Keeyask Generation Project

Aquatic Effects Monitoring Plan

Juvenile Lake Sturgeon Movement Monitoring Report

AEMP-2017-02

KEEYASK

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2016 - 2017

KEEYASK GENERATION PROJECT

AQUATIC EFFECTS MONITORING PLAN

Report #AEMP-2017-02

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

Prepared for

Manitoba Hydro

By

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June 2017

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SUMMARY

Background

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

Construction of the Keeyask GS began in mid-July 2014. During 2014 and 2015, cofferdams were constructed that blocked the north and central channels and a portion of the south channel of Gull Rapids (see map below). In 2016 there was little in-stream construction prior to the completion of field studies in fall: the central portion of the Central Dam Cofferdam was widened in April/May and work on the Tailrace Summer Level Cofferdam was started on August 4 and 5 and then stopped until October. With so little in-stream construction activity prior to completing field work in the fall, possible construction-related impacts to the aquatic environment during this period were limited to indirect effects (*e.g.*, potential impacts to water quality from discharge at the cofferdam, runoff from disturbed terrestrial areas).

Lake Sturgeon were identified as one of the key species for monitoring. They were chosen because they are culturally important to local people, the local populations have been previously impacted, and construction and operation of the GS will change or negatively impact important habitat. The plan to monitor the impacts of GS construction and operation on sturgeon includes several types of studies:

- Estimating the number of adults;
- Estimating the number and growth of juveniles up to ten years old (less than 800mm);
- Identifying spawning locations and numbers of spawning fish; and
- Recording seasonal habitat use and long distance movements (*i.e.,* over GS's or rapids) through movement studies.

The movements of juvenile Lake Sturgeon in Stephens Lake were monitored in 2011 and 2012, but because different methods are being used for AEMP data collection, the results of the two programs can't be compared. Results of the 2011/2012 study showed that young Lake Sturgeon prefer to live in the deep water during the spring, summer and fall, but move into nearby, shallower habitat outside the old river channel in winter. Also, it was unusual for juvenile Lake Sturgeon to travel large distances; instead they generally stayed on the west side of the lake, in the reservoir transition zone, where water flows decreased as they entered the lake. None of the 20 tagged juvenile Lake Sturgeon in this study went upstream through Gull Rapids or downstream past the Kettle GS.

Monitoring of juvenile sturgeon movement under the AEMP began in August 2013. A Lake Sturgeon is considered to be a juvenile if it is over one year, but less than 10 years old (less than 800 mm long). This report provides results of juvenile sturgeon movement monitoring conducted from October 2015 to October 2016. The movements of juvenile Lake Sturgeon were monitored for 10.5 months prior to changes to the river (pre-construction), and have now been monitored for approximately two years and three months following the start of construction.

KEEYASK

DATA SOURCE:
Orthophoto: Manitoba Hydro - Sep 2016

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	17-MAR-17	17-MAR-17
0 0.15 0.3 Kilometres / 0 0.15 0.3 Miles	VERSION NO: 2.0	QA/QC: PMC/FSV/MWZ

Construction Site

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

Why is the study being done?

Monitoring during construction is being done to answer three questions:

Is construction affecting the area that juvenile Lake Sturgeon occupy upstream and downstream of the construction site?

Monitoring sturgeon movement shows what areas of the river the sturgeon are using and where they are choosing to stay relative to the construction site.

Are there juvenile Lake Sturgeon close to the construction site?

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

How many juvenile Lake Sturgeon are moving through and/or away from Gull Rapids during construction and how far are they going?

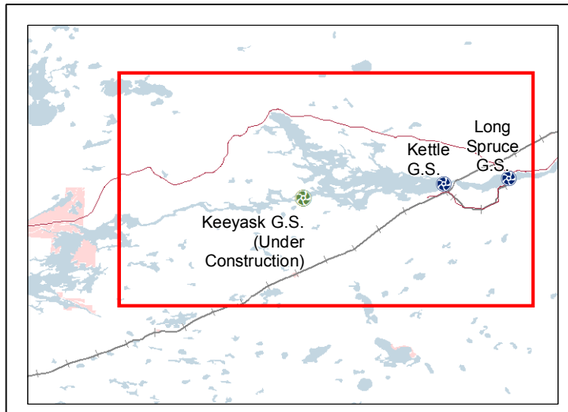
Movement studies tell us how many sturgeon are moving up or down through Gull Rapids, how far they travel up or downstream away from the site, whether they are leaving the Keeyask area completely and when they are making these movements. The distance they travel is monitored as far upstream as the inlet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

What was done?

The movements of juvenile sturgeon were tracked using acoustic telemetry. This is a technique in which a tag is surgically implanted inside a fish. The tag emits a sound signal (called a “ping”) that is picked up by receivers placed along the Nelson River between Clark Lake and the Limestone GS (see study area map below). Each fish is given a tag that transmits a unique ping which can be detected up to 1 km away from a receiver. By looking at the pings that were recorded by different receivers, the movement of each fish can be tracked. The tags are powered by batteries with a four-year life-span.

During fall 2013, 20 tags were applied to juvenile sturgeon in Gull Lake and 20 were applied to juveniles in Stephens Lake.

Surgery on juvenile Lake Sturgeon to implant acoustic tag.



N

Sky Pilot Lake
Sky Pilot
Ferris Bay
Wilson Channel
STEPHENS LAKE
River
Moswakot
South
North Access Road
280
Back
Looking
Creek
Kettle Rapids
Long Spruce Rapids
Creek
290
Long Spruce G.S.
Kettle G.S.
Creek
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Gillam
Boots
Cache Lake
Butnau
River
Morris Point
Keeyask G.S. (Under Construction)
Gull Rapids
Gillrat Lake
GULL LAKE
RIVER
NELSON
Birthday Rapids
Carscadden Lake
Joslin Lake
Clark Lake
SPLIT LAKE
Wapikopaw Lake
Butnau Lake
Butnau
River
Kettle
North
Angling
Lakes
Little Kettle Lake
Kettle Lake

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	16-FEB-17
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

Legend

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

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

2016 Acoustic Receivers
Clark Lake to Limestone Reservoir

Map showing study area. The dots represent the locations of receivers in the river. The different colours represent receivers that were in the river at different times of the year.

What was found?

How far and where sturgeon moved depended on the individual fish and whether they lived in Gull Lake or Stephens Lake. The sturgeon that were tagged in Gull Lake in 2013 stayed in Gull Lake. The sturgeon that were tagged in Stephens Lake stayed in Stephens Lake, except for two fish. One fish moved downstream past the Kettle GS (either through a turbine or over the spillway) into the Long Spruce reservoir in 2014. This fish was detected moving around in the Long Spruce reservoir in 2016. Another fish moved out of Stephens Lake through the Kettle GS in 2016; once again, it's unknown whether this fish moved downstream over the spillway or through a turbine. This fish was detected moving around the Long Spruce reservoir during the summer of 2016 and then moved downstream through the Long Spruce GS in September 2016.

Juvenile Lake Sturgeon

Juvenile sturgeon in Stephens Lake moved farther than sturgeon in Gull Lake, both during the winter and open-water seasons. This is probably because Stephens Lake has more of the deep water areas that juvenile sturgeon like to live in. In Gull Lake, there are fewer areas with deep water and so sturgeon stay in these areas.

None of the tagged juvenile sturgeon moved from Gull Lake to Stephens Lake or Stephens Lake to Gull Lake through Gull Rapids. This is different from adult Lake Sturgeon, as some adults have moved upstream and downstream over the rapids. The fast current of the rapids likely blocks the smaller juveniles from moving upstream from Stephens Lake to Gull Lake, but they should be able to move downstream easily if they wanted to. Juvenile sturgeon in Gull Lake do not spend very much time close to the construction site but the ones in Stephens Lake do spend time right below the rapids.

Monitoring movements in winter is challenging because of ice conditions. Ice has damaged receivers set in channels as deep as 17 m. For this reason, receivers are left in only a few locations, making it less likely that sturgeon will be detected. However, during winter in both Stephens and Gull lakes, juvenile sturgeon have been detected in deeper areas with little current, and most appear to move very little. In 2013, 2014, and 2015, ice booms were installed upstream of Gull Rapids to promote the formation of a solid ice cover upstream of Gull Rapids, which reduces the formation and amount of frazil ice. In 2013 and 2014, the ice booms failed, but in 2015 they worked and stable ice cover formed in Gull Lake. There were many more detections at receivers in Stephens Lake during winter 2015/2016 compared to the previous two winters. This was attributed to the reduction of frazil ice as a result of the ice booms. Frazil ice creates noise which reduces the detection of acoustic signals from the tags. During the summer, juvenile sturgeon moved farther than they did during the winter. Juvenile sturgeon tended to

move downstream in Stephens Lake in the late summer, which may be because ice builds up below Gull Rapids in the winter and the sturgeon choose to avoid the ice.

What does it mean?

For the most part, monitoring has shown that juvenile sturgeon tend to stay in the same area year after year. Since monitoring began in August 2013, no tagged juvenile Lake Sturgeon have moved upstream or downstream through Gull Rapids and two fish tagged in Stephens Lake have moved downstream past the Kettle GS. Juvenile sturgeon in Gull Lake do not use the area around the construction site very much, but the sturgeon in Stephens Lake do spend time around the site. The movement of juvenile sturgeon will continue to be monitored as construction of the Keeyask GS continues.

Information collected so far shows that juvenile sturgeon usually do not move great distances and that they live in similar locations year after year. How far sturgeon move may also depend on the habitat that they have. For example, they may move farther when they have access to a long stretch of deep river channel. For this reason, the movements of sturgeon may change after the GS is built and Gull Lake becomes part of a deep reservoir.

What will be done next?

The acoustic tags that were implanted in 2013 will last until 2017. In 2017, 40 additional tags will be applied to juvenile Lake Sturgeon, 20 in Gull Lake and 20 in Stephens Lake. Tracking individual fish over several years will provide more information about what kinds of habitats these fish need to use over many years. It will also be possible to see if the behaviour of the fish is changing as the construction of the Keeyask GS continues and the fish age and grow.

ACKNOWLEDGEMENTS

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STUDY TEAM

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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 Gilliam (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 licencing 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, juvenile Lake Sturgeon movement, for the construction and operation phases of the Project.

Monitoring of juvenile Lake Sturgeon movements was initiated in 2011, but the program was specifically focused on gaining a better understanding of juvenile Lake Sturgeon habitat preferences (water depth, water velocity and substrate type) within the Stephens Lake (Map 1). As pre-Project studies were not designed to record detailed movement patterns of in the Clarke Lake to Stephens Lake reach as a whole, their results are not directly comparable to the movement data being collected under the AEMP, but they provided valuable insights into the behaviour of this life history stage in Stephens Lake (McDougall et al 2013b, 2013c). Data were collected across three seasons (open-water 2011, winter 2011/2012, and open-water 2012), and results suggested that during periods of open water, juvenile Lake Sturgeon preferred deep-water habitat within the old river channel in the upper 6 km of Stephens Lake (an area known as the reservoir transition zone, where velocity decreases and substrate transitions from cobble to gravel to sand and silt). They moved into nearby, shallower habitat outside the old river channel during winter, possibly to avoid ice scour, but returned to the reservoir transition zone after ice-off, suggesting that the home range for this life stage is small. None of the 20 tagged juvenile Lake Sturgeon in this study were observed to go upstream through Gull Rapids or downstream through the Kettle GS.

The Keeyask AEMP juvenile Lake Sturgeon movement monitoring program was initiated in August 2013 when 40 juvenile Lake Sturgeon were tagged with acoustic transmitters, 20 in Gull Lake and 20 in Stephens Lake (Map 1). Lake Sturgeon in the study area are classified as juveniles if they are between one and ten years of age. In Gull and Stephens lakes, this age generally corresponds to sturgeon with a fork length that is less than 800 mm (Henderson *et al.* 2014).

The overall aim of this monitoring study is to describe juvenile Lake Sturgeon movement during the pre-construction (2013 – July 2014) and construction (July 2014 – 2021) phases of the Project and to determine if disturbances associated with construction alter habitat use and coarse-scale movement patterns upstream and downstream of the Project (Map 2). Results will assist in identifying the use of key habitats (*i.e.*, rearing and foraging) during construction, the potential vulnerability of sturgeon to activities at the construction site (*i.e.,* if sturgeon use the area in the immediate vicinity of the construction site they may be vulnerable to stranding during dewatering), and the potential for increased emigration or avoidance of the construction site due to disturbance (*i.e.,* blasting, suspended sediment inputs, *etc*.).

The key questions for juvenile Lake Sturgeon movement monitoring during construction include:

- Do disturbances associated with construction alter coarse-scale movement/habitat use upstream and/or downstream of the construction site?
- Are sturgeon using habitat in the immediate vicinity of the construction site?
- Does the frequency of long-distance movements (and subsequent downstream emigration/entrainment) by juvenile Lake Sturgeon increase during construction?

This report provides results from October 2015 to October 2016 which is the second winter and third open-water period of monitoring conducted since construction of the Keeyask GS began in July 2014. The study area for the Lake Sturgeon movement study in 2016 extended from Clark Lake to the upper portion of the Limestone reservoir (Map 1). Results of previous years study dating back to 2013 are presented in Hrenchuk and Barth (2014); Lacho *et al.* (2015); and Lacho and Hrenchuk (2016).

2.0 STUDY SETTING

The study area for the juvenile Lake Sturgeon movement monitoring program encompasses an approximately 110 km long reach of the Nelson River from Clark Lake to the upstream end of the Limestone reservoir. This section of river offers a diversity of physical habitat conditions, including a variety of substrate types, and variable water depths (range 0–30 m) and velocities. Water velocities were classified as low (0.2–0.5 metres per second [m/s]), moderate (0.5–1.5 m/s), or high (greater than 1.5 m/s), as described in the Keeyask AE SV.

Clark Lake is located immediately downstream of Split Lake, and approximately 42 km upstream of Gull Rapids (Map 1). Current is restricted to the main section of the lake, with off-current bays outside the main channel. The Assean River is the only major tributary to Clark Lake, and flows into the north side. Downstream from the outlet of Clark Lake, the Nelson River narrows and water velocity increases for a 3 km stretch, known as Long Rapids. For the next 7 km, the river widens, and water velocity decreases.

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

Gull Lake is a section of the Nelson River where the river widens, with moderate to low water velocity. Gull Lake is herein defined as the reach of the Nelson River beginning approximately 17 km upstream of Gull Rapids and 14 km downstream of Birthday Rapids, where the river widens to the north into a bay around a large point of land (Maps 1 and 3), and extending to the downstream end of Caribou Island, approximately 3 km upstream of Gull Rapids. Gull Lake has three distinct basins, the first extending from the upstream end of the lake downstream approximately 6 km to a large island; the second extending from the large island to Morris Point (a constriction in the river immediately upstream of Caribou Island); and the third extending from Morris Point to the downstream end of Caribou Island (Map 3).

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

Just below Gull Rapids, the Nelson River enters Stephens Lake. Stephens Lake was formed in 1971 by construction of the Kettle GS. Between Gull Rapids and Stephens Lake there is an approximately 6 km long reach of the Nelson River that, although affected by water regulation at the Kettle GS, remains riverine habitat with moderate velocity. Construction of the Kettle GS flooded Moose Nose Lake (north arm) and several other small lakes that previously drained into

the Nelson River, as well as the old channels of the Nelson River that now lie within the southern portion of the lake (Map 4). Major tributaries of Stephens Lake include the North and South Moswakot rivers that enter the north arm of the lake. Looking Back Creek is a second order stream that drains into the north arm of Stephens Lake (Map 1). Kettle GS is located approximately 40 km downstream of Gull Rapids.

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

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

2.1 CONSTRUCTION SUMMARY

Construction of the Keeyask GS began in mid-July 2014 with the construction of cofferdams in the north and central channels of Gull Rapids. These cofferdams resulted in the dewatering of the north and central channels and the diversion of all flow to the south channel. Construction of the spillway cofferdam, which extends into the south channel of Gull Rapids, was completed in 2015.

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

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

3.0 METHODS

3.1 ACOUSTIC TELEMETRY

Acoustic telemetry involves tracking movements of fish surgically implanted with internal acoustic transmitters (tags). Each transmitter emits a unique signal, recognizable by stationary receivers. When tagged fish come into range of a receiver (generally within 500 m to 1 km, depending on conditions), the transmitter code number, as well as the date and time, are stored in the receiver. Initially, the receiver array was designed to monitor adult Lake Sturgeon (Hrenchuk and Barth 2017), however the same array is also used to monitor juvenile Lake Sturgeon, Walleye (Hrenchuk and Lacho 2017), and Lake Whitefish (Burnett and Hrenchuk 2017).

3.1.1 ACOUSTIC TRANSMITTER APPLICATION

Acoustic transmitters (model # Vemco V13-1x, estimated 1480 day battery life) were applied to 40 fish in August and September 2013; 20 upstream and 20 downstream of Gull Rapids (tables 1 and 2). Tagged Lake Sturgeon had fork lengths ranging from 450 to 668 mm, which corresponds to juvenile fish based on length at age relationships for Lake Sturgeon in Gull and Stephens lakes (Henderson *et al.* 2014).

3.1.2 ACOUSTIC RECEIVERS

Since 2011, stationary acoustic receivers (VEMCO model VR2 and VR2W) have been used to continuously monitor tagged adult Lake Sturgeon in the Nelson River between Clark Lake and the Long Spruce GS. In 2016, the study area was extended further downstream as two receivers were placed downstream of the Long Spruce GS in the Limestone reservoir.

During the first three years of the construction phase of the project (2014 – 2016), receivers were deployed at the same sites as those established during the pre-construction phase (2011–2013). During the open-water period, receivers were deployed in calm water with a flat bottom free of large debris to maximize detection range, and spaced along the main river channel throughout the study area to maximize spatial coverage. In Stephens Lake, receivers were placed at locations within pre-flood river channels, based on the observation that sturgeon tend to stay within channels, even in flooded environments. At constrictions within the river channel, a series of receivers were deployed to create “gates” with the intent of recording all fish that passed by the river cross-section.

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 2013). Because it appears that receivers will only remain safe from ice if deployed at depths greater than 10 m, the number of possible receiver locations during winter, especially in Gull Lake, is limited.

3.1.2.1 WINTER PERIOD 2015/2016

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

There were several differences between the winter 2014/2015 receiver array and the winter 2015/2016 array. Two receivers were added to the array in Stephens Lake in 2015/2016 to increase detection coverage: #114226 at rkm 9.9; and #114241 at rkm 26.0 (Map 4). Two receivers set at rkm 6.1 and 6.3 downstream of the Keeyask GS construction site were lost in 2014/2015 and were not reset in 2015/2016.

3.1.2.2 OPEN-WATER PERIOD 2016

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

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

Receiver “gates” were deployed in several key areas: four between Clark Lake and Gull Rapids (44.0, 34.0, 19.0, and 10.0 rkms upstream of Gull Rapids), and two in Stephens Lake (4.5 and 40.0 rkms downstream of Gull Rapids) (Maps 6 and 7). Receiver “gates” consisted of two or more acoustic receivers set parallel to flow to provide complete signal coverage of a river cross-section. Areas between the “gates” were referred to as river zones. Receiver gates provide confidence that movements past key points are being detected, which allows for interpolation of coarse-scale positions (*i.e*. which zone) during periods which fish remain undetected. Should a

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

3.1.3 DATA ANALYSIS

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

Movements were analysed in terms of rkm distance, with the base of Gull Rapids representing a distance of 0 rkm. The area located downstream of Gull Rapids (*i.e.*, Stephens Lake and the Long Spruce reservoir) were given positive (+) distance values from Gull Rapids, while the area located upstream (*i.e.*, Gull and Clark lakes) were given negative (-) distance values (Figures 1 and 2). The average rkm distance from Gull Rapids was calculated over a 4-hour interval and plotted versus time for each fish. Total detection ranges were calculated by subtracting the furthest downstream detection location from the location of the furthest upstream detection. Proportion of time all fish spent within each river zone was calculated and plotted.

4.0 RESULTS

Section 4.1 provides a summary of movements since the study began in 2013 up until winter 2015/2016. Tables 1 to 6 provide detection summaries, acoustic tag and biological information associated with each tagged fish. Figures 1 to 14 and maps 3 to 8 provide maps of receiver locations, movement range, and proportional distribution of tagged fish both upstream and downstream of the construction site by season. Appendices 1 and 2 provide movement summaries, by rkm, for each tagged sturgeon since the study began in late August 2013.

4.1 2013–2015 RESULTS SUMMARY

4.1.1 UPSTREAM OF GULL RAPIDS

Twenty juvenile Lake Sturgeon were tagged in Gull Lake in August 2013 (Table 1). Nineteen of the twenty juveniles have been regularly detected since the study began. One was not detected in 2014 but was detected again during the open-water period of 2015. Therefore, all 20 fish were available for detection upstream of Gull Rapids during the winter 2015/2016 period.

To date, all the tagged juvenile Lake Sturgeon that have moved downstream past generating stations on the Nelson River did so when the spillway was operational, so it is unknown whether these fish moved over the spillway or through one of the turbines.

4.1.2 DOWNSTREAM OF GULL RAPIDS

Twenty juvenile Lake Sturgeon were tagged in Stephens Lake in September 2013 (Table 2). One (#32699) has not been detected since November 2013 (Appendix A2-19). This fish was not included in analyses and is not discussed in the remainder of the report. Another juvenile (#32662) tagged in Stephens Lake moved downstream through the Kettle GS into the Long Spruce reservoir between December 2013 and July 2014 and has been regularly detected in the reservoir since then (Appendix A2-2). Therefore, there were 18 juvenile Lake Sturgeon in Stephens Lake and one in the Long Spruce reservoir available to be detected during the winter 2015/2016 period.

4.2 WINTER 2015/2016

4.2.1 UPSTREAM OF GULL RAPIDS

All four of the acoustic receivers deployed in the Nelson River between Clark Lake and Gull Rapids during winter 2015/2016 were retrieved (Map 3). Ten of the 20 juvenile Lake Sturgeon available to be detected were located. A total of 57,652 detections were recorded at the three receivers at rkms -9.9, -11.1, and -19.5; there were no detections at the receiver at rkm -48.2 in Clark Lake (Table 3; Figure 3). The number of detections per fish ranged from three to 19,370 (Table 3). The vast majority of detections occurred at the receiver at rkm -9.9 (Figure 4). Fish were detected for an average of 26 days of the 202 day winter period (StDev = 37.4 days) and the number of days fish were detected ranged from one to 113 (Table 3). Individual movements are summarized in Appendix 1.

4.2.2 STEPHENS LAKE

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

In total, 208,995 detections were logged by 17 of the 18 fish available for detection in Stephens Lake, ranging from two to 33,216 detections per individual (Table 4). Fish were detected between one and 192 days of the 202 day winter period (mean: 96.0 days; StDev = 53.0 days) (Table 4). The mean detection range was 4.0 rkm (StDev = 4.5 rkm; range 0.0–13.3 rkm) (Table 4, Figure 5). Similar to Gull Lake, the vast majority of detections occurred at one receiver, at rkm 14.9 (Figure 6).

Three patterns of movement were observed:

- Nine of the eighteen fish remained in the upper end of Stephens Lake at, or upstream of rkm 10.5 for the entire winter period (Section 4.1.2.1).
- Three were detected in both the upstream and downstream (downstream of rkm 10.5) portions of Stephens Lake (Section 4.1.2.2).
- Three fish were only detected in the downstream portion of Stephens Lake (Section 4.1.2.3)

4.2.2.1 UPPER STEPHENS LAKE

Nine juvenile Lake Sturgeon remained in the upper reaches of Stephens Lake throughout the winter (Table 4; Figure 5).

- Four (#32661, #32664, #32670 and #32700) were detected only at rkm 7.7 (appendices A2-1, A2-4, A2-10, and A2-20).
- One (#32680) was only detected at rkm 7.9, in the former channel of the Moosenose River. It was detected at this site throughout the winter (Appendix A2-14).
- One (#32667) was only detected at rkm 9.9. It was detected regularly during the winter (Appendix A2-7).
- Three (#32666, #32675, and #32697) were detected between rkm 7.7 and rkm 10.2 throughout the winter (appendices A2-6, A2-13, and A2-17).

4.2.2.2 MOVEMENTS THROUGHOUT STEPHENS LAKE

Four juvenile Lake Sturgeon moved between upper (rkm 7.7–10.5) and lower (rkm 10.5–21.0) Stephens Lake during the winter period (Table 4).

- #32665 was detected between rkm 7.7 and rkm 10.2 until December 28, 2016. It then moved downstream and was detected from January to April between rkm 18.7 and rkm 21.0 (Appendix A2-5).
- #32674 was detected between rkm 9.9 and 14.9 throughout the winter period (Appendix A2-12).
- #32696 was detected between rkm 9.0 and 21.0 during the winter (Appendix A2-16).
- #32698 was detected between rkm 9.0 and 18.7 regularly during the winter (Appendix A2-18).

4.2.2.3 LOWER STEPHENS LAKE

Four juvenile Lake Sturgeon were located exclusively in lower Stephens Lake (rkm 14.9–40.8) over the winter (Table 4).

- #32668 was detected at rkm 14.9 consistently from the beginning of the winter until December 17, 2015. It was then detected regularly at rkm 18.7 from January 5, 2016 until February 2, 2016. It then moved back upstream and was detected at rkm 14.9 for the remainder of the winter (Appendix A2-8).
- #32669 was detected exclusively at rkm 14.9 during winter (Appendix A2-9).
- #32673 was detected at rkm 14.9 consistently until January 11, 2016, after which it was detected at rkm 18.7 and 21.0 until February 3. It was not detected again until the open-water season (Appendix A2-11).
- #32685 was detected at rkm 14.9 consistently until January 1, 2016. It then moved downstream to rkm 26 on March 10, 2016 (Appendix A2-15).

4.2.3 LONG SPRUCE RESERVOIR

The single receiver set in the Long Spruce reservoir at rkm 44.9 was retrieved after the winter (Map 5). The one juvenile Lake Sturgeon (#32662) in the Long Spruce reservoir was detected at this receiver a total of 7,702 times between October 12 and December 12, 2015. It was not detected again until the open-water season of 2016 (Table 4, Appendix A2-2).

4.3 OPEN-WATER 2016

4.3.1 ACOUSTIC RECEIVER RETRIEVAL

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

4.3.2 UPSTREAM OF GULL RAPIDS

Nineteen of the twenty juvenile Lake Sturgeon available for detection were located during the 2016 open-water season (Table 5). These fish were detected between three and 36,590 times over one to 144 days of the 172 day open-water period (average = 94.5 days; StDev = 40.7 days) (Table 5). The one sturgeon that was not detected, #32686, was last located at rkm -9.3 on July 14, 2015 (Appendix A1-16).

Juvenile Lake Sturgeon upstream of Gull Rapids had a mean movement range of 5.2 rkm (StDev = 3.9 rkm; range: 0–13.7 rkm) (Table 5; Figure 7) and were only detected in the two zones closest to Gull Rapids (zones 4 and 5). The majority of detections occurred at the receivers located between rkms -9 and -11.8 (Figure 8). Only one juvenile Lake Sturgeon (#32691; Appendix A1-16) was detected at the receiver closest to Gull Rapids (rkm -5.8) (Map 6). No fish were detected farther upstream than rkm -19.5, where the Nelson River enters Gull Lake (Table 5). Juvenile Lake Sturgeon spent more time in Zone 4 (mean = 73.1%; StDev = 44.9%) than Zone 5, which is closest to Gull Rapids (mean = 26.9%; StDev = 44.9%) (Figure 9). Juvenile Lake Sturgeon spent less time in Zone 5 in 2016 than in 2015 and made fewer inter-zone movements than they did in 2014 and 2015.

Five fish were detected exclusively in Zone 5 during the open-water season (Figure 9):

- #32689 was detected between rkms -9.0 and -7.4 (Appendix A1-14).

- #32690 was only detected at rkm -9.3 for three days of the open-water season (Appendix A1-15)
- #32692, #32694 and #32695 were detected between rkms -9.3 and -7.4 (appendices A1-17, A1-19, and A1-20).

Thirteen fish were detected exclusively within Zone 4. All of these fish were detected at the farthest downstream receiver in Zone 4 (rkm -9.5) during the open water season.

- Four juveniles (#32671, #32679, #32683, and #32693) were detected at the farthest upstream receiver in Zone 4 at rkm -19.5 (appendices A1-1, A1-6, and A1-18).
- One (#32676) moved upstream as far as rkm -17.4 (Appendix A1-3).
- Two (#32672 and #32681) were detected as far upstream as rkm -14.8 (appendices A1-2 and A1-7).
- Five (#32677, #32678, #32682, #32684, and #32687) moved upstream to rkm -12.9 (appendices A1-4, A1-5, A1-8, A1-10, and A1-12)
- #32688 only moved 0.6 rkm upstream to rkm -10.1 (Appendix A1-13).

Only one juvenile Lake Sturgeon was detected in both zones 4 and 5:

- #32691 was detected mainly in Zone 5, with 89.5% of its detections occurring in this location, but made multiple movements between the two zones during the open-water season. It had the highest movement range (13.7 rkm) of any fish in Gull Lake. It was the only fish detected at the farthest downstream receiver in Gull Lake, at rkm -5.8 and it moved up to rkm -19.5 at the upstream end of Zone 4 (Figure 9, Appendix A1-16).

4.3.3 DOWNSTREAM OF GULL RAPIDS

All of the eighteen fish available for detection in Stephens Lake were detected during the open-water period. Juveniles were detected between 196 and 16,855 times over 9 to 142 days of the 172 day study period (average = 97.8 days; StDev = 34.8 days) (Table 6). Located fish had a mean movement range of 11.6 rkm (StDev = 6.6 rkm; range: 0.0–22.3 rkm; Figure 11). The highest number of detections occurred at the receivers at rkms 4.4, 4.5 and 13.9 (Figure 12). On average, sturgeon spent slightly more time in Zone 7, the zone farther away from Gull Rapids (average = 59.1%, StDev = 33.5%), than in Zone 6 (average = 51.0%; StDev = 30.1%) (figures 13 and 14). In general, the relative amount of time spent in Zone 6 increased as summer progressed, then decreased after mid-August (Figure 14).

One juvenile Lake Sturgeon (#32685) that was last detected in Stephens Lake at rkm 26 in March 2016 was next detected in the Long Spruce reservoir on June 9. It was detected regularly in the Long Spruce reservoir at rkms 42.7 and 44.9 until September 9. On September 22 it was detected downstream of the Long Spruce GS in the Limestone reservoir at rkm 58.6 (Table 6, Appendix A2-15).

For the seventeen fish that remained in Stephens Lake during the open-water period:

- Two remained in the lower portion (Zone 7) of Stephens Lake (Section 4.2.2.2.); and
- Fifteen were detected in both zones in Stephens Lake (Section 4.2.2.3.).

4.3.3.1 LOWER STEPHENS LAKE

Two juvenile Lake Sturgeon were only detected in Zone 7 during the open-water period (Map 7):

- #32667 was detected periodically at rkm 9.9 on May 5 and 25 and then sporadically at rkm 10.3 between June 11 and 22. It was not detected for the remainder of the open-water season (Appendix A2-7).
- #32680 was located in the former channel of the Moosenose River. It was detected intermittently at rkms 7.9 and 6.5 throughout the open water season (Appendix A2-14).

4.3.3.2 MOVEMENTS THROUGHOUT STEPHENS LAKE

The remaining 15 sturgeon were located throughout Stephens Lake.

- #32700 was detected at receiver #114227 at rkm 6.5 in the area corresponding to the former Moosenose River channel (Map 7). It was detected in this area between June 29 and July 2, then was detected in the southern portion of the lake for the remainder of the open water season (Appendix A2-20).
- Fourteen of the fifteen fish were detected for at least one day at the receiver closest to Gull Rapids at rkm 1.2 during the open-water season:
    - #326664 was only detected at this location on June 22 (Appendix A2-4).
    - The rest of the fish were detected at this receiver sporadically during the open-water season.
        - Three (#32661, #32670, and #32700) were detected sporadically between June and September (appendices A2-1, A2-10, and A2-20).
        - Three (#32663, #32665, and #32696) were detected here in August and September (appendices A203, A2-5, and A2-16).
        - #32666 was detected occasionally between May and the beginning of October (Appendix A2-6).
        - #32668 was detected on only three days during the open water season: June 4, July 29, and August 7 (Appendix A2-8).
        - #32669 was detected only from June 14-17 (Appendix A2-9).
        - #32673 was detected intermittently between late June and mid-August (Appendix A2-11).

- Two (#32674 and #32675) were only detected at this location for a few days in July (appendices A2-12 and A2-13).

- Only one (#32700) was detected as far downstream as rkm 23.0 (Table 6; Appendix A2-20). The rest of the fish were detected no farther downstream than rkm 19.8.
- Three fish (#32661, #32664, and #32697) had over 95% of their detections occurring in Zone 6, which is the closest to Gull Rapids (Figure 13, appendices A2-1, A2-4, and A2-17).

4.3.4 LONG SPRUCE RESERVOIR

The one juvenile Lake Sturgeon (#32662) in the Long Spruce reservoir was detected during the open water season of 2016 (Table 6, Appendix A2-2). This individual was regularly detected at rkm 44.9 between May 22 and October 13, 2016 (Appendix A2-2).

5.0 DISCUSSION

This study was initiated in 2013 with the long-term objective of assessing the impacts of construction and operation of the Keeyask GS on juvenile Lake Sturgeon movement. As predicted in the AEMP and the Keeyask EIS, potential impacts include increased emigration from the population, mortality at the GS structure, and the loss of critical habitats.

Juvenile Lake Sturgeon were tagged in late summer of 2013, and construction of the Keeyask GS began in July 2014. Results collected prior to October 2015 suggested that juvenile Lake Sturgeon in both Gull and Stephens lakes remain in similar locations year after year and occupy relatively small home range areas, a result that is similar to other studies (Holtgren and Auer 2004; Smith and King 2005; Barth *et al*, 2011; Trested *et al*. 2011, McDougall *et al*. 2013a, McDougall *et al*. 2013b, McDougall *et al*. 2013c).

After two years and two months of monitoring, all tagged sturgeon remained in the respective water body in which they were tagged, with the exception of one. A juvenile Lake Sturgeon tagged in Stephens Lake moved downstream through the Kettle GS into the Long Spruce reservoir before construction of the Keeyask GS began (between December 2013 and July 2014).

In general, those juvenile sturgeon tagged in Stephens Lake moved over a greater distance than those in Gull Lake, which is likely related to the greater quantity of deep water habitat available downstream of Gull Rapids (McDougall *et al.* 2013b, McDougall *et al.* 2013c)

Data included in this report represent the second winter and full open-water season of data collection since construction of the Keeyask GS commenced. The transmitters currently being monitored have an approximate four-year lifespan and will therefore last until 2017. In 2017, the study will be repeated, meaning a similar number of juvenile Lake Sturgeon will be tagged and their movements will be monitored until 2021. The discussion below highlights movement patterns observed since the study was initiated and discusses key questions from the AEMP with respect to potential impacts of construction on the movements of juvenile Lake Sturgeon.

5.1 EVALUATION OF METHODOLOGY

Acoustic telemetry continues to be an effective method for monitoring juvenile Lake Sturgeon movements in the study area during the open-water period. Since 2014, detection frequency has remained high. In 2016, 39 of the 40 juvenile Lake Sturgeon implanted with transmitters in 2013 were detected during the open-water period. Of these, 27 were detected for more than 50% of the total days available during the open-water period (compared to 28 in 2015 and 31 in 2014) and 12 of the 39 were detected for more than 70% of the open-water period (compared to 10 in both 2015 and 2014; Lacho and Hrenchuk 2016, Lacho *et al.* 2015). Detection frequency during winter is lower due to the reduced number of receivers that are deployed. However, this

should not compromise the ability to address the key questions of the study because juvenile Lake Sturgeon move over a limited spatial extent year-round.

