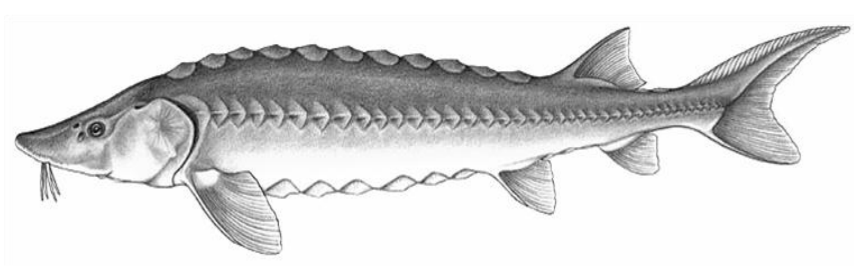
Movement and Seasonal Distribution of Lake Sturgeon in the Namakan River, Ontario

2007-2013 Completion Report



Ontario

Movement and Seasonal Distribution of Lake Sturgeon in the Namakan River, Ontario

2007-2013
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ABSTRACT

Acoustic telemetry was used to assess movement and seasonal distribution of adult lake sturgeon in the Namakan River between Namakan Lake and Lac La Croix, Ontario from May 2007 to August 2013. Three hydroelectric generating facilities have been proposed for development at Hay Rapids, High Falls, and Myrtle Falls by Ojibway Power and Energy Group (OPEG). Thirty-four lake sturgeon were sampled, surgically implanted with coded transmitters, and released in the river in 2007/2008, along with an additional 26 fish in Namakan Reservoir in 2008. An array of 15 submersible, hydrophone receivers were deployed at key points of elevation change (falls and rapids) along the river extending from below Lady Rapids to above Snake Falls. A total of 5,024,152 detections were recorded, with receivers having a mean of 334,943 detections (range 0-2,508,320) and 29.2 different fish (range 0-47). Individual fish (n=55) were detected over a range of 1 to 14 different receivers with a mean detection of 7.8 receivers/fish. Twenty-two of the 26 telemetered fish released in the Namakan Reservoir moved in to the Namakan River upstream of Lady Rapids during the 6 year study period. A total of 397 lake sturgeon (605 to 1,746 mm in length) were also externally tagged with 18 reported recaptures. Movement of tagged (n=8) and telemetered (n=22 of 34) fish from Namakan River into the Namakan Reservoir, a shared international water with Minnesota, was also detected. Transmitter detections confirmed both upstream and downstream migration of lake sturgeon at most locations including Lady Rapids, Hay Rapids, Back Channel around Eva Island, Quetico Rapids, Twisted Rapids and Myrtle/Ivy Falls. The most significant observation was 47 downstream movements of 30 individual fish over High Falls, an elevation drop of 6.8 m, while both High Falls and Snake Falls appear to be barriers to upstream migration. Movement into Quetico Provincial Park was detected at two locations, including Quetico River and Bearpelt Creek below Wolseley Rapids. Potential spawning habitats exist at most natural rapids based on the presence or staging of fish during critical periods. Over-wintering habitat was confirmed in the four lake environments and below major rapids or falls; and lake sturgeon avoided shallow rapids in winter with no detected movement between receivers from November to April. Fish moved through shallow rapids and falls at water flows ranging from 19 to 467 m^3/sec and temperatures ranging from 5.2 to 25.3°C. Upstream and downstream movements in the Back Channel, a natural by-pass reach around High Falls, were also documented at estimated flows of 6 to 48 m^3/sec. Site specific movements in relation to season, water flow and temperature are provided. This information will help inform future water management planning and site development decisions. At minimum, water management should account for impacts to migration, spawning, foraging and over-wintering habitats in order to ensure the long-term sustainability of lake sturgeon in Namakan River.

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INTRODUCTION

Little is known about the status, distribution, and exploitation of lake sturgeon *(Acipenser fulvescens)* in the Namakan River, especially since road access to the system was limited historically. Their life history, historic and intense exploitation, and the effects of dams and pollution on reproduction have all contributed to low population levels of lake sturgeon elsewhere in Canada (Scott and Crossman, 1998). In the Great Lakes, the decline in lake sturgeon populations has been primarily attributed to three factors: physical impacts on spawning and nursery habitat; barriers to migration; and over-fishing (Brousseau, 1987; Auer, 1999). Anthropogenic modifications of rivers and estuarine habitats have also reduced the growth and recruitment of other sturgeon species throughout their native range (Ziegeweid et al., 2008).

A proposal to develop three hydro-electric generation sites at Hay Rapids, High Falls, and Myrtle Falls on the Namakan River lead to the preparation of an Environmental Field Study Plan (OPEG, 2007) and commencement of an Environmental Screening process in 2006. Lake sturgeon are known to occur throughout the Namakan River from Lac La Croix downstream to Namakan Reservoir, therefore an investigation of their movements and habitat use was identified as part of a larger fisheries monitoring effort, including population assessment, genetics and habitat evaluation.

Water levels in the Namakan River are currently unregulated. However, there are two control dams downstream in the Namakan Reservoir at Kettle and Squirrel Falls that regulate water levels based on a "rule curve" established by the International Joint

Commission (IJC) through the International Rainy Lake Board of Control (IRLBC) (now the International Rainy Lake of the Woods Watershed Board). Recent changes to water regulation in 2000 lead to the development of a long-term monitoring strategy to evaluate aquatic ecosystem impacts in which a lake sturgeon inventory and assessment program was included (IRLBC, 1999; Kallemeyn, 2000; Adams et al., 2006).

Exploitation of lake sturgeon was historically limited to First Nation subsistence fishing for food and low levels of angler harvest by both residents and non-residents. Commercial fishing licenses previously existed downstream in Namakan Reservoir from 1916 to 2001, and upstream on Lac La Croix from 1959 to 1966. A portion of this licensed harvest is reported to have been taken in the upper sections of Namakan River. Annual commercial harvest records are only available since 1924, with no information on harvest prior to this period. Historical accounts indicate that a commercial pound-net fishery for lake sturgeon and whitefish existed on both Namakan Reservoir and Lac La Croix in the 1890's (Pearson, 1963). Records from Namakan Reservoir suggested a total reported Ontario harvest of 33,090 kg from 1924-1999, for a mean annual harvest of 435 kg/yr. Creel surveys have not been completed to evaluate recreational angling effort and harvest in the Namakan River. Any harvest of lake sturgeon is likely incidental and similar to Namakan Reservoir where the majority of angler effort is generated by non-residents (99%) and directed at walleye (*Sander vitreus*; 85 %) (Elder, 2001).

Prior to 2008, there was a daily catch and possession limit of one fish with no size restriction for angling of lake sturgeon on the Namakan River, with an open season of

June 30 to May 15 each year. On January 1, 2008, the open season was changed to July 1 to April 30 and a minimum size limit was implemented, whereby only fish greater than 190 cm (74.8") in total length could be retained. Effective July 1, 2008, the catch and possession limit for recreational angling of lake sturgeon was changed from one to zero throughout Ontario, resulting in a catch and release only fishery.

At the beginning of this study, lake sturgeon were designated as a species of *Special Concern* in Ontario under the Endangered Species Act (S.O. 2007). The provincial designation for the NW Ontario population of lake sturgeon changed to *Threatened* on September 11, 2009, based on a review by the Committee on the Status of Species of Risk in Ontario (COSSARO). As a result, lake sturgeon received species and habitat protection under the Act, and led to the development of a recovery strategy (Golder Associates Ltd., 2011). Concurrent with these requirements, the angling season for lake sturgeon was closed all year effective October 13, 2009. Federally, the species continues to be under review by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for possible designation under the Species at Risk Act (S.C. 2002). From an international perspective, lake sturgeon are also regulated through the Convention on International Trade in Endangered Species of Fauna and Flora (CITES – Appendix II). A designation of *Special Concern* exists in Minnesota, but the legal context is different than Ontario. Conservation status for lake sturgeon is listed as *Vulnerable* by the American Fisheries Society (AFS, 2008), while status of the species is *G3/G4 TNR (Not Yet Ranked)* globally, *N2-Imperiled* nationally and *S2-Imperiled* provincially (Natureserve, 2015).

In 1994, the Ontario-Minnesota Fisheries Committee established a Border Waters Lake Sturgeon Management Committee, which recommended that additional studies be completed on lake sturgeon populations where little or no information currently exists (OMNR and MDNR, 1995). Although previous tagging and telemetry studies have been completed in the border waters area including Lake of the Woods and Rainy River (Mosindy and Rusak, 1991; Stewig, 2005), Rainy Lake (Adams et al., 2006), and the Seine River (McLeod, 1999), none have examined the lake sturgeon population found in the Namakan River. Seasonal movement patterns can be highly variable in other large lakes and rivers based on telemetry studies on other populations (Thuemler, 1997; Rusak and Mosindy, 1997; McKinley et al., 1998; Borkholder et al., 2002; Knights et al., 2002; Friday, 2006). Given this variability, managers require specific knowledge of seasonal movements and habitat use in order to protect or improve areas critical for survival and reproduction (Rusak and Mosindy, 1997). More recent scientific studies have used acoustic telemetry to evaluate fish movements in relation to river discharge and temperature as well as passage around dams (Holbrook et al., 2009; Lallaman et al., 2008).

The objective of this study was to evaluate movement patterns, seasonal distribution, and generalized habitat use of lake sturgeon through the use of bio-telemetry and tagging. The primary purpose was to determine fish movements, if any, through the proposed development sites and other rapids/falls along the Namakan River. This information, along with the identification of potential spawning areas and timing of movements in relation to water flows and temperature, will contribute to the evaluation of potential impacts of hydro-electric development. This study of fish movement should also provide valuable baseline data for the development of mitigation plans, water management plans and long-term effectiveness monitoring, particularly if development proposals proceed.

This completion project report represents a final consolidation of movement information collected from May 2007 to August 2013, and all progress reports completed since 2009 (McLeod and Debruyne, 2009; McLeod and Martin, 2010; McLeod and Denyes, 2011; McLeod et al., 2013). During this study, a similar collaborative telemetry and tagging investigation was undertaken on Namakan Reservoir beginning in 2008 (Shaw, 2010; Shaw et al., 2012; Shaw et al., 2013); as well as a juvenile lake sturgeon study beginning in 2010 (Trembath, 2013). In the Namakan River, the adult sturgeon population was also sampled and described (McLeod, 2008a) while total abundance was estimated in Little Eva Lake (McLeod, 2008b). Additional research explored genetic diversity of lake sturgeon in comparison to documented movements of telemetered adult fish (Welsh, 2008; Welsh and McLeod, 2010). The Namakan River was also sampled while investigating the variation in lake sturgeon abundance in rivers across Ontario, and assessing the magnitude of effect of hydroelectric production (Haxton et al., 2014; 2015).

STUDY AREA

The Namakan River is located immediately downstream of Lac La Croix and upstream of Namakan Reservoir (Figure 1), approximately 80 km southeast of Fort Frances, Ontario. This mesotrophic river is found in the southern range of the boreal forest in North

America, and is typical of Canadian Shield lakes and rivers with soft water and little submerged aquatic vegetation. The Namakan River drains close to 8,860 km^2 in Ontario with an elevation drop of 19.2 m over a distance of 30.5 km from Lac La Croix to Namakan Reservoir (OPEG, 2007). It provides approximately 75% of the inflow to Namakan Reservoir, and contributes the largest single source of inflow with a mean discharge of 109 m^3/sec (Kallemeyn et al., 2003). Table 1 provides a summary of known physical and chemical characteristics, and reflects current knowledge of the three lakes situated along the Namakan River, including Little Eva Lake (281 ha), Bill Lake (134 ha), and Three Mile Lake (399 ha).

A number of potential barriers to fish migration exist along the river from the outlet of Lac La Croix downstream to the Namakan Reservoir. The following elevation changes are reported for the various rapids/falls under average flow conditions: 3.2 m at Snake Falls, 4.0 m at Myrtle Falls and Ivy Falls, 1.0 m at Twisted Rapids, 0.7 m at Quetico Rapids, 6.8 m at High Falls, 7.0 m at the Back Channel (over 2 km and 8-9 rapids), 3.0 m at Hay Rapids, and 1.6 m at Lady Rapids (Figure 1) (OPEG, 2007).

Table 1: Physical and chemical characteristics of the Namakan River, Ontario.

