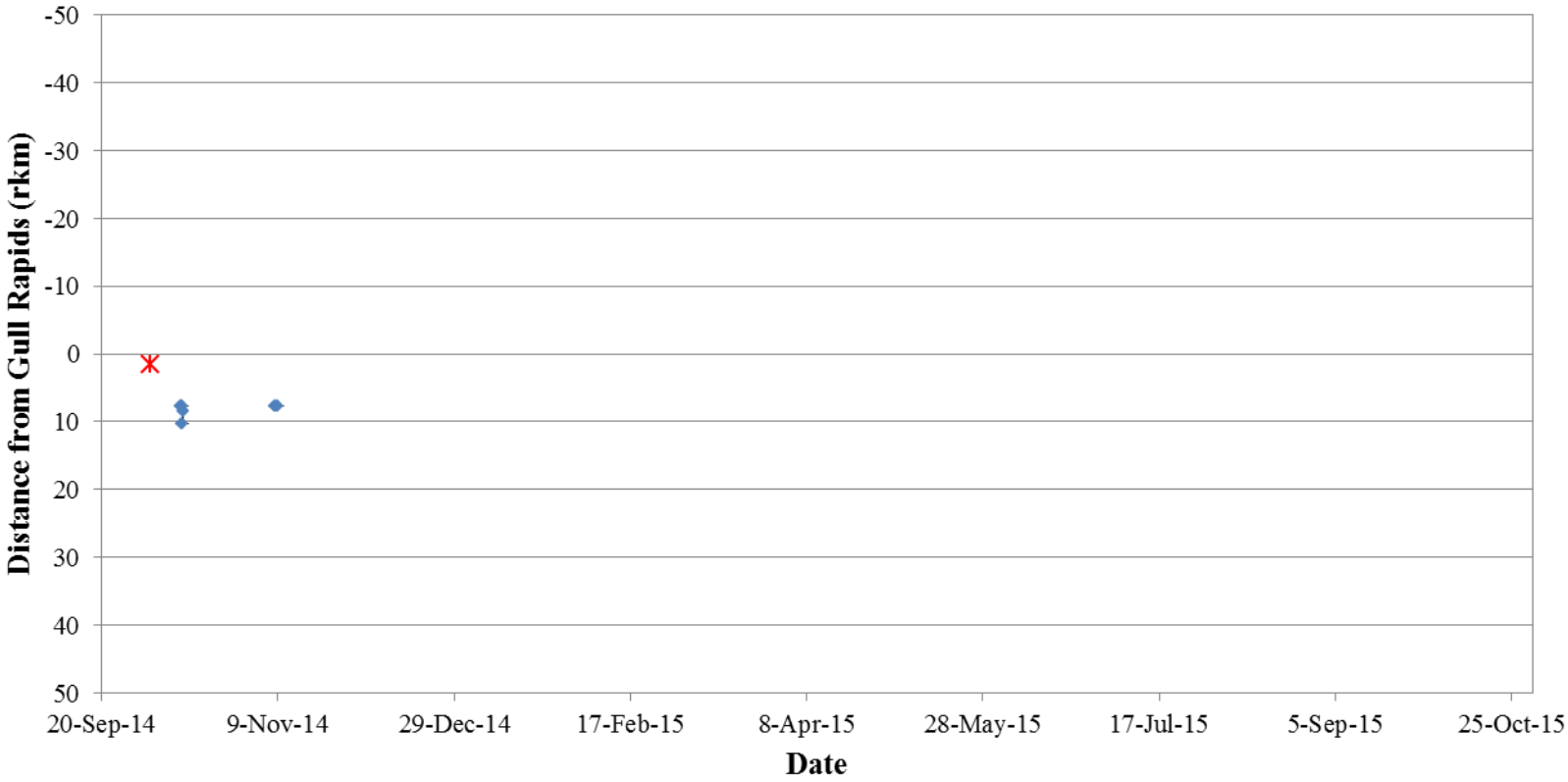


Figure A3-25: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33823) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