There was a notable increase in detection frequency of fish in Stephens Lake during the 2015/2016 winter period. During winter 2013/2014, 19 of the 20 fish in Stephens Lake were detected for an average of 27.7% of the period (Lacho *et al.* 2014). In 2014/2015, 18 fish were detected for an average of 18.6% of the winter period (Lacho and Hrenchuk 2016). In winter 2015/2016, 18 fish were also detected; however, the mean percentage of days detected increased to 46.3%. The increased detection frequency during the winter period of 2015/2016 is likely due to the success of the ice booms installed upstream of Gull Rapids, allowing a stable ice cover to form on Gull Lake and preventing the formation of frazil ice from moving downstream through Gull Rapids and building up in Stephens Lake. It is believed that movements of frazil ice during previous winters created noise that reduced the detection efficiency of the acoustic receivers.in Stephens Lake.

5.2 KEY QUESTIONS

The key questions, as described in the AEMP, for juvenile Lake Sturgeon movement monitoring during construction of the Keeyask GS are as follows:

Will the frequency of long-distance movements (and subsequent downstream emigration/ entrainment) by juvenile Lake Sturgeon increase during construction and operation of the project?

Since monitoring began in 2013, no tagged juvenile Lake Sturgeon has moved downstream through Gull Rapids. As of October 2016, two of the twenty juvenile Lake Sturgeon tagged in Stephens Lake have moved downstream through the Kettle GS. One of the fish passed through the station between December 2013 and July 2014 before construction began (Lacho *et al.* 2015). In 2016, a second juvenile Lake Sturgeon moved downstream through the Kettle GS and then moved downstream through Long Spruce GS. Both fish survived passage past the generating stations. None of the fish tagged in Stephens Lake have moved through Gull Rapids. Based on these data, the frequency of long-distance movements has not increased during construction.

To date, no juvenile Lake Sturgeon have moved permanently out of Gull Lake, either upstream or downstream. As construction progresses and Gull Lake becomes a reservoir, movement patterns of juvenile Lake Sturgeon may change.

Are juvenile Lake Sturgeon using habitat in the immediate vicinity of the construction site?

As in previous years (Lacho and Hrenchuk 2016, Lacho *et al.* 2015), juvenile Lake Sturgeon upstream of Gull Rapids do not frequently utilize habitat in the vicinity of the construction site. Only one juvenile Lake Sturgeon was detected at the receiver closest to Gull Rapids, at rkm -5.8 in 2016. This fish moved downstream, was detected at this receiver for three days during the

summer, and then moved back upstream. In addition, only four fish were detected at the second-closest receiver to Gull Rapids at rkm -7.4. In 2015, no juveniles were detected at the receiver closest to Gull Rapids (Lacho and Hrenchuk 2016), while in 2014, two juveniles were detected at this receiver (Lacho *et al.* 2014). Similar to previous years' observations, juvenile Lake Sturgeon in Gull Lake are not moving away from the construction site, as all detections were in the two zones closest to Gull Rapids. In 2015, only one juvenile Lake Sturgeon made a movement upstream of Zone 4, and then returned to the zone closest to Gull Rapids during the open water season (Lacho and Hrenchuk 2016). The highest number of detections have consistently occurred near the boundary of Zones 4 and 5 since the study began.

In contrast, juvenile Lake Sturgeon in Stephens Lake are frequently detected at the receiver closest to Gull Rapids (rkm 1.2). Fourteen juvenile Lake Sturgeon were detected at the receiver closest to Gull Rapids during the 2016 open-water period. Fish were detected at rkm 1.2 during the whole time the receiver was in the water, from June to October. Therefore, juvenile Lake Sturgeon in Stephens Lake could be susceptible to construction-related activities such as increased sedimentation, changes in flow, and/or disturbances associated with blasting or construction equipment.

Will disturbances associated with construction of the Keeyask GS alter coarse-scale movement upstream or downstream of the GS?

Juvenile Lake Sturgeon movement patterns continue to remain similar from year-to-year. Juveniles in Gull Lake have had nearly the same movement range in all three open-water periods since the study began (4.1 rkm in 2014, 5.1 rkm in 2015, and 5.2 rkm in 2016; Lacho *et al.* 2015, Lacho and Hrenchuk 2016). Similarly, mean movement range in Stephens Lake has remained almost identical during the three open-water periods since the study began (11.1 rkm in 2014, 11.2 rkm in 2015, and 11.6 rkm in 2016; Lacho *et al.* 2015, Lacho and Hrenchuk 2016).

In 2015, one fish moved briefly upstream out of Gull Lake into more riverine habitat, while the remaining fish tagged in Gull Lake have not moved out of this area since the study began. In all three years, fish in Stephens Lake were detected upstream, close to Gull Rapids, in the middle of the summer and moved downstream as the open-water season progressed.

6.0 SUMMARY AND CONCLUSIONS

- Acoustic monitoring continues to be an effective method for monitoring juvenile Lake Sturgeon in the study area during the open-water period, as 39 of the 40 sturgeon tagged in 2013 were detected during the open-water period of 2016.
- A reduced number of receivers are used to monitor movements during the winter period. In Stephens Lake, detection frequency was higher in winter 2015/2016 compared to the previous two winter periods, likely due to the installation of an ice boom upstream of Gull Rapids that resulted in the formation of stable ice cover on Gull Lake and a reduction in the amount of frazil ice flowing into Stephens Lake. Frazil ice tends to cause interference that is picked up by the receivers.
- The key questions, as described in the AEMP, for juvenile Lake Sturgeon movement monitoring during construction of the Keeyask GS are as follows:
    - *Will the frequency of long-distance movements by juvenile Lake Sturgeon increase during construction and operation of the project?*

      Since monitoring commenced, only two juvenile Lake Sturgeon have moved downstream out of the study area. The first fish likely moved downstream through Kettle GS before construction began at Keeyask. The second fish moved downstream through the Kettle and Long Spruce generating stations in 2016. Therefore, there has not been an observed increase in the frequency of long-distance movements by juvenile Lake Sturgeon.
    - *Are juvenile Lake Sturgeon using habitat in the immediate vicinity of the construction site?*

      Data collected since inception of the study suggest that juvenile Lake Sturgeon tagged upstream of Gull Rapids do not frequently utilize habitat in the vicinity of Gull Rapids. In Stephens Lake, however, juveniles do use the area immediately downstream of the construction site and could be susceptible to construction-related activities.
    - *Will disturbances associated with construction of the Keeyask GS alter coarse-scale movement upstream or downstream of the GS?*

      Qualitatively and quantitatively, there has been no observed change in the movement patterns of juvenile Lake Sturgeon since the study began. Juvenile sturgeon in Gull and Stephens lakes have remained in similar areas during each year of study and the average distance moved has also remained similar.

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TABLES

Table 1: Acoustic tag and biological data for the 20 juvenile Lake Sturgeon tagged in Gull Lake in 2013.

Tag ID	Date Tagged	Fork Length (mm)	Total Length (mm)	Weight (g)
32671	29-Aug-13	498	577	850
32672	29-Aug-13	485	545	800
32676	29-Aug-13	518	607	875
32677	29-Aug-13	492	559	750
32678	29-Aug-13	512	583	950
32679	29-Aug-13	570	638	1450
32681	29-Aug-13	572	650	1250
32682	29-Aug-13	550	618	1100
32683	29-Aug-13	536	610	900
32684	29-Aug-13	496	562	750
32686	28-Aug-13	668	768	2450
32687	28-Aug-13	490	557	800
32688	28-Aug-13	480	535	725
32689	28-Aug-13	487	561	825
32690	28-Aug-13	475	553	725
32691	28-Aug-13	518	590	950
32692	28-Aug-13	585	650	1350
32693	28-Aug-13	565	647	1225
32694	28-Aug-13	470	532	750
32695	28-Aug-13	483	555	700

Table 2: Acoustic tagging and biological data for the 20 juvenile Lake Sturgeon tagged in Stephens Lake in 2013.

Tag ID	Date Tagged	Fork Length (mm)	Total Length (mm)	Weight (g)
32661	17-Sep-13	500	571	1075
32662	17-Sep-13	515	554	900
32663	21-Sep-13	539	610	1000
32664	22-Sep-13	530	596	900
32665	23-Sep-13	580	657	1375
32666	16-Sep-13	594	666	1510
32667	17-Sep-13	518	564	1000
32668	21-Sep-13	495	564	900
32669	21-Sep-13	558	634	1350
32670	17-Sep-13	559	648	1475
32673	21-Sep-13	576	643	1250
32674	21-Sep-13	549	621	1300
32675	22-Sep-13	450	514	575
32680	22-Sep-13	450	510	600
32685	22-Sep-13	573	654	1275
32696	16-Sep-13	497	557	800
32697	16-Sep-13	572	660	1425
32698	16-Sep-13	610	699	1800
32699	17-Sep-13	470	525	750
32700	21-Sep-13	620	690	1800

Table 3: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometer (rkm) detection sites, and detection range for each of 20 juvenile Lake Sturgeon tagged and monitored upstream of Gull Rapids during the 2013/2014 (16 October, 2013 – 30 April, 2014), 2014/2015 (13 October, 2014 – 30 April, 2015), and 2015/2016 (12 October, 2015 – 30 April, 2016) winter periods.

Tag ID	2013/2014					2014/2015					2015/2016				
	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)
32671	9727	69	-12.9	-12.9	0.0	2479	44	-12.9	-12.9	0	2678	39	-9.9	-9.9	0.0
32672	3696	48	-12.9	-9.9	3.0	126	15	-12.9	-12.9	0	-	-			
32676	2528	29	-12.9	-9.9	3.0	-	0	-	-	-	-	-			
32677	4785	59	-12.9	-9.9	3.0	-	0	-	-	-	19370	113	-9.9	-9.9	0.0
32678	17388	135	-9.9	-9.9	0.0	-	0	-	-	-	4949	41	-9.9	-9.9	0.0
32679	31	7	-12.9	-12.9	0.0	-	0	-	-	-	30	3	-11.8	-11.8	0.0
32681	8205	76	-12.9	-9.9	3.0	-	0	-	-	-	9728	78	-9.9	-9.9	0.0
32682	270	12	-9.9	-9.9	0.0	136	6	-12.9	-12.9	0	3	2	-9.9	-9.9	0.0
32683	2864	42	-12.9	-9.9	3.0	42	10	-12.9	-12.9	0	-	-			
32684	2941	57	-9.9	-9.9	0.0	-	0	-	-	-	1683	42	-9.9	-9.9	0.0
32686	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32687	-	-	-	-	-	-	0	-	-	-	707	31	-9.9	-9.9	0.0
32688	-	-	-	-	-	-	0	-	-	-	4339	58	-9.9	-9.9	0.0
32689	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32690	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32691	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32692	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32693	-	-	-	-	-	-	0	-	-	-	14165	108	-19.5	-9.5	10.0
32694	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-
32695	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-

Table 4: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometer (rkm) detection sites, and detection range for each of 20 juvenile Lake Sturgeon tagged and monitored downstream of Gull Rapids during the 2013/2014 (16 October, 2013 – 30 April, 2014), 2014/2015 (13 October, 2014 – 30 April, 2015), and 2015/2016 (12 October, 2015 – 30 April, 2016) winter periods.

Tag ID	2013/2014					2014/2015					2015/2016				
	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)
32661	567	19	6.1	7.7	1.6	4883	46	7.7	10.2	2.5	5021	52	7.7	7.7	0
32662	484	10	6.1	21	14.9	1422	24	47.5	47.5	0	7702	55	44.9	44.9	0
32663	10755	87	6.1	16.8	10.7	8428	63	7.7	10.2	2.5	-	-	-	-	-
32664	3531	52	6.1	7.7	1.6	93	19	7.7	7.7	0	2724	40	7.7	7.7	0
32665	272	10	6.1	7.7	1.6	1276	48	7.7	10.2	2.5	1675	42	7.7	21	13.3
32666	1242	27	6.1	10.5	4.4	2860	26	7.7	10.2	2.5	5437	59	7.7	10.2	2.5
32667	4980	54	6.1	10.2	4.1	-	0	-	-	-	13210	87	9.9	9.9	1
32668	-	-	-	-	-	963	25	14.9	14.9	0	14723	145	14.9	18.7	3.8
32669	1089	10	7.9	7.9	0	-	0	-	-	-	33216	192	14.9	14.9	0
32670	27731	141	6.1	7.7	1.6	2770	54	7.7	10.5	2.8	58	58	7.7	7.7	0
32673	1548	17	6.1	21	14.9	1404	19	14.9	40.8	25.9	12889	96	14.9	21	6.1
32674	243	8	7.7	14.9	7.2	399	14	14.9	14.9	0	17596	117	9.9	14.9	5
32675	6497	66	6.1	7.7	1.6	4218	43	7.7	7.7	0	5624	87	7.7	10.2	2.5
32680	11457	115	6.1	10.5	4.4	8863	97	7.9	10.5	2.6	15103	139	7.9	7.9	0
32685	8417	101	6.1	14.9	8.8	1319	16	7.7	21	13.3	7093	86	14.9	26	11.1
32696	2027	23	10.2	21	10.8	2284	23	7.7	21	13.3	31092	187	9.9	21	11.1
32697	10294	87	6.1	7.7	1.6	371	14	7.7	10.2	2.5	23211	93	7.7	10.2	2.5
32698	2153	71	6.1	14.9	8.8	275	14	7.7	14.9	7.2	20321	148	9.9	18.7	8.8
32699	877	17	6.1	7.7	1.6	-	-	-	-	-	-	-	-	-	-
32700	12749	122	6.1	10.5	4.4	11466	88	7.7	10.2	2.5	2	1	7.7	7.7	0

Table 5: **Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometer (rkm) detection sites, and detection range for each of 20 juvenile Lake Sturgeon tagged and monitored upstream of Gull Rapids during the 2013 (28 August – 15 October, 2013), 2014 (1 May – 12 October, 2014), 2015 (1 May – 11 October, 2015), and 2016 (1 May – 19 October, 2016) open-water seasons.**

Tag ID	2013					2014					2015					2016				
	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)
32671	8302	46	-12.9	-9.9	3	9056	98	-19.4	-9.5	9.9	12115	126	-19.5	-9.5	10	10091	128	-19.5	-9.5	10
32672	676	35	-12.3	-9.9	2.4	7601	88	-12.9	-9.5	3.4	8996	86	-17.4	-9.5	7.9	4483	67	-14.8	-9.5	5.3
32676	5460	39	-10.3	-9.9	0.4	5176	100	-17.4	-12.9	4.5	10299	79	-17.4	-9.5	7.9	3261	82	-17.4	-9.5	7.9
32677	1648	40	-12.3	-9.9	2.4	8866	96	-12.9	-9.5	3.4	16278	120	-17.4	-9.5	7.9	12182	114	-12.9	-9.5	3.6
32678	4925	46	-10.3	-9.9	0.4	22368	135	-10.1	-9.5	0.6	41794	134	-10.1	-9.5	0.6	24792	130	-12.9	-9.5	3.4
32679	637	35	-12.9	-9.9	3	9726	100	-19.5	-9.5	10	12607	82	-19.5	-9.5	10	7829	77	-19.5	-9.5	10.2
32681	834	38	-12.9	-9.9	3	12817	100	-17.4	-9.5	7.9	12201	125	-12.9	-9.5	3.4	17724	135	-14.8	-9.5	5.3
32682	4736	44	-10.3	-9.9	0.4	15245	98	-12.9	-9.5	3.4	11238	128	-12.9	-9.5	3.4	6592	84	-12.9	-9.5	3.4
32683	258	40	-12.3	-9.9	2.4	4684	98	-17.4	-9.5	7.9	7347	97	-14.8	-9.5	5.3	2510	65	-19.5	-9.5	10
32684	16091	46	-10.3	-9.9	0.4	14878	102	-10.8	-5.8	5	28581	125	-14.8	-9.5	5.3	29743	143	-12.9	-9.5	3.4
32686	131	2	-10.9	-10.9	0	140	3	-5.8	-5.8	0	4028	26	-9.3	-7.4	1.9	-	-	-	-	-
32687	70	16	-7.4	-7.4	0	14680	120	-9	-7.4	1.6	27075	121	-17.4	-9	8.4	36590	144	-12.9	-9.5	3.4
32688	-	-	-	-	-	9142	63	-11.8	-7.4	4.4	31073	120	-10.1	-9.5	0.6	13267	89	-10.1	-9.5	0.6
32689	2	1	-7.4	-7.4	0	9835	112	-9	-7.4	1.6	9662	78	-9	-7.4	1.6	3918	104	-9	-7.4	1.6
32690	12027	35	-10.9	-10.9	0	34865	129	-10.9	-9	1.9	3884	34	-9.3	-9	0.3	3	1	-9.3	-9.3	0
32691	-	-	-	-	-	23712	110	-10.9	-9	1.9	-	-	-	-	-	4595	91	-19.5	-5.8	13.7
32692	126	17	-7.4	-7.4	0	16704	122	-10.9	-7.4	3.5	17810	131	-9.3	-7.4	1.9	14974	131	-9.3	-7.4	1.9
32693	777	24	-10.9	-10.9	0	26300	117	-10.9	-9	1.9	20360	120	-26.5	-9	17.5	12907	110	-19.5	-9.5	10
32694	2582	30	-10.9	-7.4	3.5	38932	130	-14.8	-9	5.8	3808	67	-10.1	-9	1.1	16324	115	-9.9	-7.4	2.5
32695	1203	22	-10.9	-7.4	3.5	6974	61	-10.9	-7.4	3.5	9706	95	-9.3	-7.4	1.9	8804	80	-9.3	-7.4	1.9

Table 6: Number of detections (n), number of days detected, farthest upstream (U/S) and downstream (D/S) river kilometer (rkm) detection sites, and detection range for each of 20 juvenile Lake Sturgeon tagged and monitored downstream of Gull Rapids during the 2013 (28 August – 15 October, 2013), 2014 (1 May – 12 October, 2014), 2015 (1 May – 11 October, 2015), and 2016 (1 May – 19 October, 2016) open-water seasons.

Tag ID	2013					2014					2015					2016				
	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)	n	# Days	U/S (rkm)	D/S (rkm)	Range (rkm)
32661	644	11	2.5	12.1	9.6	12372	92	1.3	14.9	13.6	6280	107	1.3	17.4	16.1	7440	102	1.2	10.3	9.1
32662	4164	26	2.5	14.9	12.4	11682	74	44.9	47.5	2.6	8910	71	42.7	44.9	2.2	16855	102	44.9	44.9	0
32663	2690	25	2.5	7.7	5.2	10771	121	0.5	13.4	12.9	3745	82	1.3	10.5	9.2	6675	88	1.2	13.9	12.7
32664	1890	15	2.5	10.2	7.7	14347	111	2.9	10.2	7.3	17796	115	1.3	11	9.7	5200	49	1.2	10.3	9.1
32665	360	4	2.5	4.9	2.4	7433	85	2.9	21	18.1	4196	61	1.3	19	17.7	3411	100	1.2	18.7	17.5
32666	396	7	0.7	10	9.3	9527	81	0.5	10.2	9.7	7921	85	1.3	11	9.7	9022	101	1.2	7.9	6.7
32667	3633	21	2.5	7.7	5.2	4660	26	4.4	10.2	5.8	259	7	11	11	0	196	9	9.9	10.3	0.4
32668	2768	21	2.5	12.1	9.6	8076	79	4.3	14.9	10.6	8016	94	2.2	14.9	12.7	10610	128	1.2	14.9	13.7
32669	75	7	2.5	4.9	2.4	12559	93	1.3	14.9	13.6	19628	117	1.3	14.9	13.6	9335	122	1.2	14.9	13.7
32670	4289	23	0.7	7.7	7	25924	135	1.3	10.2	8.9	18930	131	1.3	11	9.7	14227	132	1.2	7.9	6.7
32673	2191	25	2.5	14.9	12.4	11506	83	2.9	21	18.1	11254	105	1.3	19	17.7	9784	127	1.2	21	19.8
32674	2468	22	2.5	12.1	9.6	13328	111	2.9	10.2	7.3	10650	105	1.3	14.9	13.6	8052	106	1.2	14.9	13.7
32675	2933	22	2.5	7.7	5.2	19778	134	2.9	10.2	7.3	16380	126	1.3	7.7	6.4	16763	142	1.2	14.9	13.7
32680	1579	18	0.7	10	9.3	1238	59	7.9	10.5	2.6	2273	62	7.9	7.9	0	2432	38	6.5	7.9	1.4
32685	2034	21	2.5	10	7.5	18830	130	2.9	18.7	15.8	20054	135	1.3	21	19.7	11354	66	42.7	58.6	15.9
32696	3803	25	2.5	18.7	16.2	9650	81	2.9	21	18.1	11864	133	1.3	14.9	13.6	13886	130	1.2	21	19.8
32697	1623	21	0.7	4.9	4.2	9822	108	1.3	6.1	4.8	14190	120	1.3	11	9.7	13186	102	2.2	10.3	8.1
32698	2082	18	2.5	14.9	12.4	9414	99	1.3	21	19.7	14110	116	1.3	14.9	13.6	11868	111	1.2	16.8	15.6
32699	556	11	2.5	6.3	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32700	2830	21	2.5	14.9	12.4	14196	112	0.5	14.9	14.4	11478	120	1.3	19	17.7	5913	103	1.2	23.5	22.3

FIGURES

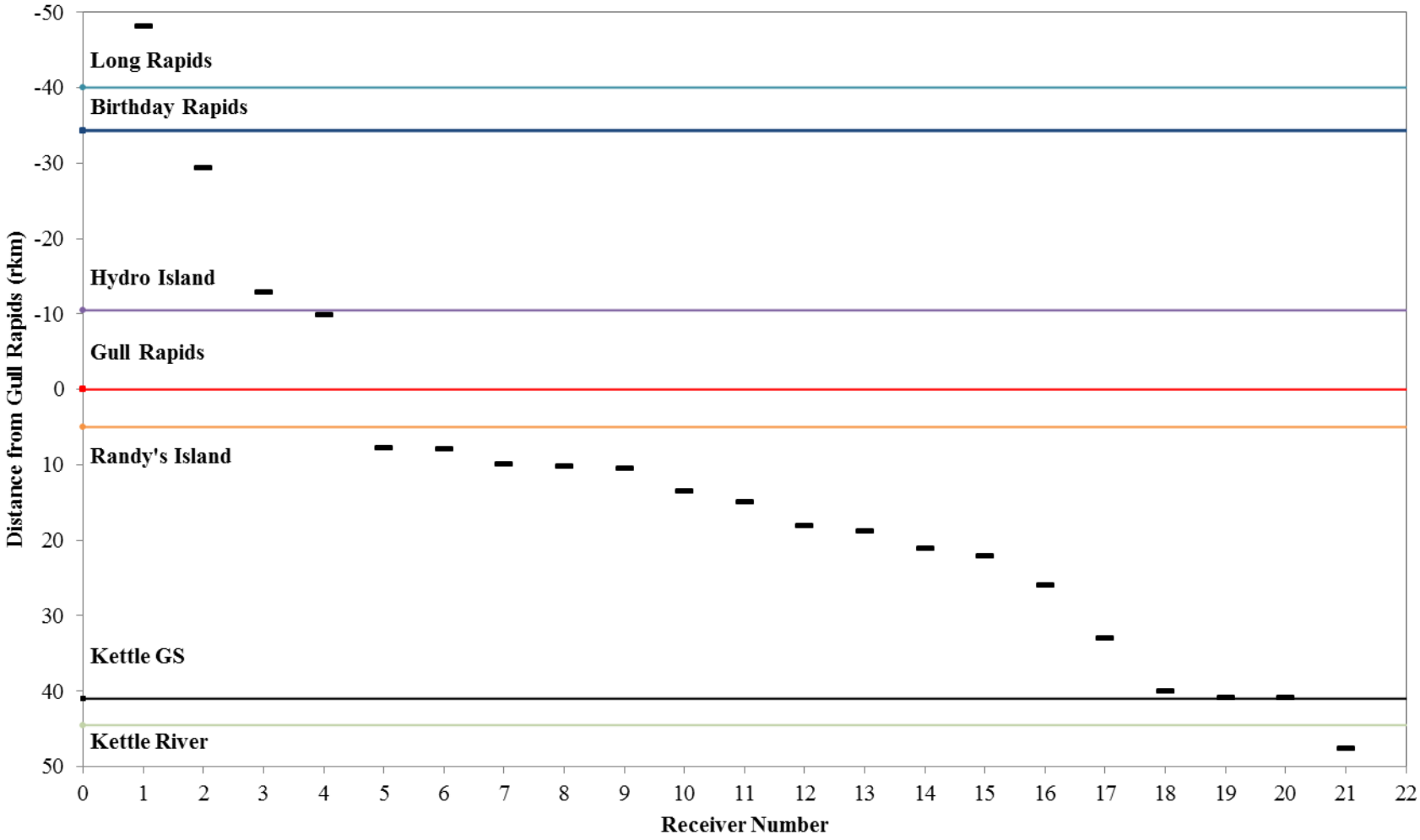


Figure 1: Locations of stationary acoustic receivers (dashes) in relation to the base of Gull Rapids (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Long Spruce GS between October 2015 and June 2016.

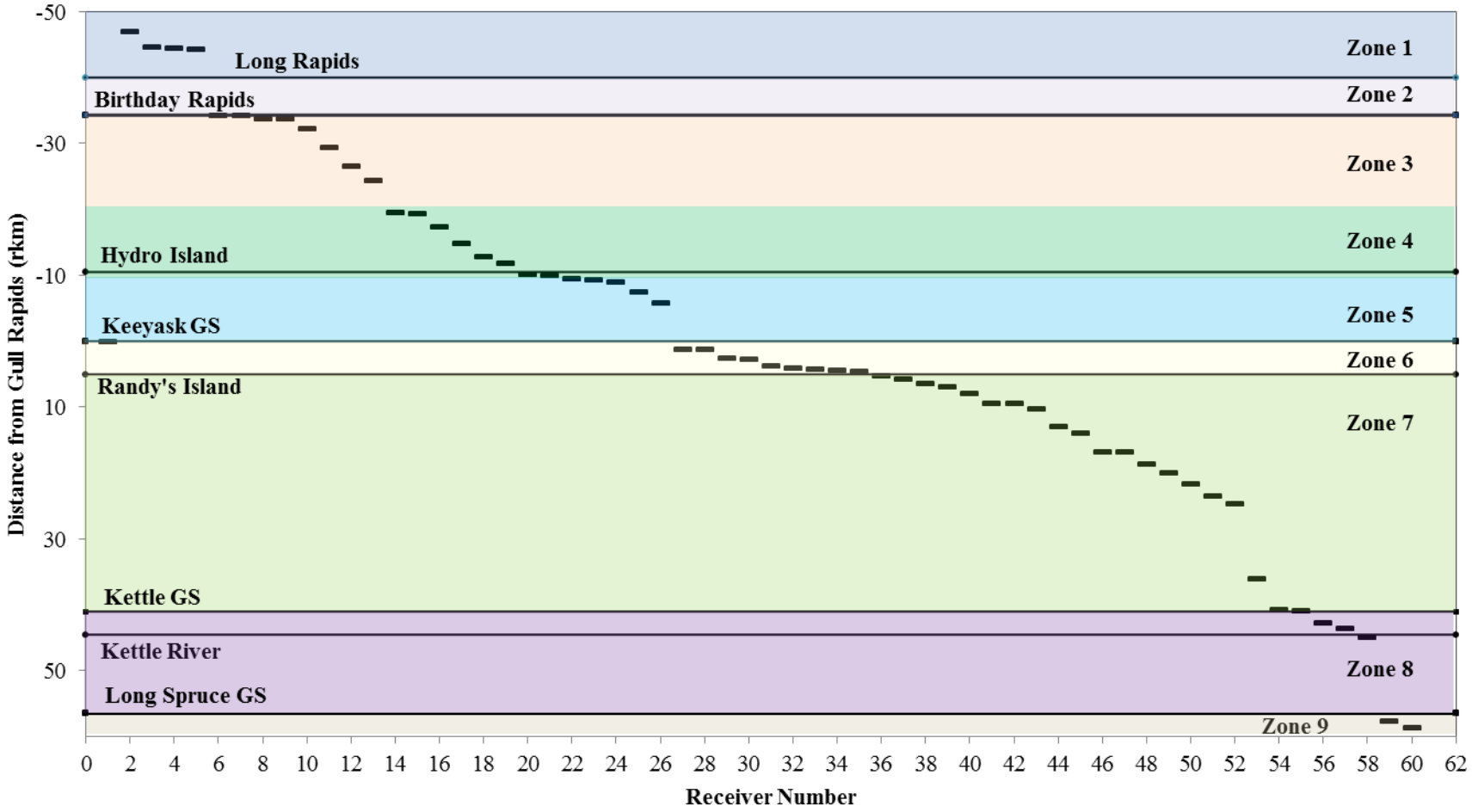


Figure 2: **Locations of stationary acoustic receivers (dashes) in relation to the base of Gull Rapids (rkm 0) and other major landmarks (lines) in the Nelson River between Clark Lake and the Long Spruce GS between June and October, 2016. River zones are indicated by shading.**

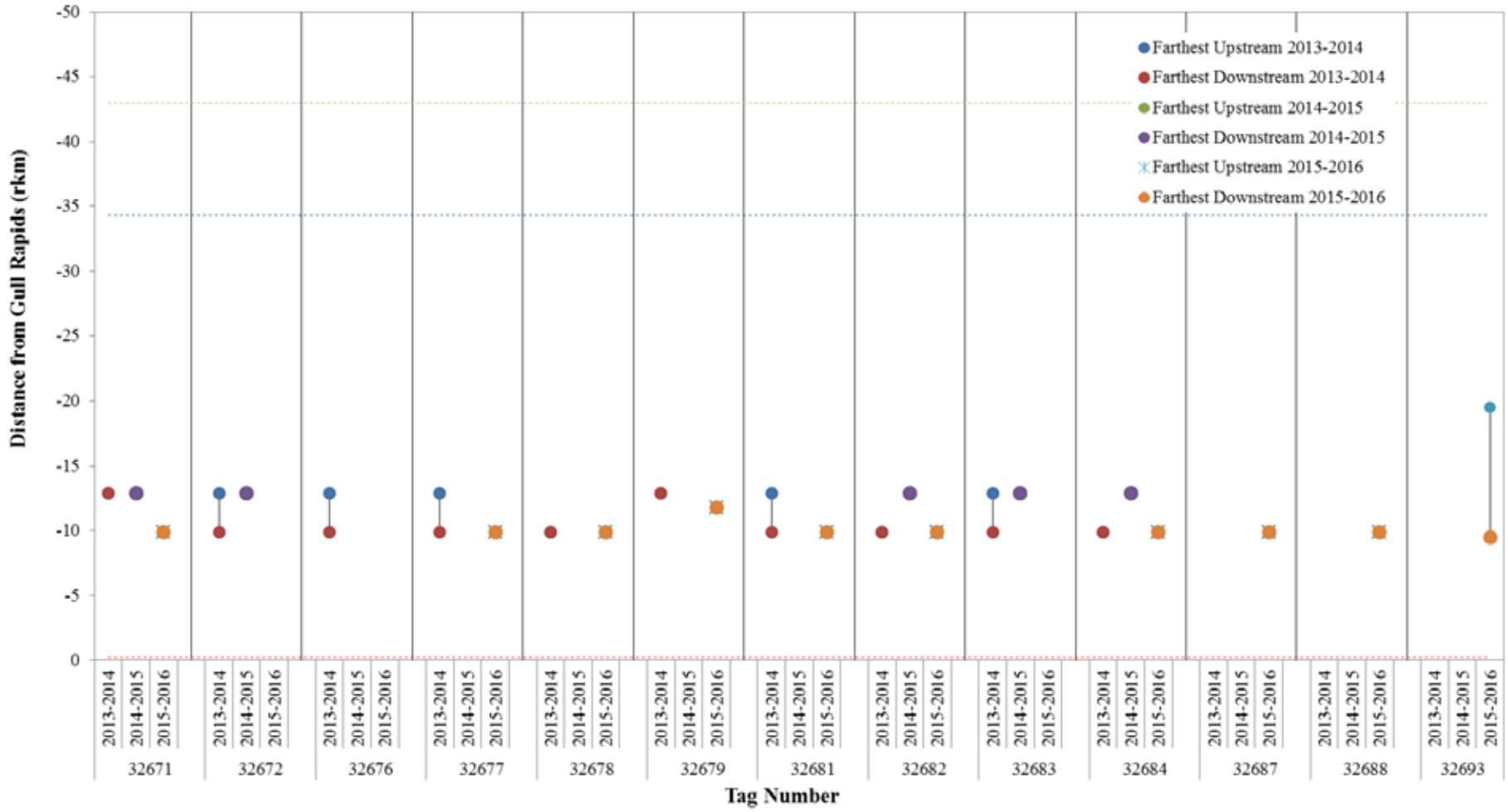


Figure 3: Detection ranges for acoustic tagged juvenile Lake Sturgeon detected between Clark Lake and Gull Rapids during the winter 2013/2014, 2014/2015, and 2015/2016 periods. Dashed horizontal lines represent location of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

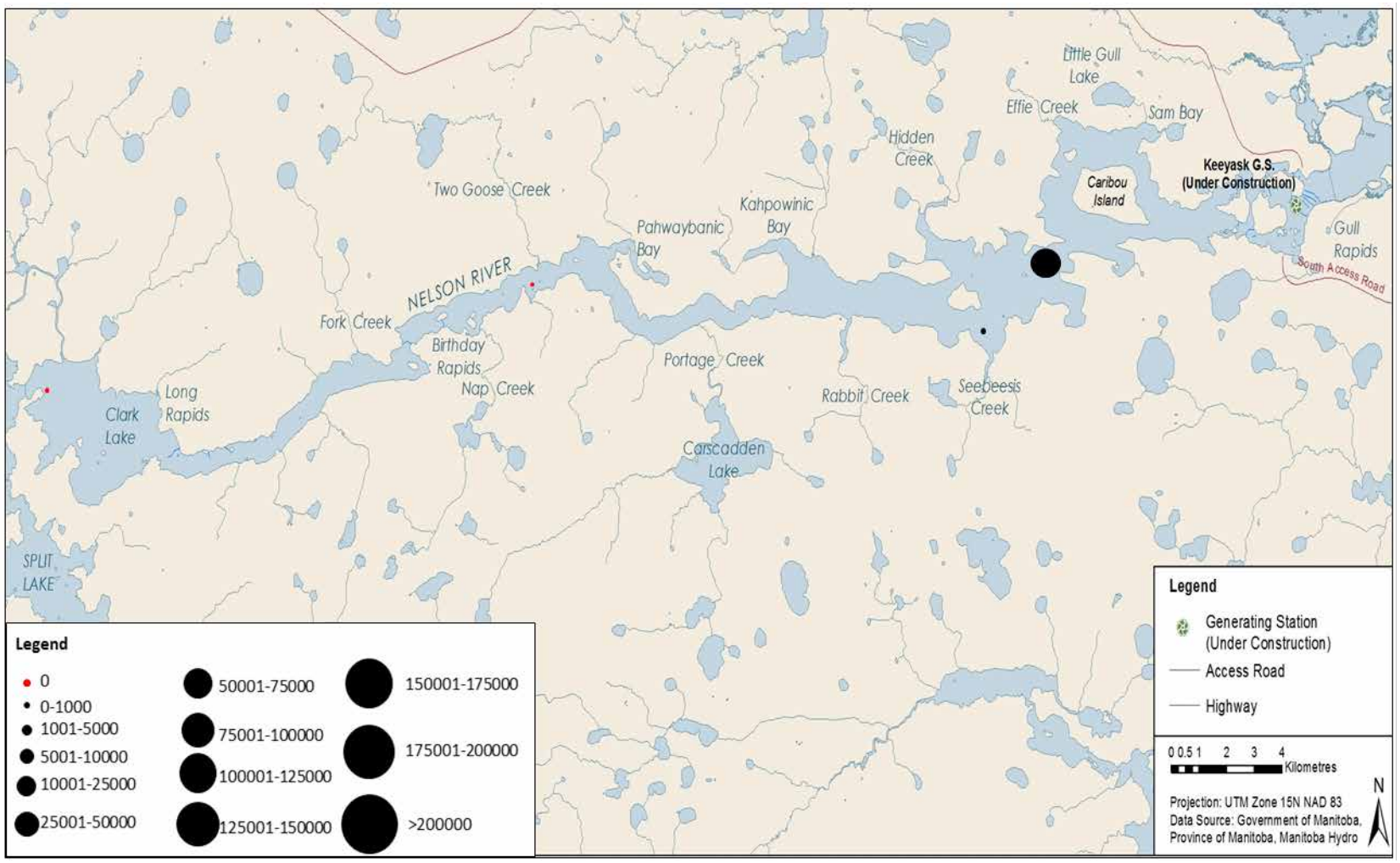


Figure 4: Relative number of detections at each acoustic receiver set between Clark Lake and Gull Rapids during winter 2015/2016 (October 12, 2015, to April 30, 2016). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