Parameter	Little Eva Lake	Bill Lake	Three Mile Lake	Namakan River
Surface Area (ha)	281	134	399	1,252
Mean Depth (m)	5.1	4.5	-	-
Maximum Depth (m)	18.1	23.0	-	23.0
Mean Summer Secchi Depth (m)	2.5	2.5	-	2.5
Perimeter Shoreline (km)	25.5	7.6	-	-
Island Shoreline (km)	4.0	0.7	-	-
T.D.S. (mg/L)	45	45	-	45
M.E.I.	8.82	10.0	-	-

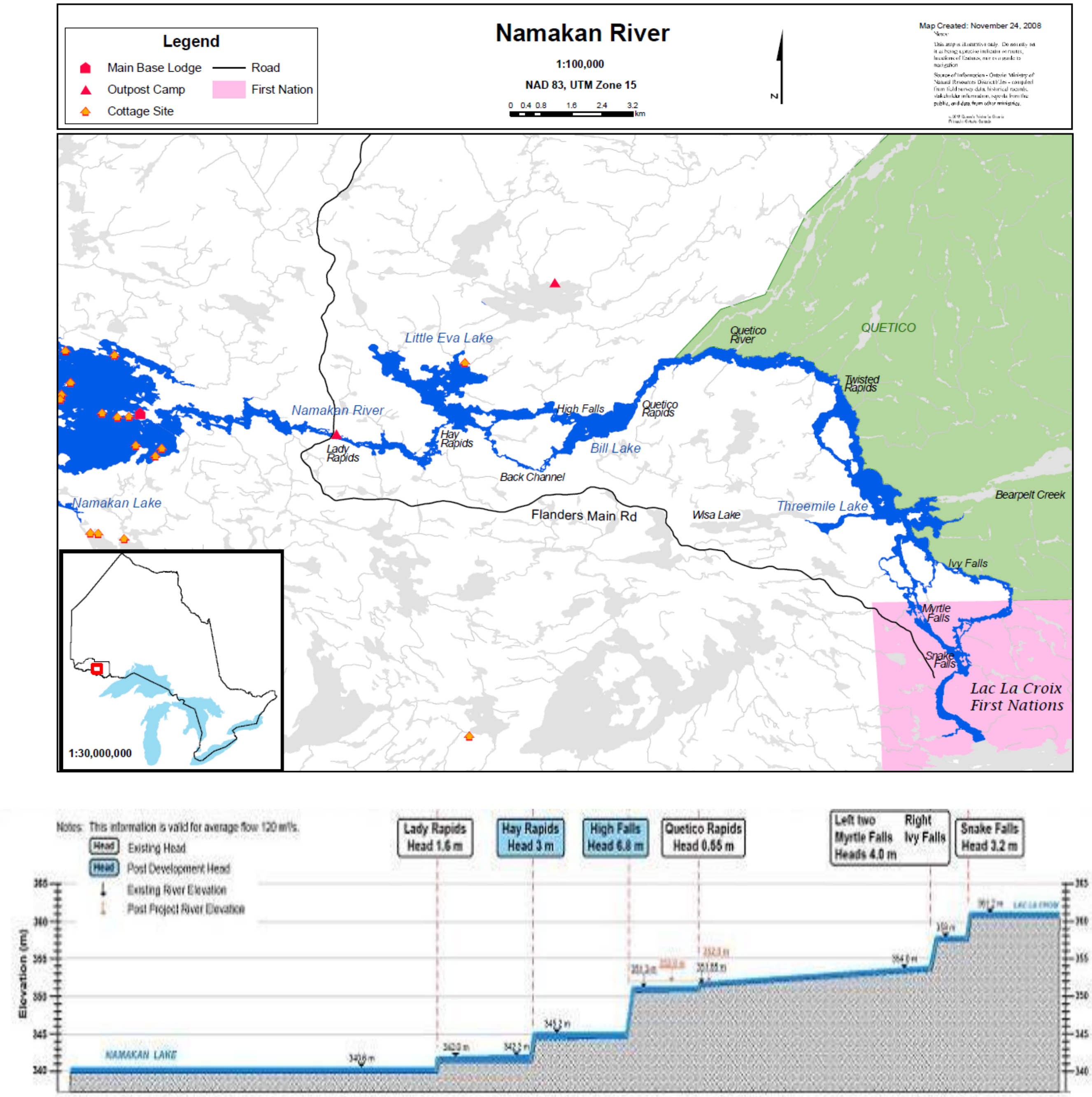


Figure 1: Location of the Namakan River, Ontario. Proposed hydro development sites are located at Hay Rapids, High Falls and Myrtle Falls. Elevations are based on a mean flow of 120 m^3/s.

Namakan Reservoir is located immediately downstream of the river and consists of five large lakes including Namakan, Sand Point, Crane, Little Vermilion, and Kabetogama Lakes. The combined surface area is 26,000 ha, with approximately 23% in Ontario (Kallemeyn et al., 2003). The reservoir has a drainage basin area of 19,300 km^2 and is part of the headwaters of the Winnipeg-Nelson River system (OMNR and MDNR, 2004).

Water levels and flows in the Namakan River are not regulated. A Meteorological Service of Canada (Environment Canada) water level gauge at the outlet of Lac La Croix provides relevant information on inflows to the Namakan River and has done so since 1921 (LWCB, 2015). A maximum flow of 771 m^3/sec was recorded in June 1950 while a minimum flow of 15 m^3/sec was recorded in January 1977 and February 1924. Annual flow metrics derived from a recent 20-year period (1980-1999) provides a mean and median flow of 118 m^3/sec and 87 m^3/sec respectively. Time exceeded (percentile) flows are estimated at 182 m^3/sec (20%) and 51 m^3/sec (80%). Other major inlets downstream of Lac La Croix include Bearpelt Creek and Quetico River flowing from adjacent Quetico Provincial Park, as well as Bullmoose Creek and an intermittent connection to Wisa Lake.

Little fisheries information is available and no aquatic habitat inventory (lake or river survey) has been completed. More recently, several fisheries investigations have been completed including Fall Walleye Index Netting (FWIN) on Little Eva Lake in 2006 (McLeod and Rob, 2008) and Bill Lake in 2007 (Rob and McLeod, 2008. A diverse coolwater fish community with 14 species was found to be present in Bill and Little Eva

Lakes, while a total of 43 fish species are known to occur immediately downstream in the Namakan Reservoir (McLeod and Trembath, 2007).

Development on the shoreline of Namakan River consists of one private cottage/outpost camp, and three commercial boat caches on Little Eva Lake, and nine commercial boat caches on Three Mile Lake. Portage trails exist at Little Eva Lake, Lady Rapids, Hay Rapids, High Falls, Quetico River, Bearpelt Creek (Wolseley Lake), Ivy Falls, and Snake Falls, as well as boat access from Wisa Lake off the Flanders Road. Lac La Croix First Nation (LLCFN, also known as Neguaguon Lake 25D) is situated in the upper reaches of the river, with a registered population of 308 on-reserve (AANDC, 2014). Quetico Provincial Park borders the north side of the river for approximately 13 km from LLCFN to the mouth of Quetico River. The entire inland area south of the river falls within the Agreement of Co-Existence between LLCFN and the Province of Ontario (Ontario, 1994).

METHODS

Lake sturgeon were first captured, sampled, and tagged in Little Eva Lake using large mesh gill nets during the period of October 10-11, 2006. Fish were captured using 178 mm (7"), 203 mm (8"), 228 mm (9"), 254 mm (10"), and 305 mm (12") stretched mesh, multifilament gill nets. Each net panel was 91 m (300') long and 2.8 m (9') high. All mesh sizes were white in colour with the exception of the 228 mm (9”) mesh which was light green. Nine net lifts occurred at nine different sample locations, and included a variable selection of mesh sizes.

Additional sampling occurred from May 14-24, 2007 at four locations along the Namakan River in conjunction with a bio-telemetry, tagging, and genetics study of lake sturgeon. Selected sampling locations included: below Hay Rapids; below the Back Channel in Little Eva Lake; below Quetico Rapids in Bill Lake; and below Ivy Falls in Three Mile Lake. Thirteen net lifts occurred at ten different net locations, using an assortment of stretched mesh sizes (203-305 mm) and a similar net configuration as was used in October, 2006.

Lake sturgeon were also captured and tagged on Little Eva Lake during the period of October 9-19, 2007, using the same large mesh, multifilament gill nets. Twenty-one net lifts occurred, and included a random selection of mesh sizes. Lake sturgeon were also captured and tagged during FWIN studies on Little Eva Lake from October 2-6, 2006, and Bill Lake from October 1-4, 2007 with monofilament mesh sizes of 127 mm (5”) and 152 mm (6”). Further sampling was completed from May 30-June 2, 2008 immediately below Snake Falls. Six net lifts occurred, using a random selection of stretched mesh sizes, and a similar net configuration used in October, 2006. Final sampling occurred from October 6-10, 2008 in Little Eva Lake deploying only 178 (7”), 203 mm (8”), and 356 mm (14”) stretched mesh gill nets. Fourteen net lifts occurred at fourteen different net locations. In all sampling events, nets were set over-night with durations ranging from 15.3 to 24.5 hours. Nets were set as close to perpendicular (90^{o}) from shore as each net site would allow.

Immediately upon capture, all fish were examined for external tags and pectoral fin ray clips. Fish with existing tags were released at the capture location after recording the individual tag number, while all other fish were temporarily retained in a large plastic holding bin filled with ambient lake water. As needed, fish were placed in a single compartment (12 m^3) holding net with a floating plastic frame anchored to shore near the daily sample location.

All lake sturgeon were sampled for total and fork length (mm), girth (mm), and round weight (g); tagged with an individually numbered Carlin disk dangler tag; and live released. Yellow OMNR tags were attached immediately below the centre of the dorsal fin with 0.5 mm stainless steel wire following methods outlined by Minnesota DNR (Stewig, 2005). A 3-4 cm section of the large, marginal ray of the left pectoral fin was removed for age determination, and provided a secondary mark. Sex and maturity of individual fish were only determined externally for ripe fish during the spawning period, or from internal observations of gonad development during surgical implantation of acoustic transmitters (Bruch et al., 2001). All aging structures were assessed by the OMNR Northwest Regional Aging Facility in Dryden, Ontario. Data were compiled and analyzed using FISHNET2 (Lester and Korver, 1996).

A total of 34 acoustic transmitters were deployed in Namakan River fish with an additional 26 transmitters in Namakan Reservoir downstream. From May 15 to 25, 2007, 30 individual fish were selected for surgical implantation of transmitters (V16-4L; Vemco - Amirix Systems Inc., Halifax, Nova Scotia) at four different sample locations:

below Hay Rapids (n = 10), below the Back Channel in Little Eva Lake (n = 10), below Quetico Rapids in Bill Lake (n = 5), and below Ivy Falls in Three Mile Lake (n = 5). An additional 4 fish were captured and selected for transmitter implants from April 30 to May 2, 2008 at the remaining sample location below Snake Falls (upstream of Ivy Falls and the proposed development at Myrtle Falls). The transmitters operated at 69 kHz, were 68 x 16 mm in size, and weighed 10 g in water, therefore did not exceed 2% of the total body weight for any given fish. Each transmitter emitted a unique code on a random interval of 60 to 120 seconds with a programmed operating life of 2,190 days (6 years).

An array of 15 submersible acoustic receivers (VR2W; Vemco) with Bluetooth wireless download capability was used to collect data on lake sturgeon locations and movements. The receivers were 308 x 73 mm in size and weighed 1,450 g in air, with an 8 MB flash memory (1 million detections). Each receiver contained a 3.6 v lithium battery with an expected operating life of 12-15 months. At selected sample locations, each stationary receiver was suspended vertically approximately 1 m off bottom with a nylon rope, 15 kg cement anchor, and round net buoy in water depths of 3- 6 m to avoid winter freeze-up. Anchors were also attached to an exposed shore anchor or treed shrub with 20-30 m of lead core rope in order to provide easy deployment and retrieval.

The vendor-provided interface software (Vemco User Environment, VUE) was used for initialization, configuration, data upload, and storage from each receiver. The VUE software package also allowed data from multiple receivers and transmitters to be combined into a single integrated database. Each submersible receiver detects and decodes the ultrasonic pulses from transmitters within 500 m, logging the date, time, and individual transmitter code for each detection to internal storage. Verification of detection efficiency was conducted at one location prior to deployment and was verified to a minimum 300 m with direct line of sight. A collaborative Namakan Reservoir study initiated in 2008 by Voyageurs National Park (VNP) and South Dakota State University (SDSU) also reported 100% detection efficiency to a maximum distance of 525 m. However, the maximum detection efficiency was highly variable based on site location, substrate and bathymetry (Stephanie Shaw, pers. comm). Most sites in Namakan River were strategically located near natural constrictions, and likely provided a detection range that exceeded the width of the river or lake opening.

A manual tracking receiver and directional hydrophone (VR100 and VH110; Vemco) mounted on a hand-held aluminium pole was also used to locate individual fish and ensure proper transmitter function prior to release. In most cases, fish were manually tracked by boat/canoe immediately after release, or the next day, to help ascertain post-operative dispersal from the release site.

In preparation for surgical implantation of transmitters, a 350-litre fish holding tank was filled with 300 litres of clean water and 1.5 kg of salt (NaCl) was added. Lake sturgeon that were sampled and selected for surgical implantation, were placed ventral side up in a canvass cradle suspended in the holding tank and water was continually flushed over the gills using a small pump and hose. A disinfectant solution was prepared by adding 50 ml of Germiphene germicidal concentrate to 4 litres of distilled water. Surgical instruments and transmitters were immersed in this solution for at least 10 minutes to ensure full spectrum disinfection then subsequently rinsed with sterile saline solution prior to surgery.

Surgical procedures followed guidelines by Hart and Summerfelt (1975), and were similar to Adams et al. (2006). Lake sturgeon were not anaesthetized for the procedure. A sterile, fenestrated polylined towel (Convertors) was placed over the ventral surface with the opening centred over the implant location. A 3-5 cm incision was made with a surgical scalpel on the ventral surface approximately 1 cm off the midline and 3-4 cm anterior to the pelvic girdle. The transmitter was inserted into the abdominal cavity with minimal pressure exerted on the internal organs. Following implantation, the peritoneum and associated muscle tissue were closed with a continuous modified Cushings suture technique (3-0 Ethicon PDS II, ½" CT-2 needle) followed by five simple interrupted sutures (2-0 Ethicon Prolene, ½" SH needle) to close the skin. Post-operative fish were released at the surgical site which was in close proximity to the capture site.

Telemetry data obtained from fish implanted with transmitters were used to examine seasonal distribution, over-wintering areas, distance and timing of fish movement, daily movement speeds, and range of travel within the Namakan River. Movement of individual lake sturgeon throughout the river was determined by recording the first daily detection at each station for every fish detected, and their range within the river was determined using detections from the two extreme receiver stations traveled. Movement past each receiver station was examined in relation to temperature and daily water flow to determine if those factors had any influence on movement patterns. Water flows were obtained using gauge data at the outlet of Lac La Croix, while surface water temperatures (1 m) were obtained from a HOBO temperature logger located at Lady Rapids.

The seasonal distribution of fish detections by receiver location, and the diel movements through distinct rapids/falls were analyzed based on the solstice periods. Four separate seasons were described as winter (December 21-March 19), spring (March 20-June 20), summer (June 21-September 21), and fall (September 22-December 20). Analyses of both upstream and downstream movements through shallow rapids/falls were based on the last detection from the departing receiver and the first detection from the arriving receiver, depending on the direction of travel.