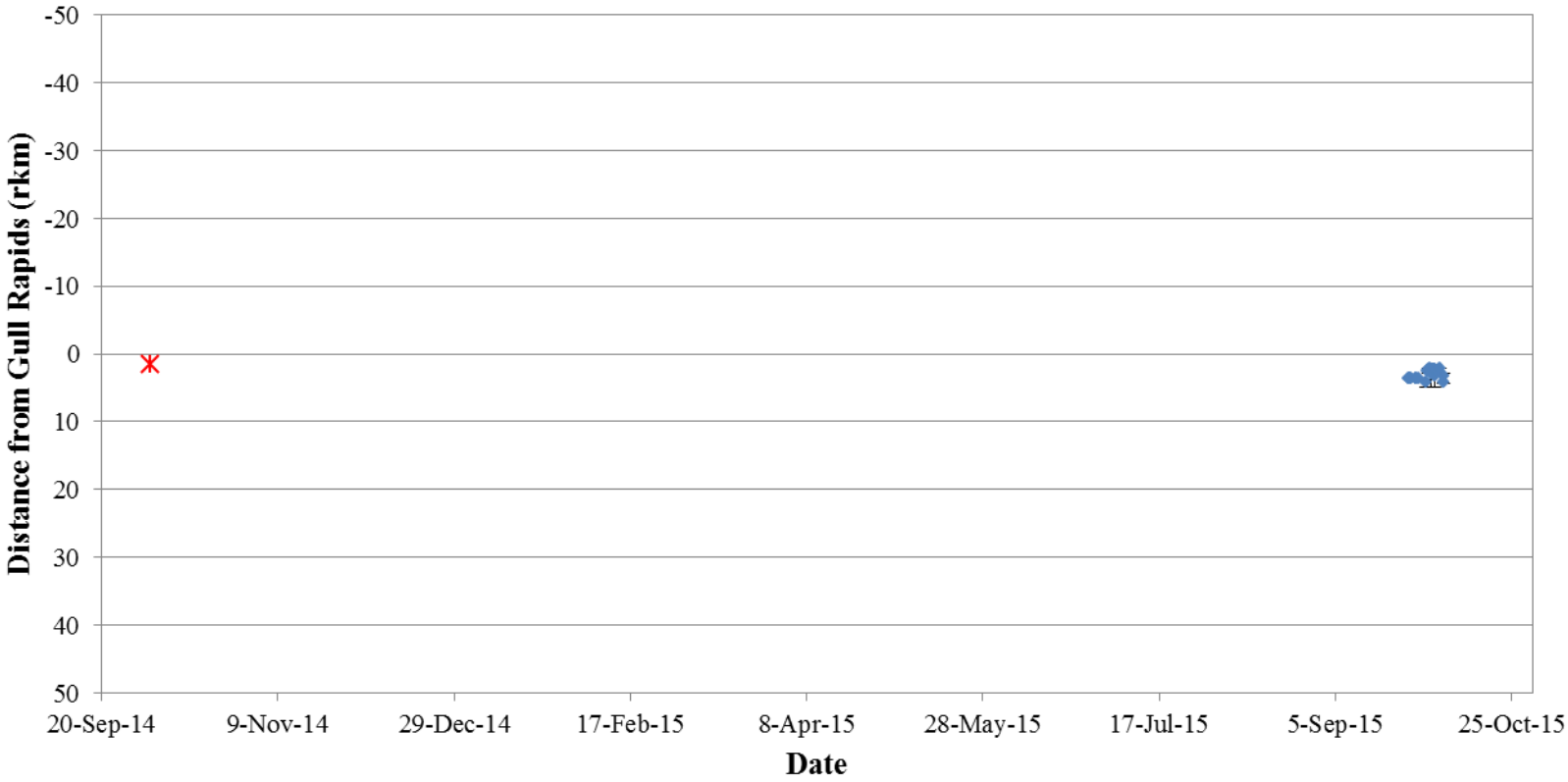


Figure A3-26: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33824) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