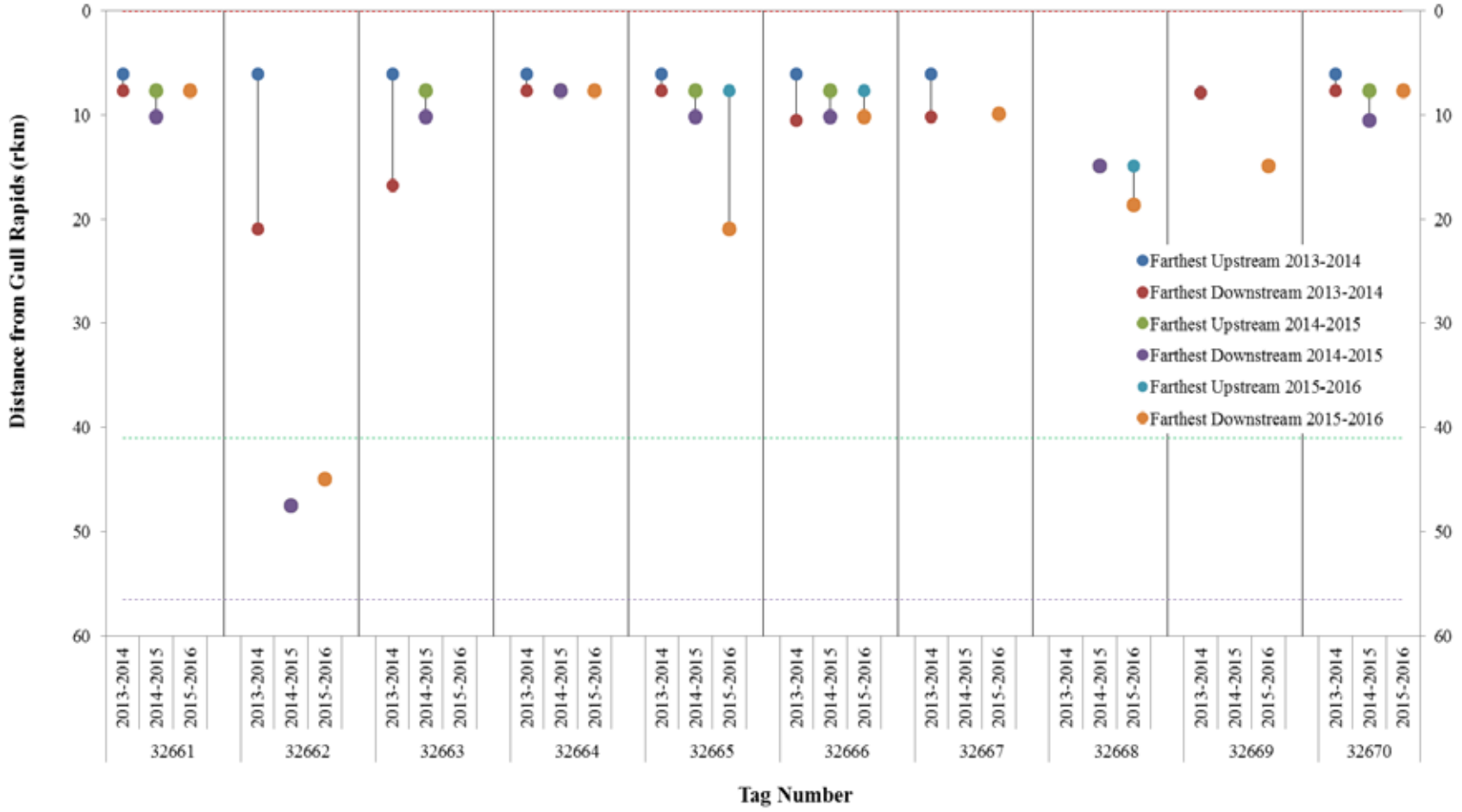


Figure 5: Detection ranges for acoustic tagged juvenile Lake Sturgeon detected downstream of Gull Rapids during the winter 2013/2014, 2014/2015, and 2015/2016 periods. Dashed horizontal lines represent locations of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

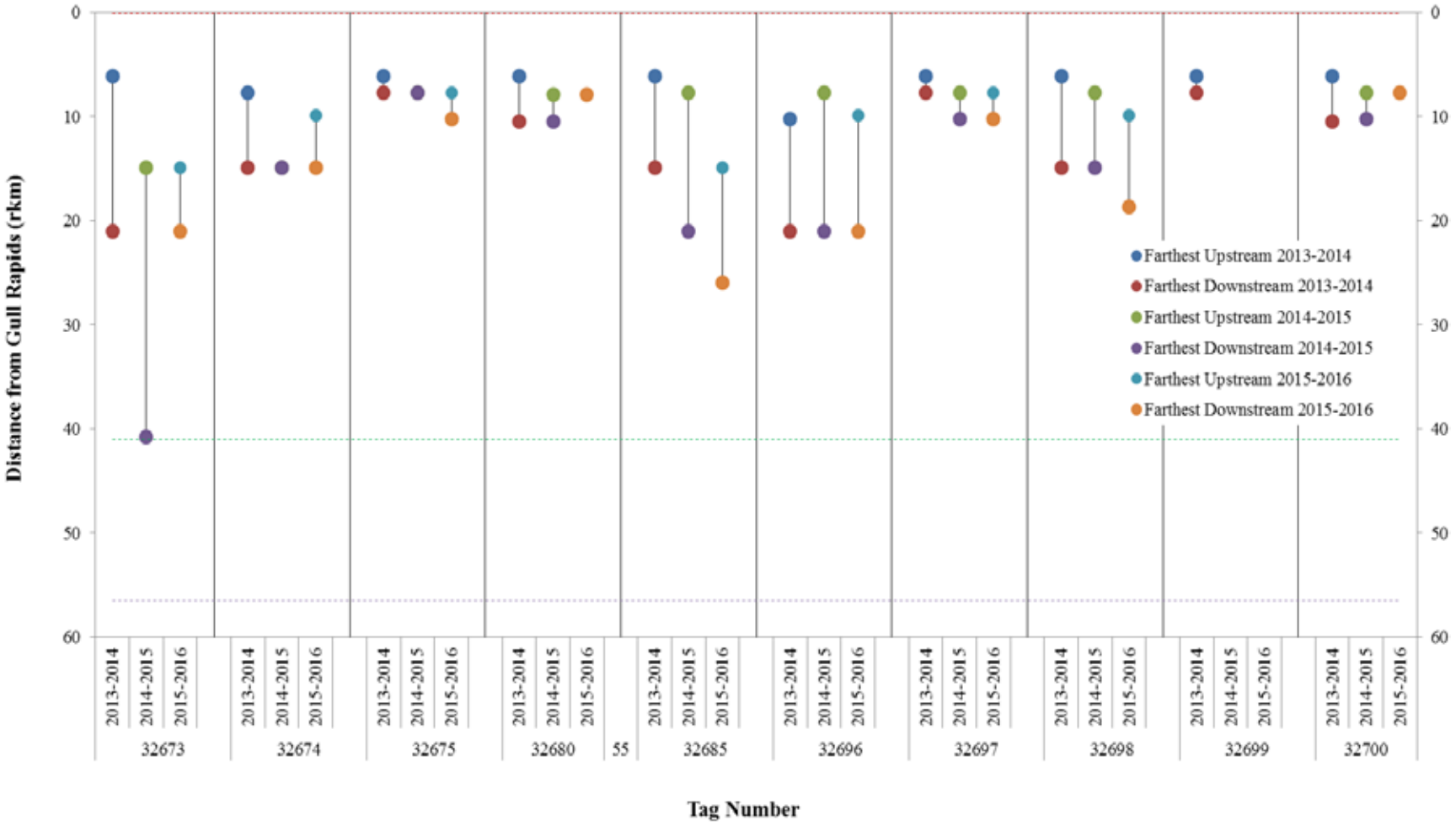


Figure 5: Detection ranges for acoustic tagged juvenile Lake Sturgeon detected downstream of Gull Rapids during the winter 2013/2014, 2014/2015, and 2014/2015 periods. Dashed horizontal lines represent locations of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple) (continued).

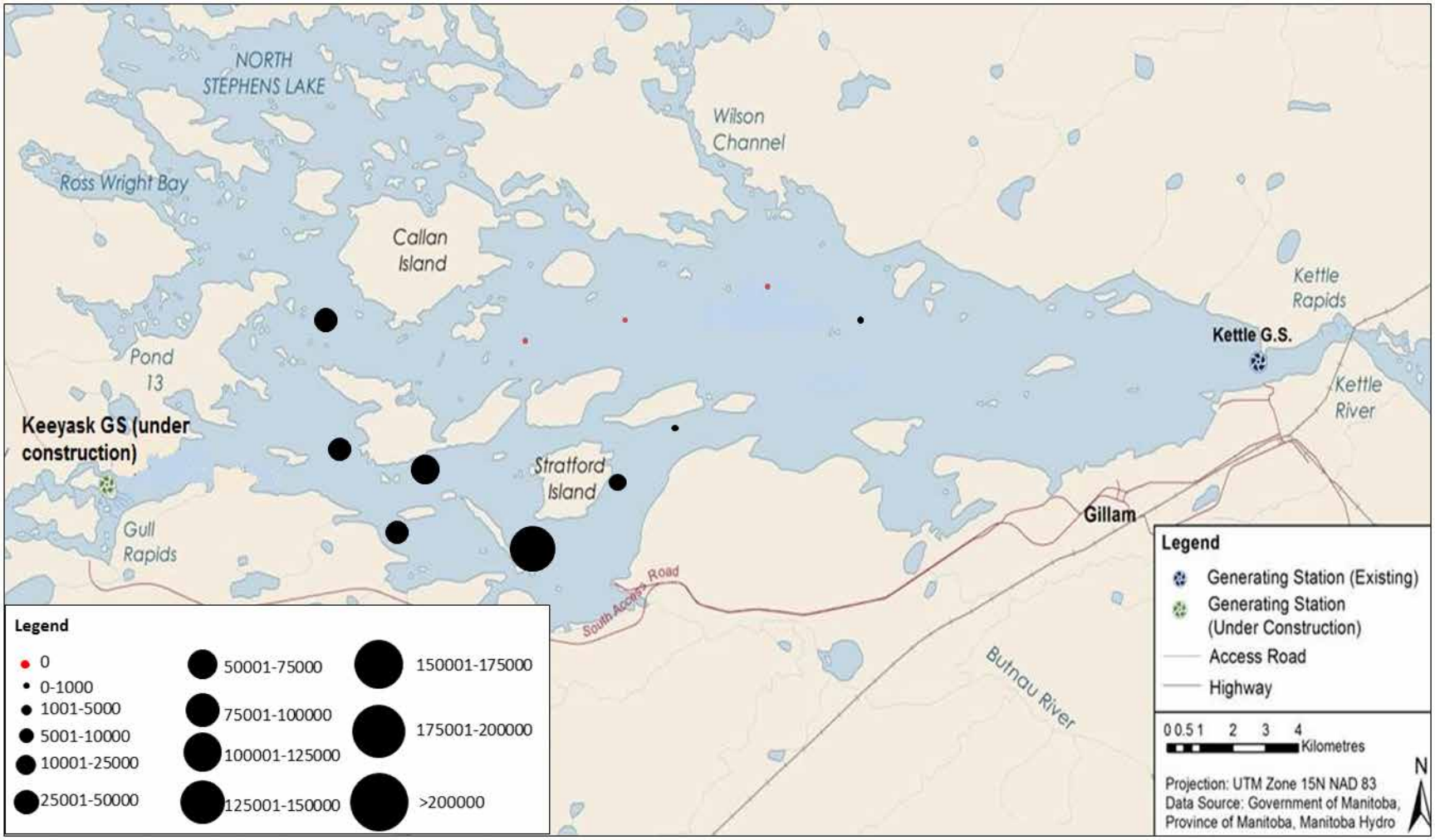


Figure 6: Relative number of detections at each acoustic receiver set in Stephens Lake during winter 2015/2016 (October 12, 2015, to April 30, 2016). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

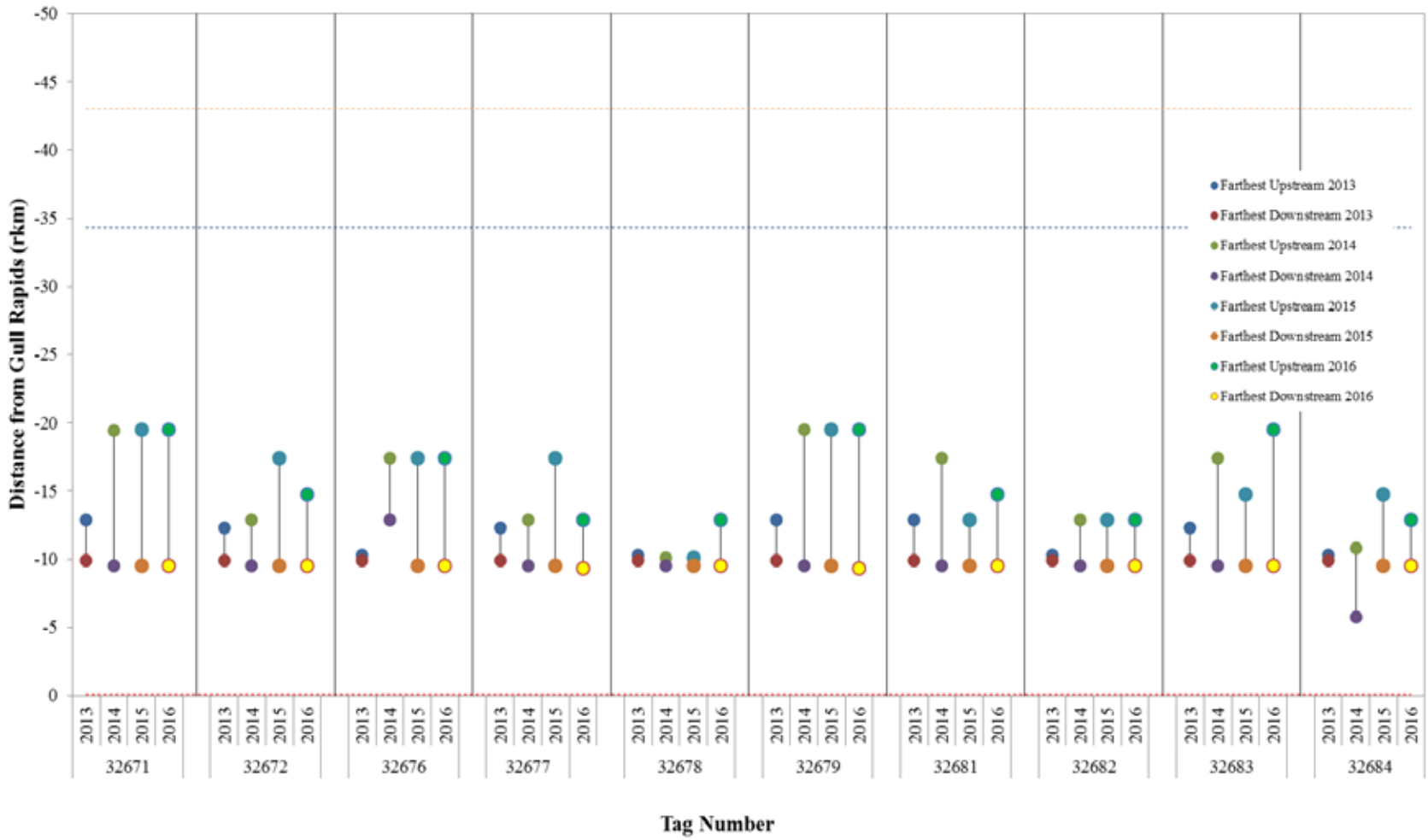


Figure 7: Detection ranges for acoustic tagged juvenile Lake Sturgeon between Clark Lake and Gull Rapids during the open water periods of 2013–2016. Dashed horizontal lines represent location of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

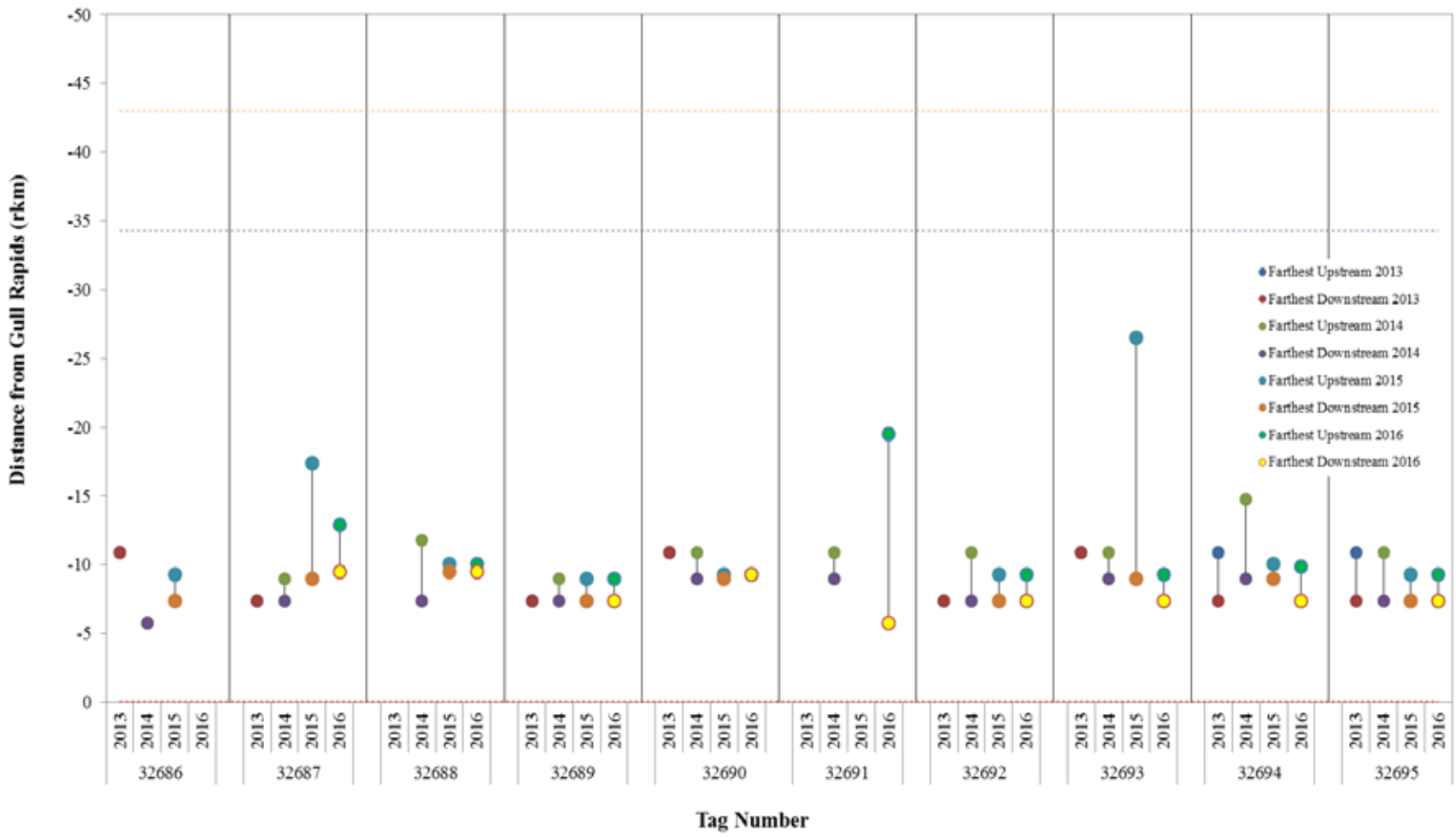


Figure 7: Detection ranges for acoustic tagged juvenile Lake Sturgeon between Clark Lake and Gull Rapids during the open water periods of 2013–2016. Dashed horizontal lines represent location of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange) (continued).

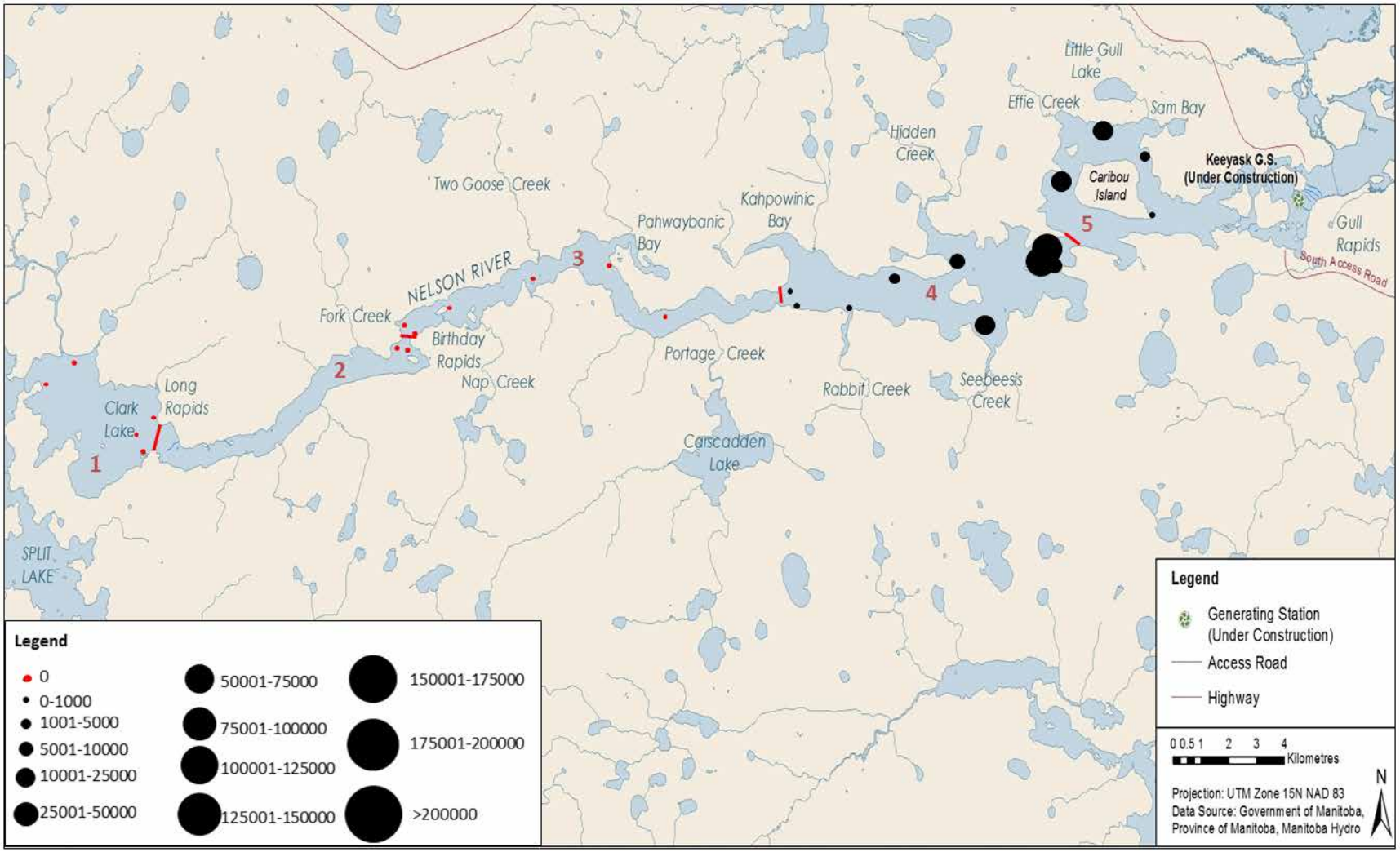


Figure 8: Relative number of detections at each acoustic receiver set in the Nelson River between Clark Lake and Gull Rapids during the 2016 open-water period (May 1 to October 19). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

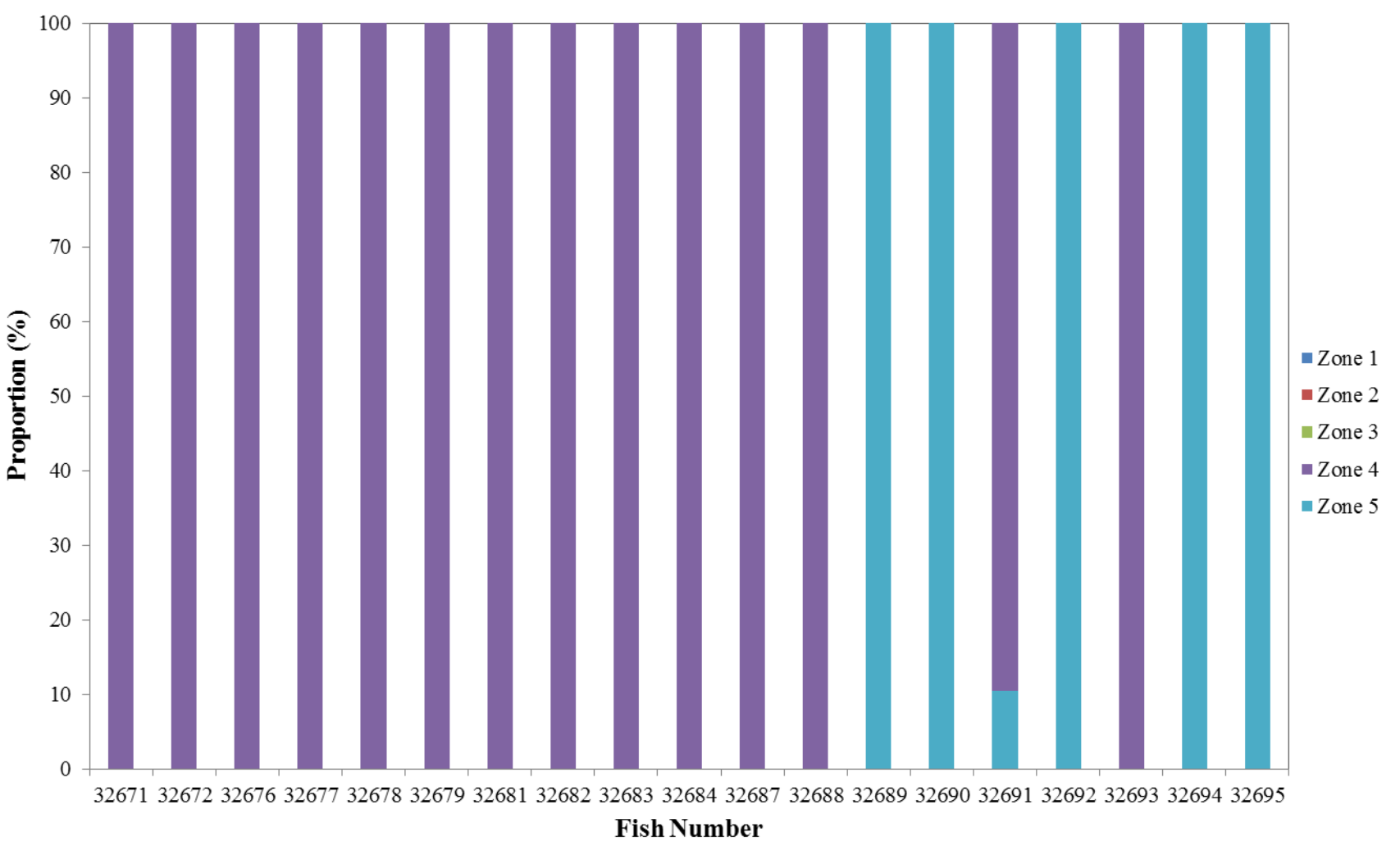


Figure 9: Proportional distributions by zone for individual juvenile Lake Sturgeon between Clark Lake and Gull Rapids during a portion of the 2016 open-water period (25 June to 19 October, 2016).

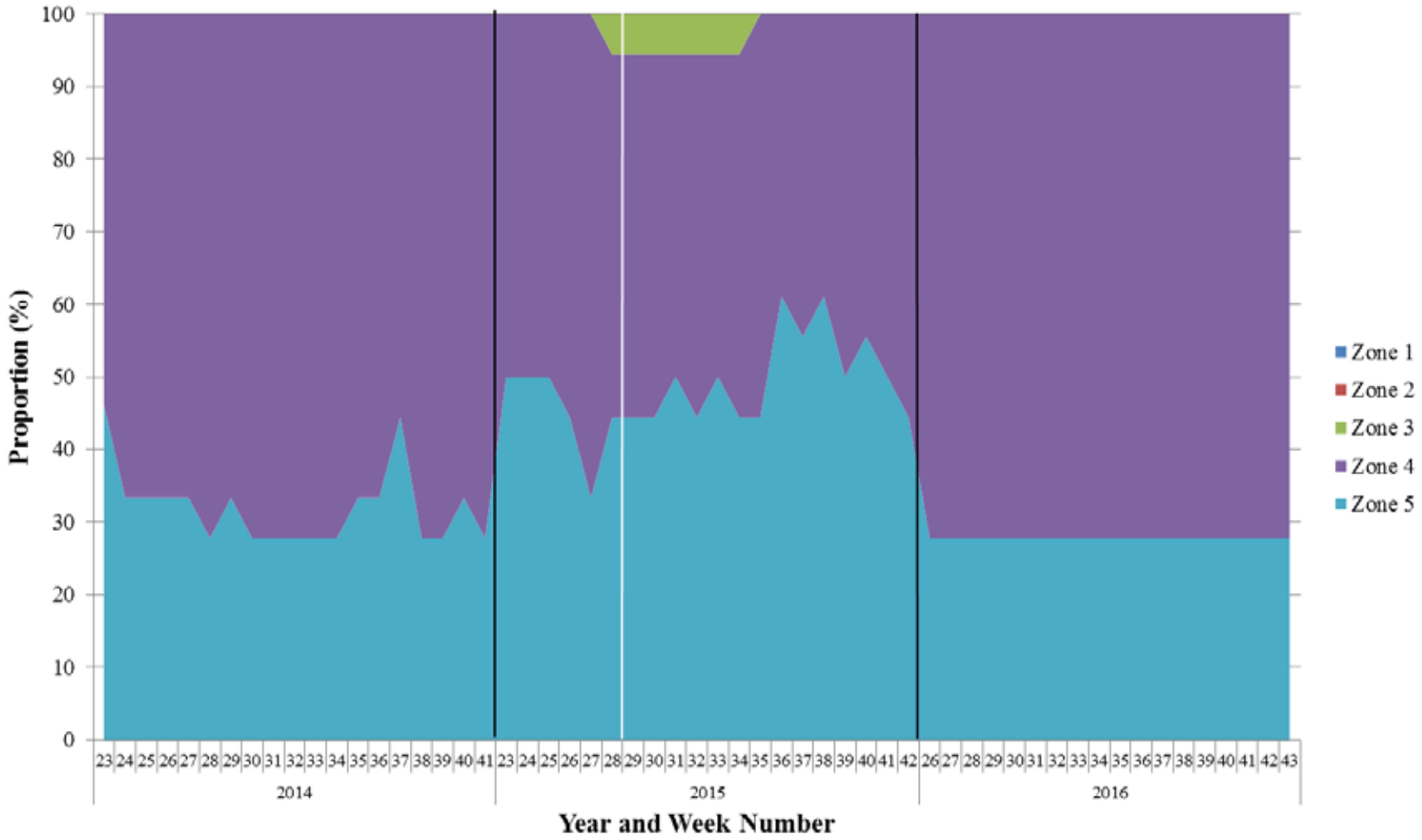


Figure 10: Proportional distribution by zone per week for juvenile Lake Sturgeon between Clark Lake and Gull Rapids during portions of the open-water periods of 2014 (4 June to 10 October), 2015 (4 June to 11 October), and 2016 (25 June to 19 October). Black vertical lines demarcate years. White vertical line indicates start of construction of Keeyask GS.