Speed of movement was also calculated for individual fish that were detected by a minimum four receivers and had travelled a minimum distance of 10 km, using the last detection from the “departure” location to the first detection of the “arrival” location during periods of intense movement (less than two weeks travel time). Total distance traveled per month within the Namakan River was determined for every individual fish by calculating the cumulative distance traveled between receiver locations. Lastly, upstream and downstream diel movements were determined using daily solar rise and set times (NRC, 2009) and were grouped seasonally for every individual detected to examine the timing of daily movement through shallow rapids/falls. All statistical analyses were conducted using Microsoft Office Excel (Microsoft Corporation 2003) with a significance of $p < 0.05$.

RESULTS

A total of 430 lake sturgeon were captured at the five sample locations over the sampling period (Table 2). Of the 430 fish captured, 407 were biologically sampled and 397 were externally tagged and released, including 362 fish exceeding 1,000 mm total length. Water temperatures during the seven capture periods ranged from 3.0-15.0°C. Catches from a single gill net ranged from 0 to 29 fish. Incidental catch was minimal with only two northern pike (*Esox lucius*) and one walleye caught and released. Only one lake sturgeon died prior to release as a result of gill damage and bleeding during capture.

Eighteen tagged fish where recaptured during the study period, with two fish recaptured on two separate occasions. Eight lake sturgeon tagged in the river between 2006 and 2008 (McLeod, 2008a) were recaptured in the Namakan Reservoir by natural resource agencies and members of the public between May, 2007 and May, 2011. Recaptured of tagged fish confirmed both downstream (n = 8) and upstream (n = 3) movements between Namakan Lake and Little Eva Lake through Hay and Lady Rapids.

Table 2: Summary of lake sturgeon capture and tagging efforts in the Namakan River, 2006-2008.

Dates	Location	# Sturgeon Captured	# Sturgeon Tagged	# Sturgeon Recaptured
October 2-6, 2006	Little Eva Lake	4	3	0
October 10-11, 2006	Little Eva Lake	106	97	0
May 14-25, 2007	Namakan River	99	98	1
October 1-4, 2007	Bill Lake	5	0	0
October 9-18, 2007	Little Eva Lake	157	147	10
April 29–May 2, 2008	Below Snake Falls	4	4	0
October 6-10, 2008	Little Eva Lake	55	48	7
Total	**-**	**430**	**397**	**18**

Table 3 provides a summary of the fish description, ID code and release location of all lake sturgeon implanted with transmitters. These sampled fish (n = 34) had a mean total length of 1,211 mm (863-1,662 mm), mean fork length of 1,095 mm (780-1,527 mm), mean girth of 426 mm (329-659 mm), and mean round weight of 11,453 g (4,250-30,800 g) (Table 3). These values were similar to all tagged fish (n = 397), which had a the mean total length of 1,211 mm (605-1,746 mm), mean fork length of 1,092 mm (531-1,577 mm), mean girth of 442 mm (195-766 mm), and a mean round weight of 11,858 g (1,100-36,350 g). Mean age of transmitter fish was 27.9 years (16-47 years) compared to 26.1 years (7-61 years) for all sampled and tagged fish. Based on the round weight of individual fish, implanted transmitters ranged from 0.03 to 0.23% of body weight.

Eleven submersible Vemco receivers were deployed in the Namakan River on May 15 to 25, 2007, at the specific locations outlined in Table 4. Sites were selected to evaluate fish movement through the numerous rapids and falls situated along the Namakan River and in Quetico Provincial Park. Receiver locations were also selected at both the upstream and downstream sections of the Back Channel, a shallow 2 km stretch of river around High Falls and Eva Island between Bill and Little Eva Lakes. On April 30 and May 22, 2008, two additional receivers were deployed below and above Snake Falls, in order to investigate potential movements of fish through Myrtle, Ivy and Snake Falls in the upper reaches of the Namakan River. In May, 2009, two additional receivers were deployed above Ivy Falls in the Ivy Channel and below Myrtle Falls in order to better detect movements of fish through the multiple channels between Ivy and Myrtle Falls. Table 4 provides a summary of the serial number, description and location of all receivers deployed during the 6-year study.

Minor receiver malfunctions occurred in 2009 and 2010, and the Above Hay Rapids (Little Eva Lake) receiver (serial # 100846) was not functioning due to human disturbance from August 1 to October 20, 2011. No problems with receiver function were noted after October, 2011 until completion of the study. On May 15, 2011, there was a reported subsistence harvest of Fish ID 8493 from below Snake Falls. Although moving for 2 weeks post-release, Fish ID 8494 was detected in the same location from June 2008 to October 2012, and is suspected to have either died or expelled its transmitter. This fish was excluded from analyses due to the high number of detections below Snake Falls (location 14) and the influence on total detections and fish movements. A number of adult transmitters have also been detected in the juvenile receiver array in Bill Lake; however these detections have not been included in analysis for this project.

Table 3: Fish description, transmitter code and capture/release location for lake sturgeon implanted with coded transmitters in the Namakan River, Ontario in 2007 and 2008.

Transmitter ID Code	OMNR Fish Tag No.	Release Date	TLEN (mm)	FLEN (mm)	Girth (mm)	Weight (g)	Sex *	Age (years)	Capture/Release Location
4739	63802	15-May-07	1194	1091	455	11850	U	21	Namakan River - below Hay Rapids
4740	63813	15-May-07	1257	1150	458	13050	FI	29	Namakan River - below Hay Rapids
4741	63888	15-May-07	1156	1048	415	10100	U	27	Namakan River - below Hay Rapids
4742	63893	15-May-07	1220	1106	448	11900	MM	23	Namakan River - below Hay Rapids
4743	63876	15-May-07	1293	1168	391	11100	U	27	Namakan River - below Hay Rapids
4744	63855	16-May-07	1524	1389	463	18720	U	44	Namakan River - below Hay Rapids
4745	63809	16-May-07	1622	1494	606	29150	FI	27	Namakan River - below Hay Rapids
4746	63871	16-May-07	863	780	329	4250	U	20	Namakan River - below Hay Rapids
4747	63835	16-May-07	1076	972	375	7700	U	-	Namakan River - below Hay Rapids
4748	63848	16-May-07	1292	1167	506	14600	U	34	Namakan River - below Hay Rapids
4749	63720	17-May-07	1348	1224	401	11950	U	42	Little Eva Lake – below back channel
4750	63735	17-May-07	1160	1038	382	8600	U	25	Little Eva Lake – below back channel
4751	63738	17-May-07	1183	1050	390	8750	U	21	Little Eva Lake – below back channel
4752	63791	17-May-07	1662	1527	659	30800	FM	47	Little Eva Lake – below back channel
4753	63798	17-May-07	1038	920	360	6150	M	22	Little Eva Lake – below back channel
4588	63732	18-May-07	1136	1016	371	6850	U	25	Little Eva Lake – below back channel
4589	63733	18-May-07	1045	930	377	6700	U	16	Little Eva Lake – below back channel
4590	63734	18-May-07	1111	987	421	8250	U	16	Little Eva Lake – below back channel
4591	63793	18-May-07	1162	1046	419	8800	M	16	Little Eva Lake – below back channel
4592	63796	18-May-07	1187	1101	458	11400	MM	29	Little Eva Lake – below back channel
4593	63700	23-May-07	1188	1061	379	8700	M	26	Bill Lake – below Quetico Rapids
4594	63714	23-May-07	1485	1378	505	19400	FM	32	Bill Lake – below Quetico Rapids
4595	63728	23-May-07	1158	1035	426	9450	M	28	Bill Lake – below Quetico Rapids
4596	63756	23-May-07	1146	1037	384	8400	U	30	Bill Lake – below Quetico Rapids
4597	63777	23-May-07	1128	1002	399	7750	U	34	Bill Lake – below Quetico Rapids
4598	63718	24-May-07	996	889	385	6650	U	33	Three Mile Lake – below Ivy Falls
4599	63707	24-May-07	1203	1092	434	11100	M	22	Three Mile Lake – below Ivy Falls
4600	63761	25-May-07	991	889	340	5200	U	23	Three Mile Lake – below Ivy Falls
4601	63783	25-May-07	1317	1204	456	13350	MM	28	Three Mile Lake – below Ivy Falls
4602	63781	25-May-07	1346	1190	520	16500	FI	27	Three Mile Lake – below Ivy Falls
8491	50447	30-Apr-08	1075	959	378	7600	U	24	Namakan River – below Snake Falls
8492	50448	30-Apr-08	1214	1151	439	12650	FI	38	Namakan River – below Snake Falls
8493	50446	02-May-08	1255	1130	428	13000	FI	38	Namakan River – below Snake Falls
8494	50445	02-May-08	1134	1019	349	9000	U	28	Namakan River – below Snake Falls
Mean			**1211**	**1095**	**426**	**11453**		**27.9**	

*F = female, maturity unknown; FM = female, mature (gravid); FI = female, developing; M = male, maturity unknown; MM = male, mature (ripe); MI = male, developing; U = unknown.

Table 4: Serial number, description and location of VR2W submersible acoustic receivers in the Namakan River, Ontario from 2007 to 2013, ordered by date and time of deployment.

Receiver Serial No.	UTM Location	Date of Deployment	Date of Retrieval	Location Description
100847	547347 5365369	15-May-07	29-Aug-13	Namakan River - below Hay Rapids
100855	549195 5365895	17-May-07	11-Jul-13	Namakan River – back channel above first rapids
100846[1]	548468 5366363	17-May-07	11-Jul-13	Little Eva Lake – above Hay Rapids
100853	550641 5366874	18-May-07	11-Jul-13	Little Eva Lake – below High Falls
100849	555250 5369250	22-May-07	18-Sept-07	Quetico River – above first rapids (QPP)
100848	553224 5367427	22-May-07	11-Jul-13	Namakan River – above Quetico (Bill) Rapids
100851	544310 5366389	22-May-07	28-May-07	Namakan River – below Lady Rapids (VNP)
100852	550984 5365634	23-May-07	11-Jul-13	Bill Lake – above back channel
100850	560161 5363439	24-May-07	11-Jul-13	Three Mile Lake – below Ivy and Myrtle Falls channel
100689	558319 5367294	24-May-07	18-Sept-07	Three Mile Lake – above Twisted Rapids
100854	560235 5364154	25-May-07	07-Oct-07	Three Mile Lake – mouth of Bearpelt Creek (QPP)
100851[2]	540596 5366483	28-May-07	06-Sept-08	Namakan River – mouth of Namakan Lake
100849[3]	555305 5369225	18-Sept-07	11-Jul-13	Quetico River – below second rapids
100689[4]	558003 5367479	18-Sept-07	11-Jul-13	Namakan River - below Twisted Rapids
100854[5]	562169 5364364	12-Oct-07	20-Aug-10	Bearpelt Creek - below Wolseley Lake (QPP)
101942	561210 5360316	30-April-08	22-Jul-13	Namakan River – below Snake Falls
103459	561160 5358657	22-May-08	22-Jul-13	Namakan River – above Snake Falls (OPEG)
104898	562350 5361290	14-May-09	22-Jul-13	Namakan River- Above Ivy Falls
104901	559827 5362906	20-May-09	11-Jul-13	Namakan River- below Myrtle Falls
104900[6]	544310 5366389	28-May-09	11-Jul-13	Namakan River – below Lady Rapids

[1] reciever not functioning due to human disturbance from Aug. 1 to Oct. 20, 2011
[2] lost due to theft or disturbance by anglers and moved to less visible, long-term location. No data after Sept. 6, 2008.
[3] moved further upstream to deeper water below second rapids to avoid potential freeze-in during winter months.
[4] moved to below Twisted Rapids to better evaluate habitat use below the rapids, while still documenting fish passage
[5] moved to planned location within QPP. Low water prevented boat access to Bearpelt Creek prior to Oct. 7, 2007. Receiver removed Aug. 20, 2010.
[6] replaced 100851 at the mouth of Namakan River in May 28, 2009.

A total of 5,024,152 detections were recorded throughout the Namakan River over the 2007-2013 sampling period (Table 5). Each receiver had a mean of 334,943 detections (SD=630,885) ranging from 0 to 2,508,320, and detected a mean of 29.2 (SD=14.9) transmitters per receiver (range of 0 to 47). Daily movement patterns between all 15 receiver locations were analyzed for each individual lake sturgeon implanted with a transmitter in 2007 and 2008 (Appendix I and II respectively). Table 6 provides a summary of all detections for individual fish including release date and location, last detection date and location, and number of receivers encountered within the receiver array. All 34 implanted sturgeon from Namakan River, along with an additional 22 of 26 individuals from the collaborative Namakan Reservoir study, were detected at a minimum of one receiver location (n=56). The mean number of detections/fish was 179,434 (SD=107,050), and the mean number of receivers that each fish encountered was 7.8 (SD=3.8). The maximum number of detections from a single fish was 514,243 (ID 4753) as the fish stayed primarily in Little Eva Lake, while the minimum number of detections was 8 (ID 49645). One individual (ID 4589) was detected at a maximum of 14 of the 15 stations, over a distance of 28.8 km. Two individuals were detected at one station only.

Data analysis for 2007-2008 only demonstrated that most of the detections occurred in summer (52%) and the least occurred in winter (8%), while a similar amount of detections were received during spring and fall (19% and 21% respectively). The receiver located in Little Eva Lake above Hay Rapids had the most fish detections for each season, while the location above Snake Falls had no detections for any season

(Figures 2a-d). Fish were only detected at 6 of the 15 receivers during the winter season. All winter detections were recorded in the four lakes (Namakan, Little Eva, Bill and Three Mile) as well as below Hay Rapids and Snake Falls.

Table 5: Lake sturgeon detections by receiver location in the Namakan River, Ontario from May, 2007 to August, 2013.