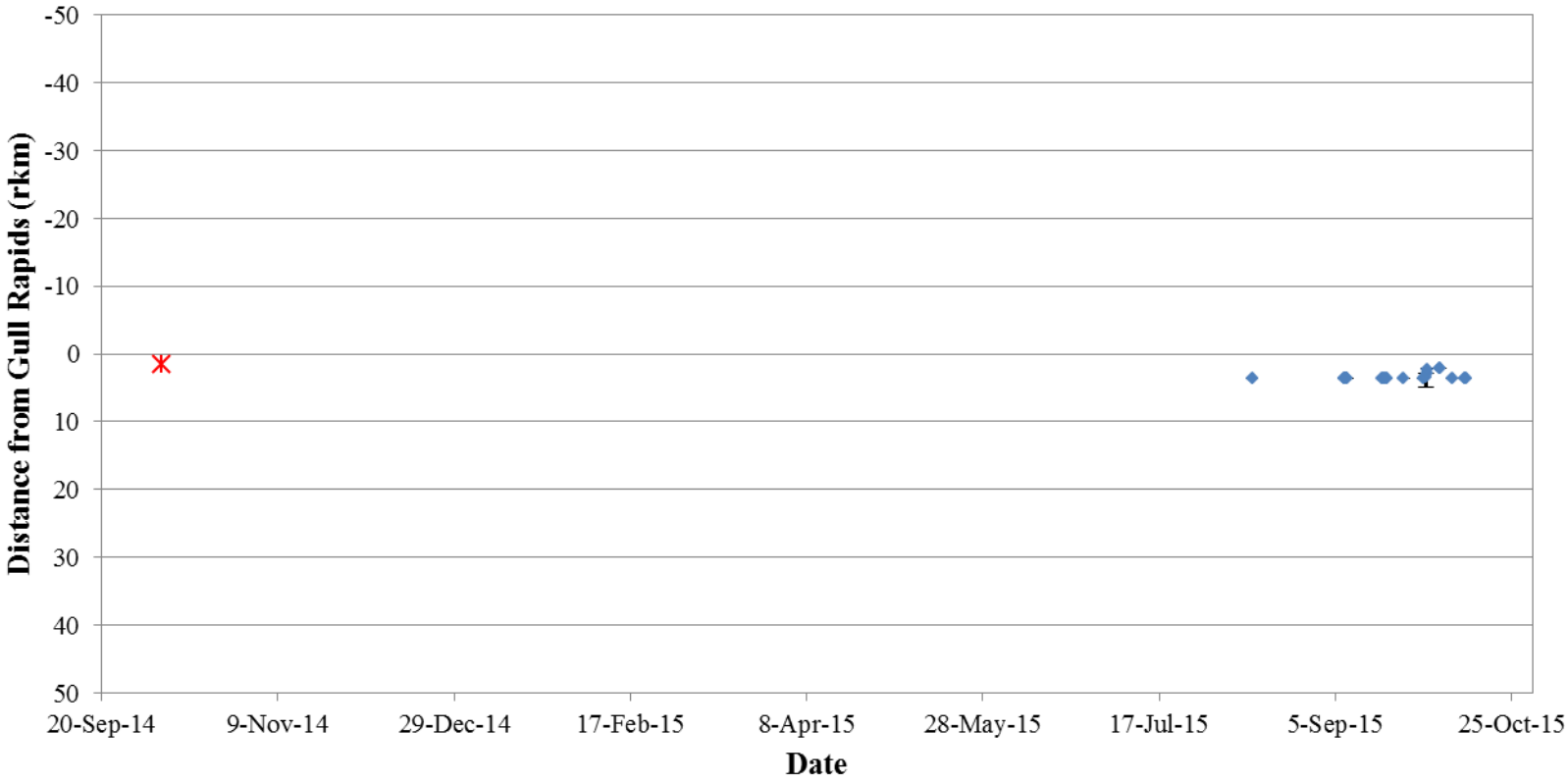


Figure A3-27: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33825) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