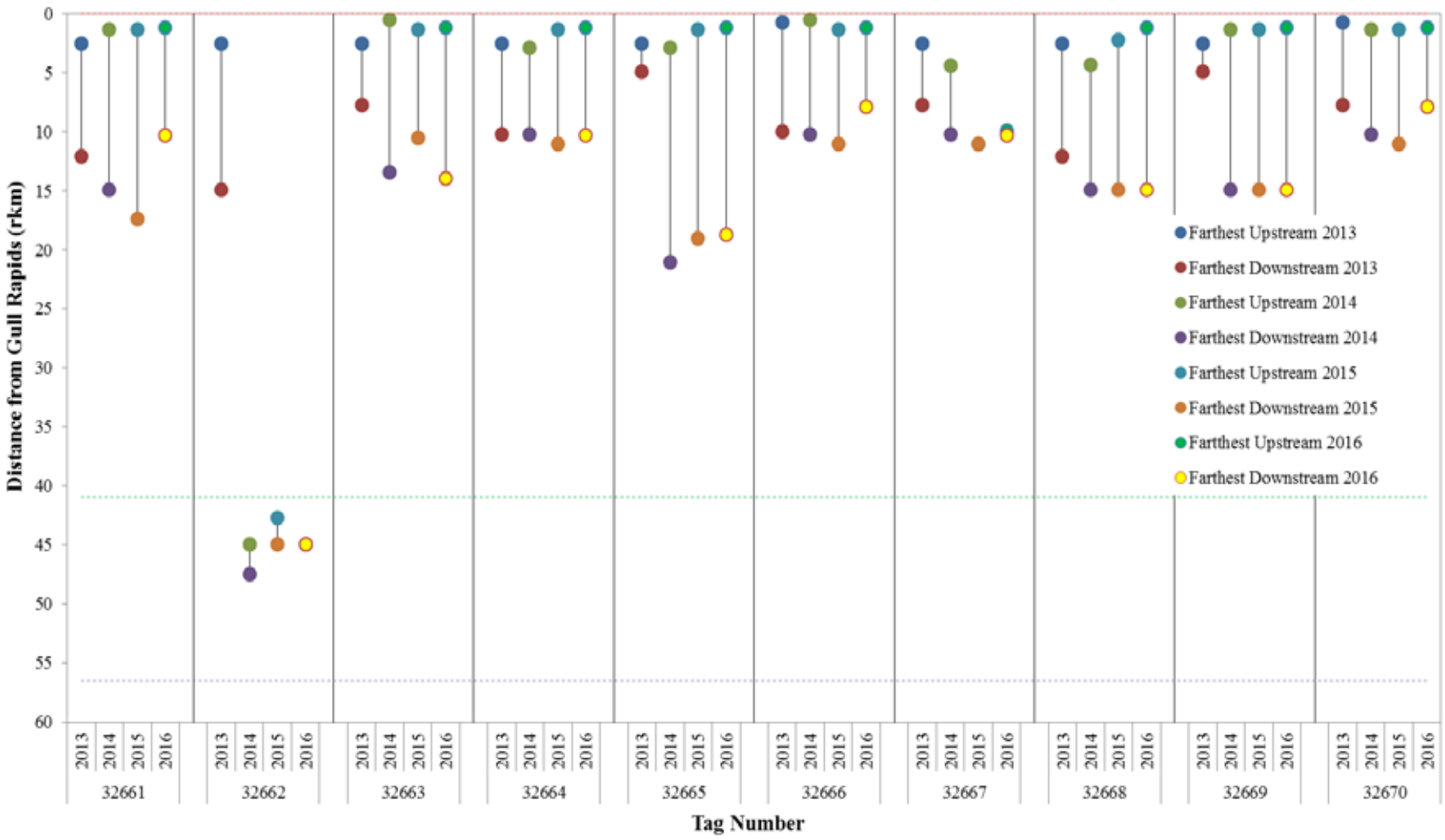


Figure 11: Detection ranges for acoustic tagged juvenile Lake Sturgeon downstream of Gull Rapids during the open-water periods of 2013–2016. Dashed horizontal lines represent locations of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

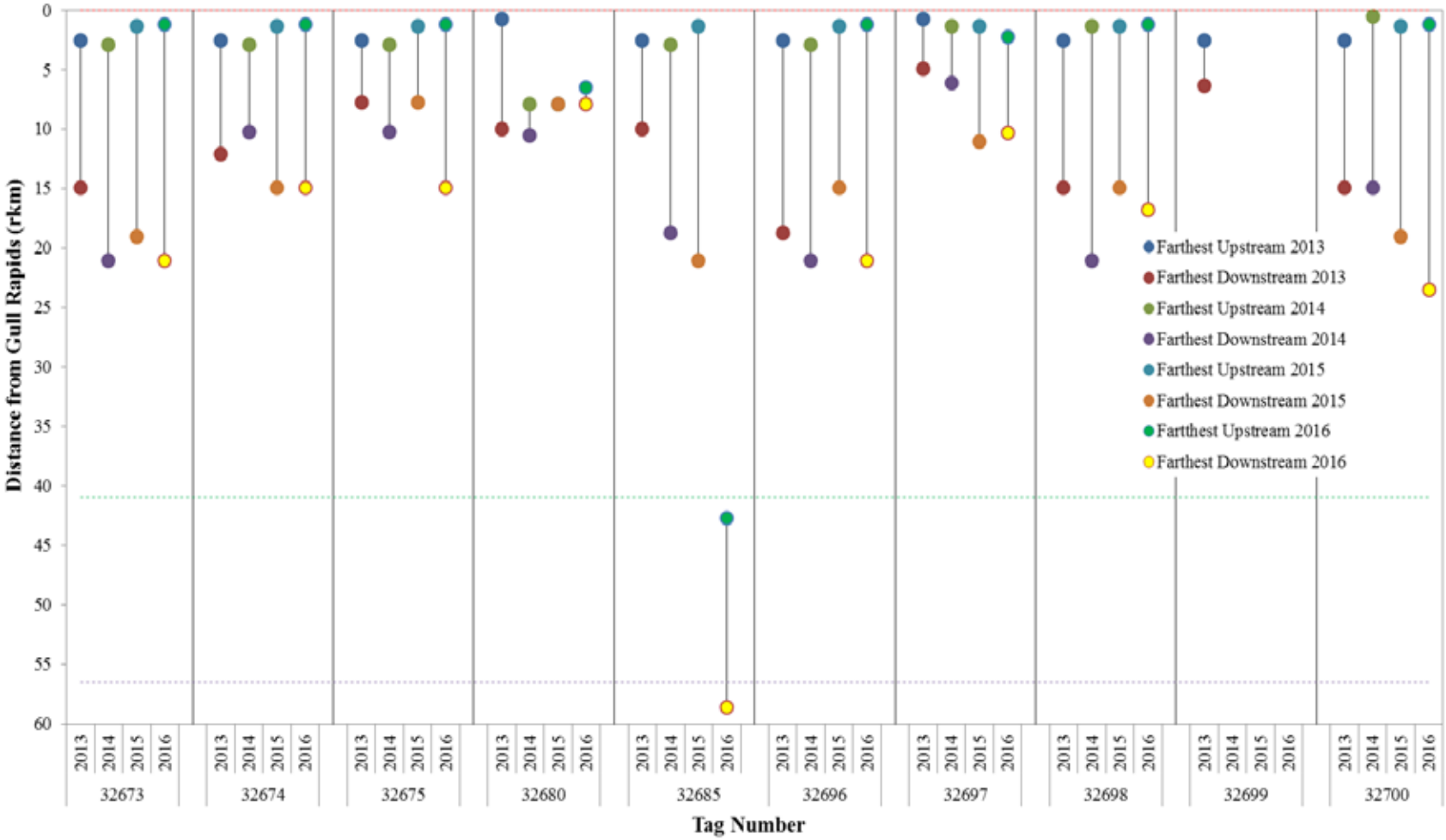


Figure 11: Detection ranges for acoustic tagged juvenile Lake Sturgeon downstream of Gull Rapids during the open-water periods of 2013–2016. Dashed horizontal lines represent locations of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple) (continued).

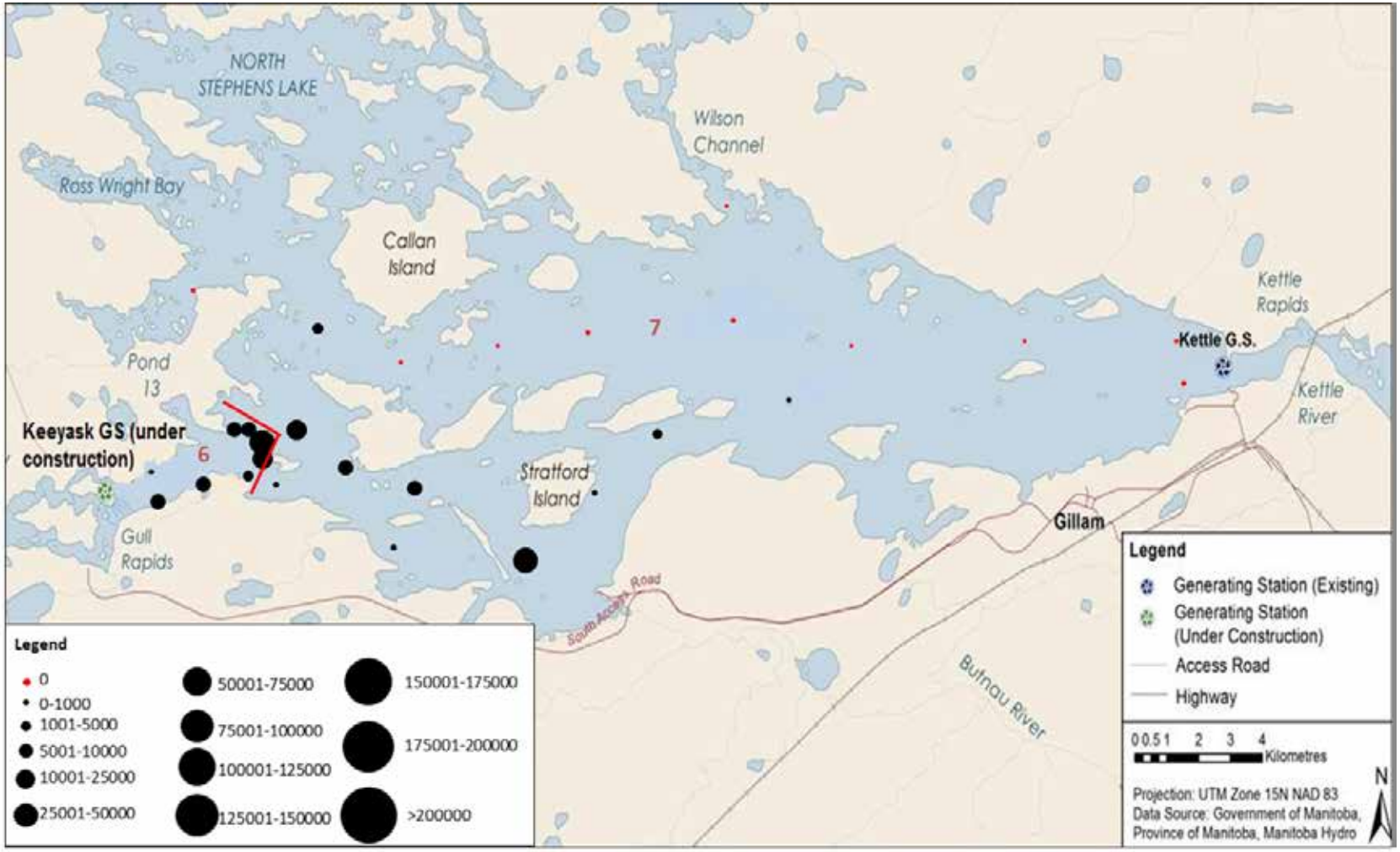


Figure 12: Relative number of detections at each acoustic receiver set in Stephens Lake during the 2016 open-water period (May 1 to October 19). Number of detections indicated by size of bubble (defined in legend). Receivers with no detections indicated with red dot.

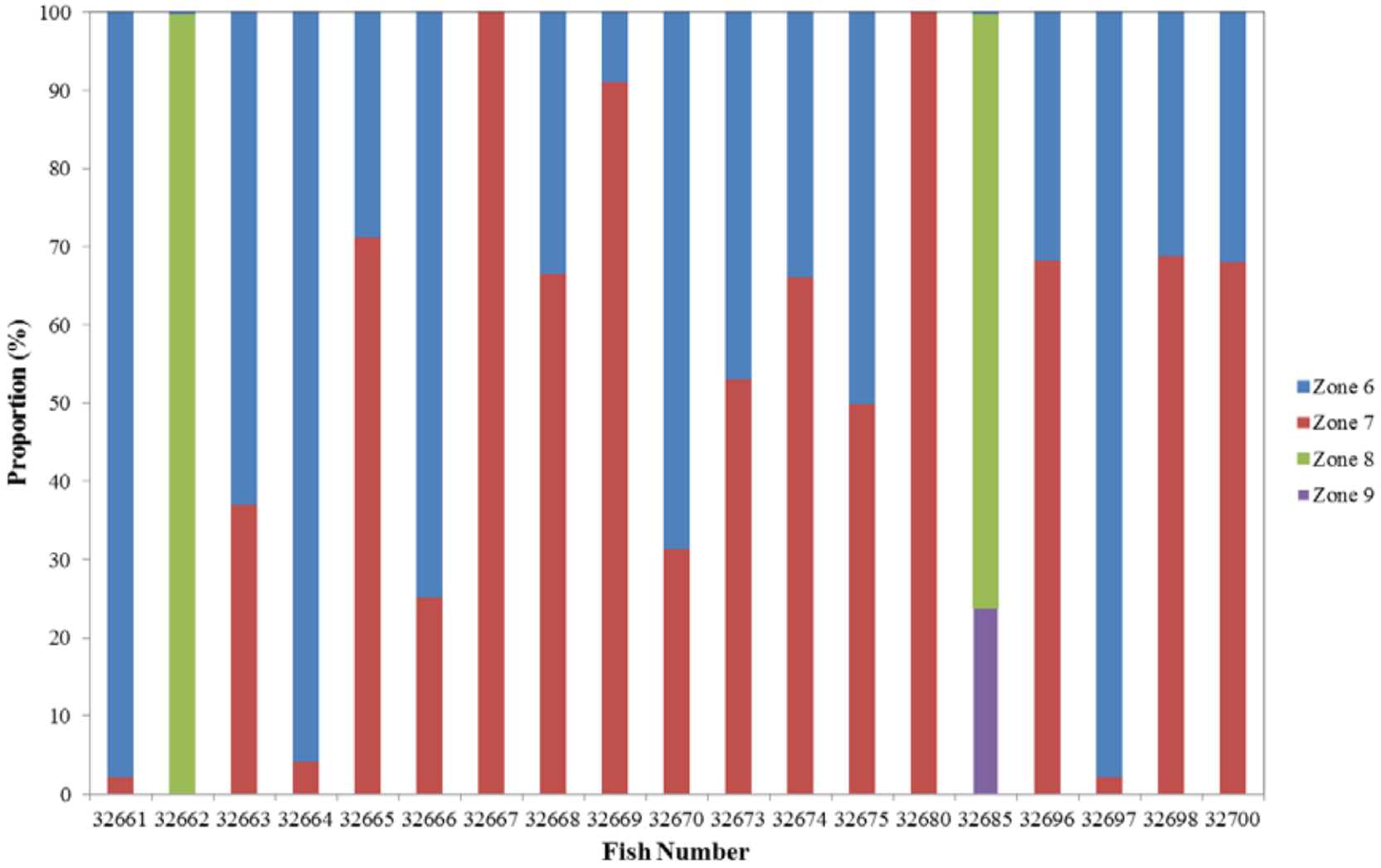


Figure 13: Proportional distributions by zone for individual juvenile Lake Sturgeon downstream of Gull Rapids during a portion of the 2016 open-water period (25 June to 19 October, 2016).

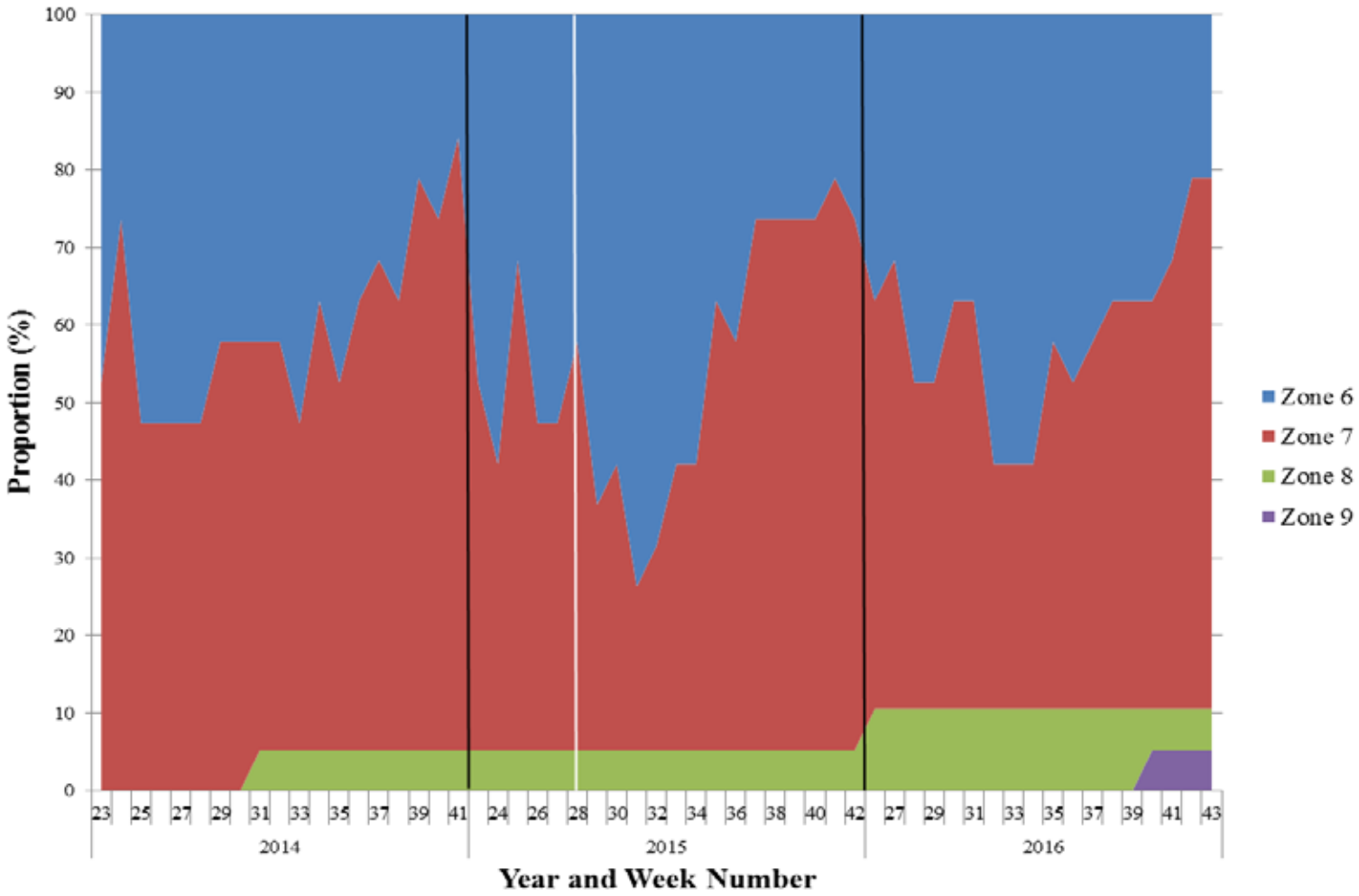


Figure 14: Proportional distribution by zone per week for juvenile Lake Sturgeon downstream of Gull Rapids during portions of the 2014 (4 June to 10 October), 2015 (4 June to 11 October), and 2016 (25 June to 19 October) open-water periods. Black vertical lines demarcate years. White vertical line indicates start of construction of Keeyask GS.

MAPS

N

Nelson River
North Moswakot River
South Moswakot R.
North Access Road
Looking Back Creek
Assean R.
Clark Lake
Nelson R.
Birthday Rapids
Gull Lake
Morris Point
Caribou Island
Hydro Island
Gull Rapids
Keeyask G.S. (Under Construction)
Stephens Lake
Kettle G.S.
Long Spruce G.S.
Limestone G.S.
Boots Ck.
Fox Lake Cree Nation
Fox Lake (Bird)
Fox Lake Cree Nation
A Kwis Ki Mahka Reserve
Gillam
Tataskweyak Cree Nation
Tataskweyak (Split Lake)
Assean Lake
Split Lake
Butnau Lake
Kettle River
Kettle Lake
Fox (Atkinson) Lake
Anipitapiskow Rapids
Sakitowak Rapids
York Factory First Nation
York Landing (Kawechiwasik)
Aiken River
Moose Nose Lake
War Lake First Nation
Ilford (Mooseocoot)
Burntwood River
First Rapids
Grass Witchai Lake Falls
Witchai Lake
Kelsey G.S.
Nelson River
280
290

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	07-JUN-17
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)
- Highway
- Rail
- First Nation Reserve

Keeyask G.S. Site and Juvenile Lake Sturgeon Movement Monitoring Study Setting

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

KEEYASK

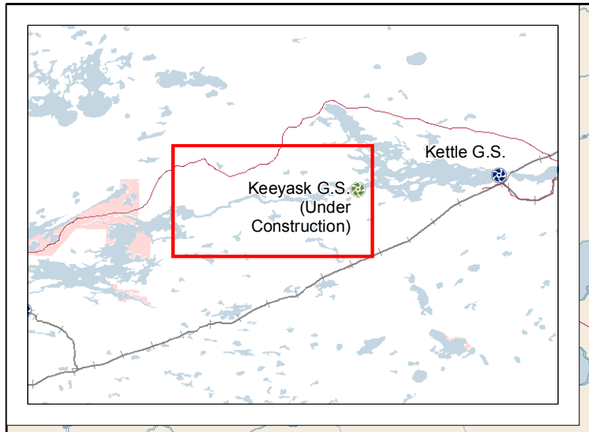
DATA SOURCE:
Orthophoto: Manitoba Hydro - Sep 2016

CREATED BY:
North/South Consultants

COORDINATE SYSTEM:	DATE CREATED:	REVISION DATE:
UTM NAD 1983 Z15N	17-MAR-17	17-MAR-17
0 0.15 0.3 Kilometres; 0 0.15 0.3 Miles	VERSION NO: 2.0	QA/QC: PMC/FSV/MWZ

Construction Site

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



Ross Wright Bay

North Access Road

Looking Back Creek

280

Effie Creek

Pond 13

Hidden Creek

Caribou Island

Morris Point

Keeyask G.S.
(Under Construction)

Gull Rapids

South Access Road

Two Goose Creek

Trickle Creek

NELSON RIVER

127095

114228

122780

Fork Creek

Portage Creek

Rabbit Creek

Seebeesis Creek

125105

Nap Creek

Birthday Rapids

Long Rapids

Clark Lake

Carscadden Lake

SPLIT LAKE

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	01-NOV-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

Legend

Receiver Locations

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

Winter 2015/16 Acoustic Receiver Locations:

Clark Lake to Gull Rapids

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

N

STEPHENS LAKE

Ferris Bay

Wilson Channel

Callan Island

O'Neil Bay

Randy's Island

Straford Island

Gull Rapids

Gillrat Lake

Cache Lake

North Access Road

South Access Road

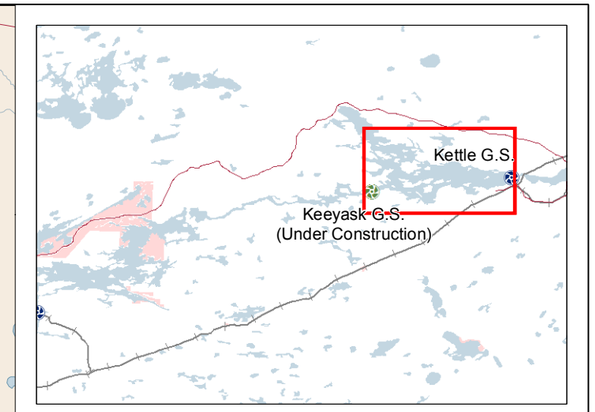
Keeyask G.S.
(Under Construction)

Kettle G.S.

Gillam

280

114227
7778
122866
4079
5389
114241
122778
114240
108003
108007
125103
122863
114226
114244
122776
108009



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	08-JUN-17
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

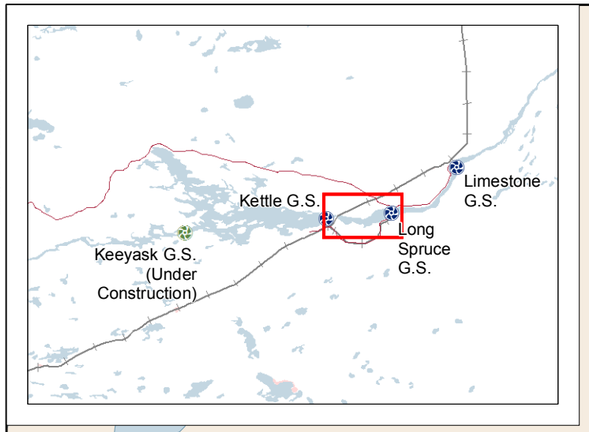
Legend

Receiver Locations
- Retrieved
- Lost

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

Winter 2015/16 Acoustic Receiver Locations:
Stephens Lake

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



N

Sky Pilot Creek

Long Spruce Forebay

Long Spruce G.S.

Kettle Rapids

Kettle G.S.

108000

Kettle River

Boots Creek

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	28-OCT-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

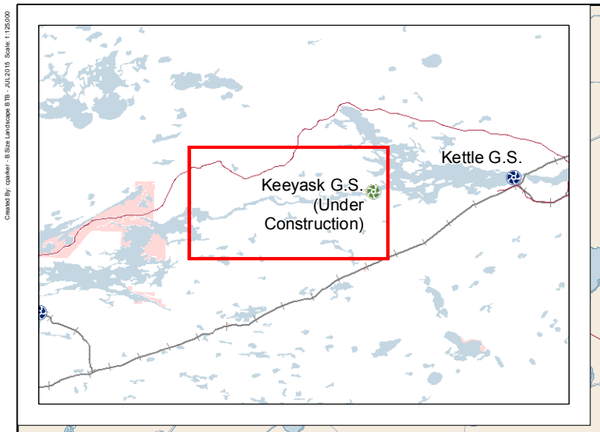
Legend

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

Winter 2015/16 Acoustic Receiver Locations:

Long Spruce Reservoir

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



Ross Wright Bay
North Access Road
Looking Back Creek
280
Effie Creek
Hidden Creek
Pond 13
125553
127089
107999
Caribou Island
Morris Point
125102
Keeyask G.S.
(Under Construction)
Gull Rapids
South Access Road
Two Goose Creek
Trickle Creek
NELSON RIVER
3
108002
127095
107998
127088
122774
114228
5
127084
125557
125104
107996
4
122780
125101
Fork Creek
129191
125552
122781
129185
114243
2
Portage Creek
Nap Creek
Birthday Rapids
Rabbit Creek
Seebeesis Creek
100656
125105
129192
7021
4548
Clark Lake
Long Rapids
1
Carscadden Lake
SPLIT LAKE

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	28-OCT-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

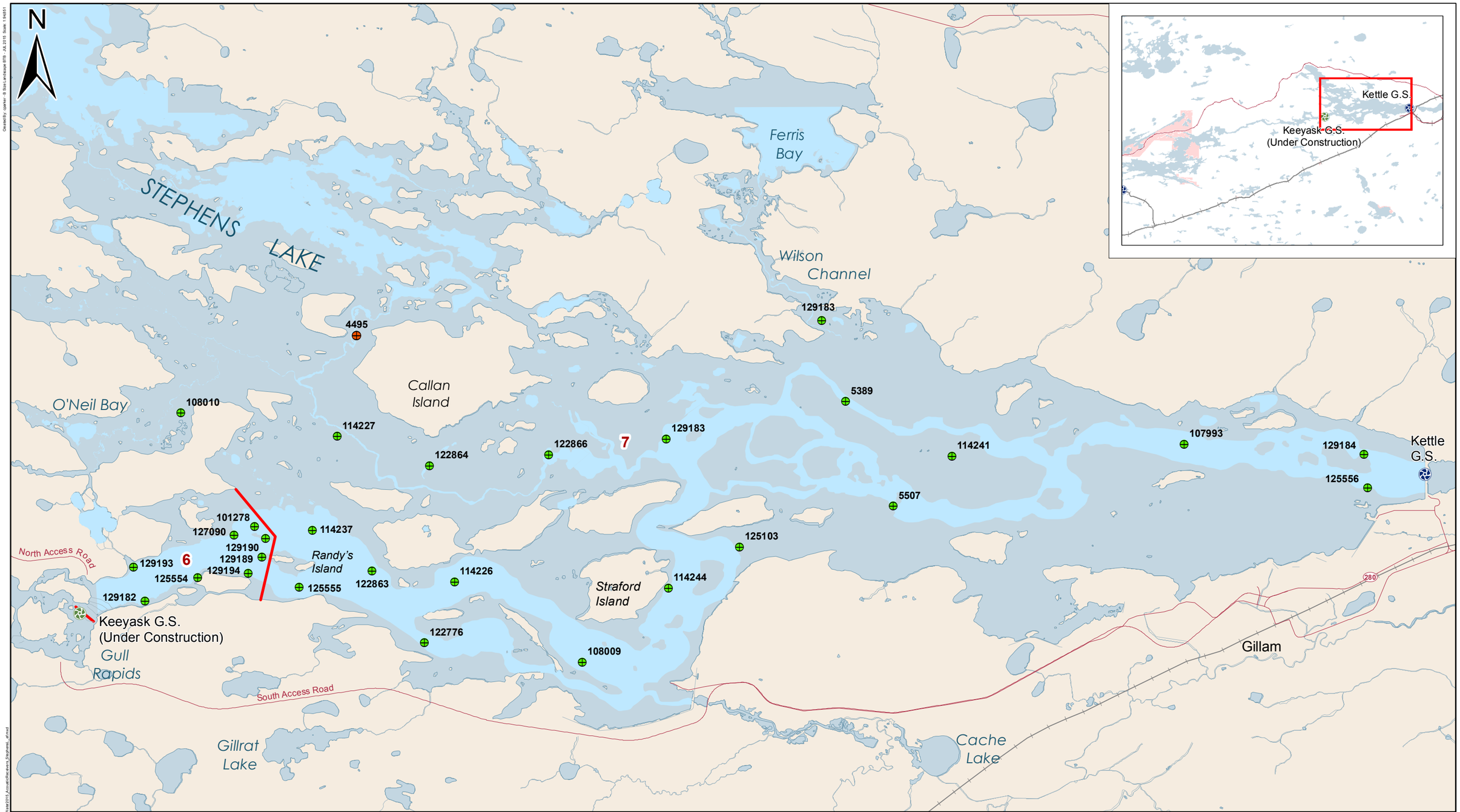
Legend

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

Open-water 2016 Acoustic Receiver Locations:

Clark Lake to Gull Rapids

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



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	04-NOV-16
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

Legend

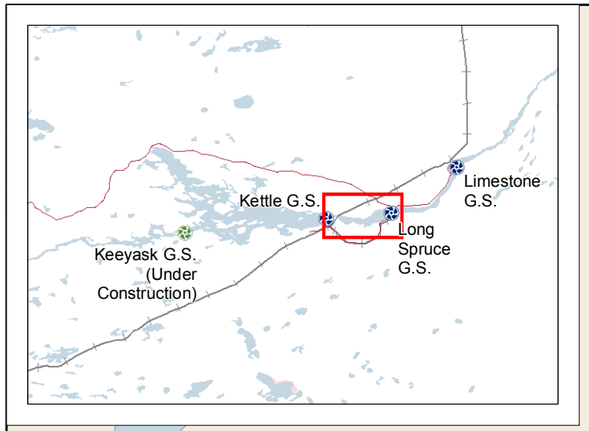
Receiver Locations
- Retrieved
- Lost

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

- Zones
- Highway
- Rail
- First Nation Reserve

Open-water 2016 Acoustic Receiver Locations:
Stephens Lake

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



N

Sky Pilot Creek

100779

Long Spruce Forebay

Long Spruce G.S.

114234

Kettle Rapids

Kettle G.S.

122779

5505

108000

Kettle River

Boots Creek

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	16-FEB-17
0 0.45 0.9 Kilometres 0 0.35 0.7 Miles	VERSION NO: 1.0	QA/QC: CMP/YYY/ZZZ

Legend

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

Open-water 2016 Acoustic Receiver Locations

Long Spruce and Limestone Reservoirs

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

APPENDICES

APPENDIX 1:
LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC TAGGED JUVENILE LAKE STURGEON UPSTREAM OF GULL RAPIDS, AUGUST 2013 TO OCTOBER 2015

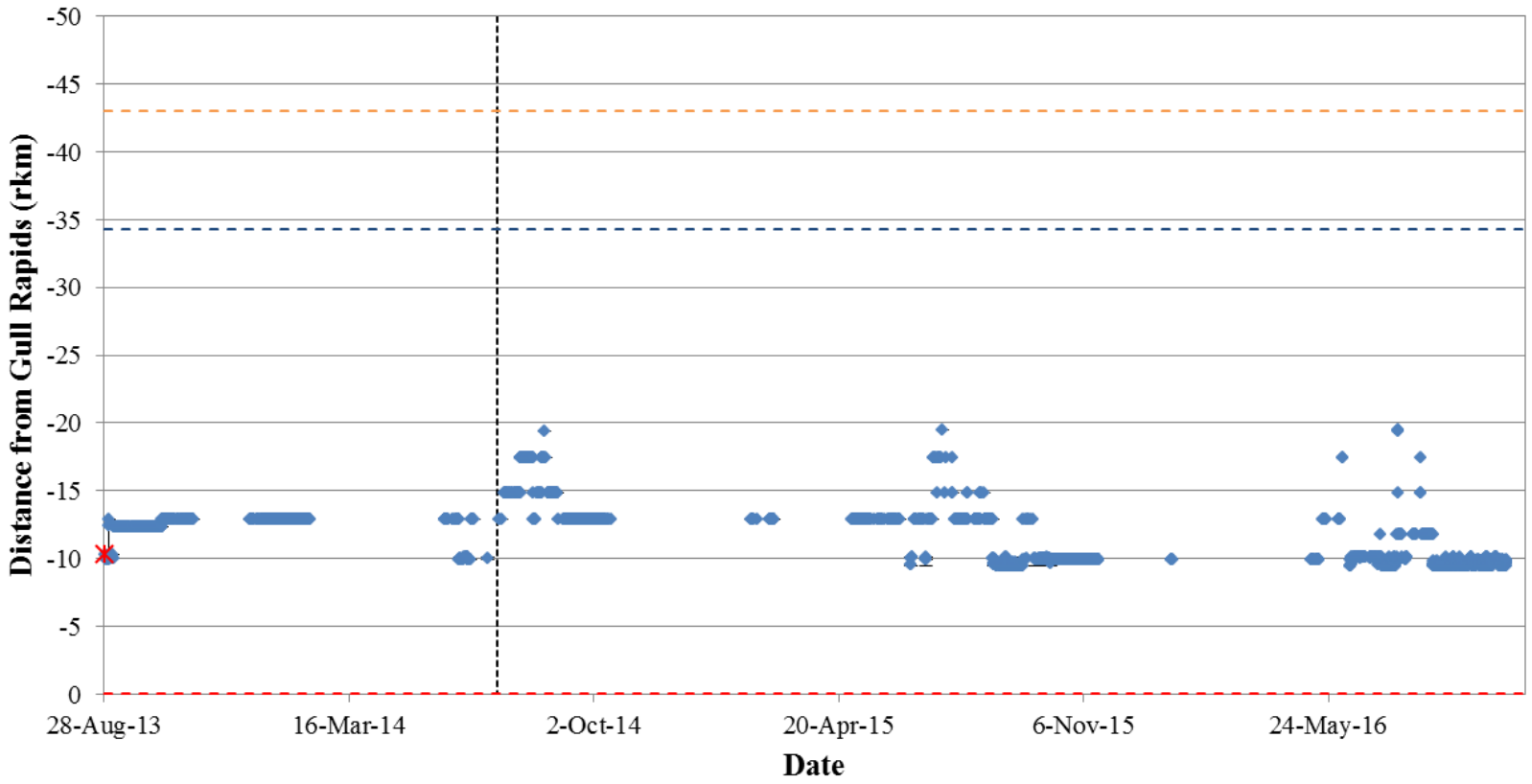


Figure A1-1: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32671) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

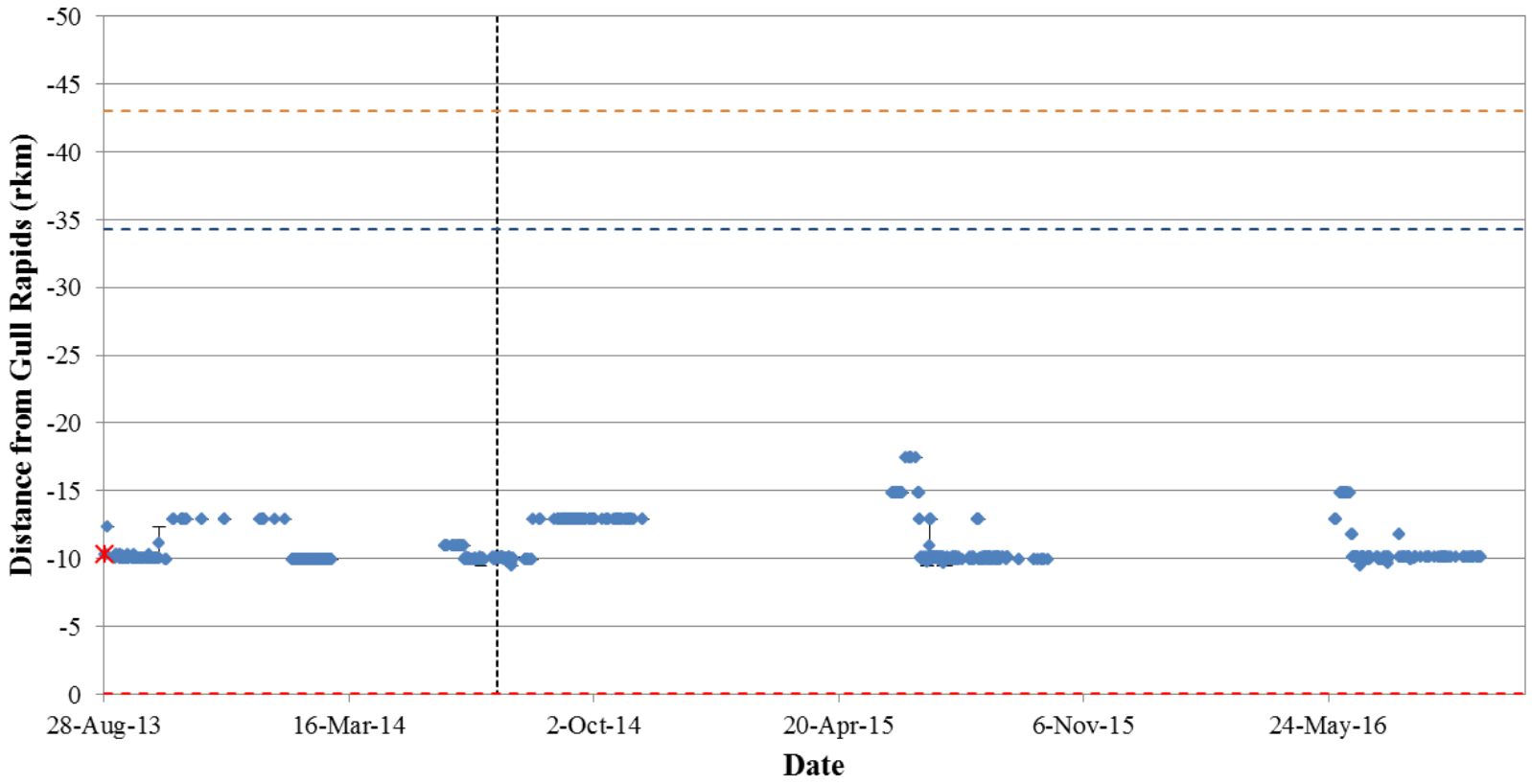


Figure A1-2: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32672) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