Location No.	Location Description	Distance Upstream (km)	Receiver Serial No.	No. Detections	No. Transmitters Detected
1	Below Lady Rapids	0	100851/104900	564,130	43
2	Below Hay Rapids	7.4	100847	417,315	46
3	Little Eva Lake	9.1	100846	2,508,320	47
4	Below High Falls	11.7	100853	134,429	44
5	Lower Back Channel	10.2	100855	6,181	33
6	Bill Lake	12.6	100852	527,485	35
7	Above Quetico Rapids	14.7	100848	14,794	35
8	Quetico River	17.5	100849	2,618	7
9	Below Twisted Rapids	20.0	100689	51,864	37
10	Bearpelt Creek [1]	27.4	100854	289,132	13
11	Three Mile Lake	24.7	100850	237,617	35
12	Below Myrtle Falls	25.5	104901	58,062	28
13	Above Ivy Falls	27.3	104898	52,418	14
14	Below Snake Falls	28.8	101942	159,787	21
15	Above Snake Falls	30.5	103459	0	0
Total	-	-	-	**5,024,152**	-
Mean	-	-	-	**334,943**	**29.2**

[1] only 2 fish detected at revised location after October 12, 2007. Receiver removed Aug. 20, 2010.

Table 6: Individual lake sturgeon detections and last known date/location by transmitter code in the Namakan River, Ontario from May, 2007 to August, 2013. Shaded rows represent transmitters detected from the Namakan Reservoir study.

Transmitter ID Code	Release Date	Release Location	Last Detection Date	Last Known Location	No. Detections	No. Receivers [1]
4739	15-May-07	Below Hay Rapids	13-May-13	Little Eva Lake	269,852	4
4740	15-May-07	Below Hay Rapids	20-Jun-09	Namakan Lake	50,411	12
4741	15-May-07	Below Hay Rapids	10-Apr-13	Little Eva Lake	187,537	10
4742	15-May-07	Below Hay Rapids	08-Oct-12	Namakan Lake	198,878	4
4743	15-May-07	Below Hay Rapids	13-May-12	Namakan Lake	33,024	9
4744	16-May-07	Below Hay Rapids	13-May-13	Little Eva Lake	149,581	4
4745	16-May-07	Below Hay Rapids	13-May-13	Little Eva Lake	126,377	4
4746	16-May-07	Below Hay Rapids	12-May-13	Below Hay Rapids	385,056	12
4747	16-May-07	Below Hay Rapids	19-May-07	Below Hay Rapids	453	1
4748	16-May-07	Below Hay Rapids	10-Aug-09	Namakan Lake	56,772	2
4749	17-May-07	Little Eva Lake	26-Mar-12	Namakan Lake	48,919	10
4750	17-May-07	Little Eva Lake	06-Jun-09	Namakan Lake	11,985	4
4751	17-May-07	Little Eva Lake	12-Oct-12	Little Eva Lake	154,243	4
4752	17-May-07	Little Eva Lake	29-Apr-13	Namakan Lake	201,348	10
4753	17-May-07	Little Eva Lake	13-May-13	Little Eva Lake	514,754	3
4588	18-May-07	Little Eva Lake	07-Jun-09	Namakan Lake	59,245	4
4589	18-May-07	Little Eva Lake	06-Jul-09	Namakan Lake	5,827	14
4590	18-May-07	Little Eva Lake	20-May-10	Namakan Lake	6,488	4
4591	18-May-07	Little Eva Lake	11-May-13	Namakan Lake	76,865	4
4592	18-May-07	Little Eva Lake	12-Jan-13	Below Hay Rapids	266,505	13
4593	23-May-07	Bill Lake	12-May-13	Namakan Lake	39,241	13
4594	23-May-07	Bill Lake	21-May-13	Three Mile Lake	65,549	12
4595	23-May-07	Bill Lake	31-May-09	Namakan Lake	12,445	10
4596	23-May-07	Bill Lake	17-May-13	Bill Lake	414,094	2
4597	23-May-07	Bill Lake	27-Apr-13	Bill Lake	34,543	5
4598	24-May-07	Three Mile Lake	07-May-13	Three Mile Lake	98,773	4
4599	24-May-07	Three Mile Lake	20-Jun-09	Above Ivy Falls	20,067	6
4600	25-May-07	Three Mile Lake	14-Apr-10	Bill Lake	59,415	5
4601	25-May-07	Three Mile Lake	18-May-13	Back Channel	111,690	10
4602	25-May-07	Three Mile Lake	28-Jul-12	Namakan Lake	31,575	11
8491	30-Apr-08	Below Snake Falls	17-Jul-13	Below Snake Falls	80,288	4
8492	30-Apr-08	Below Snake Falls	12-May-12	Below Snake Falls	173,061	10
8493[2]	02-May-08	Below Snake Falls	01-Feb-11	Below Snake Falls	71,720	9
8494[3]	02-May-08	Below Snake Falls	31-Jul-12	Below Snake Falls	-	-
8495	14-May-08	Sand Point Lake	17-Jun-09	Namakan Lake	1,065	3
49630	20-May-08	Namakan Lake	13-May-13	Namakan Lake	97,438	10
49631	16-May-08	Little Vermillion Lake	13-Jun-13	Namakan Lake	54,303	8
49632	15-May-08	Sand Point Lake	04-Jun-13	Namakan Lake	28,237	9
49633	21-May-08	Namakan Lake	08-Jul-13	Namakan Lake	108,849	9

49634	21-May-08	Namakan Lake	30-Jun-13	Namakan Lake	46,437	12
49635	20-May-08	Namakan Lake	09-Sep-12	Namakan Lake	83,514	12
49636	21-May-08	Namakan Lake	19-Jul-13	Below Snake Falls	5,110	12
49637	21-May-08	Namakan Lake	19-Jun-13	Namakan Lake	22,294	12
49638	20-May-08	Namakan Lake	09-Jul-13	Namakan Lake	81,323	10
49640	14-May-08	Sand Point Lake	23-Jun-12	Namakan Lake	44,227	12
49641	14-May-08	Sand Point Lake	18-May-12	Namakan Lake	75,213	11
49642	07-May-08	Crane Lake	26-Jun-13	Namakan Lake	71,520	12
49643	07-May-08	Crane Lake	21-Jul-12	Namakan Lake	33,613	9
49644	07-May-08	Crane Lake	09-Aug-10	Namakan Lake	8,743	10
49645	07-May-08	Crane Lake	29-Oct-12	Little Eva Lake	8	1
49646	07-May-08	Crane Lake	24-Oct-12	Above Hay Rapids	14,077	10
49647	13-May-08	Sand Point Lake	24-Sep-12	Below High Falls	135,656	4
49650	15-May-08	Sand Point Lake	29-Aug-12	Namakan Lake	46,246	10
49652	14-May-08	Sand Point Lake	16-Jun-13	Namakan Lake	7,123	4
49653	14-May-08	Sand Point Lake	05-Jun-13	Namakan Lake	24,282	10
49654	14-May-08	Little Vermilion Lake	15-May-12	Namakan Lake	18,293	4
Total	**56**	**-**	**-**	**-**	**5,024,152**	**-**
Mean	**-**	**-**	**-**	**-**	**179,434**	**7.8**

[1] Receiver 100851 and its replacement 104900 (Below Lady Rapids) were considered 1 receiver for the purposes of this report.
[2] Reported mortality (subsistence harvest) on May 15, 2011.
[3] Suspected mortality or expelled transmitter. Detections not included in analysis.

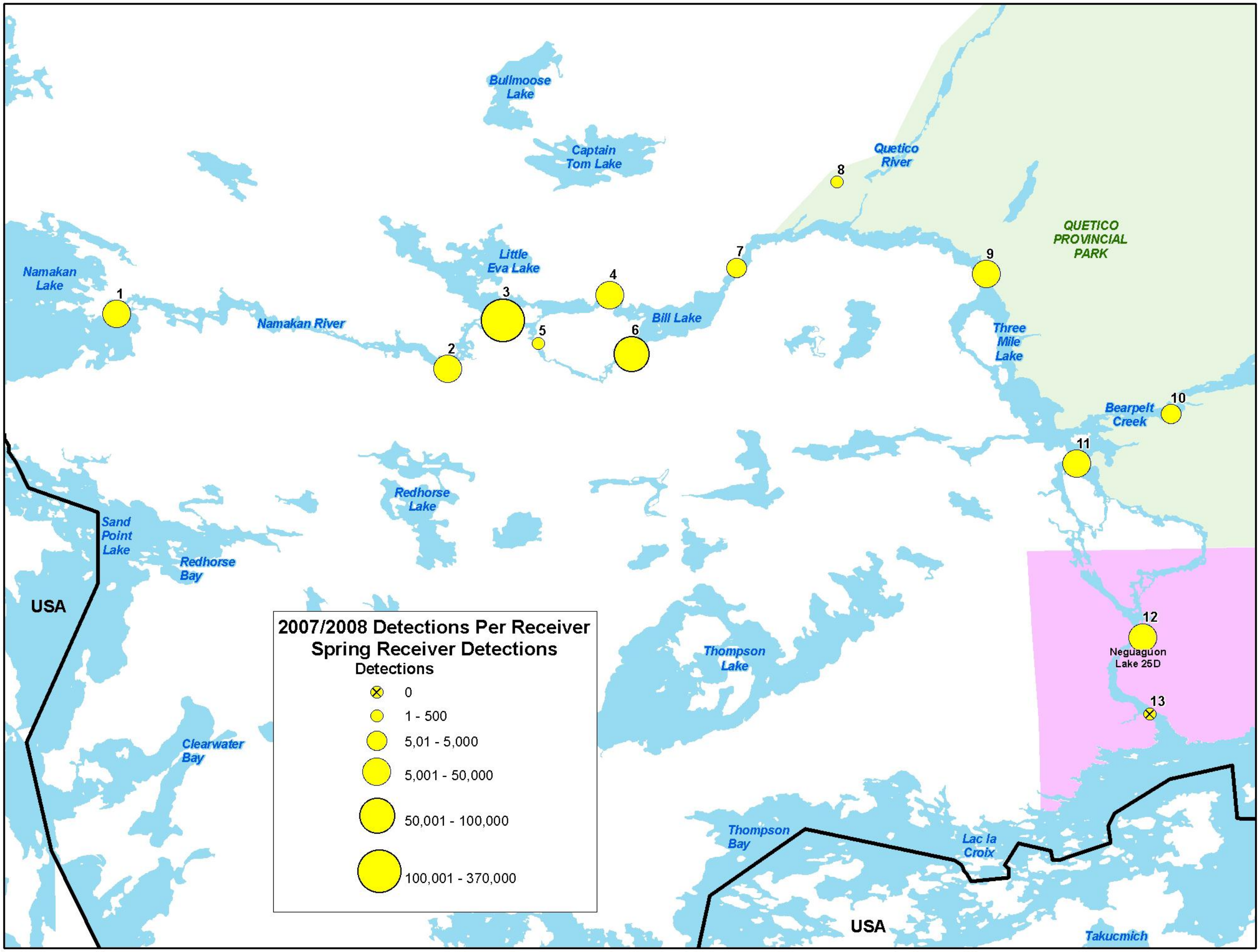


Figure 2a: Number of detections per receiver in the Namakan River during spring 2007 and 2008.

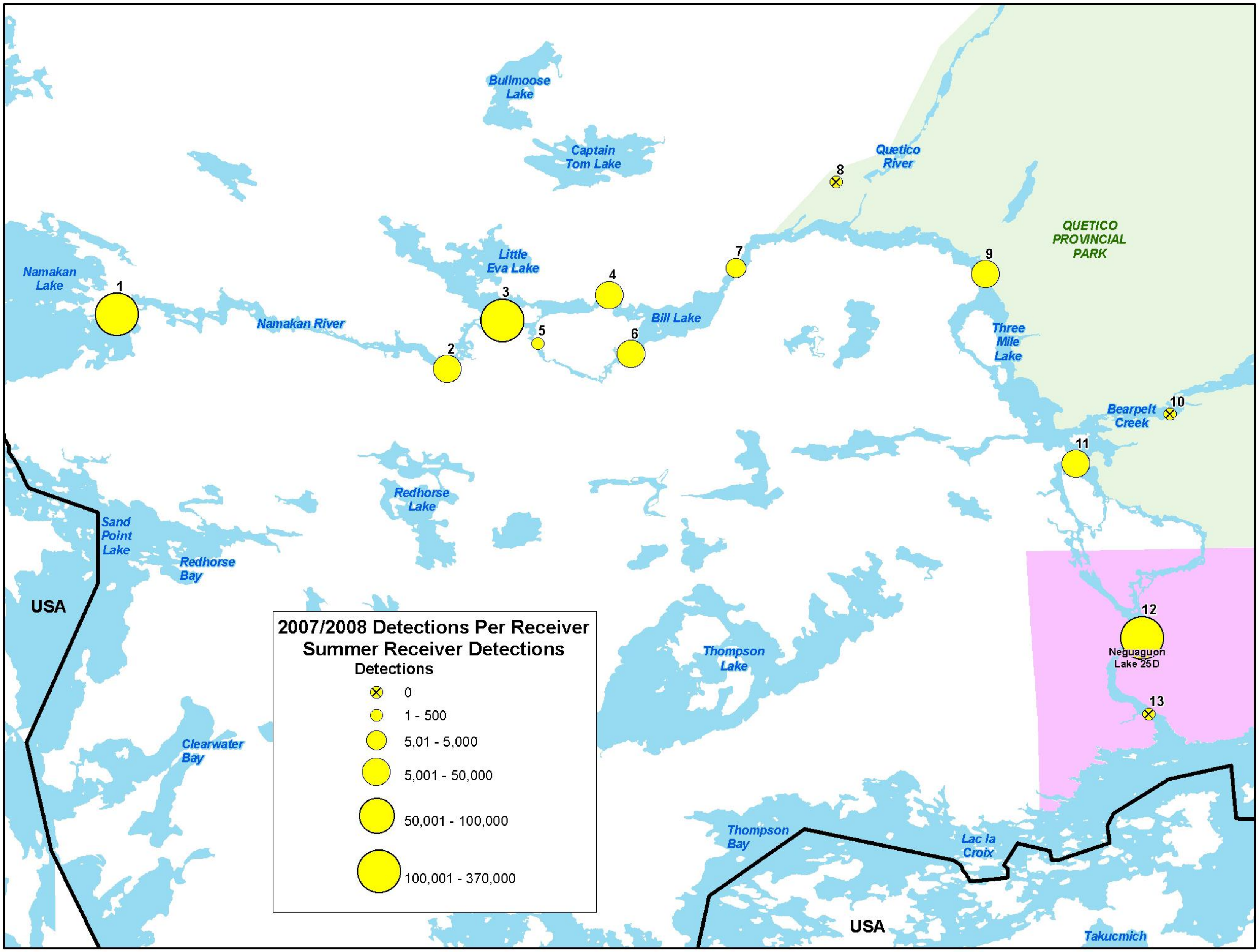


Figure 2b: Number of detections per receiver in the Namakan River during summer 2007 and 2008.