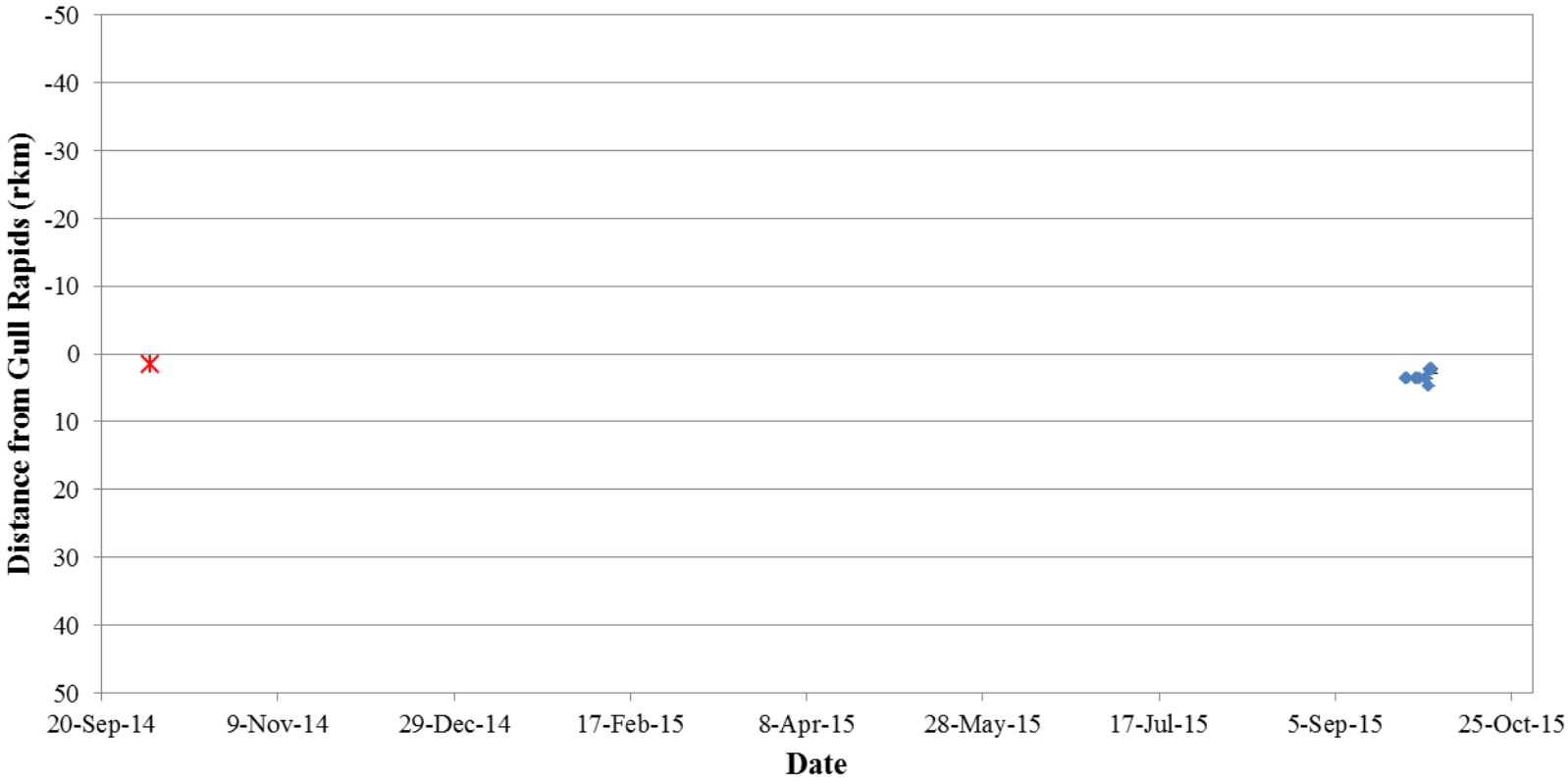


Figure A3-28: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33827) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