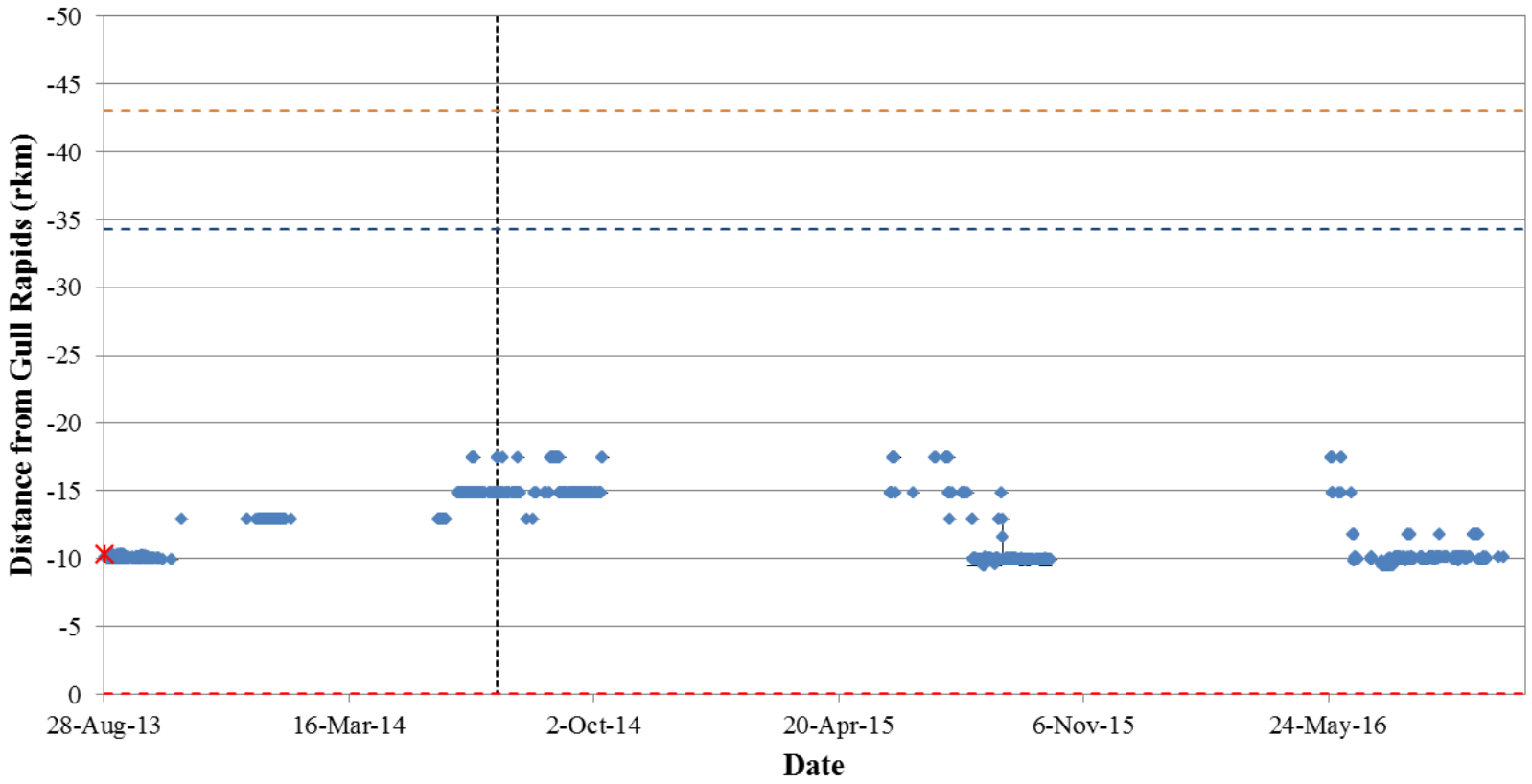


Figure A1-3: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32676) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

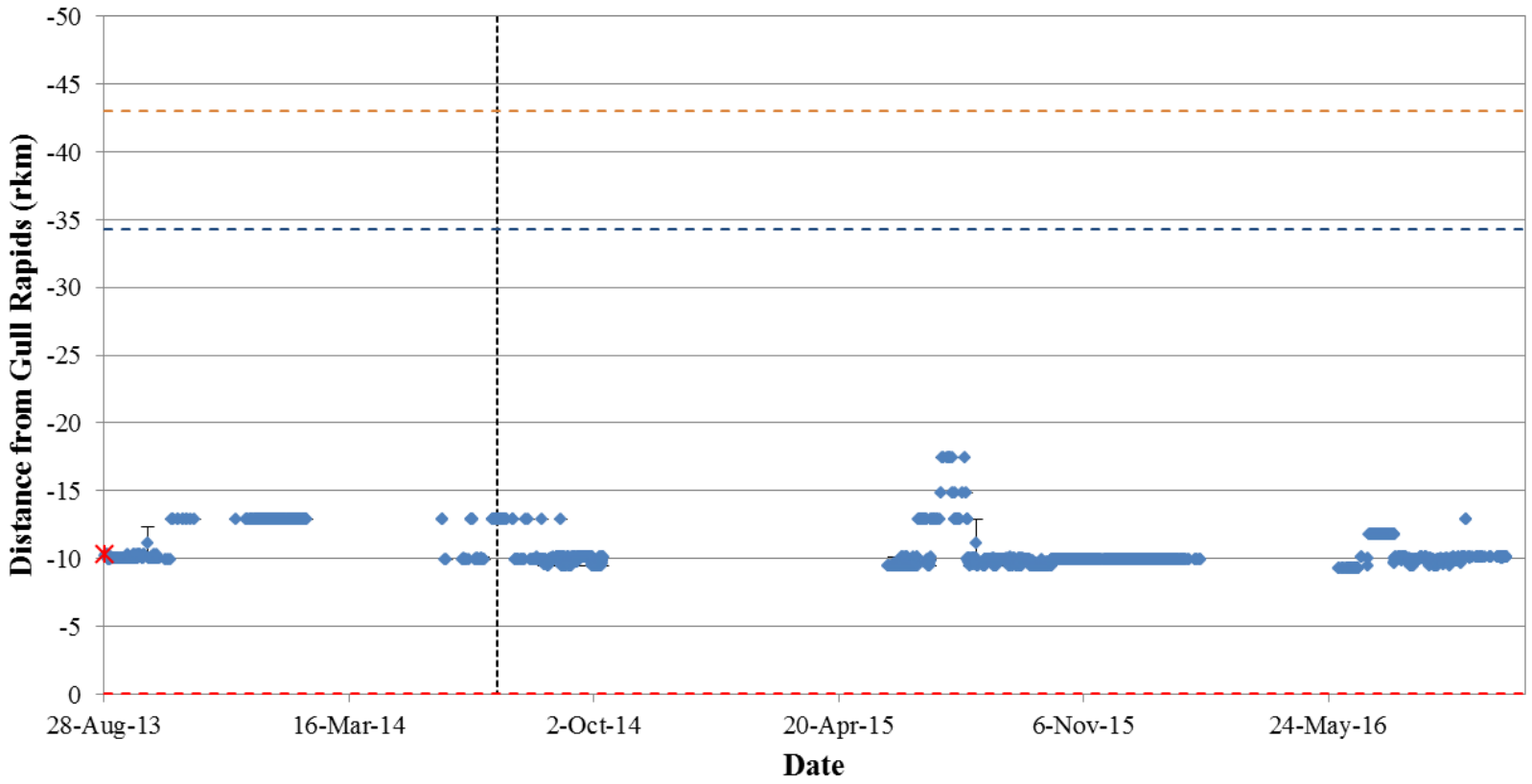


Figure A1-4: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32677) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

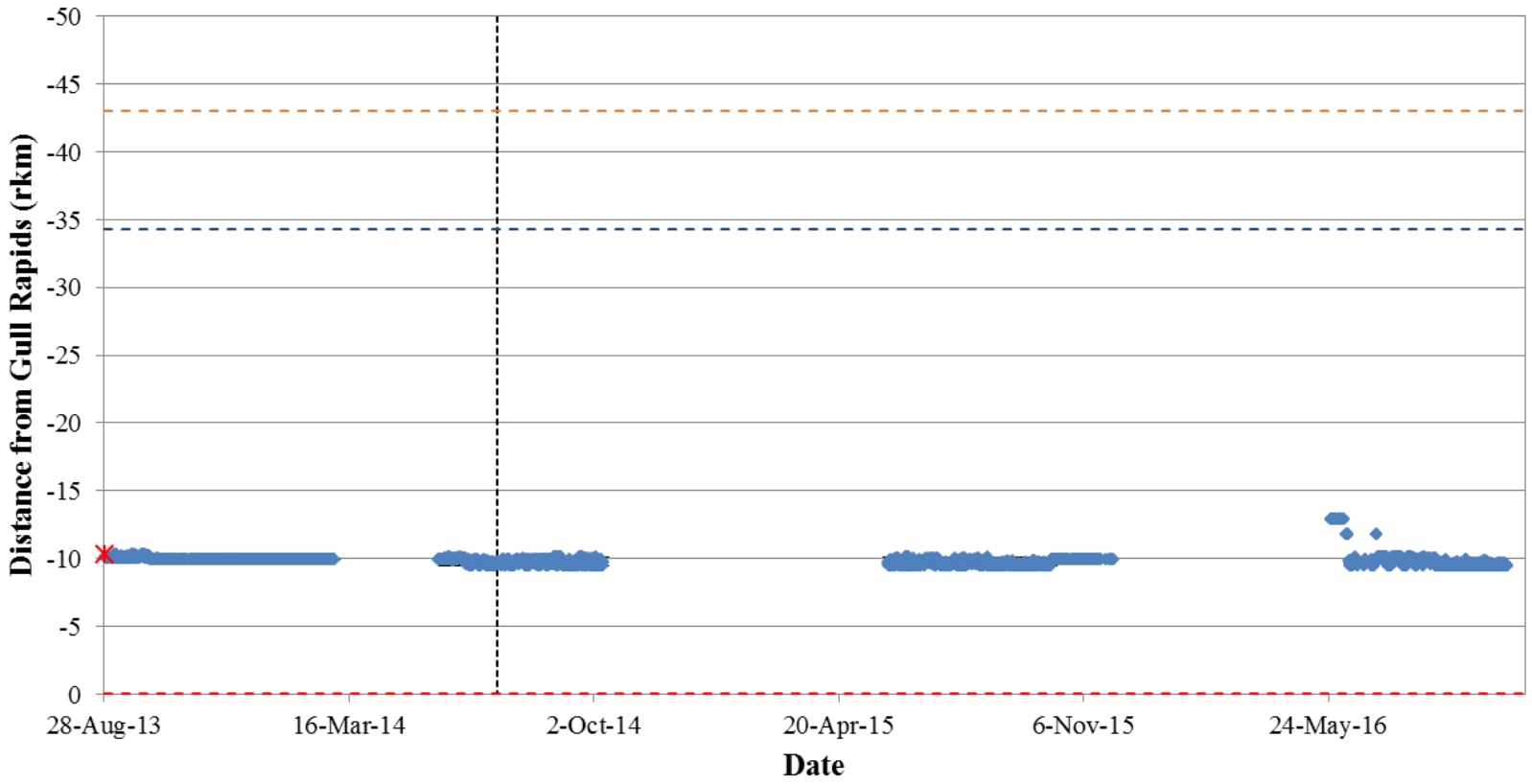


Figure A1-5: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32678) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

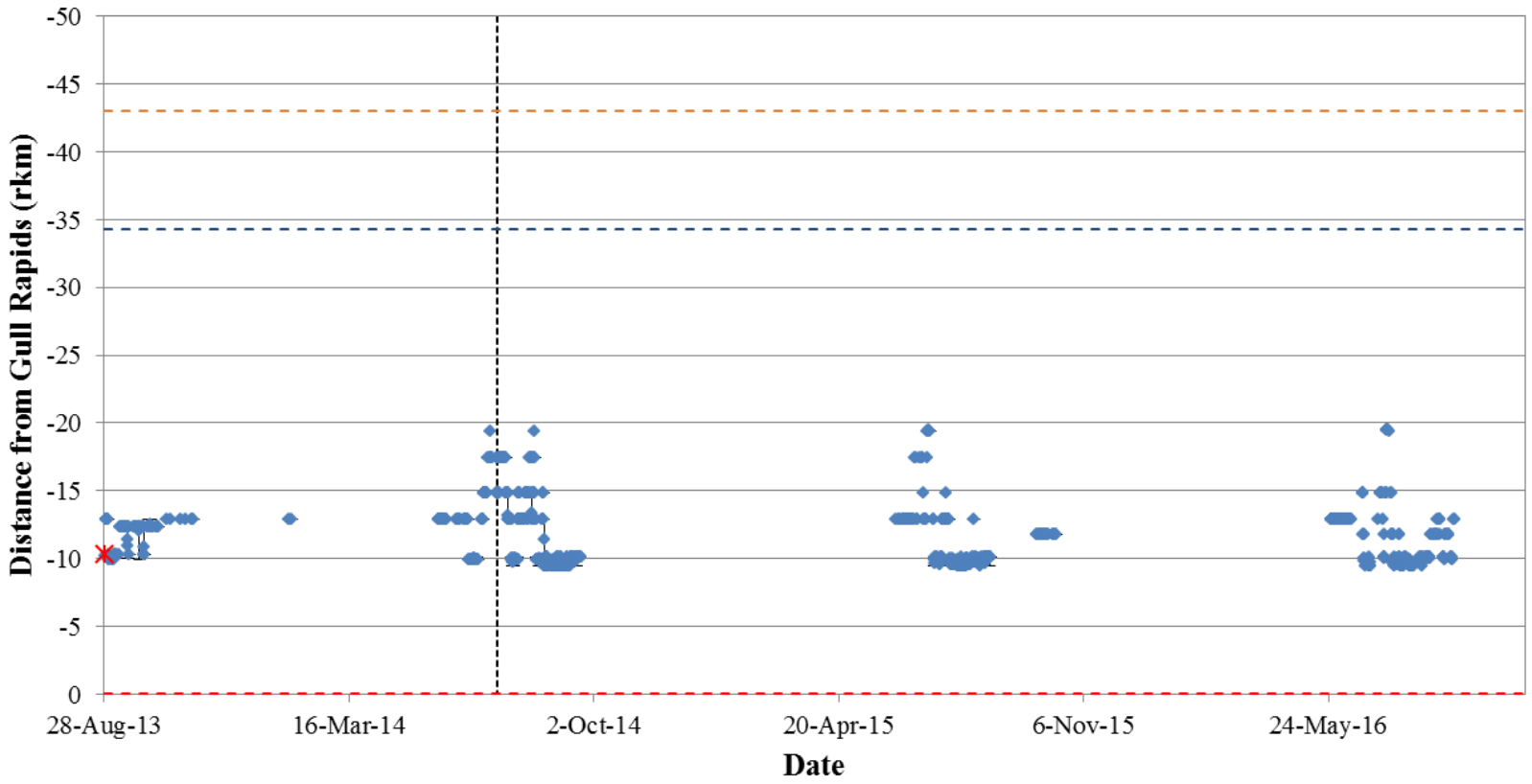


Figure A1-6: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32679) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

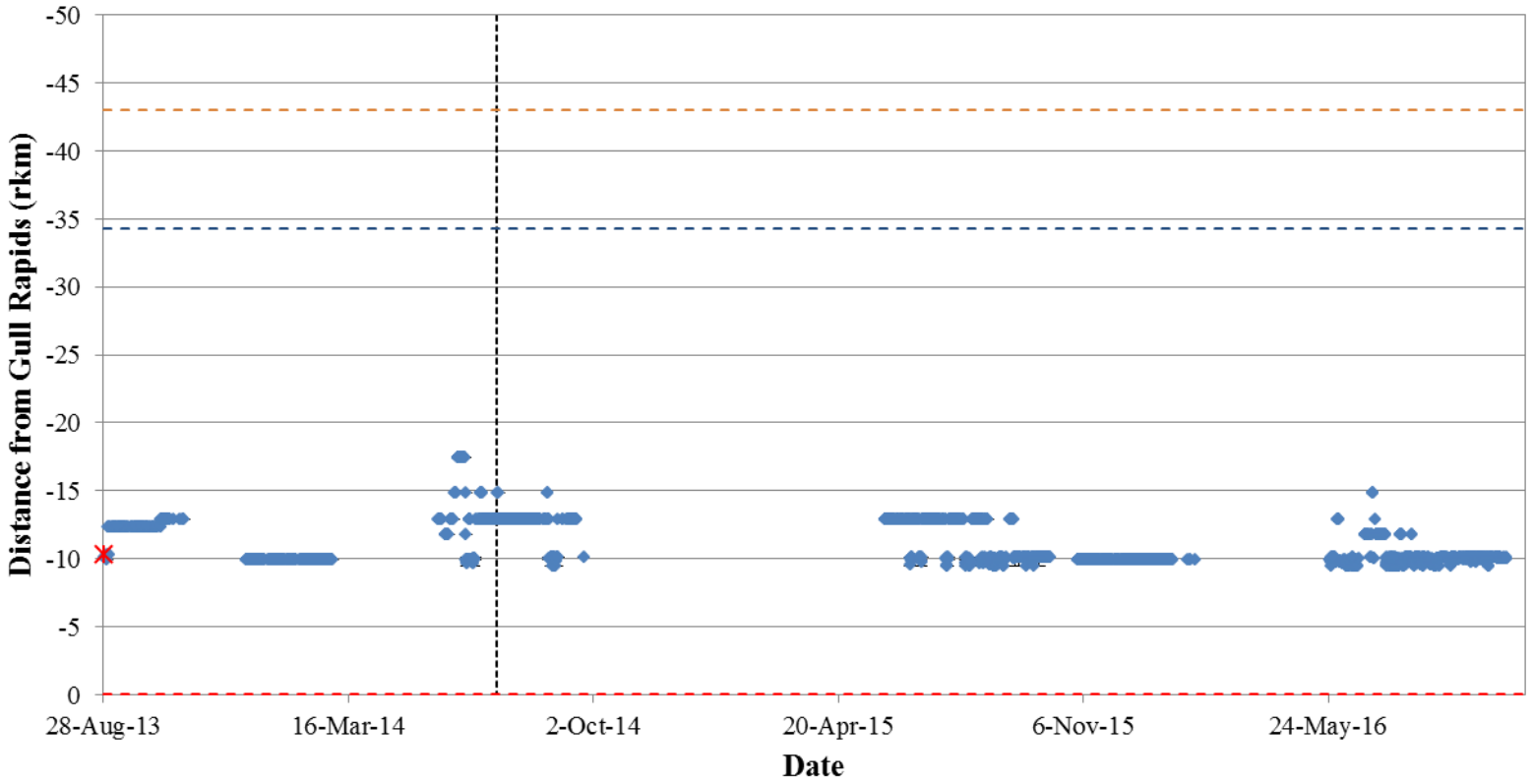


Figure A1-7: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32681) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

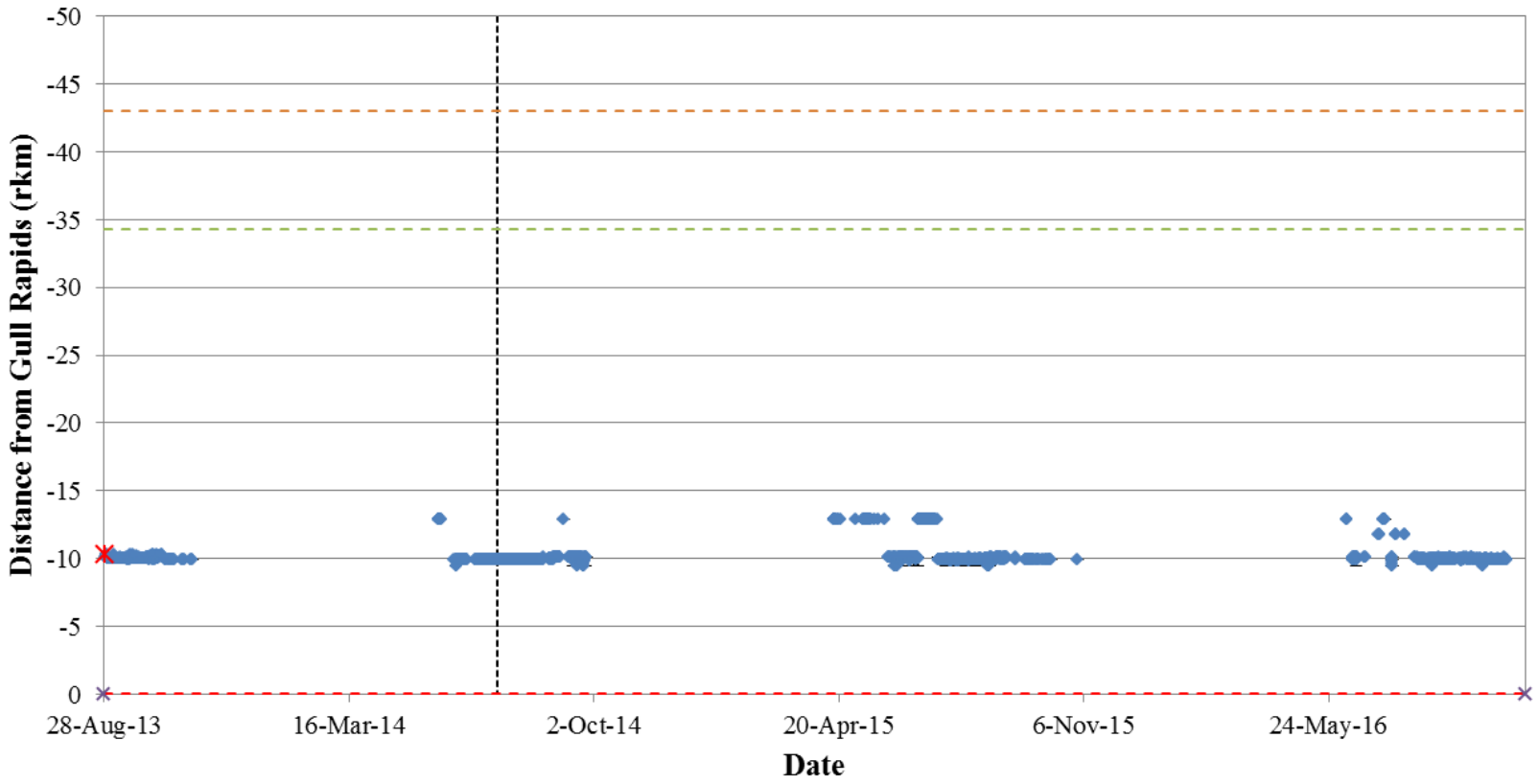


Figure A1-8: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32682) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

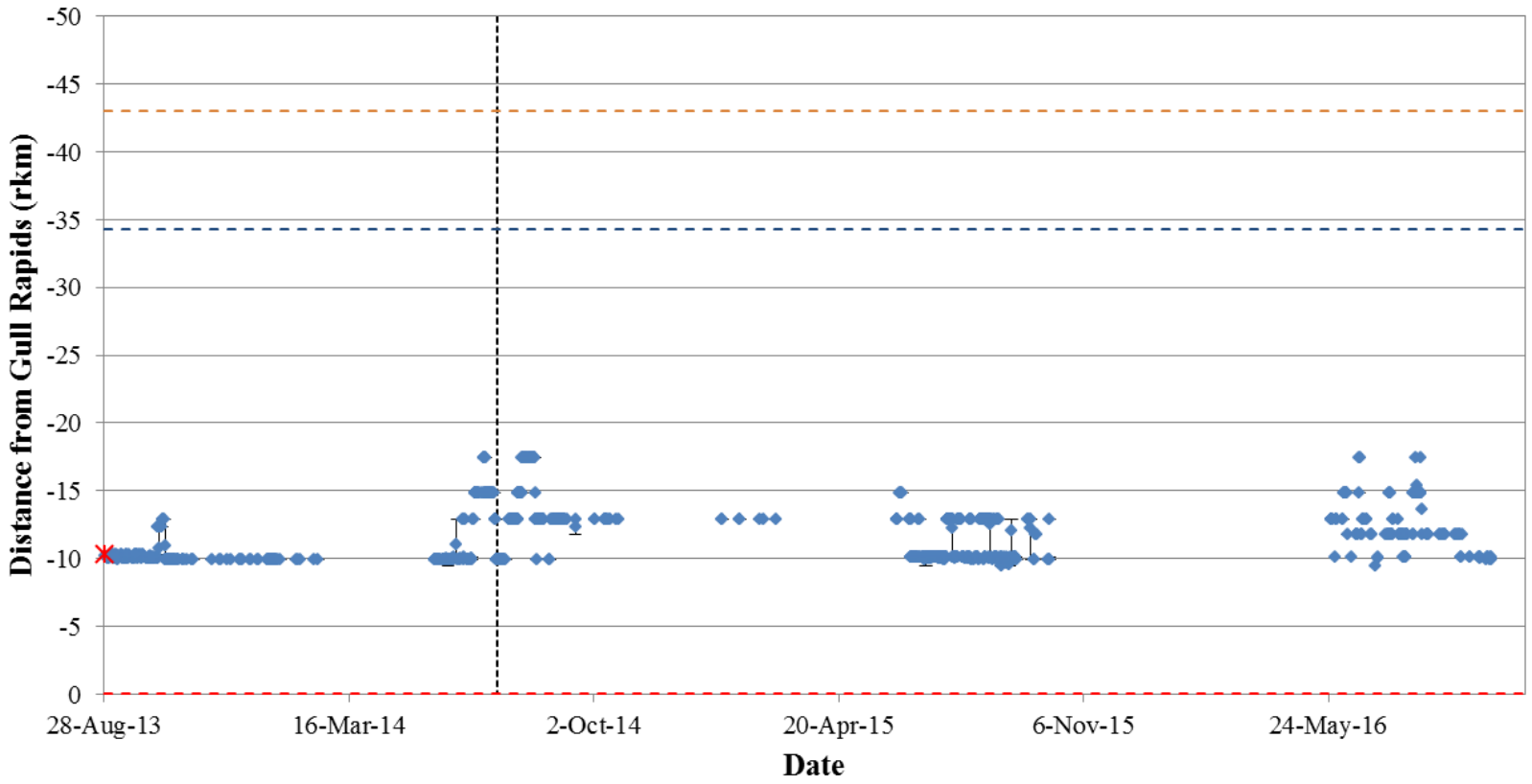


Figure A1-9: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32683) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

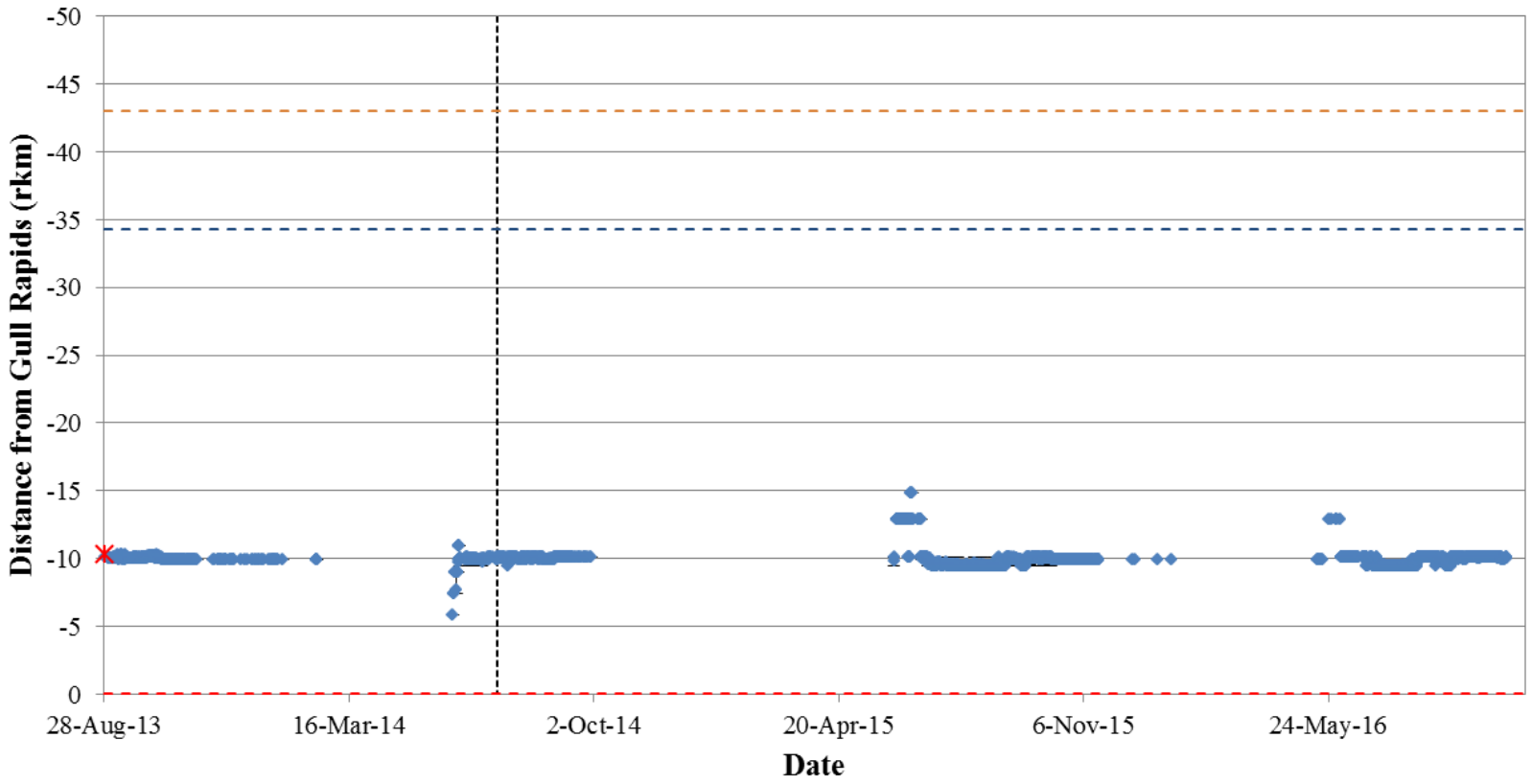


Figure A1-10: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32684) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

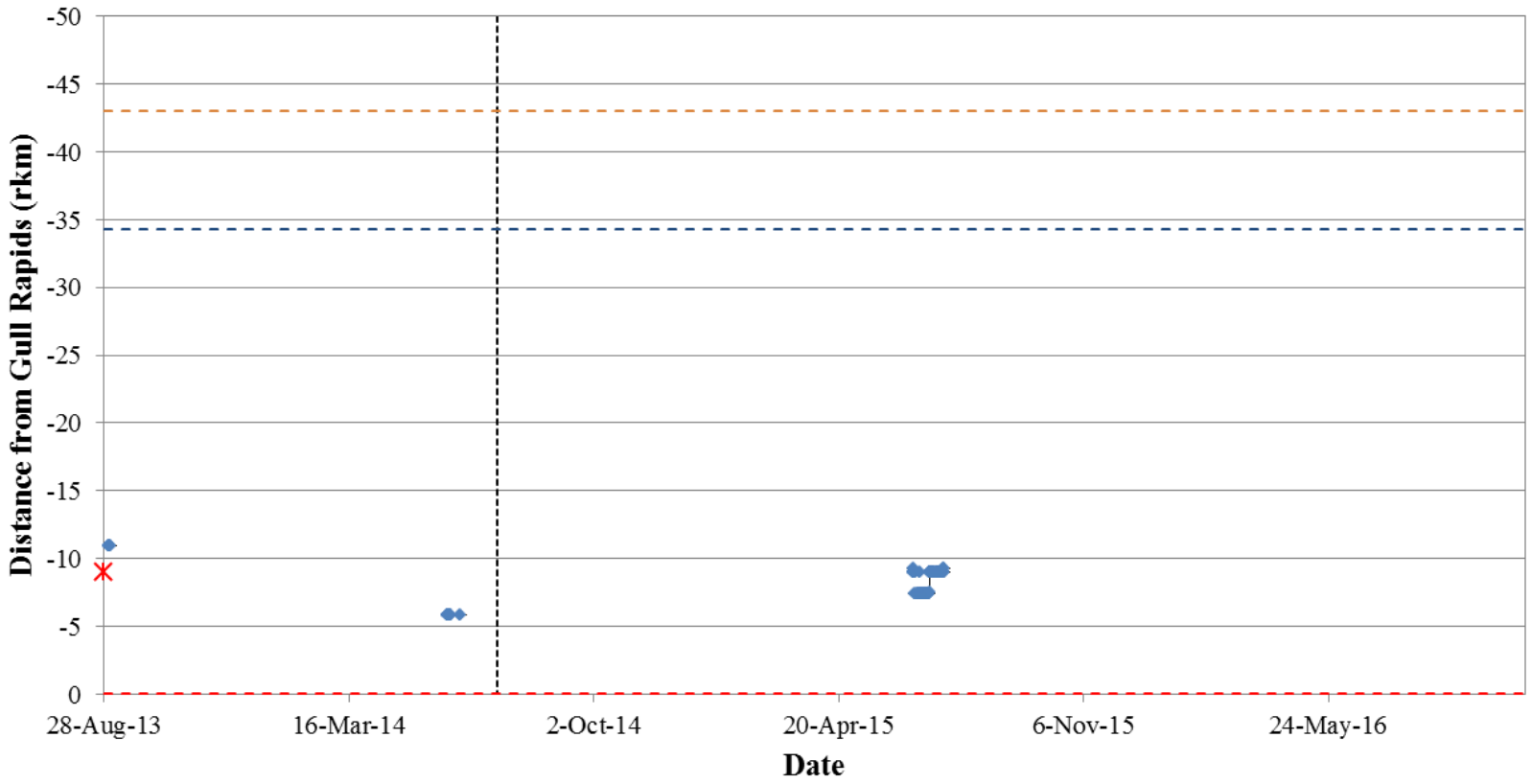


Figure A1-11: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32686) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