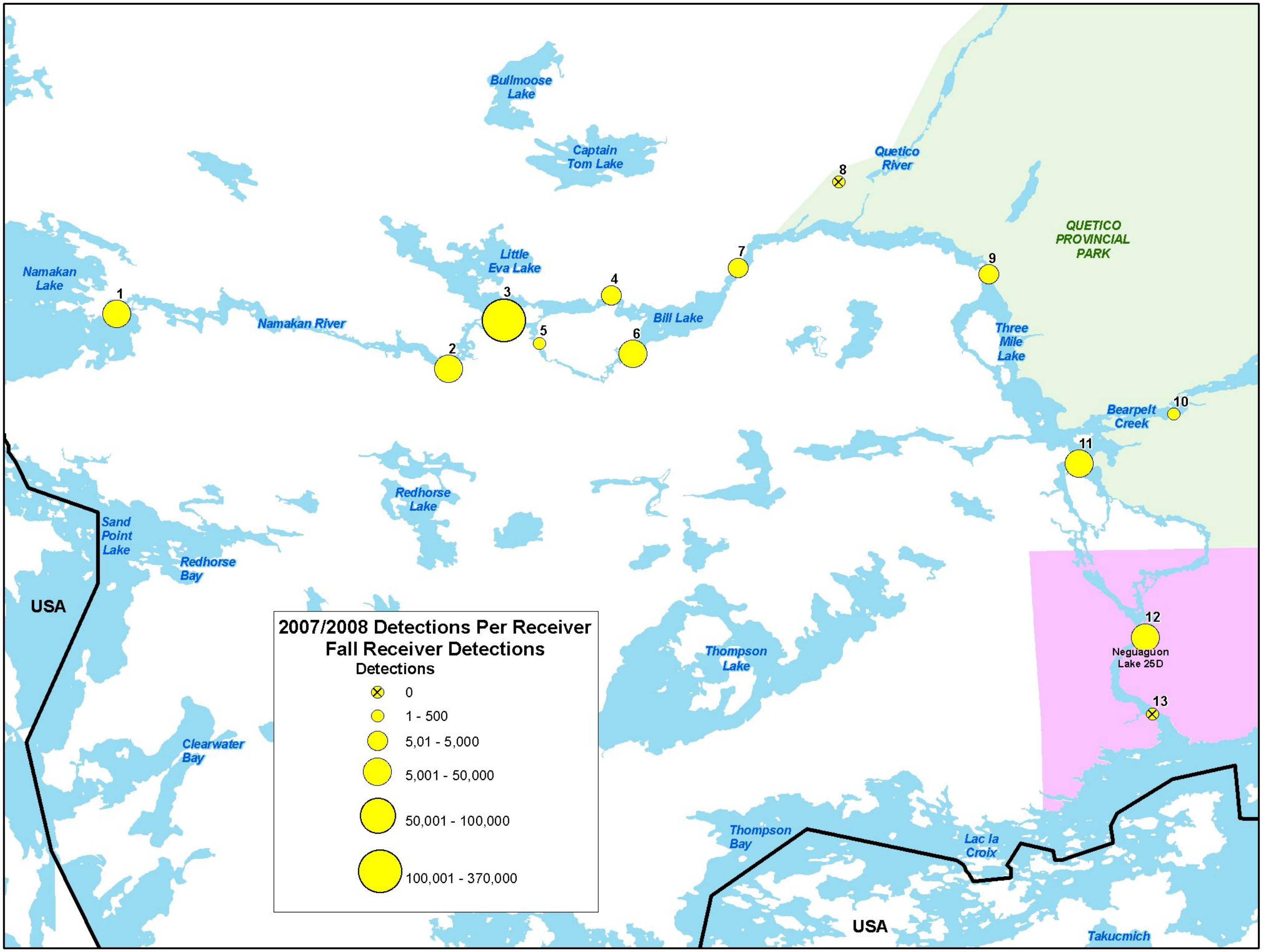


Figure 2c: Number of detections per receiver in the Namakan River during fall 2007 and 2008.

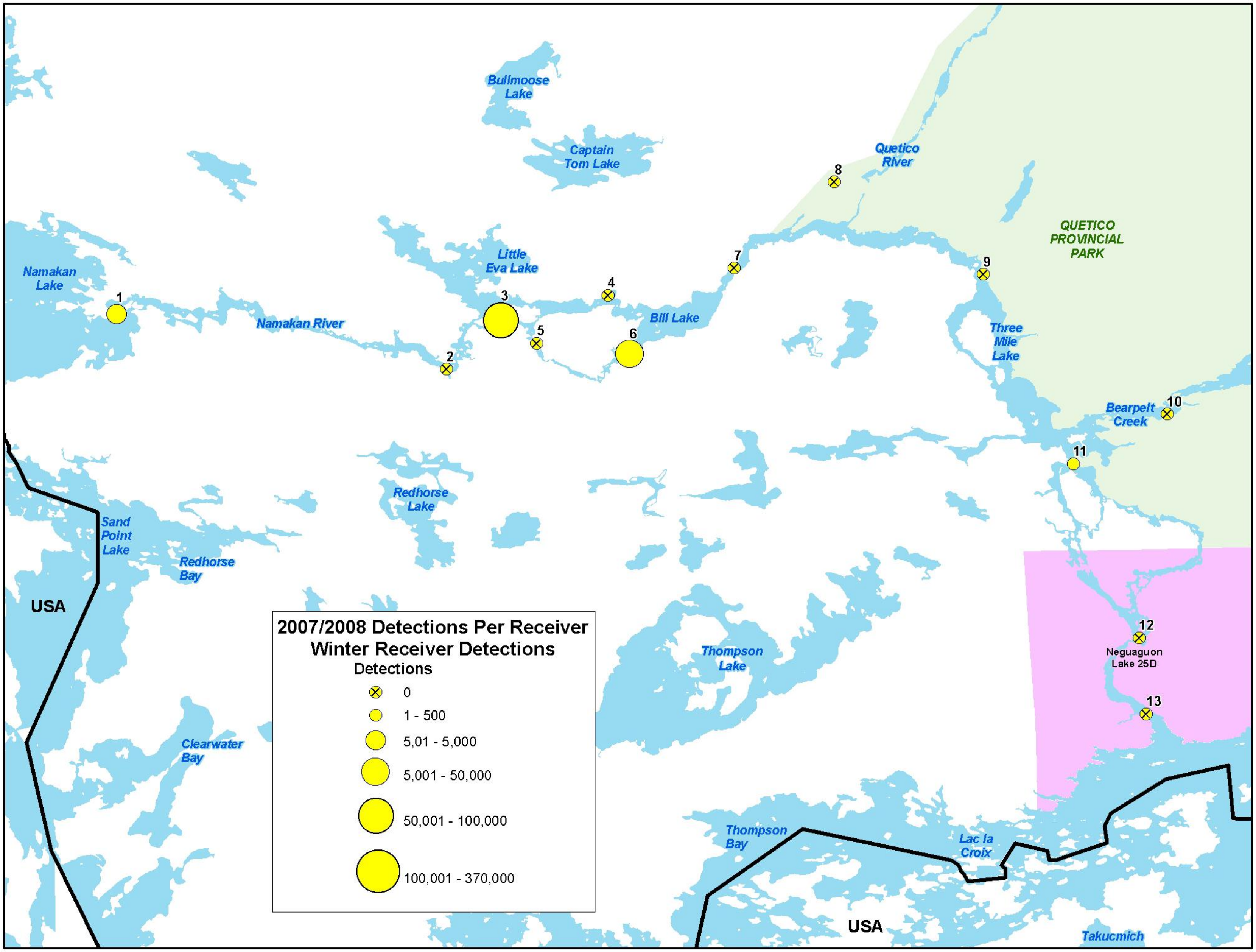


Figure 2d: Number of detections per receiver in the Namakan River during winter 2007 and 2008.

The number of detections of individual fish declined from downstream near the mouth of Namakan Lake (location 1 - km 0) to upstream near Snake Falls (location 14 - km 30.5) (Figure 3). This scatter plot includes two outliers for receiver locations that are on tributaries to the main stem flow of Namakan River, including the Quetico River (location 8 – km 17.4) and Bearpelt Creek (location 13 – km 27.5). Few telemetered fish entered these smaller tributaries, and typically movements only occurred during spring spawning or foraging periods. No fish were detected upstream of Snake Falls (location 15 – km 30.5).

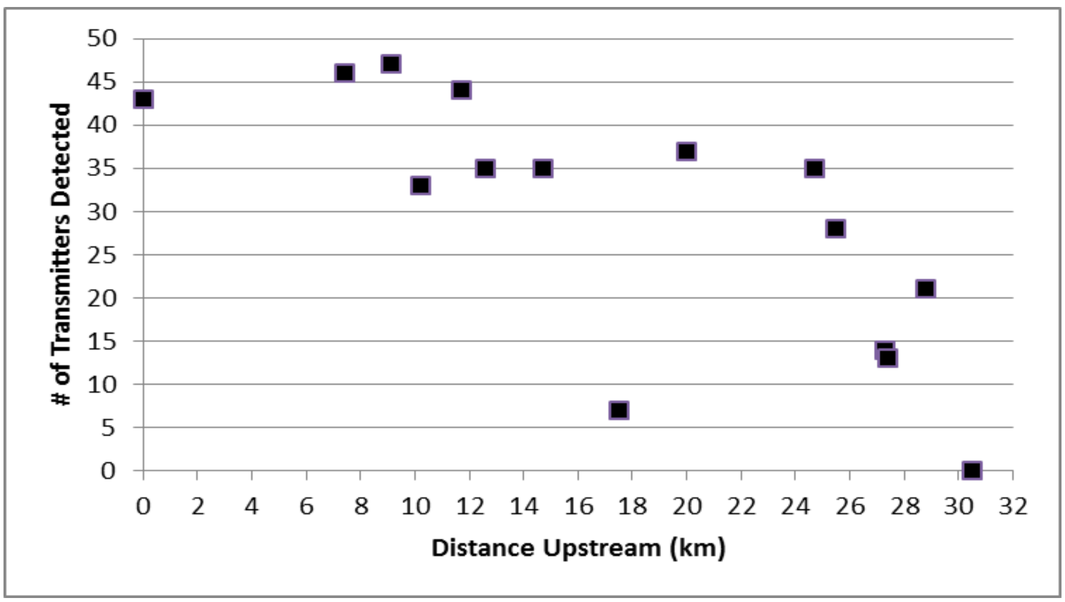


Figure 3: Number of individual telemetered fish detected at each receiver based on distance upstream in Namakan River, 2007-2013.

In May 2012, the presence of 11 different telemetered fish was confirmed below a potential spawning location over several days with suitable water temperatures for spawning (12-18°C). A similar aggregation of 10 fish was confirmed in mid to late May, 2009 at the same location. A smaller group of 4 different fish was also detected in May, 2012 compared to peak detections of only 3 fish in May 2011. A short-term staging of telemetered fish (n=7) occurred in 2010, possibly a result of low flows restricting upstream movement of lake sturgeon through the system. Another significant observation was the upstream and downstream movement of 7 different fish into the Quetico River in late May, 2009. These movements and/or aggregations form part of the evidence used to infer the presence of suitable lake sturgeon spawning habitat at several locations in the Namakan River. Specific details of these spawning locations are not provided in this report as the information is deemed "sensitive" in Land Information Ontario (LIO) and supporting Metadata Management Tool. As such, restrictions may be placed on access and data is not available for public distribution.

Distribution of total monthly movements over the 2007-2008 study period is illustrated in Figure 4. Mean distance traveled differed significantly between months of movement from May to October (ANOVA; $F_{5, 272} = 4.137$, $p = 0.001$, $n = 278$). Movement throughout the Namakan River peaked in June with a mean monthly distance traveled of 11.1 km (SE = 2.1), and was lowest in August with a mean of 2.8 km (SE = 1.1). A maximum monthly movement of 48.9 km was observed in June, and movement ceased entirely from November to April each year.