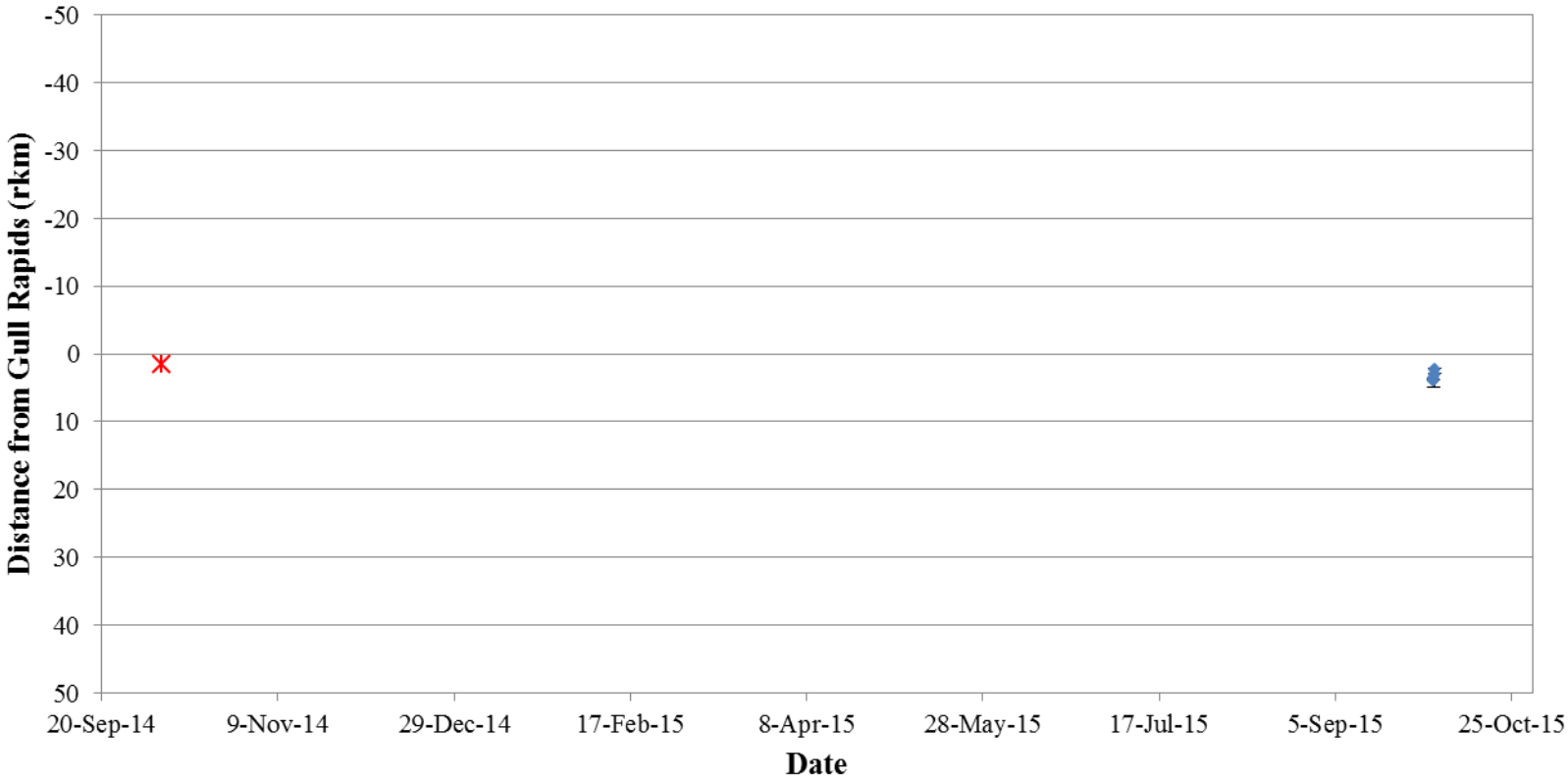


Figure A3-29: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33829) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