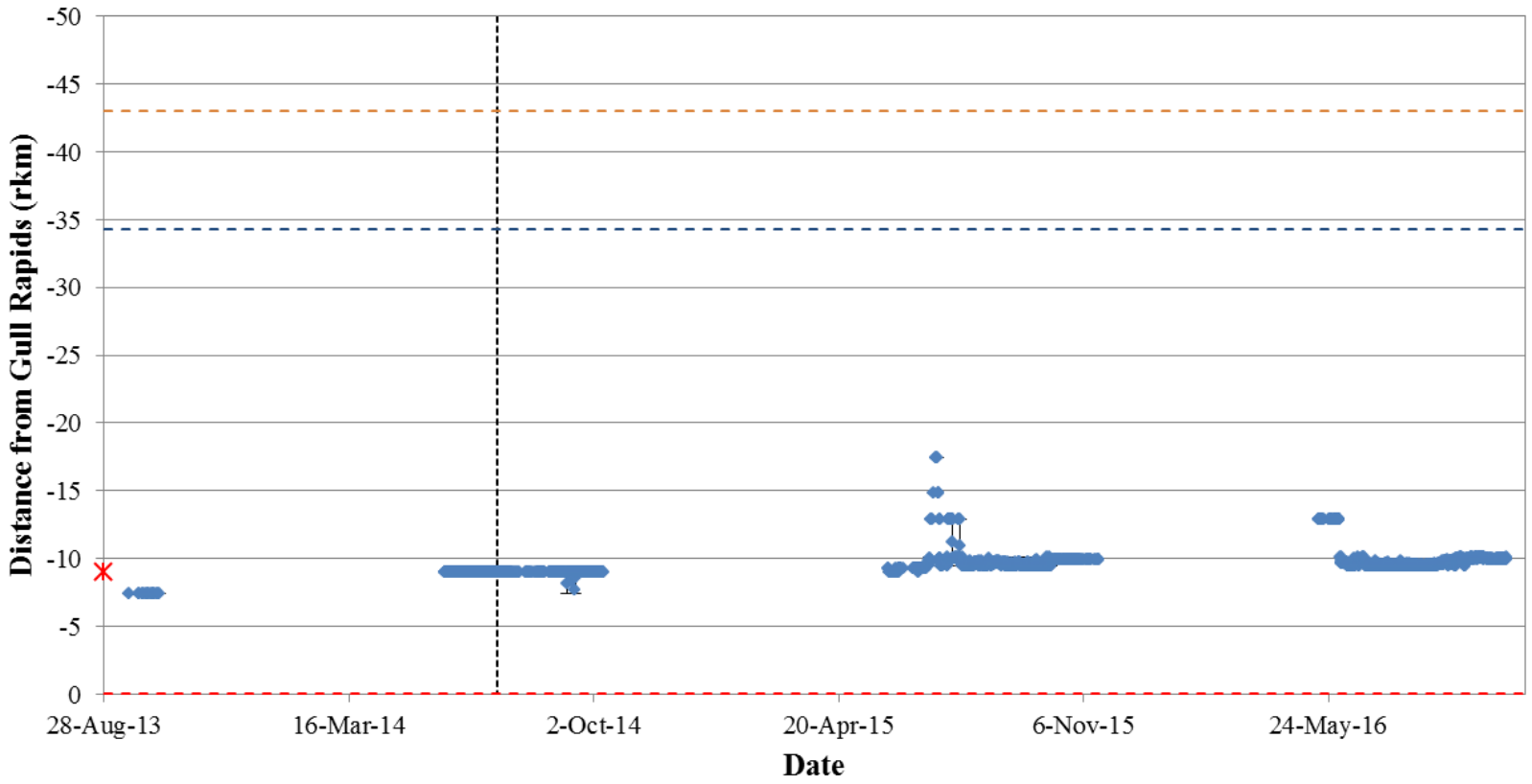


Figure A1-12: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32687) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

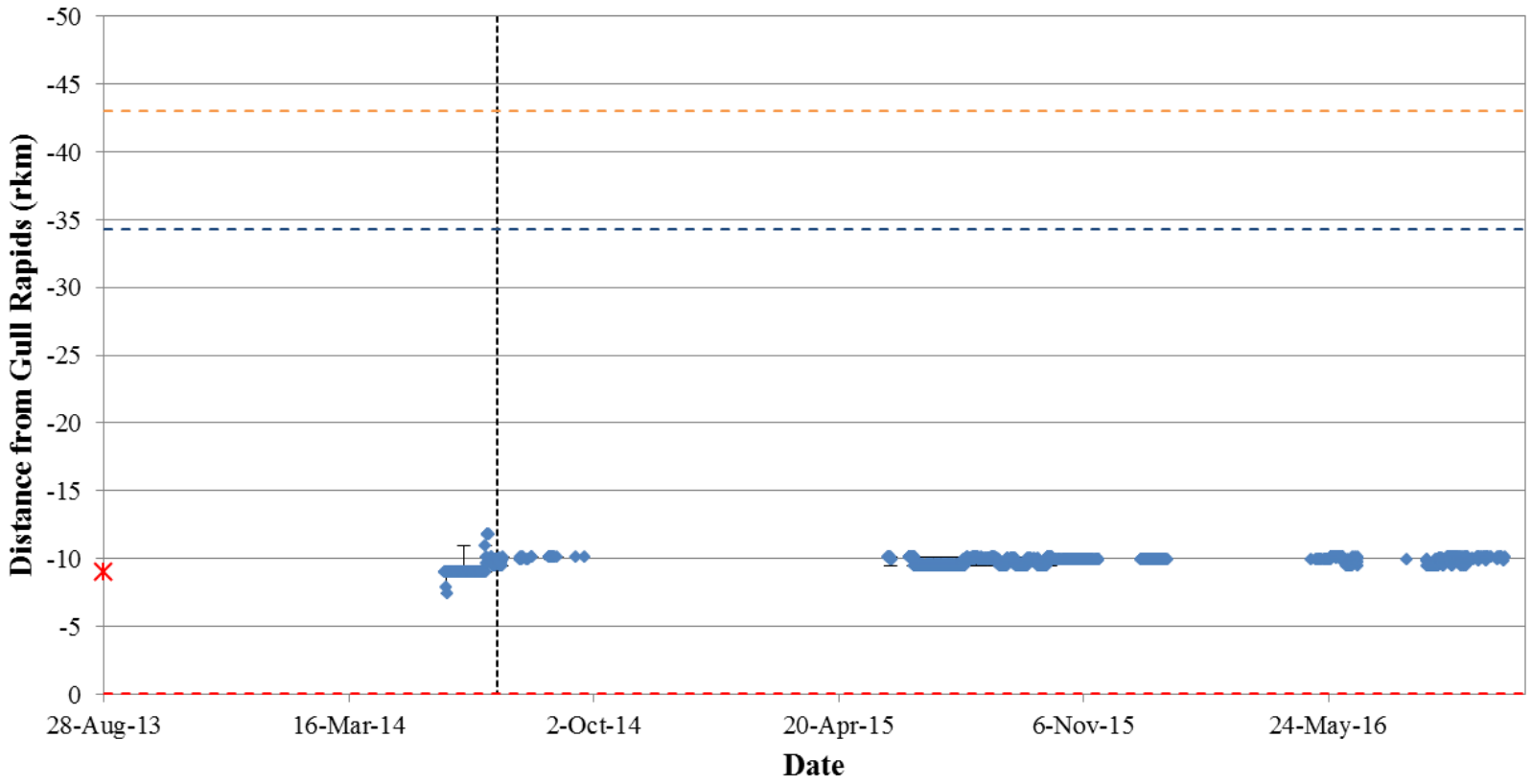


Figure A1-13: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32688) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

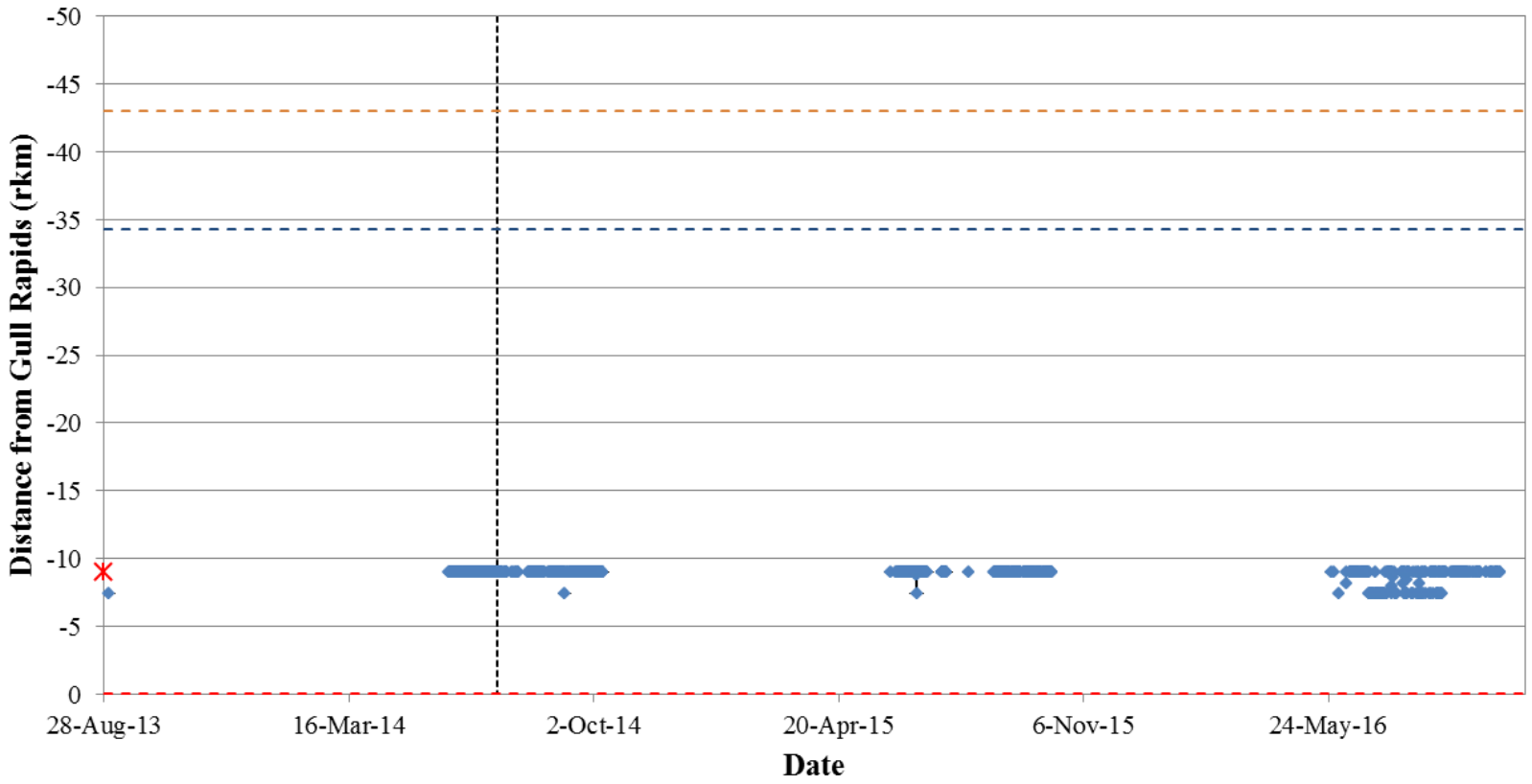


Figure A1-14: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32689) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

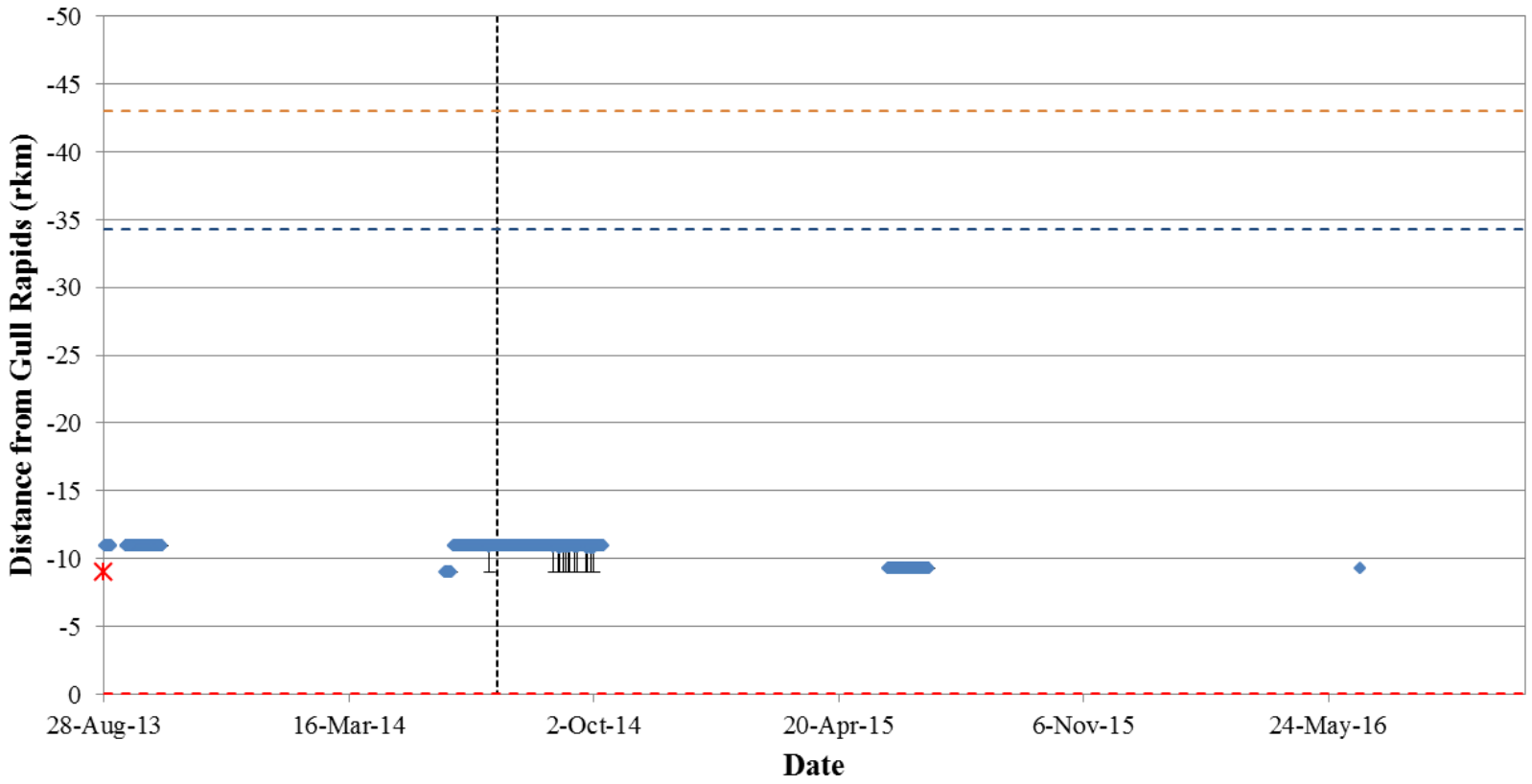


Figure A1-15: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32690) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

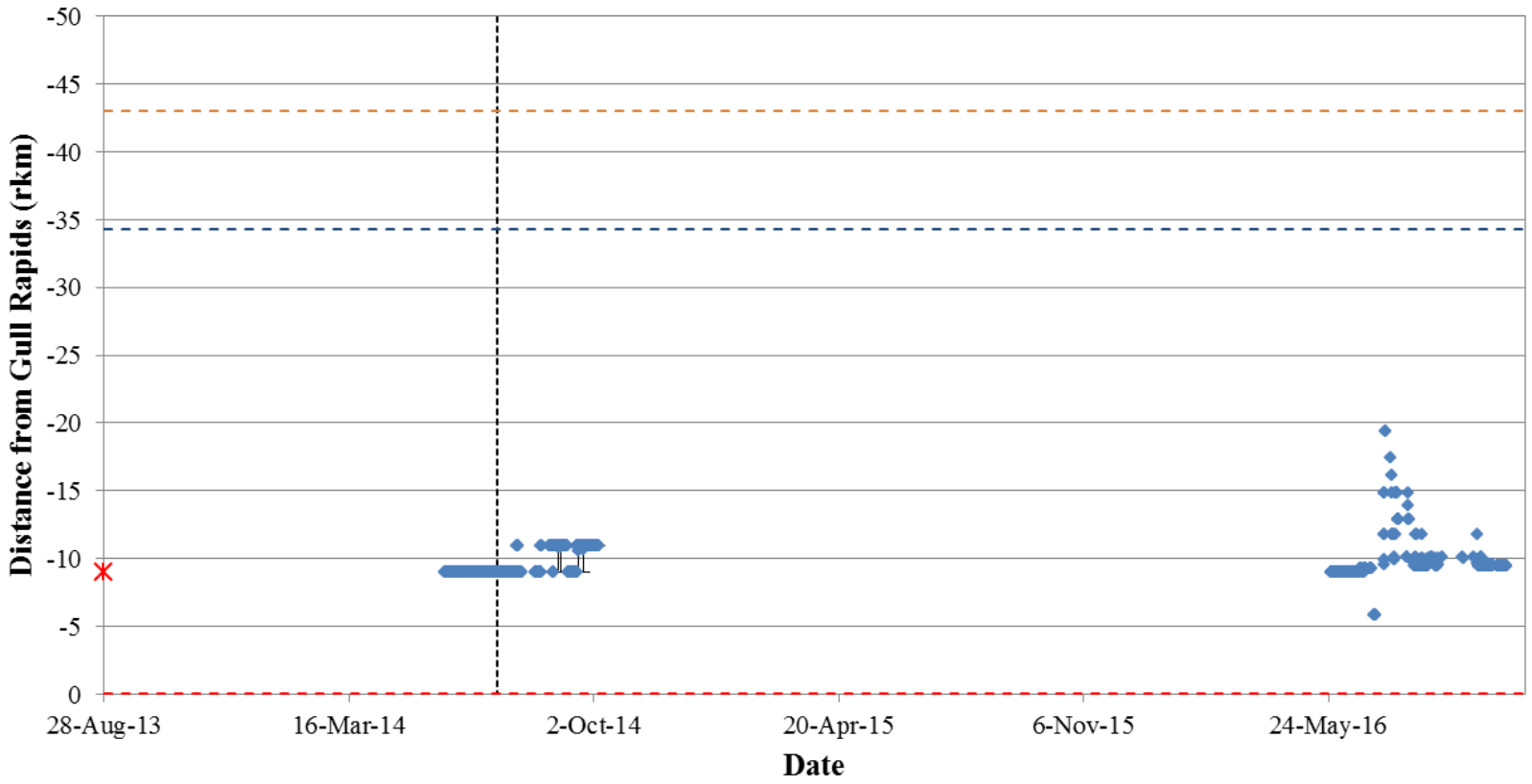


Figure A1-16: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32691) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

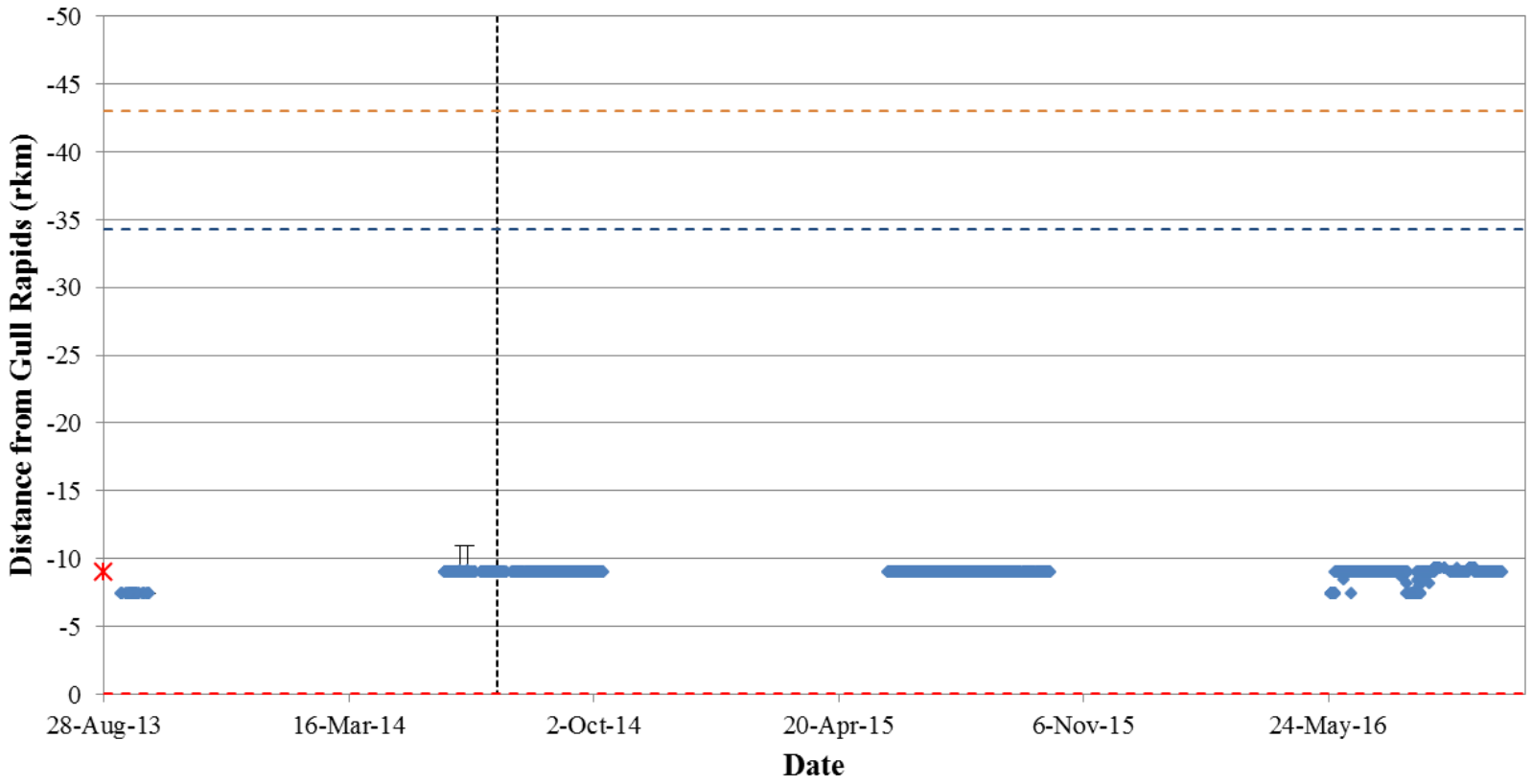


Figure A1-17: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32692) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

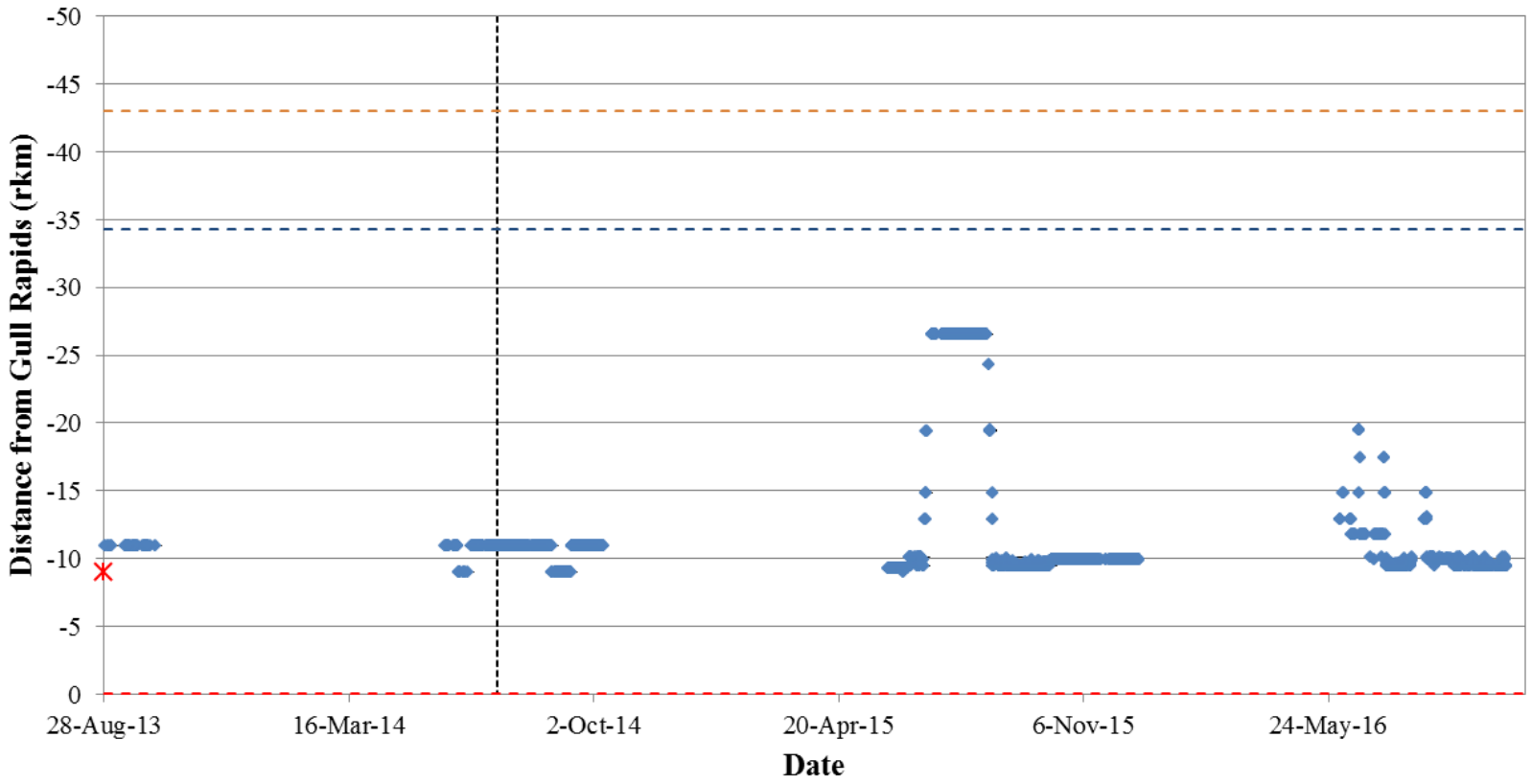


Figure A1-18: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32693) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

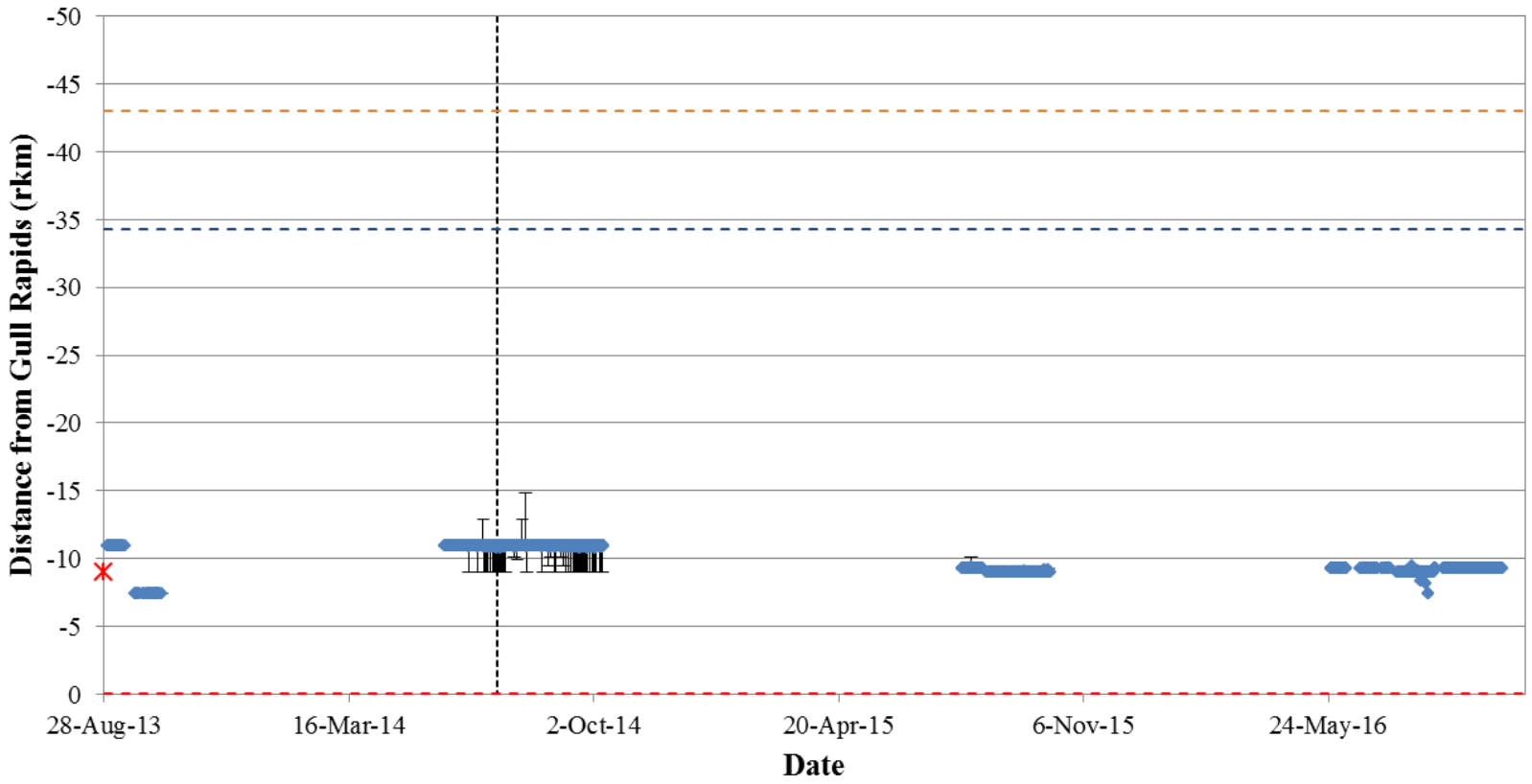


Figure A1-19: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32694) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

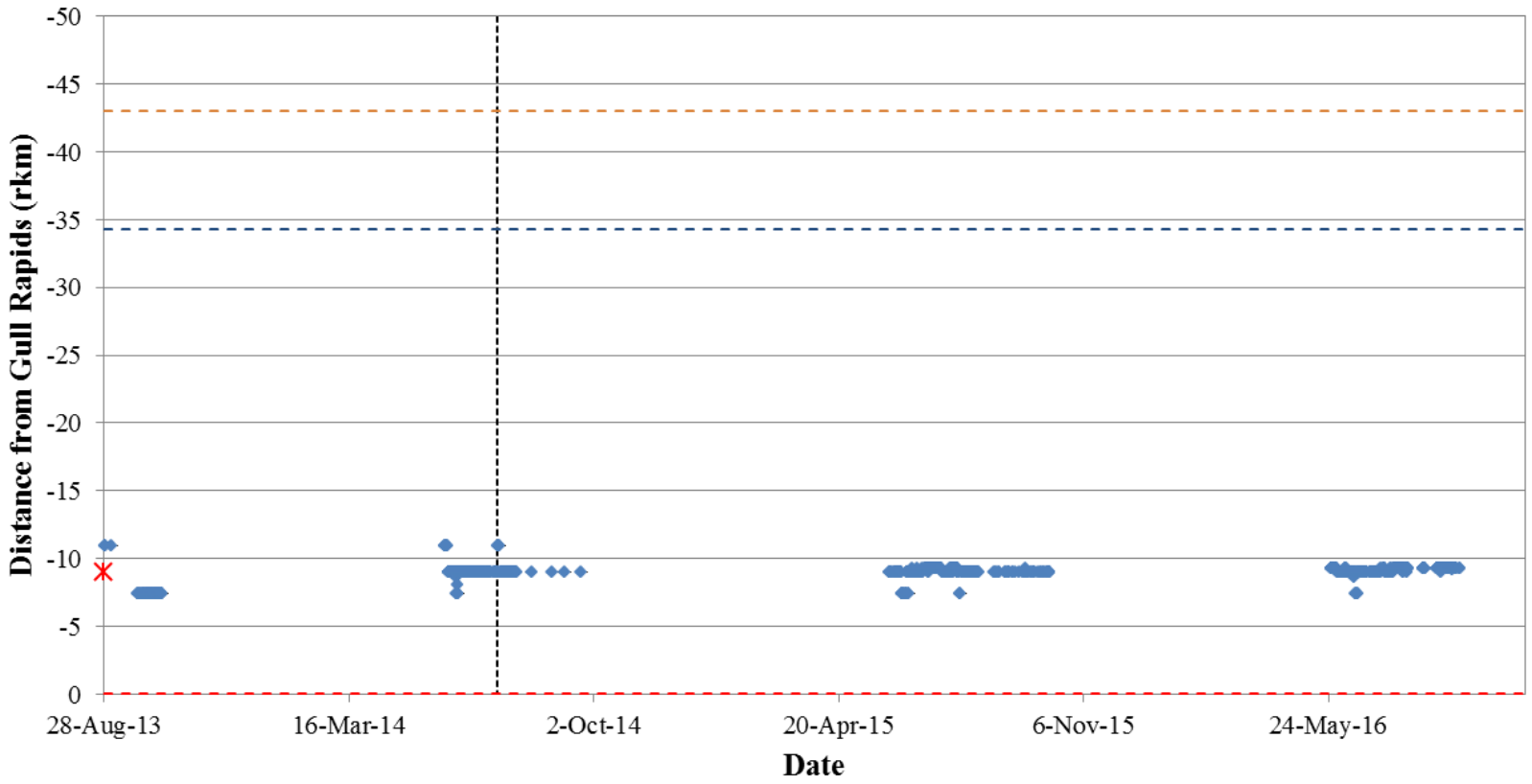


Figure A1-20: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32695) in Gull Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated by red X. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Birthday Rapids (blue), and the entrance to Clark Lake (orange).

APPENDIX 2:
LOCATION SUMMARY FOR INDIVIDUAL ACOUSTIC TAGGED JUVENILE LAKE STURGEON DOWNSTREAM OF GULL RAPIDS, AUGUST 2013 TO OCTOBER 2015

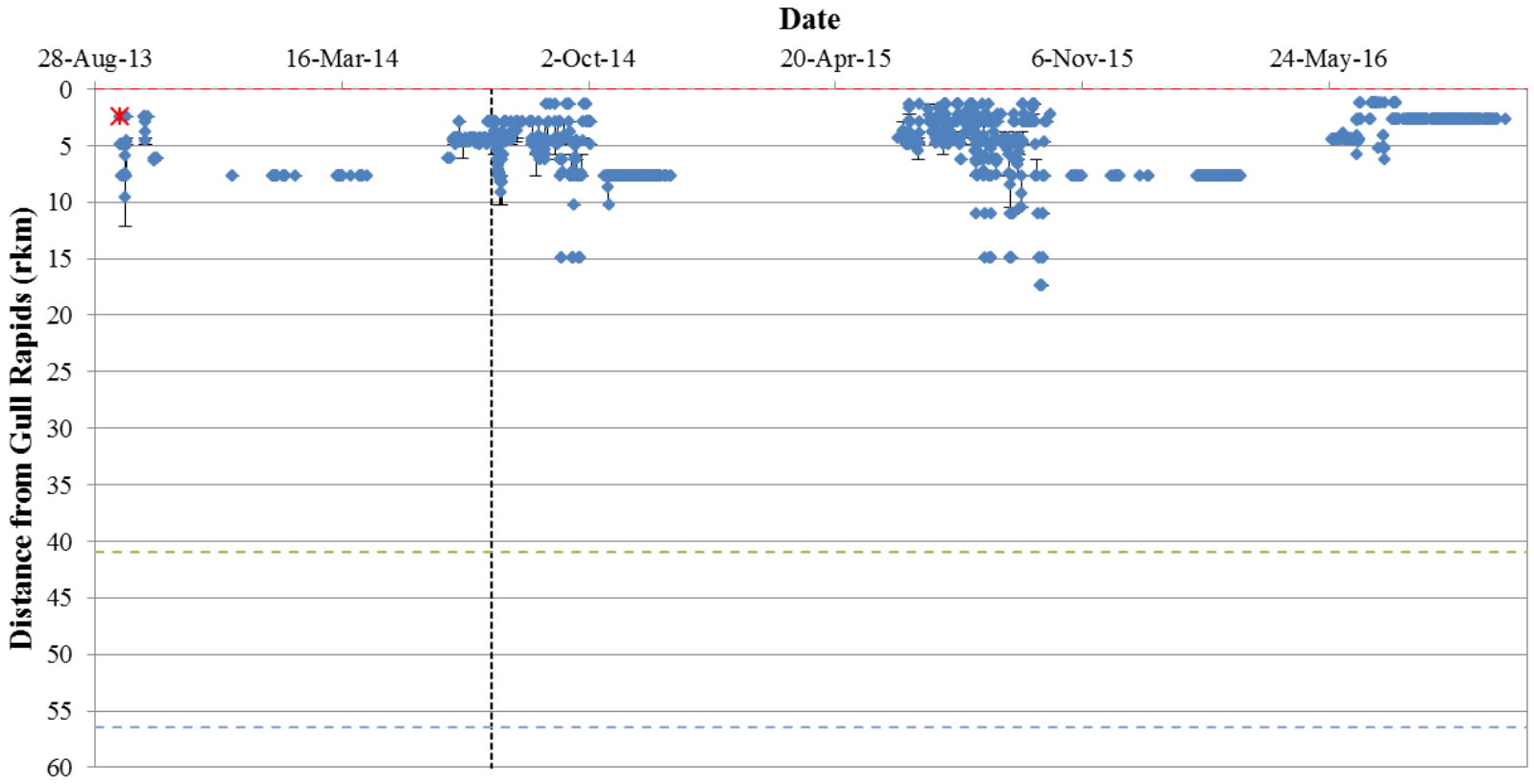


Figure A2-1: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32661) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (blue).