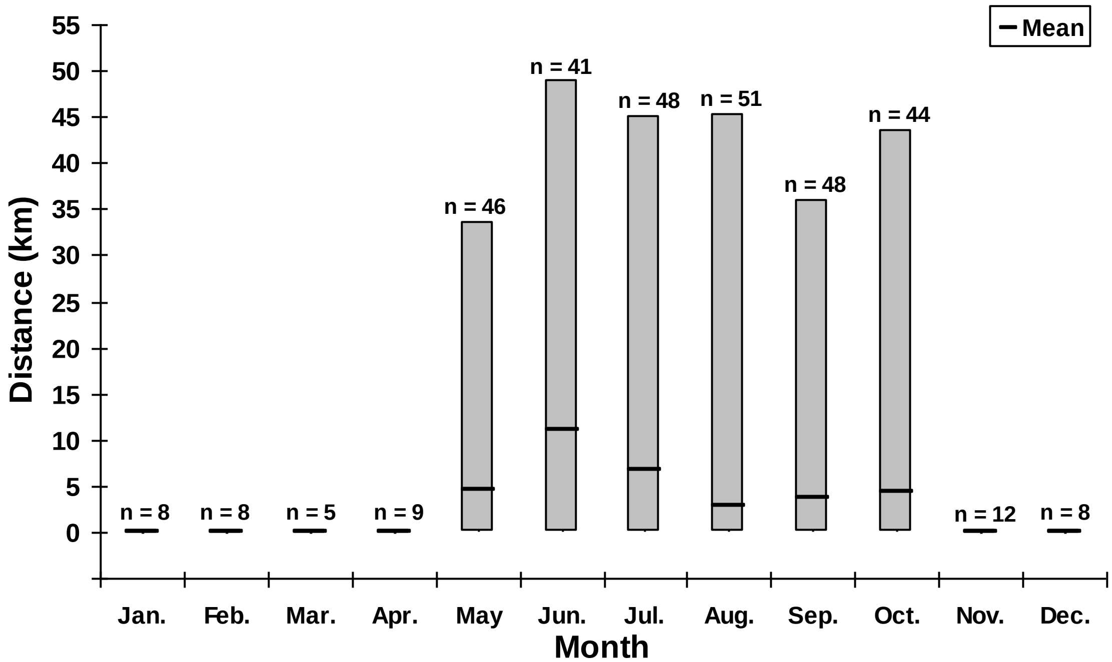


Figure 4: Total monthly movement of lake sturgeon between fixed receiver locations in the Namakan River, from May 2007 to October 2008. Mean, range and sample size are provided for each month.

Over-winter locations of telemetered lake sturgeon were also evaluated after 6 complete winters of study, based on movement data from 33 transmitters in Namakan River in 2007/08 and an additional 26 transmitters deployed in Namakan Reservoir in 2008 (Table 7). Annual winter locations were also postulated based on known and continuous fish locations in late October after fall movements in the river had generally ceased. Between 2007 and 2013, most telemetered lake sturgeon over-wintered in the Namakan Reservoir (59.8% of over-wintering events), with 44 of 59 individual fish over-wintering in the reservoir at least once. The remaining over-winter events (40.2%) were documented within the Namakan River, with most of these occurring in Little Eva Lake over the 6 years. The remaining events occurred in Three Mile Lake, Bill Lake, below Hay Rapids and below Snake Falls. In total, 93% of over-wintering events occurred in lake environments. Some over-winter locations within Namakan River included riverine habitats below Hay Rapids (n=13) and below Snake Falls (n=8). Forty-three fish over-wintered in the Namakan River at least once during the 6 year period.

Table 7: Over-winter locations of adult lake sturgeon in the Namakan River and Reservoir from 2007 to 2013.

Location	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	Total (%)
Namakan Reservoir	18	30	37	40	34	27	**186 (59.8)**
Below Hay Rapids	1	2	0	2	6	2	**13 (4.2)**
Little Eva Lake	3	14	12	7	5	10	**51 (16.4)**
Bill Lake	2	3	4	3	2	2	**16 (5.1)**
Three Mile Lake	6	8	6	4	4	9	**37 (11.9)**
Below Snake Falls	0	2	0	3	1	2	**8 (2.6)**
Total (n)	**30**	**59**	**59**	**59**	**52**	**52**	**311 (100.0)**

Examination of seasonal and diel movement through shallow rapids in 2007/08 revealed more frequent movements during the day in both spring and summer, and more frequent movements at night in the fall (Table 8). However, there is no difference in movements between daylight (52%) and nighttime (48%) hours on an annual basis, and movements through rapids/falls were limited entirely to the spring, summer, and fall seasons.

Table 8: Diel and seasonal movements of lake sturgeon through shallow rapids/falls in the Namakan River, Ontario in 2007/08 based on sunrise and sunset times.

Season	DAY (No. of movements)	NIGHT (No. of movements)	Total
Spring	53	34	**87**
Summer	60	43	**103**
Fall	6	34	**40**
Winter	0	0	**0**
Total	**119**	**111**	**230**

Movements of individual fish through shallow rapids and falls along the river were also evaluated based on detections from both upstream and downstream receivers (Table 9). Movements through the proposed hydro development sites at Hay Rapids, High Falls, Back Channel, and Ivy/Myrtle Falls were documented (Appendix III), as well as all other undeveloped sites along the Namakan River and Quetico River (Appendix IV). The only exceptions were that no upstream movements were recorded at Snake Falls and High Falls. The maximum number of movements (n = 200) was observed at Hay Rapids at the outlet of Little Eva Lake. This was followed closely by Lady Rapids (n=187) in the lowest reach of the Namakan River, and Twisted Rapids (n=159) at the outlet of Three Mile Lake, with direction of movement distributed nearly equally between upstream and downstream over the sampling period. The most significant observations were 47 recorded downstream movements of 30 individual fish over High Falls, an elevation drop of 6.8 m. Several fish made the downstream passage on multiple occasions, with one fish (ID 49630) passing over the falls a maximum of 5 times during the 6 year period.

In addition, both upstream and downstream movements of lake sturgeon through the Back Channel first occurred in October, 2007. Of the 70 recorded fish movements, the majority (84.2%) were moving upstream from Little Eva Lake to Bill Lake, through a natural by-pass channel around High Falls. The majority of downstream movements of adult fish occurred over High Falls, representing 47 (79.7%) of the 59 total downstream movements. Six partial or interrupted upstream movements were detected in the Back Channel, but these have been excluded from the analysis and remain highlighted in

Appendix III. Duration of movements in the 2 km long Back Channel was also evaluated based on telemetry detections. Upstream movements (n=58) were longer in duration with a mean of 53.7 hours (SE=8.1) and range of 8.5 to 307.5 hours. Downstream movements (n=12) in the direction of flow were much shorter in duration with a mean of 20.4 hours (SE=5.1) and range of 3.4 to 64.5 hours.

Table 9: Movements of lake sturgeon through undeveloped rapids/falls in the Namakan River, Ontario from May, 2007 to August, 2013. Locations are listed from downstream to upstream, and proposed hydro development sites are in bold

Location	Elevation[1] (m)	Upstream	Downstream	Total
Lady Rapids	1.6	84	103	187
Hay Rapids	**3.0**	**106**	**94**	**200**
Back Channel (Eva Island)	**7.0**	**58**	**12**	**70**
High Falls	**6.8**	**0**	**47**	**47**
Quetico Rapids	0.7	76	78	154
Quetico River (QPP)	-	11	11	22
Twisted Rapids	-	77	82	159
Ivy/Myrtle Falls	**4.0**	**35**	**33**	**68**
Ivy Falls [2]	-	0	12	12
Myrtle Falls [2]	-	2	13	15
Side Channel [2]	-	25	1	26
Snake Falls	3.2	0	0	0

[1] change in elevation at an average flow of 120 m3/sec.
[2] site-specific movements since additional receivers were deployed in May, 2009

Thirty-five upstream and 33 downstream movements of 17 individual fish were recorded at Ivy Falls, Myrtle Falls and the side channel collectively over 2007 – 2013 (Appendix III). The addition of two receivers above Ivy Falls and below Myrtle Falls in 2009 helped identify fish movements through the three available migration routes. Detections since May 2009 indicate that downstream movements occur predominately through Ivy and Myrtle Falls while upstream migration of telemetered fish occurs most often in the side channel (20 of 22 movements or 91%) where elevation change is more gradual and flow velocities are lower.

Time and speed of both upstream and downstream travel between a minimum of four stations are provided in Table 10. For extensive upstream movements in excess of 10 km, travel duration ranged from 1.4 to 12.5 days with an estimated mean speed of 3.8 km/day (SE = 0.6). Based on 2007/08 data, the duration of downstream travel ranged from 1.2 to 13.3 days with a mean speed of 3.1 km/day (SE = 0.5). Data for travel speeds were also pooled for all fish since a one-way analysis of variance indicated no significant difference between upstream and downstream movement speeds (ANOVA; $F_{1,13} = 1.51$: $p = 0.230$, n=26). Mean speed of all fish movements (n = 37) ranged from 1.1 to 9.9 km/day, with a mean of 3.4 km/day (SE = 0.6). The maximum travel distance observed in the river was 28.8 km by 12 different fish (ID 4589, 4593, 4594, 4602, 4740, 49634, 49635, 49636, 49637, 49640, 49641, 49642) from Namakan Lake upstream to below Snake Falls.

Table 10: Duration, speed and direction of lake sturgeon movements between fixed receiver locations (minimum 4 receivers and 10 km in travel distance) in the Namakan River, Ontario in 2007/08.

Fish ID	Departure Date	Receivers	Distance traveled (km)	Duration (days)		Speed (km/day)
				Upstream	Downstream	
4602	Oct. 19, 2007	3 to 9	10.9	1.4		8.0
49633	Jul. 7, 2008	3 to 11	15.6	1.6		9.9
4593	Sep. 25, 2008	6 to 11	12.1	2.2		5.6
4740	Aug. 1, 2008	1 to 4	11.7	2.8		4.2
4595	Jun. 28, 2008	7 to 12	14.1	2.8		5.0
4592	Jun. 19, 2008	3 to 12	19.7	3.3		6.0
4741	Jul. 25, 2007	1 to 4	11.7	5.5		2.1
4741	May 27, 2008	3 to 11	15.6	4.7		3.3
4742	Jul. 17, 2008	1 to 4	11.7	5.7		2.1
49630	Jun. 22, 2008	1 to 6	12.6	5.9		2.1
49633	Jun. 24, 2008	1 to 4	11.7	6.5		1.8
49633	Jul. 10, 2008	11 to 4	13.0	7.5		1.7
49632	Jun. 28, 2008	1 to 11	24.7	10.6		2.3
4592	May 23, 2008	3 to 12	19.7	10.9		1.8
4741	Jun. 26, 2008	2 to 11	17.3	12.0		1.4
49634	Jun. 23, 2008	2 to 11	17.3	12.5		1.4
4590	Jun. 17, 2007	4 to 1	11.7		3.7	3.2
4592	Jun. 06, 2008	12 to 3	19.7		13.3	1.5
4593	Jul. 18, 2007	11 to 6	12.1		9.8	1.2
4593	Oct. 1, 2007	11 to 6	12.1		4.2	2.9
4593	Oct. 8, 2007	6 to 1	12.6		10.2	1.2
4594	Jun. 8, 2007	10 to 1	27.4		5.2	5.3
4595	Jul. 2, 2008	12 to 6	16.2		9.6	1.7
4595	Jun. 26, 2008	12 to 7	14.1		2.5	5.7
4597	May 28, 2008	11 to 6	12.1		6.6	1.8
4600	May 31, 2007	11 to 6	12.1		6.4	1.9
4601	May 22, 2008	9 to 1	20.0		9.7	2.1
4602	Jun. 1, 2007	11 to 1	24.7		7.6	3.2
4602	Jun. 4, 2008	12 to 1	28.8		5.0	5.8
4741	Jul. 24, 2008	11 to 6	12.1		3.2	3.8
4741	Jun. 10, 2008	11 to 2	17.3		6.5	2.6
4749	May 27, 2007	4 to 1	11.7		1.2	9.9
4752	Sep. 17, 2007	4 to 1	11.7		3.2	3.6
49630	Jul. 9, 2008	9 to 3	10.9		4.0	2.7
49632	Jul. 12, 2008	11 to 6	12.1		8.7	1.4
49632	Oct. 14, 2008	11 to 6	12.1		5.1	2.4
n	–	–	**36**	**16**	**20**	**36**
Mean	–	–	**15.0**	**5.9**	**6.3**	**3.4***
Min	–	–	**10.9**	**1.4**	**1.2**	**1.2**
Max	–	–	**28.8**	**12.5**	**13.3**	**9.9**

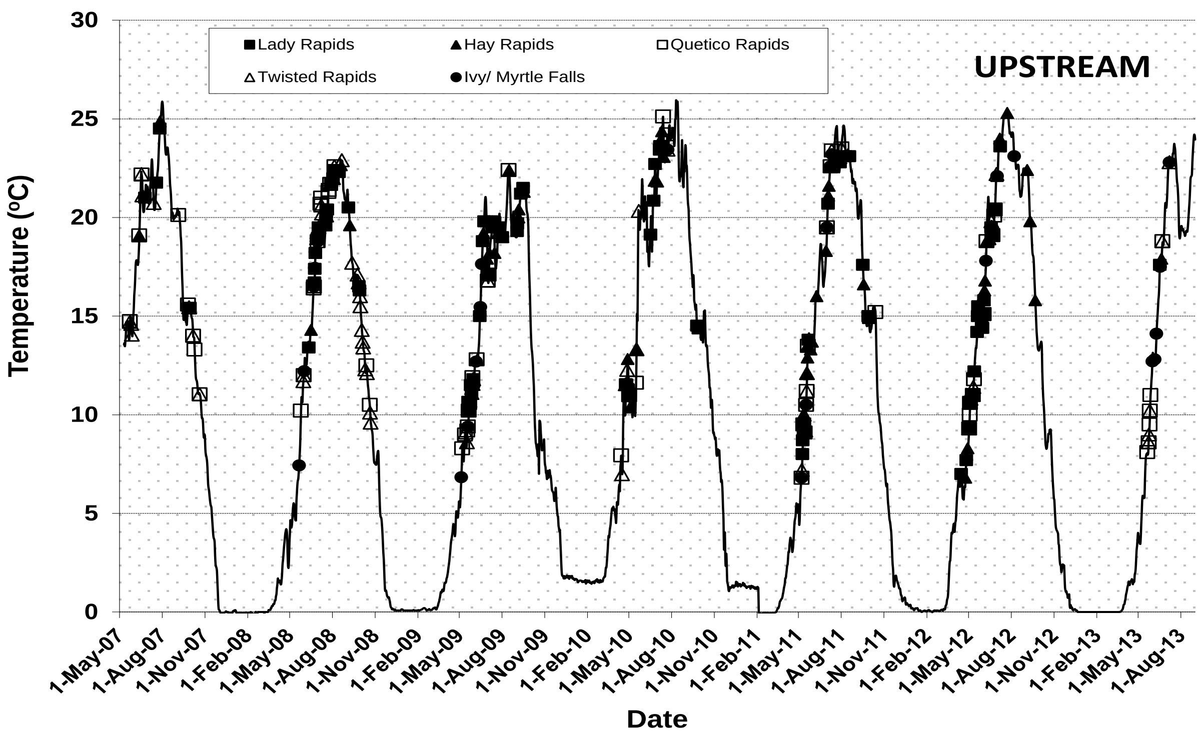
***A one-way analysis of variance (ANOVA) indicated no significant difference between upstream and downstream speed ($P > 0.05$), therefore data were pooled.