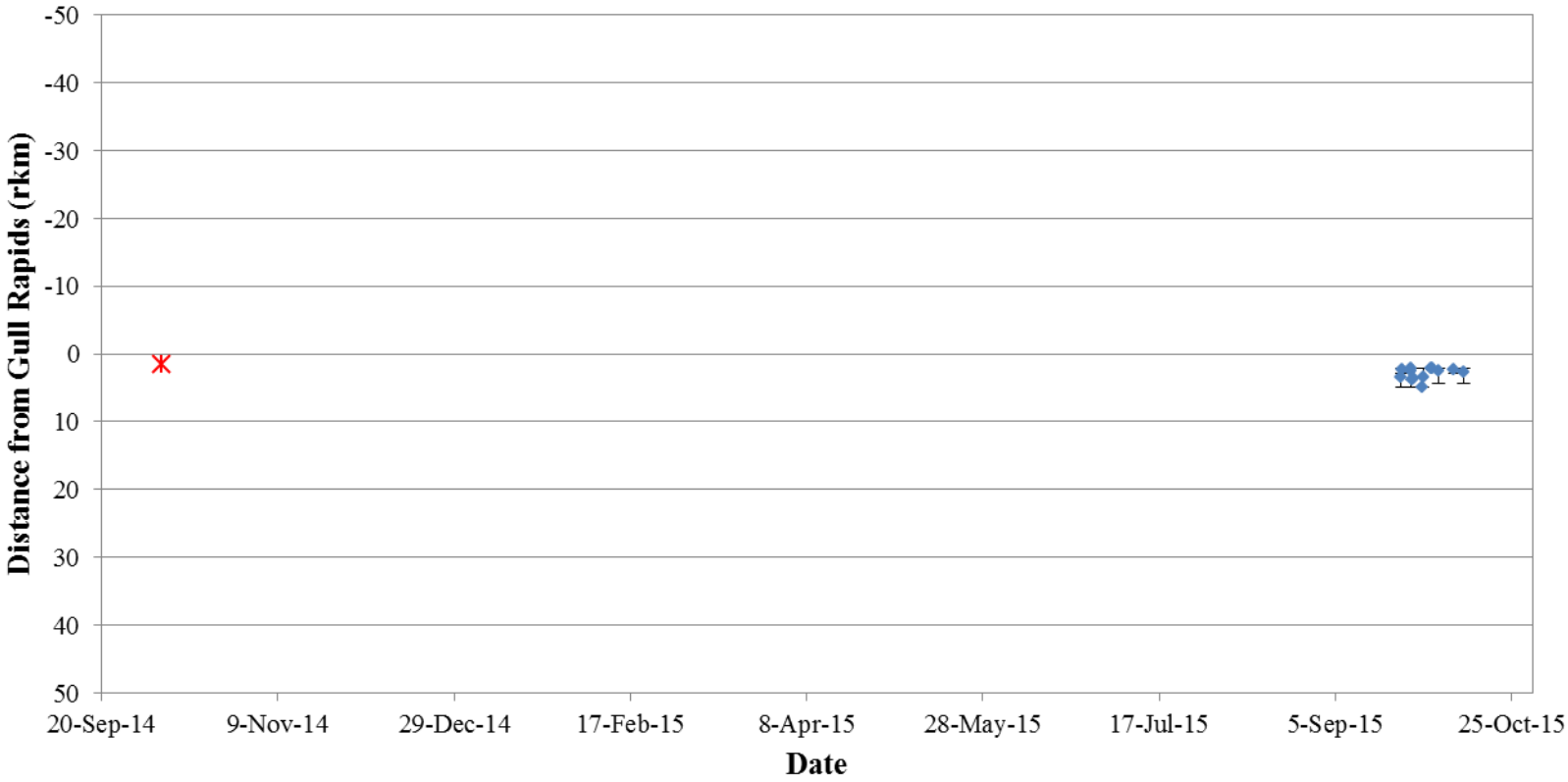


Figure A3-30: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33831) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