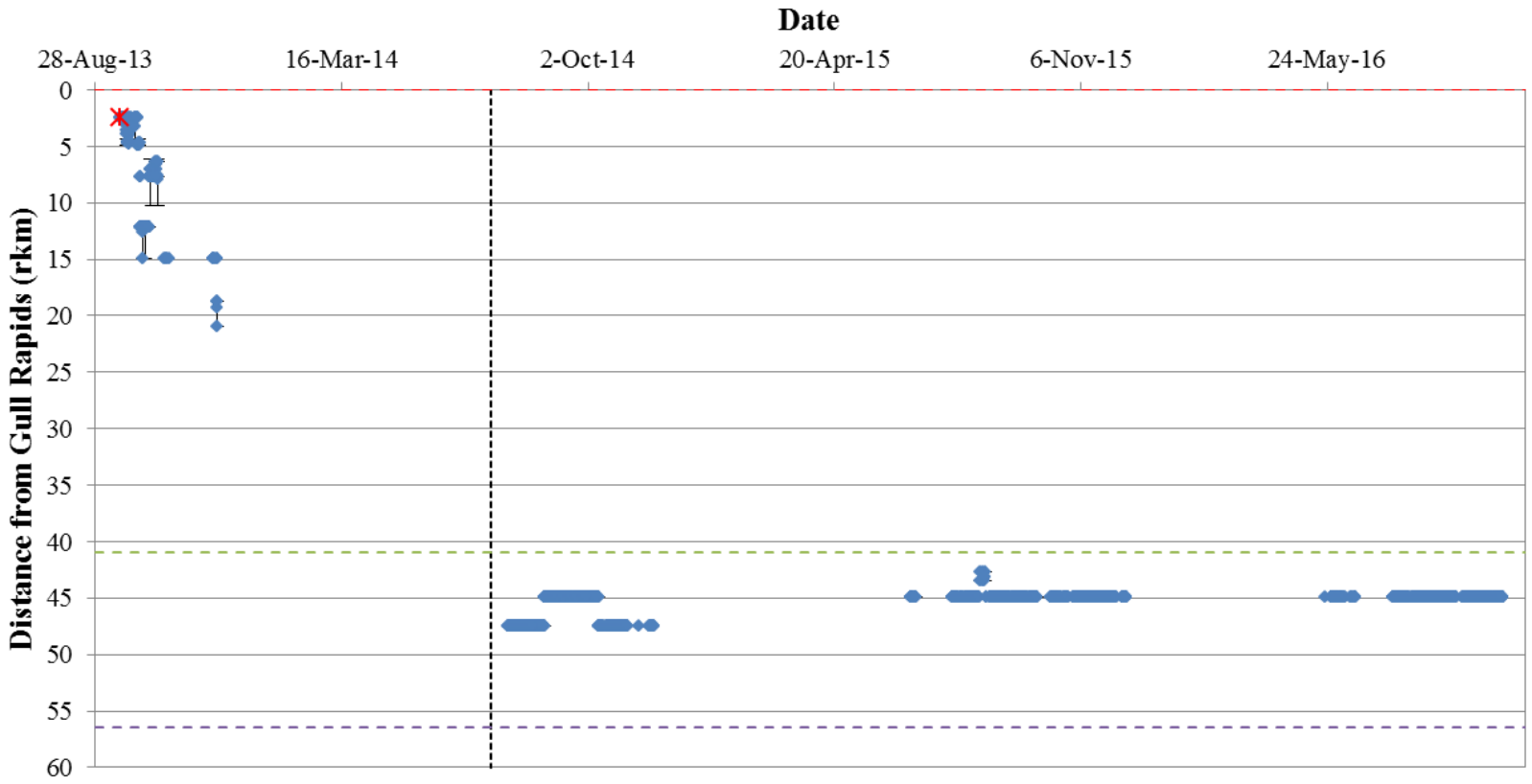


Figure A2-2: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32662) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

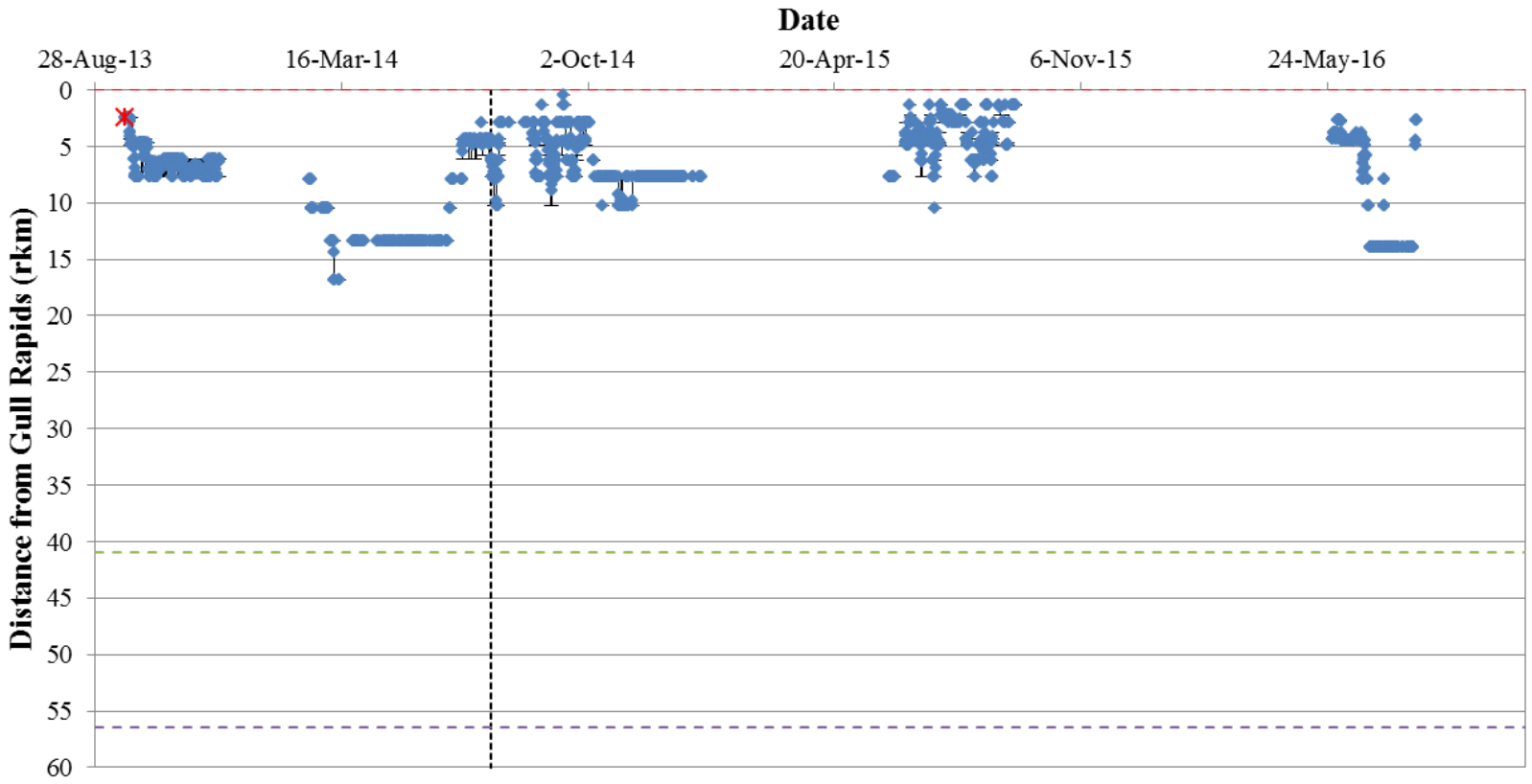


Figure A2-3: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32663) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 11 October, 2015. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

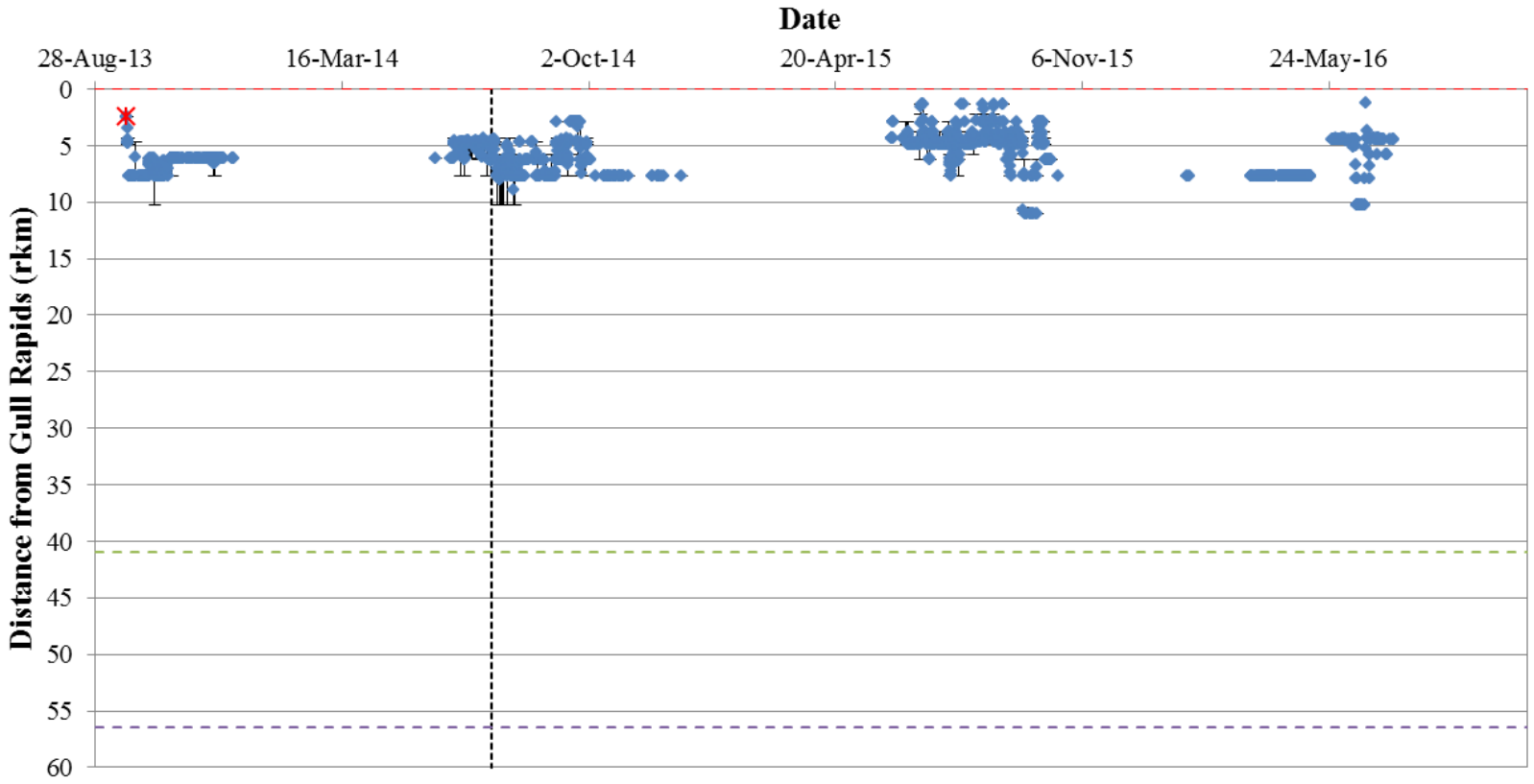


Figure A2-4: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32664) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

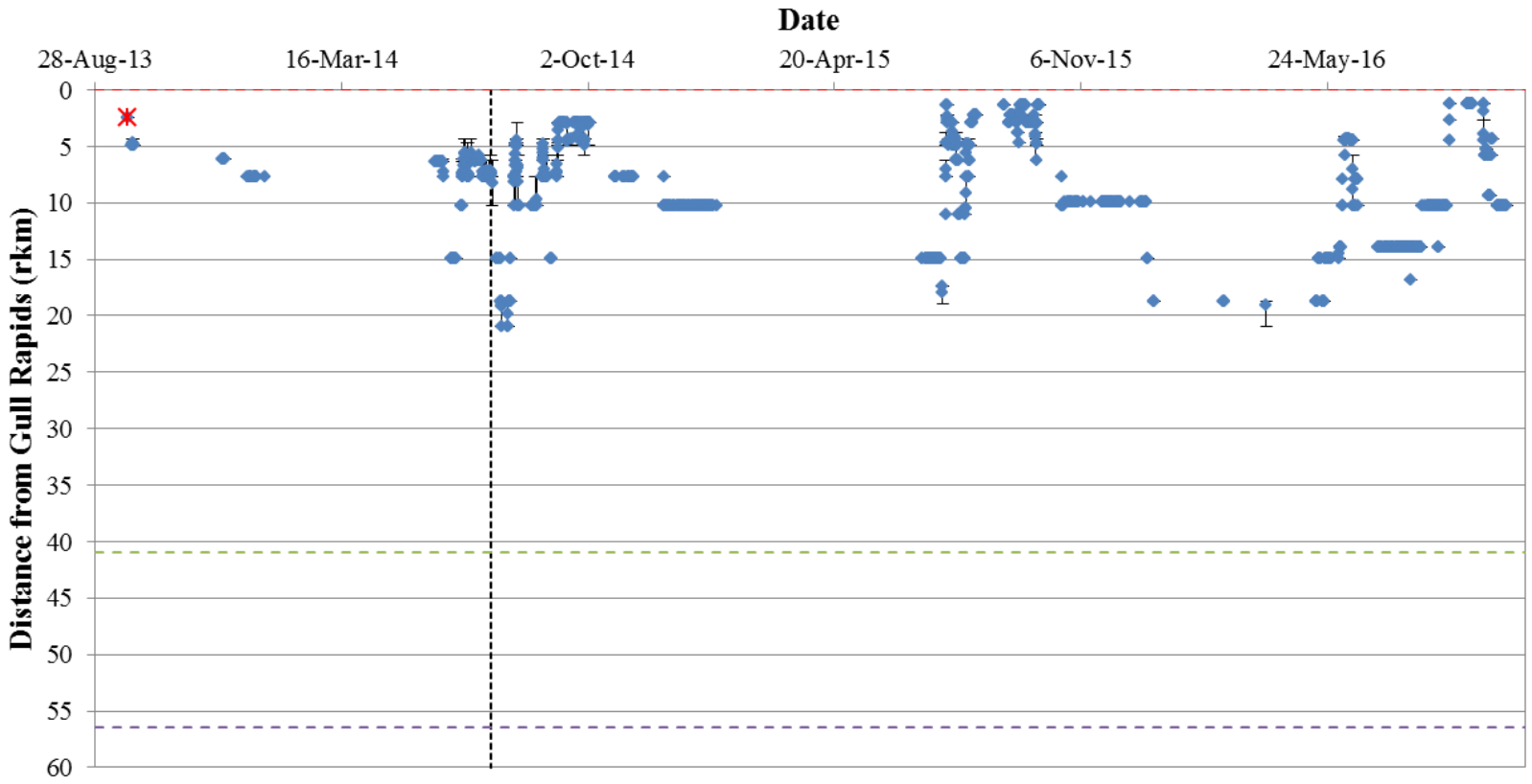


Figure A2-5: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32665) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

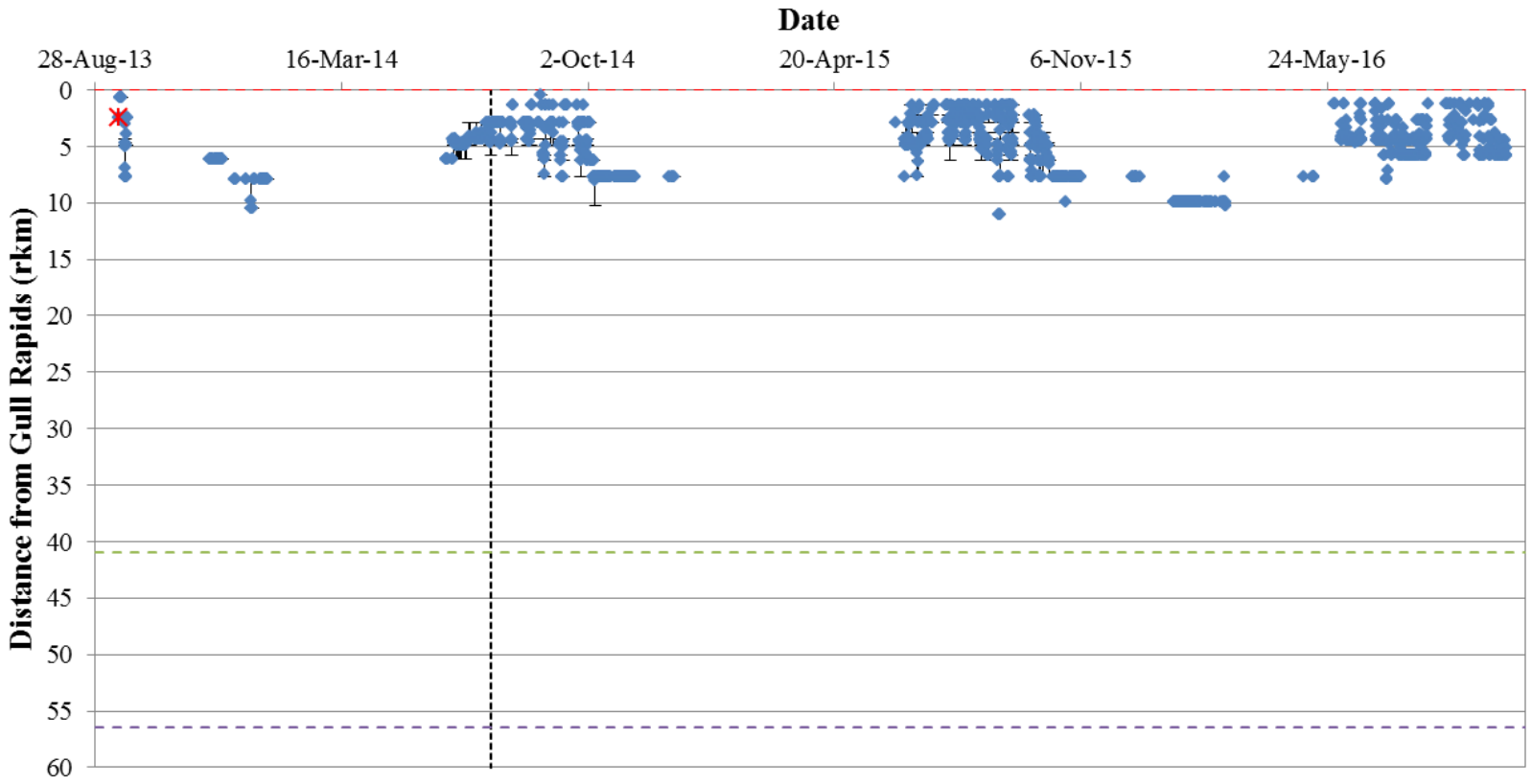


Figure A2-6: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32666) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

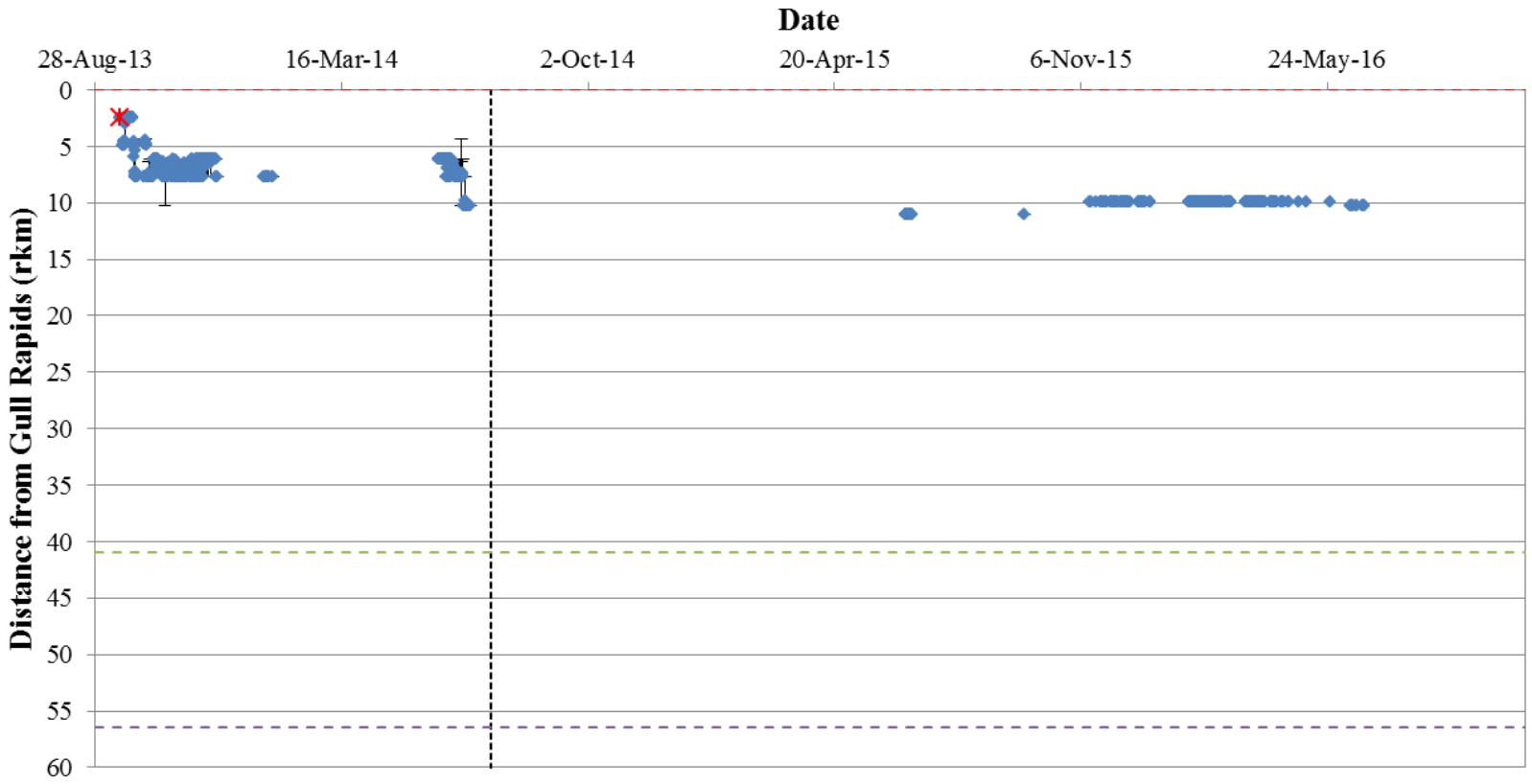


Figure A2-7: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32667) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

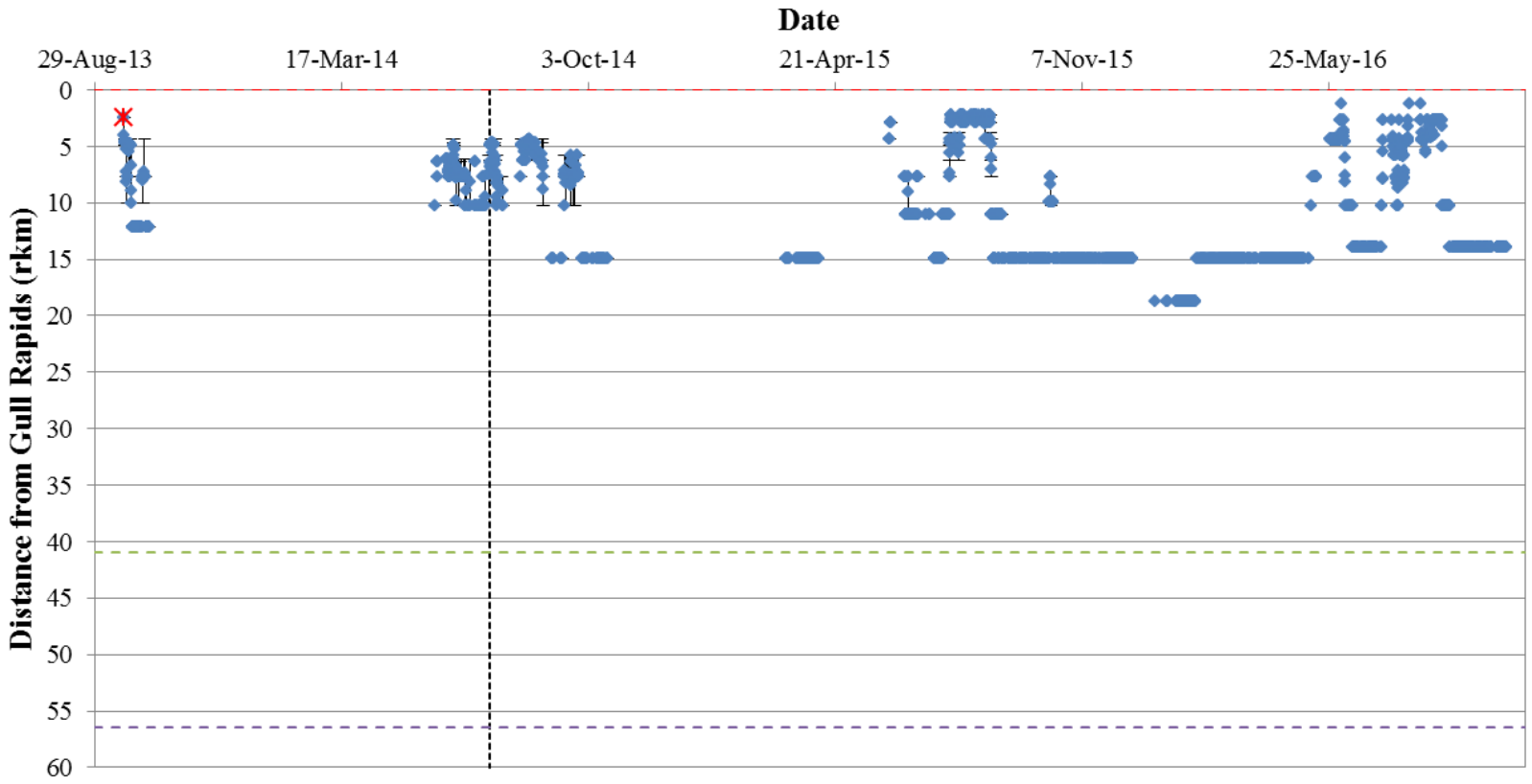


Figure A2-8: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32668) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

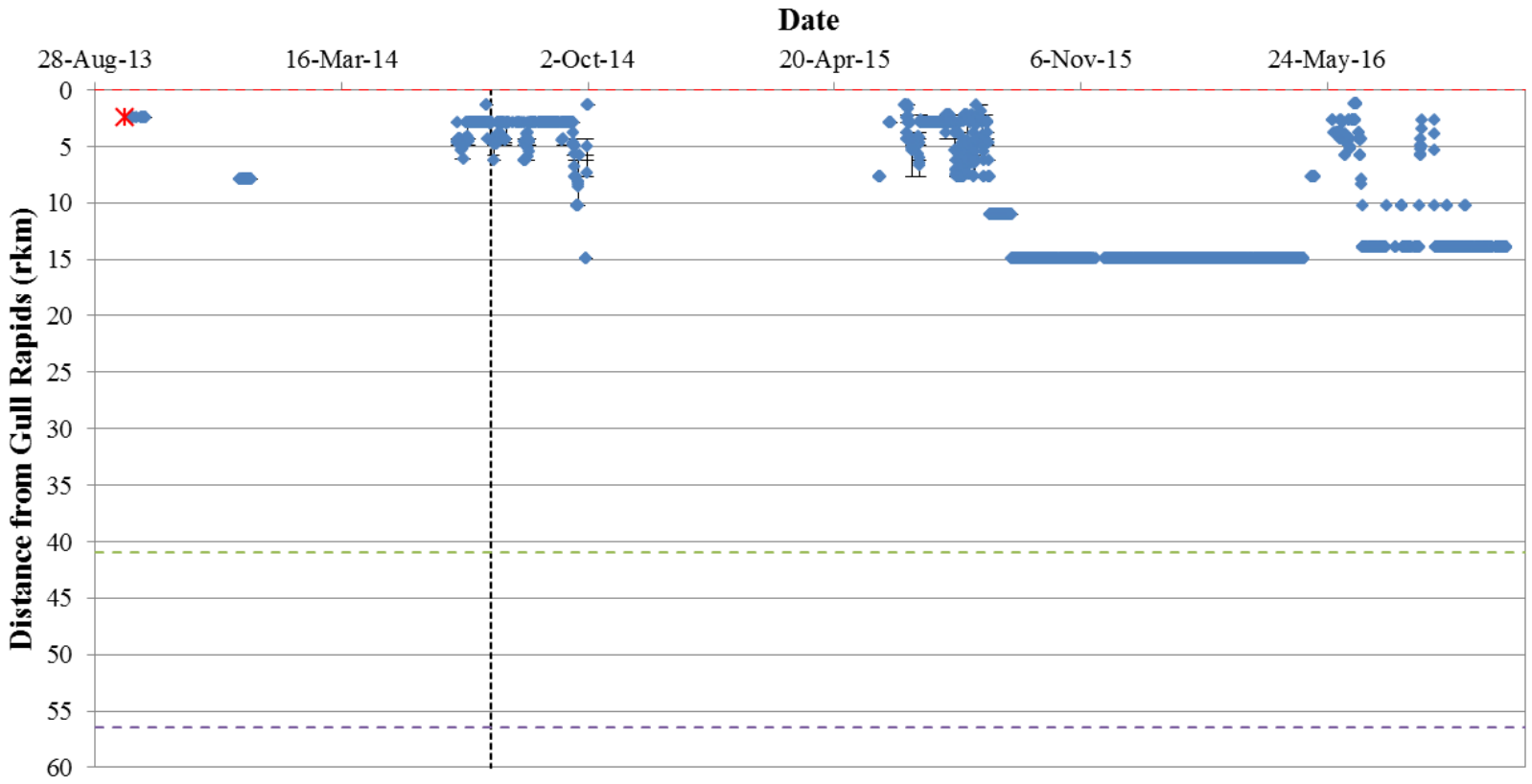


Figure A2-9: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32669) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

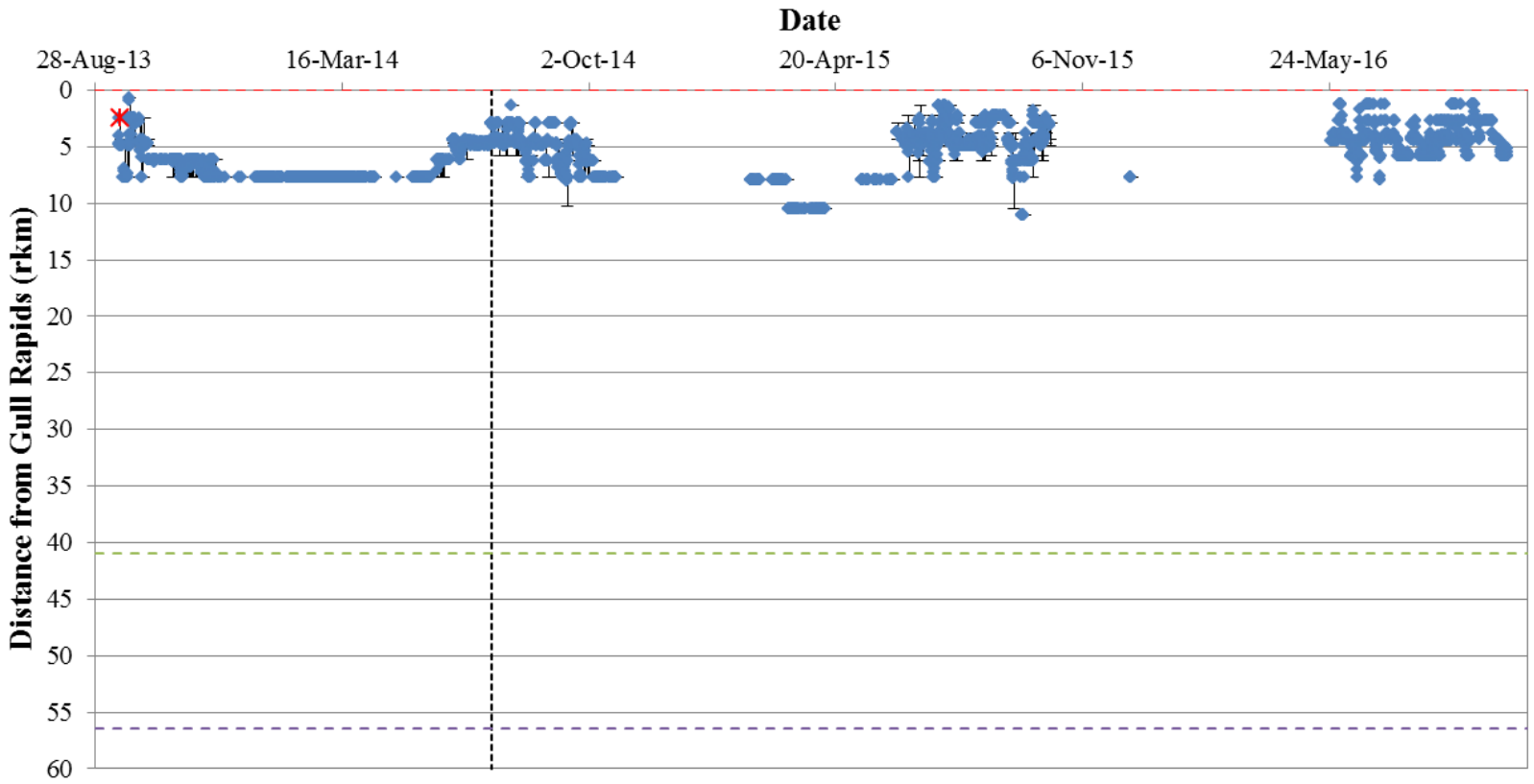


Figure A2-10: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32670) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

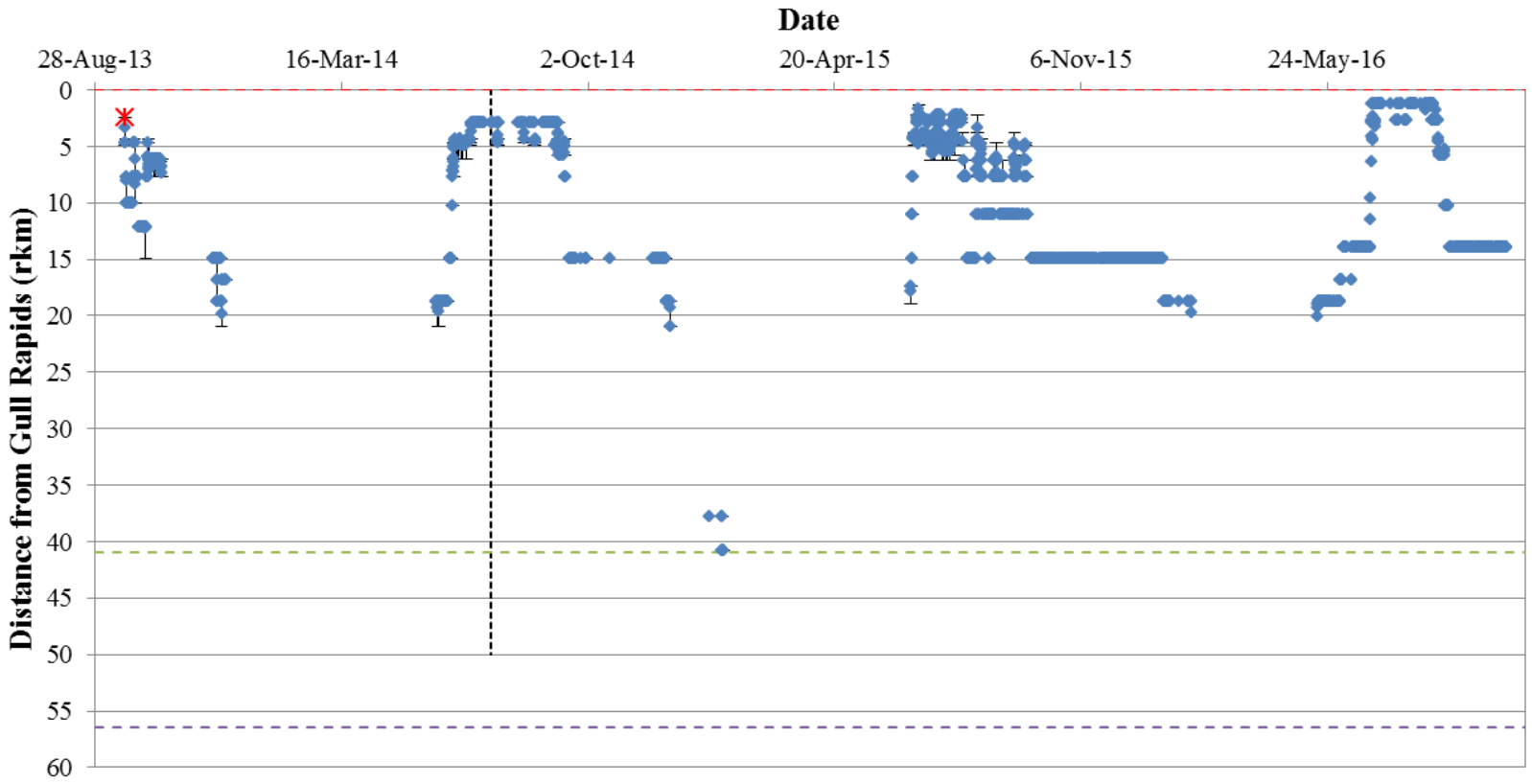


Figure A2-11: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32673) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