Mean daily water temperatures were also obtained from a HOBO temperature logger at Lady Rapids from May 10, 2007 to October 19, 2009 and October 22, 2010 to August 31, 2013 (Appendix V). Surface water temperature data from Lac La Croix was used from the October 2009 to October 2010 period due to malfunction of the data logger at Lady Rapids. Movements through the rapids/falls occurred between temperatures of 5.2-24.6°C downstream and 6.8-25.3°C upstream (Table 11; Figure 5). In general, no movement of fish through shallow rapids/falls were recorded when temperatures were lower than 5.2°C. The majority of fish movements, both upstream and downstream, occurred during the period of increasing water temperatures. With the exception of 2008, few movements of fish through rapids/falls occurred during the descending temperature period in late summer and fall. Mean water temperatures when fish moved through specific sites are also provided (Table 11). There are no obvious or consistent trends moving upstream within the Namakan River, and no apparent differences between upstream and downstream movements.

Table 11: Mean and range of water temperatures for lake sturgeon movements through undeveloped rapids/falls in the Namakan River, Ontario from May, 2007 to August, 2013. Locations are listed from downstream to upstream, and proposed hydro development sites are in bold.

Location	Downstream			Upstream		
	n	Mean (ºC)	Range (ºC)	n	Mean (ºC)	Range (ºC)
Lady Rapids	103	15.2	5.2-23.9	84	17.0	7.0-24.5
Hay Rapids	**94**	**15.6**	**5.6-24.6**	**106**	**18.1**	**6.8-25.3**
Back Channel	**12**	**17.4**	**9.3-24.5**	**58**	**15.5**	**7.5-25.1**
High Falls	**47**	**15.4**	**8.0-24.1**	**0**	**-**	**-**
Quetico Rapids	78	15.9	7.5-23.6	76	15.1	6.8-25.1
Twisted Rapids	82	15.7	6.8-23.6	77	15.2	7.0-23.5
Ivy/Myrtle Falls	**33**	**16.6**	**11.0-23.6**	**35**	**14.7**	**6.8-23.4**

A)



B)

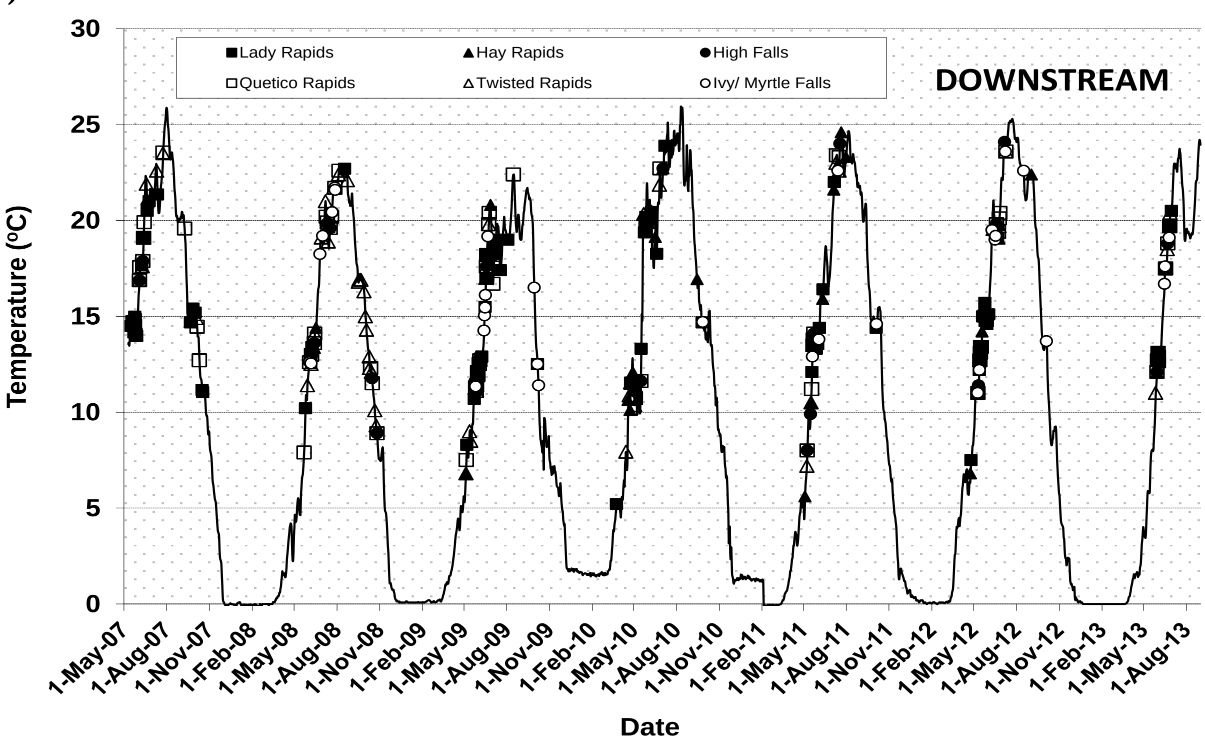


Figure 5: Upstream (A) and downstream (B) movements of lake sturgeon in relation to mean daily temperature through undeveloped rapids/falls in the Namakan River.

Further details of downstream and upstream movements in relation to temperature through individual rapids/falls are provided in Appendix III and IV. Typical movement patterns in relation to temperature were observed annually, with the exception that 3 upstream movements occurred in 2012 during particularly low temperatures in early spring (6.0 – 6.3°C). Site specific movements for the proposed hydro development at High Falls and Back Channel are also displayed in Appendix VI. In general, fish movement in the Back Channel occurred during periods of increasing water temperature, and continues until the annual mid-summer temperature peak occurs.

Estimated daily outflows from Lac La Croix for 2007-2013 were provided by Environment Canada and the Lake of the Woods Control Board (LWCB, 2013), and were used to represent the flow conditions in the Namakan River (Appendix VII). Downstream and upstream movements of lake sturgeon were correlated to daily mean flows at each of the undeveloped rapids/falls (Table 12). There were no documented movements of fish at Snake Falls, and water flow information was not available for either Quetico River or Bearpelt Creek within QPP. Partitioned water flows for the Back Channel were used, since only a portion of the natural flow occurs around Eva Island and High Falls. Detailed flow information for this channel was collected by OPEG (revised by Hatch, 2012 through a calibrated hydraulic model).

Further details of downstream and upstream fish movements in relation to daily flow through each undeveloped rapids/falls are provided in Appendices III and IV, while site specific movements for High Falls and Back Channel are presented in Appendix VIII.

Table 12: Mean and range of water flows for lake sturgeon movements through undeveloped rapids/falls in the Namakan River, Ontario from May, 2007 to August, 2013. Locations are listed from downstream to upstream, and proposed hydro development sites are in bold.

Location	Downstream			Upstream		
	n	Mean (m^3/s)	Range (m^3/s)	n	Mean (m^3/s)	Range (m^3/s)
Lady Rapids	103	181	29-464	84	177	31-407
Hay Rapids	**94**	**199**	**40-464**	**106**	**174**	**19-411**
Back Channel[1]	**12**	**25**	**6-47**	**58**	**24**	**6-47**
High Falls	**47**	**240**	**41-406**	**0**	**-**	**-**
Quetico Rapids	78	229	36-467	76	224	29-464
Twisted Rapids	82	207	40-446	77	192	21-444
Ivy/Myrtle Falls	**33**	**231**	**28-409**	**35**	**272**	**45-464**
Ivy Falls	12	195	28-317	0	-	-
Myrtle Falls	13	227	51-385	2	158	152-163
Side channel	1	140	-	25	247	45-394

[1] Flows in Back Channel represent values converted from the Namakan River outflow and the flow distribution reported by OPEG, 2009 (Genivar - Technical Note #2, Revision 3.0 and revised by Hatch, 2012). All other values represent outflows reported from Lac La Croix (05PA006).

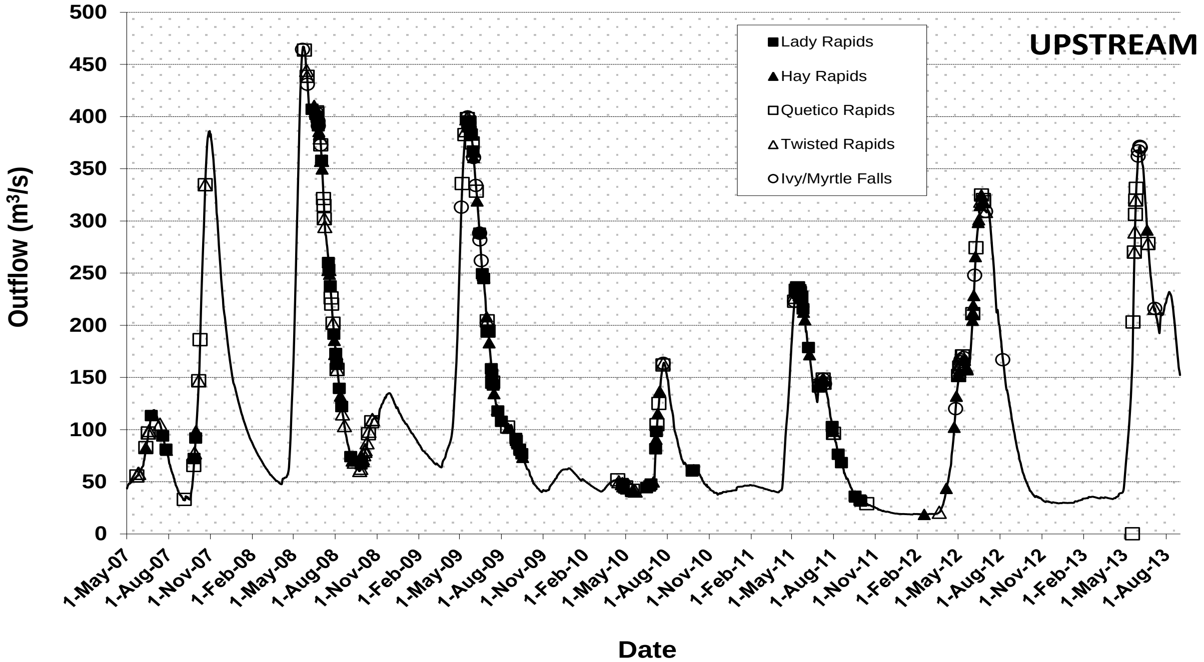
Ivy/Myrtle Falls had the highest mean flow for upstream movements at 272 m^3/sec, while High Falls had the highest mean flow for downstream movements at 240 m^3/sec respectively. Lady Rapids had the lowest mean flow for downstream movements at 181 m^3/sec, while Hay Rapids had the lowest value for upstream movements at 174 m^3/sec. The lowest observed flow for successful upstream movement at any of the shallow rapid/falls was 21 m^3/sec at Twisted Rapids, which has a reported elevation change of 1.0 m. Lake sturgeon were also able to move upstream at river flows as high as 464 m^3/sec at both Quetico Rapids and Ivy/Myrtle Falls. Relative to other rapids, upstream sturgeon movements through Ivy/Myrtle Falls occurred during the highest mean river flow of 272 m^3/sec, including the side channel at 247 m^3/sec. Total estimated river flow has been used for all fish movements at the Ivy/Myrtle Falls location, even though there are 3 or more distinct channels present. Channel-specific flow estimates would need to be developed for any more detailed analysis of fish movements.

Movement of telemetered fish through the Back Channel around Eva Island and High Falls occurred in all years of the study from late fall 2007 to mid-summer 2013, when flow conditions were suitable (Appendix VIII). Mean flows for all upstream movements (n=58) were estimated at 24 m^3/sec for this specific channel while those experienced during downstream movements (n=12) were estimated at 25 m^3/sec. A minimum flow (6 m^3/sec) for downstream fish passage through the entire Back Channel was recorded in 2012 and matches the minimum flow observed for successful upstream passage. There have been six partial or incomplete upstream movements documented since 2007.

Other than the Back Channel, upstream lake sturgeon movements through Hay Rapids occurred during lowest mean flow of 174 m^3/sec, while a single downstream movement through the Side Channel between Ivy and Myrtle Falls occurred during a low flow of 140 m^3/sec. The minimum Namakan River flow during which an upstream movement was detected was 19 m^3/sec at Hay Rapids; while the lowest downstream movement was 28 m^3/sec at Ivy Falls in October, 2011. Adult lake sturgeon were also able to move upstream at river flows as high as 464 m^3/sec at both Quetico Rapids and Ivy/Myrtle Falls (Table 12).