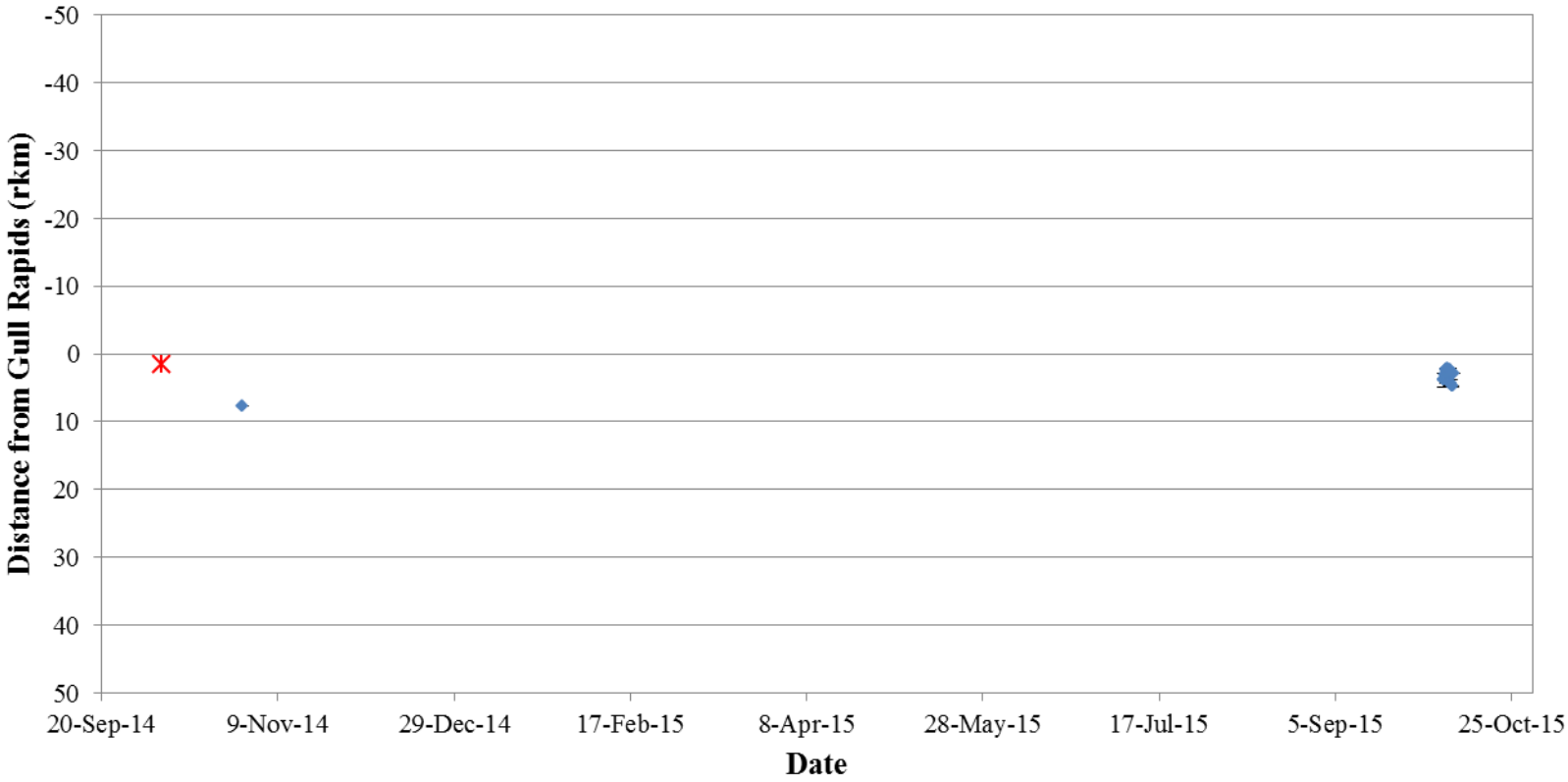


Figure A3-31: Position of a Lake Whitefish tagged with an acoustic transmitter (code #33832) in Stephens Lake, in relation to Gull Rapids (rkm 0), from October 2014 to October 2015. The date and location of tagging are indicated by a red star.

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