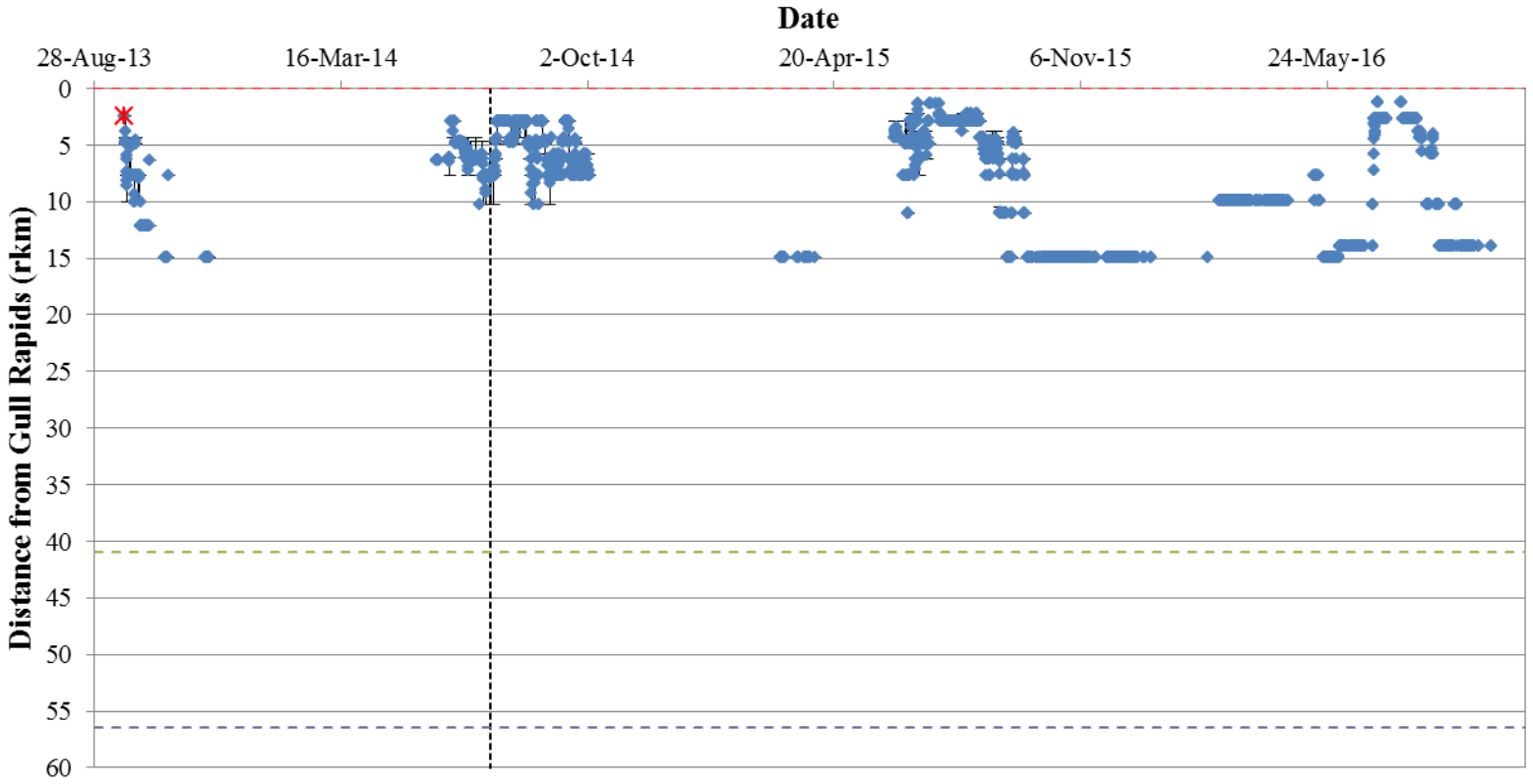


Figure A2-12: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32674) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

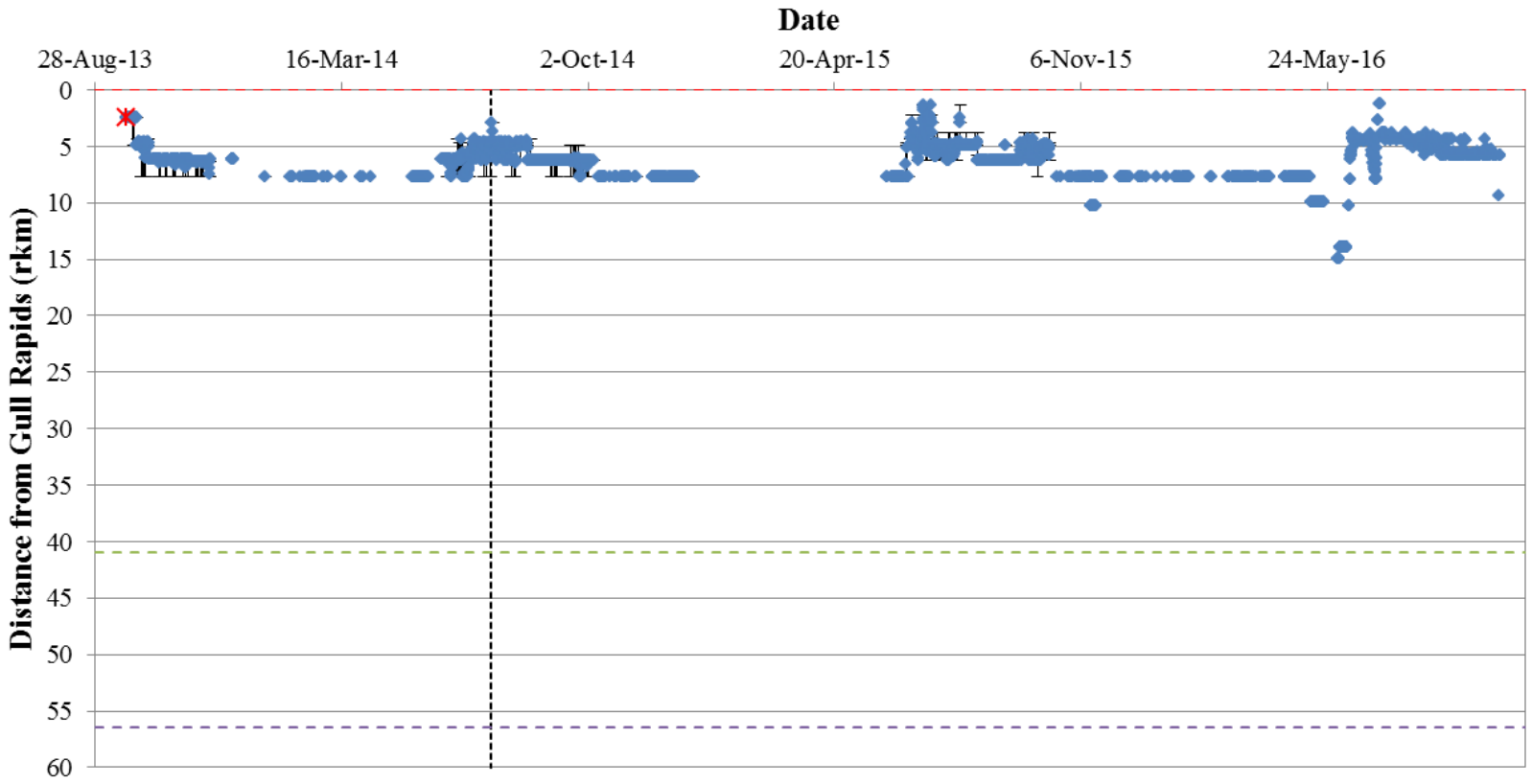


Figure A2-13: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32675) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

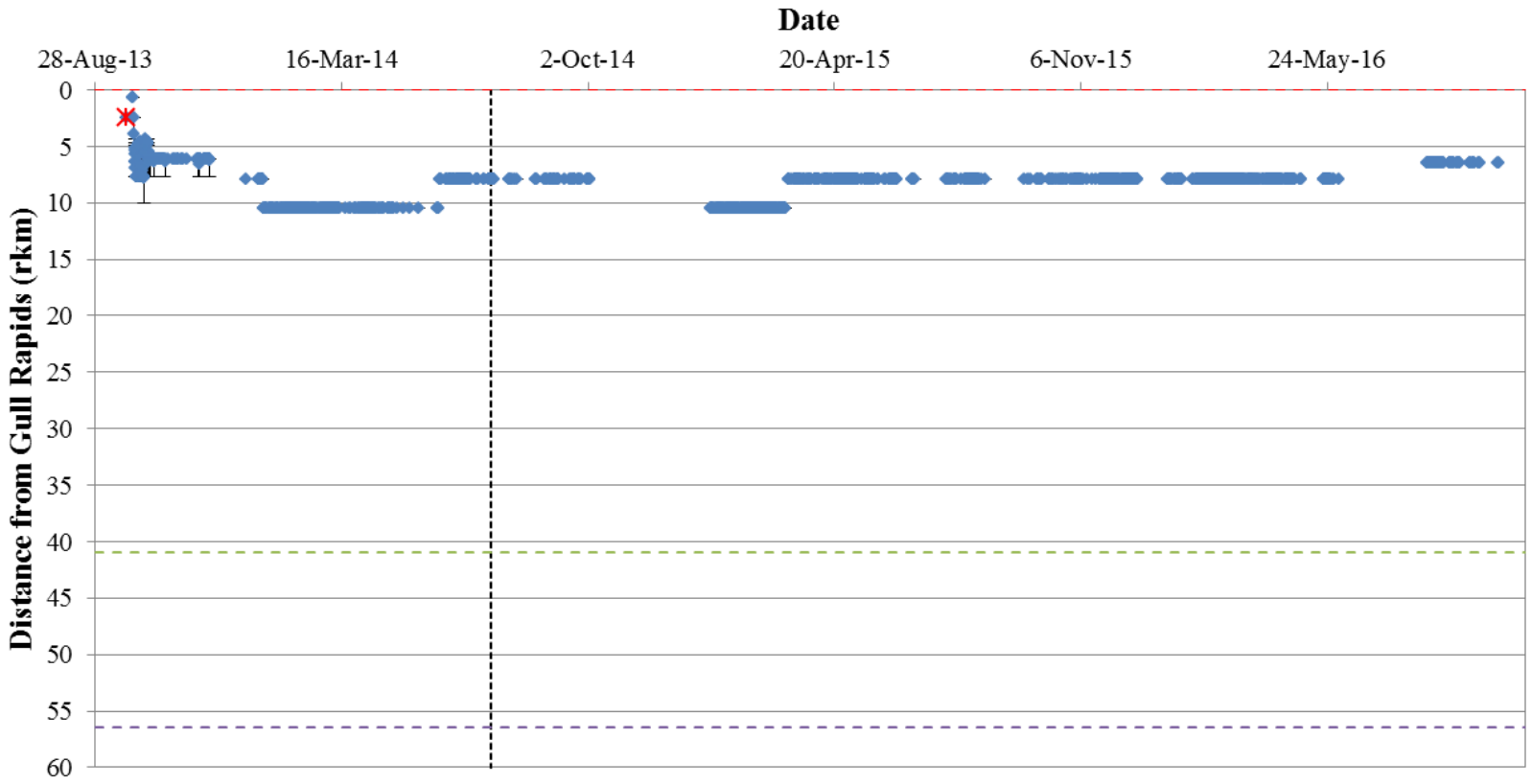


Figure A2-14: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32680) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

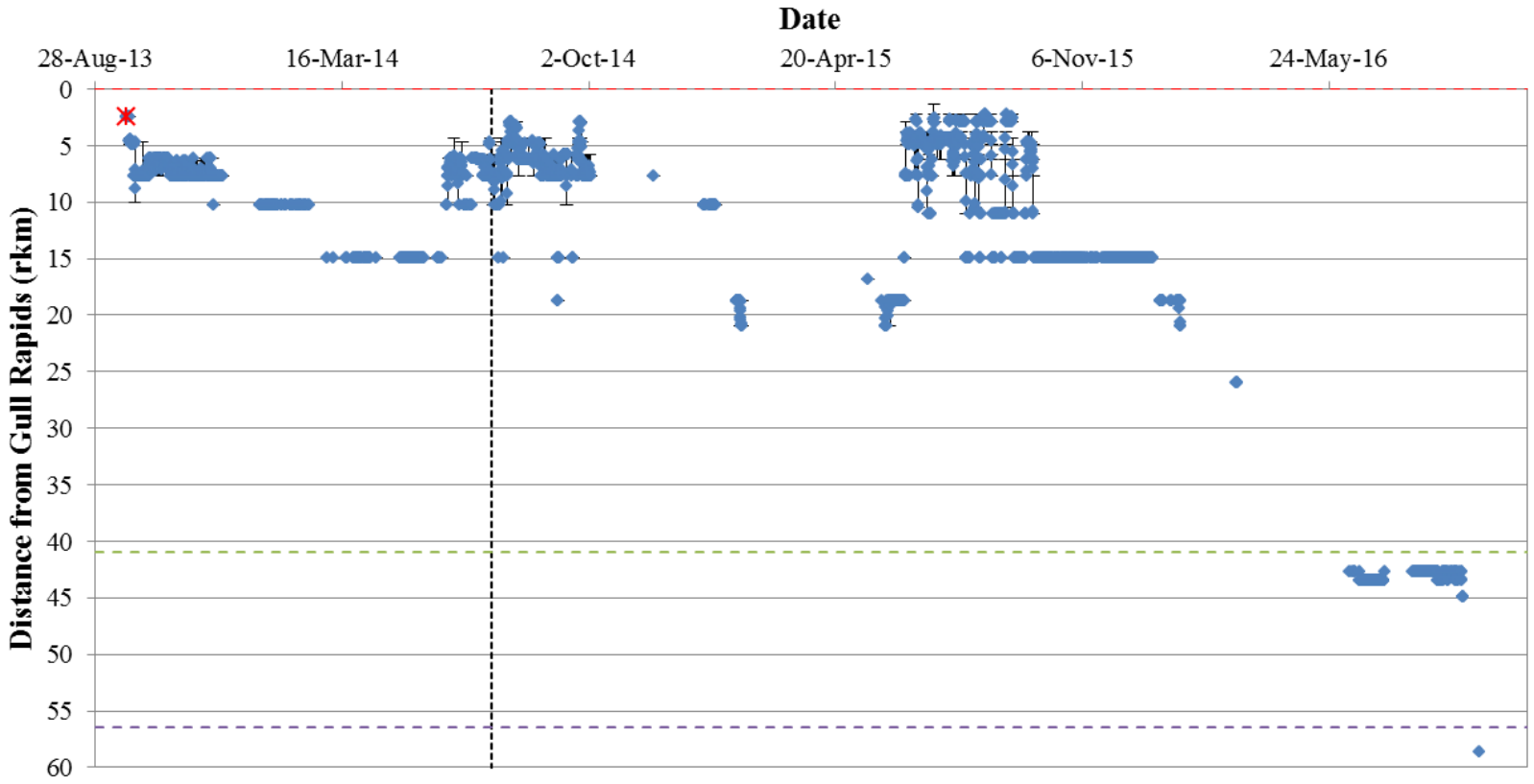


Figure A2-15: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32685) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

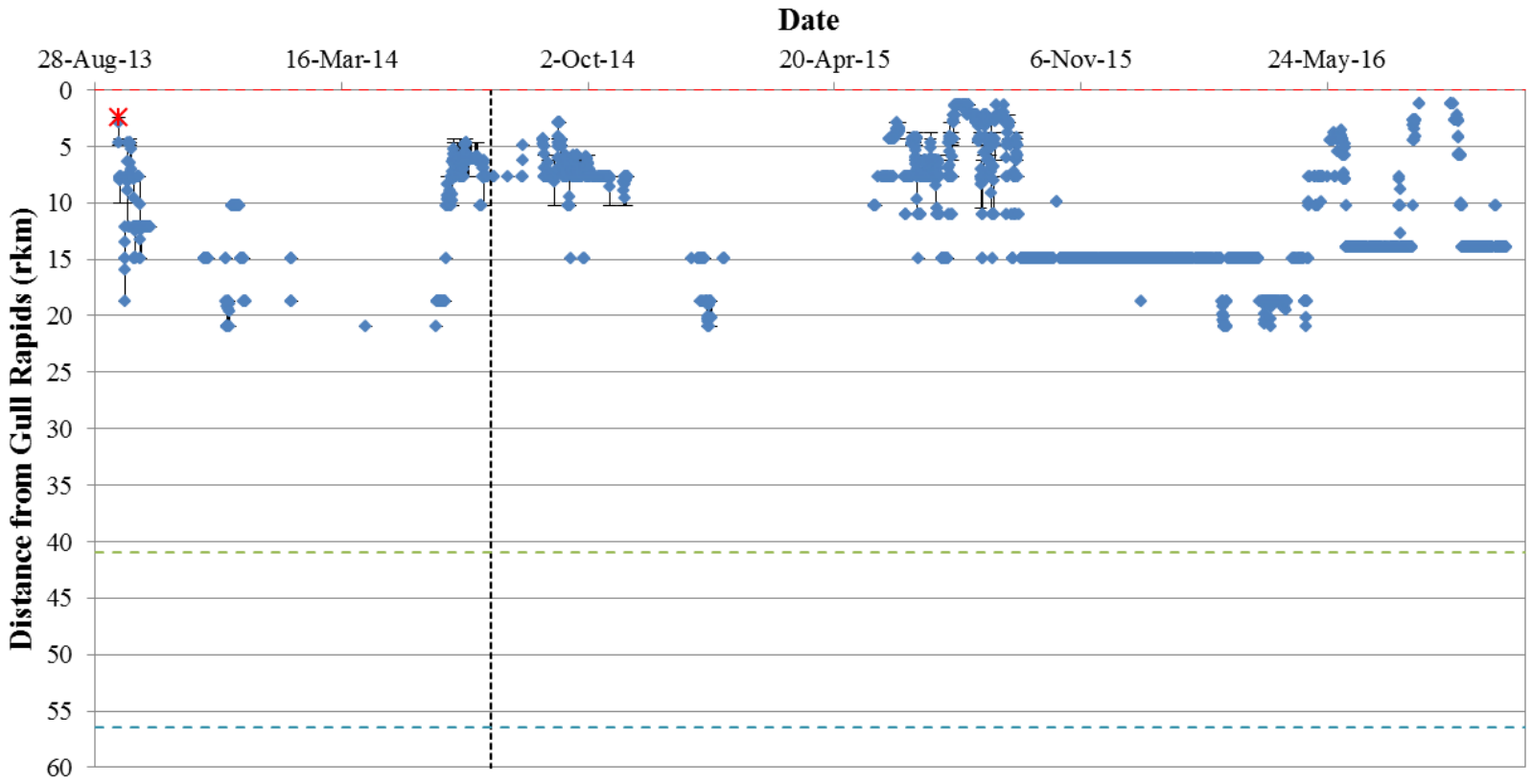


Figure A2-16: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32696) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

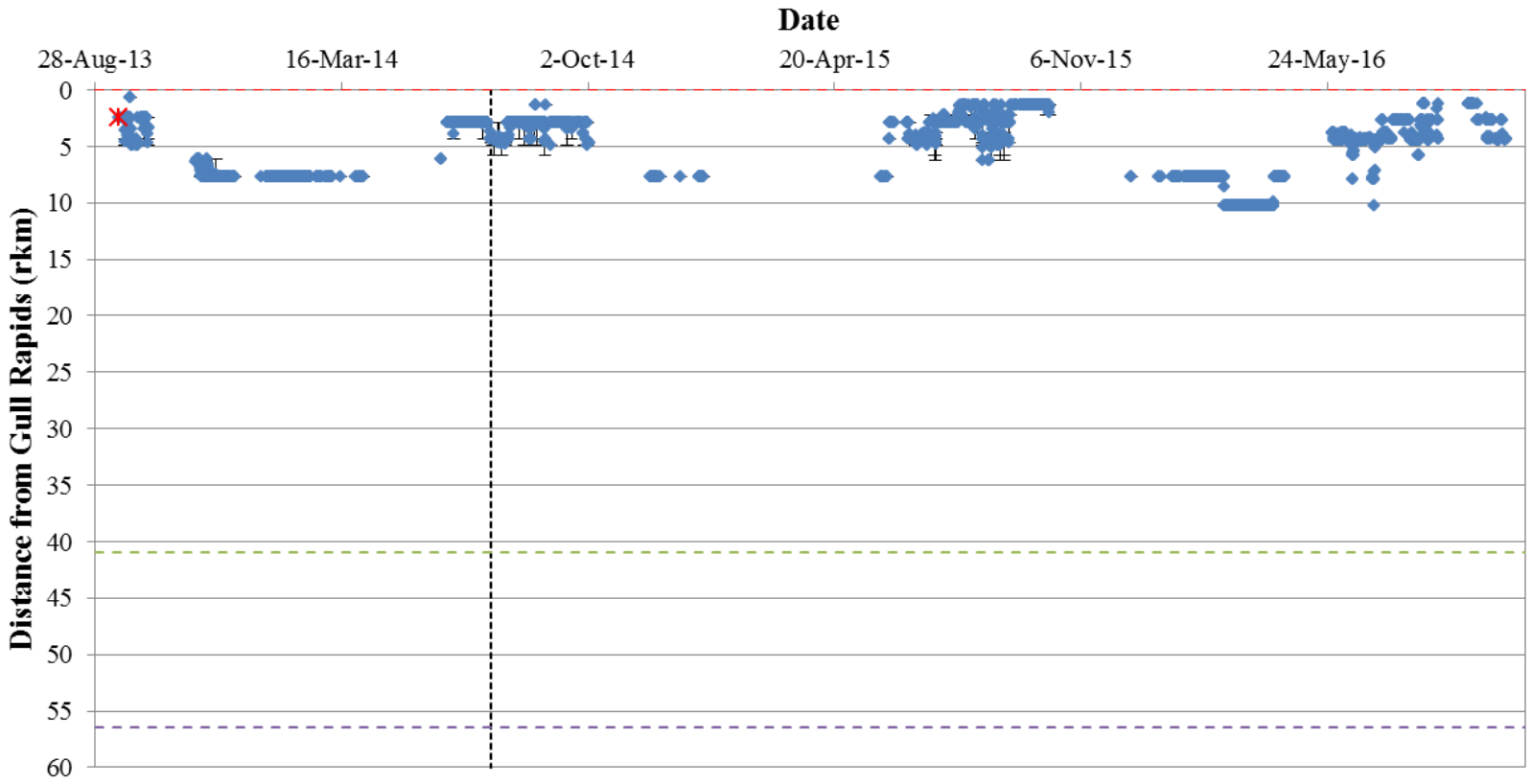


Figure A2-17: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32697) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

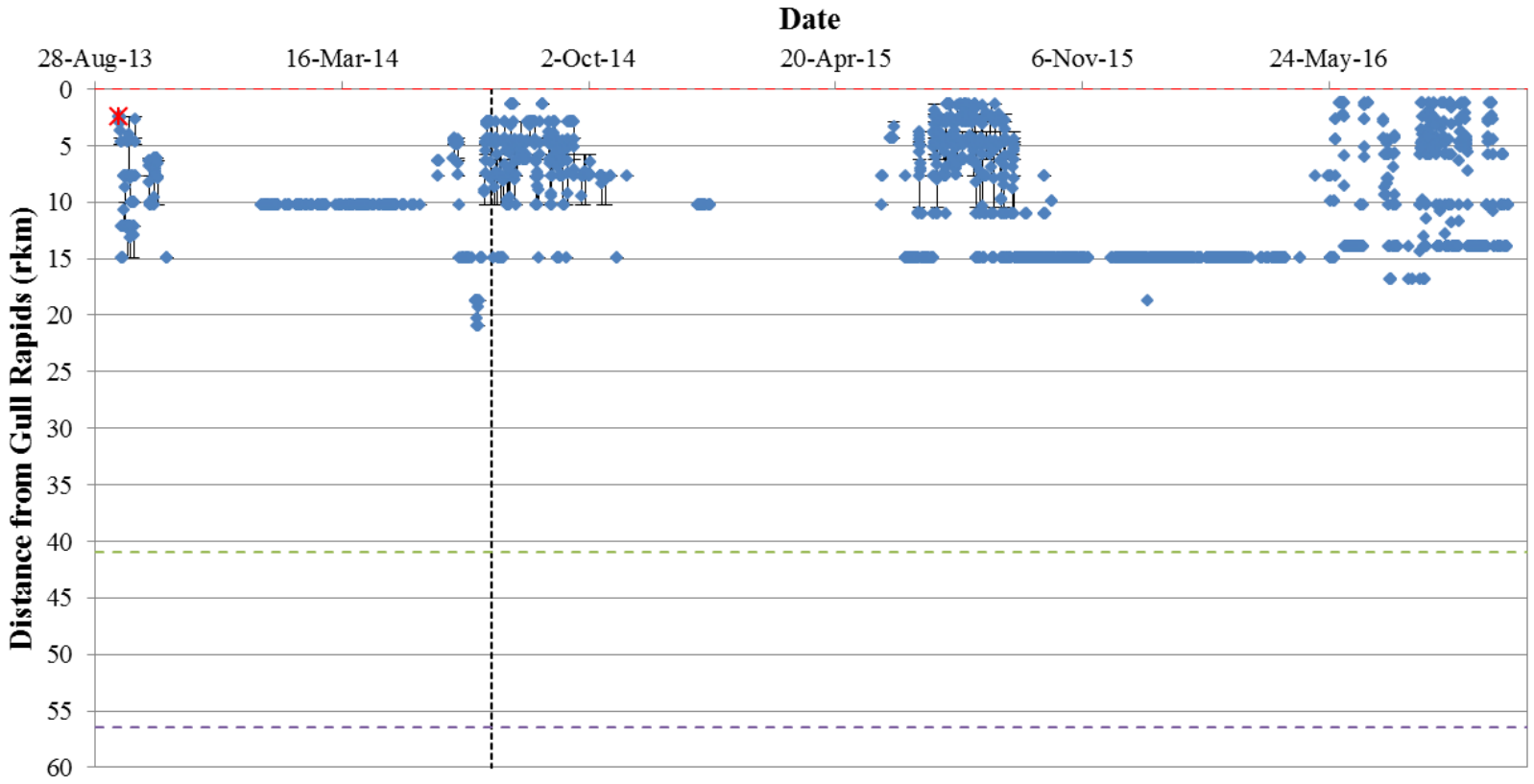


Figure A2-18: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32698) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

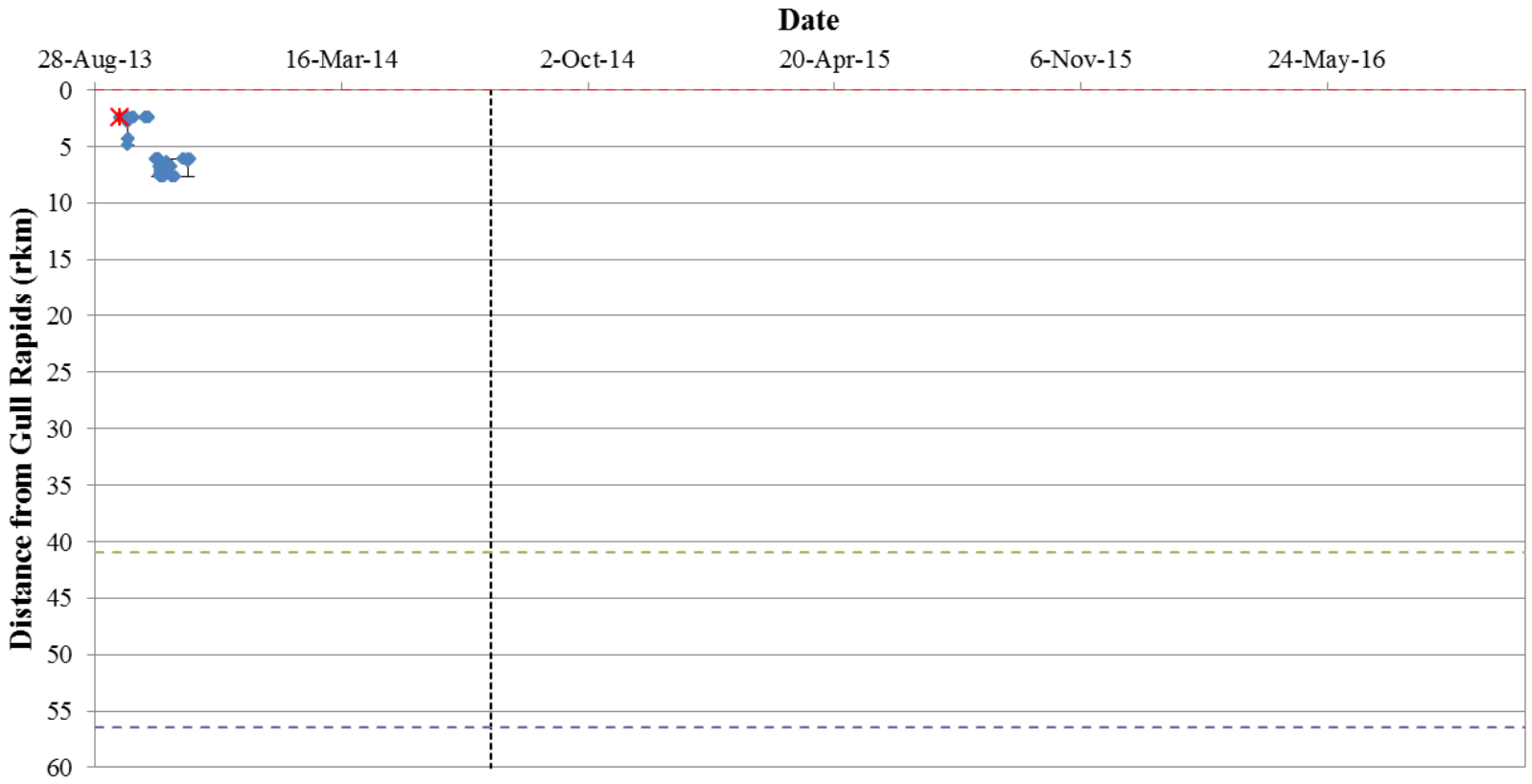


Figure A2-19: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32699) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).

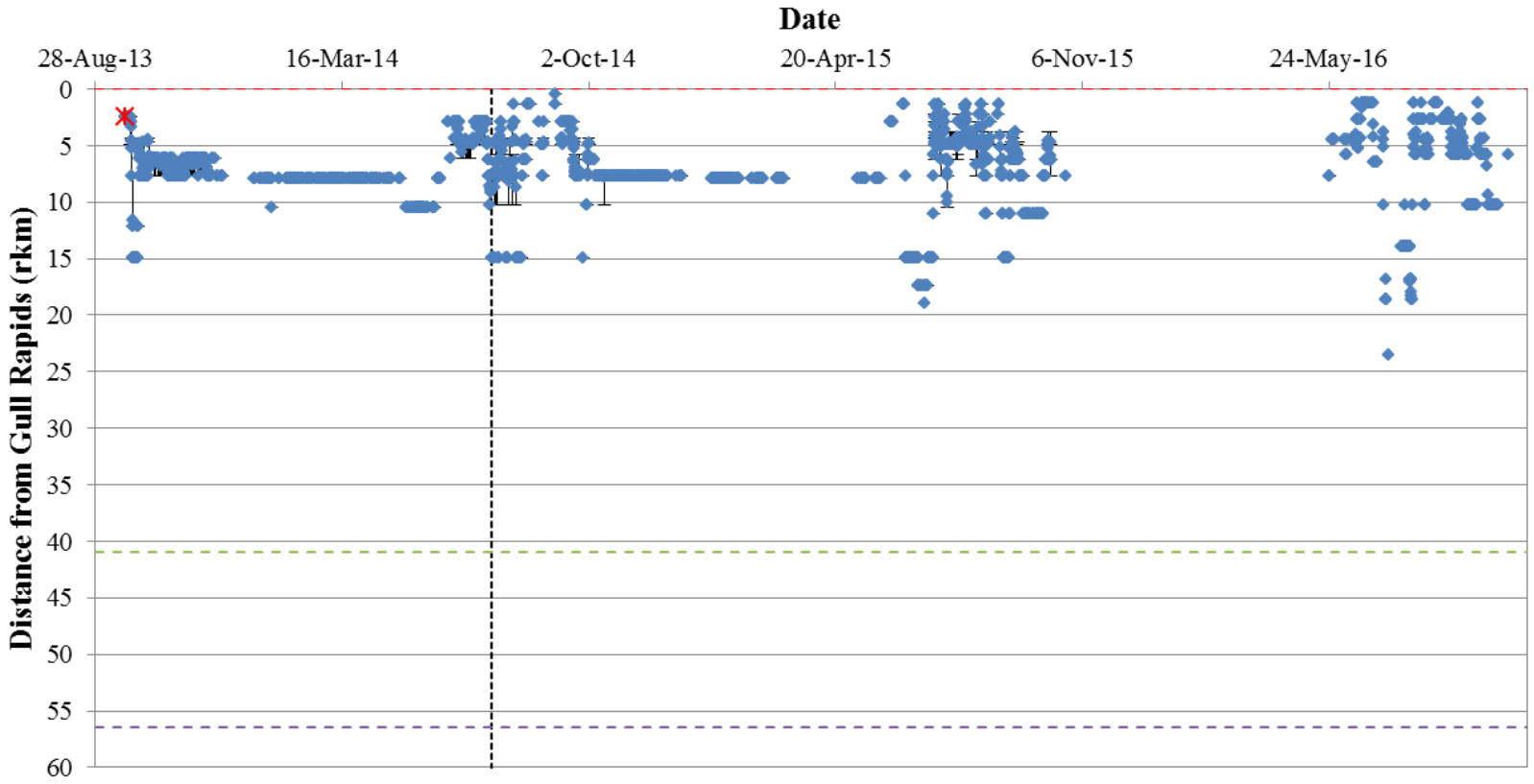


Figure A2-20: Position of a Lake Sturgeon tagged with an acoustic transmitter (code #32700) in Stephens Lake in relation to Gull Rapids (rkm 0), from 28 August, 2013 to 19 October, 2016. Date and location of tagging is indicated in red. Error bars are shown in solid black. Black vertical dashed line represents start date of construction of the Keeyask GS. Horizontal dashed lines indicate the positions of Gull Rapids (red), Kettle GS (green), and Long Spruce GS (purple).