Most movements through undeveloped rapids/falls occurred during periods of increasing and decreasing outflow from May through November each year (Figure 6). In 2008, 2009 and 2011, peak spring flows corresponded closely with the Namakan River temperature reaching 10ºC (within 4 days) and the majority of lake sturgeon movements occurred during a lengthy period of

A)



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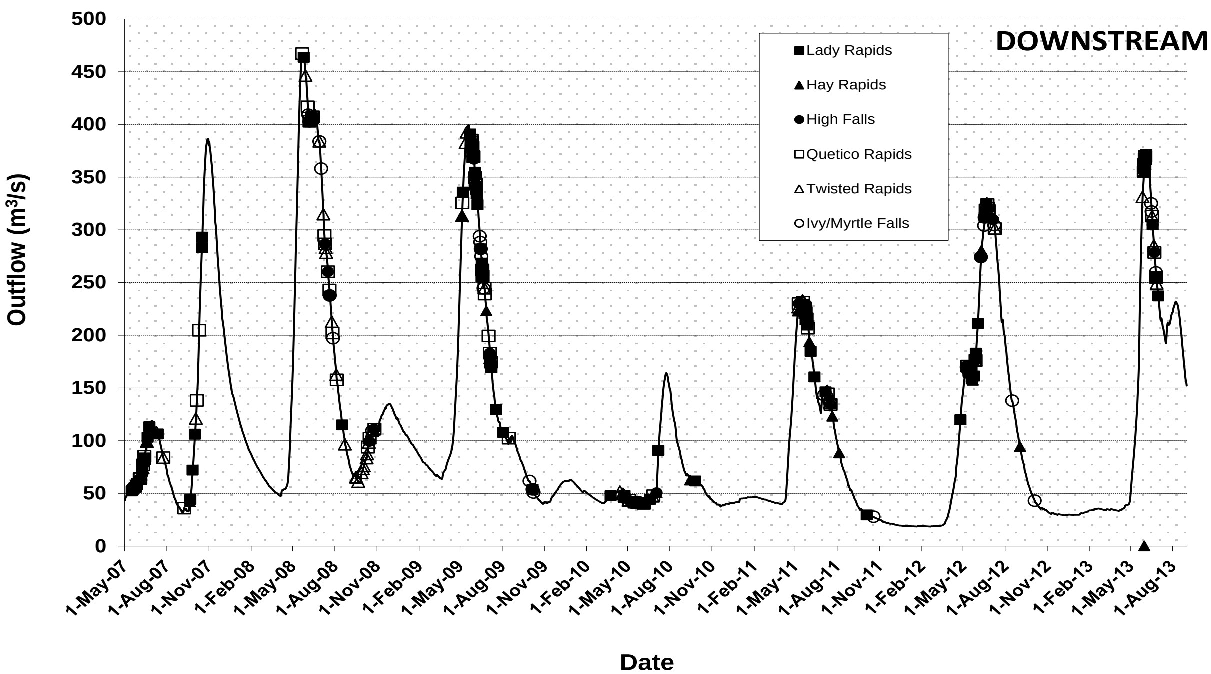

Figure 6: Upstream (A) and downstream (B) movements of lake sturgeon in relation to mean daily outflow through undeveloped rapids/falls in the Namakan River.

decreasing outflow. Little or no movement was documented during the earlier period of increasing spring flows over these three years. In contrast, many upstream and downstream lake sturgeon movements were recorded during increasing spring flows during 2007, 2010 and 2012. During these years, a water temperature of 10ºC was reached in the Namakan River at least 50 days prior to peak spring flows. These observations suggest water temperature may have greater influence than changes in flow on spring lake sturgeon movements, although a longer term dataset is needed to more rigorously evaluate this hypothesis.

DISCUSSION

Acoustic telemetry and tagging has provided an effective means of evaluating the movement, seasonal distribution and lake/riverine habitat use of lake sturgeon within the Namakan River, and continues to provide important information for both the river and Namakan Reservoir downstream. Movements of 56 (34+22) individual, telemetered fish and 18 recaptures of tagged fish have contributed new information from a previously unstudied system. This sample of lake sturgeon represented a broad segment of the adult population, with total lengths ranging from 605 to 1,746 mm and ages ranging from 16 to 61 years.

The seasonal distribution of telemetry data suggested that lake sturgeon were widely distributed in the Namakan River in spring, summer, and fall. There are preferred areas by season, with the majority (52%) of fish detections occurring in Little Eva Lake across all four seasons in 2007/08, followed closely by the river mouth below Lady Rapids and the area below Snake Falls in summer. Over-wintering of fish within lake environments was clearly detected in Little Eva Lake, Bill Lake, Three Mile Lake, and the Namakan Reservoir. Moreover, shallow rapids and falls were generally avoided in winter based on the absence of detections, except for below Hay Rapids and Snake Falls. Scott and Crossman (1998) suggested that lake sturgeon moved from shallow waters to deeper areas in summer, back to shallow areas in fall and back to deep areas in winter.

Bemis and Kynard (1997) reported on the potamodromous behaviour of sturgeon to migrate within a river system for two basic purposes: feeding and reproduction. They postulated three possible spawning migration patterns: one step, short two step, and long two step. One step spawning migrations are those in which fish move directly upstream to the spawning site and return downstream. The short two step migration involves upstream movement, usually in the fall, followed by over-wintering near the spawning site, followed by a very short migration to spawn the following spring. This pattern may enable fish to use bio-energetic reserves gained during summer foraging for their initial long upstream migration. Lastly, the long two step spawning migrations refer to fish that make an initial upstream migration followed by seasonal staging, then followed by a long upstream migration to the spawning site. This latter pattern of migration is characteristic of larger sturgeon species (*Acipenseriforms*) in the longest rivers, but is not typical of lake sturgeon. Telemetered lake sturgeon really only exhibited the first two spawning migration patterns in the Namakan River. This could be due to the high complexity of this river system, and the relatively short migration distance of 30 km from Namakan Reservoir to a natural barrier at the outlet of Lac La Croix.

Lake sturgeon can be highly mobile and exhibit complex behaviour, especially in large systems where movements are not restricted. In the Upper Mississippi River system, reported movements ranged from 3 to 198 km (median of 56 km) (Knights et al., 2002). Spawning migrations from lakes to rivers are often as long as 125 km and may be as far as 400 km (Scott and Crossman, 1998). Auer (1999) found that lake sturgeon left spawning grounds in the Sturgeon River, MI and dispersed 70 to 280 km throughout southern Lake Superior with males and females using different locations. Lake sturgeon utilized spawning grounds along the full 140 km of the Rainy River and its tributaries, but made extensive feeding movements during the late spring and summer throughout the south basin of Lake of the Woods (Rusak and Mosindy, 1997). Sandilands (1986) also reported movements of 130 km and 180 km for fish in the Kenogami River in northern Ontario.

This study confirmed a smaller range of movements from 0 to 28.8 km, which represents the entire distance of the Namakan River. However, the total distance travelled by these fish is much greater based on additional movements throughout the Namakan Reservoir. Although movements of 100 km or more have been observed in other populations, the majority of lake sturgeon can exhibit more sedentary behaviour with movement ranges less than 20 km (Sandilands, 1986; Nowak and Jessop, 1987; Block, 2001). Several fish in this study showed limited movement with detections at only two or three receiver locations (n=4), compared to four receiver locations (n=14). The interrupted pattern of detections indicated that these fish were still alive and occasionally moving outside the detection range of the receiver throughout the monitoring period. The extent of movement within a season was also highly variable among fish. Some fish readily moved among habitats while movements of others were more constrained. The size, maturity, and stage of sexual development were likely an important factor in the movement pattern of telemetered fish. Haynes et al. (1978) observed that larger white sturgeon with higher metabolic rates required more food than smaller fish, and therefore tended to travel longer distances.

Based on movement patterns of individual fish, potential spawning habitats exist at several sites in the Namakan River. Suitable substrates and flow conditions were observed at each of these potential locations identified during this field study. The preferred spawning habitat for lake sturgeon includes shallow, flowing waters with substrates consisting of a combination of gravel, cobble, boulder and/or rock (Scott and Crossman, 1998; Block, 2001).

Lake sturgeon have been reported to begin their upstream (spawning) migration in the Mattagami River as early as January, with the pattern continuing through May as fish appeared at spawning locations with water temperatures of 8-10°C (McKinley et al., 1998). Fish dispersed further downstream as spring water temperatures approached 13°C and continued throughout the summer. In the Kaministiquia River, radio-tagged lake sturgeon began their upstream spawning migration in late April as water temperatures in the lower river increased from 6.5°C to a maximum of 10°C (Friday, 2006). Fish appeared below the Kakabeka Falls spawning area with daily mean water temperatures of 9.1-11.6°C; with two separate spawning events occurring 10-12 days apart at temperatures of 13.6°C and 15.2°C. Bruch and Binkowski (2002) found that males moved onto the spawning grounds and began searching for females when water temperatures rose to 6.6-16.0°C. Females would move on to a site at temperatures of 8.8-19.1°C, with most activity occurring at 11.5-16.0°C. Spawning was typically short duration occurring for 2-4 days at each site, with rapid post-spawn dispersal from the site. This behaviour was exhibited by several potential spawning fish in this study. In the Namakan River, lake sturgeon appear to move upstream in the late summer and fall to possibly forage and over-winter in lake environments, as well as in early spring to reach potential spawning areas. Lake sturgeon clearly preferred to over-winter in lake environments, with small lakes of the Namakan River perhaps functioning as important staging areas for mature fish preparing to spawn (Bemis and Kynard, 1997; McLeod and Debruyne, 2009).

In addition to spawning, the factors influencing movement can include water temperature, flow, depth, and substrate selection (Kerr et al., 2011). Movements in other lake sturgeon populations are reported to be highly correlated with water temperature (Lallaman et al., 2008; Rusak and Mosindy, 1997). Temperatures near or above 20°C can cause of decrease in movement (McKinley et al., 1998), and sturgeon will avoid waters where temperatures exceed 23°C. In this study, there were many (n=48) movements of lake sturgeon through shallow rapids/falls at or above a water temperature of 23.0°C, to a high of 25.3°C. There appeared to be no upper limit for upstream or downstream movements with the highest natural water temperature recorded at 25.9°C over the study period. However, there did appear to be a lower limit where no lake sturgeon movement was observed between receivers at temperatures below 5.2°C.

Both upstream and downstream movements of lake sturgeon in the Namakan River appear to be influenced by discharge, and occur over a wide range of flow conditions (19 to 467 m^3/sec) experienced from 2007 to 2013. Movement was limited through most rapids/falls during the low spring flows observed in 2007 and 2010. Fish movements in the remaining study years occurred in both directions immediately after the peak in discharge, and continued throughout the spring and summer under declining flows. Borkholder et al. (2002) found that lake sturgeon movement in the Kettle River, MN was also highly correlated with change in discharge, with upstream movements occurring during periods of rising discharge and downstream movements during falling discharge. Lallaman et al. (2008) also indicated that upstream and downstream migration movements in the Manistee River, MI varied with discharge. In the Kaministiquia River, Friday (2006) confirmed upstream migration and spawning of lake sturgeon at low flows of 14-23 m^3/sec, while other fish moved upstream under mean daily flows of 20-60 m^3/sec. More recent telemetry studies indicated lake sturgeon migrating upstream with mean daily river flows of 92-121 m^3/sec (M. Friday, pers. comm).

After spawning, lake sturgeon are reported to return to home areas and/or feeding areas followed by a late summer migration to areas where they spend the winter (Thuemler, 1997; Rusak and Mosindy, 1997; Scott and Crossman, 1998; Sandilands, 1986; Block, 2001; Adams et al., 2006). Moreover, Bruch and Binkowski (2002) suggested an autumn pre-spawn migration to staging areas within the spawning tributaries. Both these behaviour patterns were observed in the Namakan River during the six year investigation.

Downstream movements to Little Eva Lake and further to Namakan Reservoir would suggest that adult fish were seeking more productive foraging areas lower in the system. While a significant portion of lake sturgeon exhibited migratory behaviour in the Namakan River, a few telemetered fish did not make large-scale movements and remained sedentary for extended periods of time. According to a model by Northcote (1978), fish migrate among three basic types of habitat (spawning, feeding, and wintering) to optimize feeding and reproduction, avoid unfavourable conditions and enhance colonization. Presumably, the choice of winter habitat balances the need to feed, and the energetic cost of migrating from spawning or feeding habitats.

Previous studies of movement and habitat use by lake sturgeon have noted distinct areas preferred by groups of adult fish within riverine environments. In the Upper Mississippi River system, sturgeon moved throughout a large geographic area, but extensively used cores areas (Knights et al., 2002). These core areas were sites with unique hydraulic characteristics, such that depositional substrates were common yet flow was present, and that these areas probably provide important feeding habitat. In this study, Little Eva Lake and Bill Lake represented core areas for lake sturgeon and provided the majority of fish detections. This is consistent with the very high population density and biomass estimates for Little Eva Lake in October 2007 (McLeod, 2008a). Smith and King (2005) suggested that core areas of activity may be more important for sturgeon inhabiting riverine environments compared to lake environments. Telemetry results indicate that adult lake sturgeon exhibit a high degree of site fidelity to specific areas in the Kaministiquia River, Ontario (M. Friday, pers. comm). Another study of the Lake of the Woods/Rainy River system found two distinct populations differentiated by winter habitat preferences (Rusak and Mosindy, 1997). One group, which over-wintered in the lake, only entered the river during spawning migrations. The "river" population made extensive foraging movements in the lake during late spring and summer, returning to the river in late summer and fall to over-winter at specific locations.

The Namakan River provides a unique mix of river and lake environments with three small (<400 ha) lakes including Little Eva, Bill and Three Mile. These lake habitats may provide preferred areas for foraging and resting based on suitable substrates, flow and water depth. Little Eva Lake represents such an area where further habitat investigations may be warranted. Lake sturgeon are generally believed to be bottom dwellers but previous movement studies revealed that they spend extensive amount of time in the water column above the bottom (Block, 2001). In Round Lake and Winnipeg River, Manitoba, lake sturgeon generally selected fine and medium sand when in contact with the substrate. Benson et al. (2005) suggest that shallow, riverine areas with sand substrates, low current velocity and predominance of dipteran larvae should be protected as important nursery habitats in tributaries that support spawning populations of lake sturgeon.

Monthly movements within the Namakan River indicate that individual lake sturgeon travelled over a range of 0 to 49 km/month from May to October. Distance moved by month was highest in June (mean of 11.1 km) and lowest in August (mean of 2.8 km); while no movement of fish was observed between receiver locations from November to April over the first two years of data analysis. This lack of fish movement between receivers in late fall and winter was likely due to the cold water temperatures in shallow water and ice conditions.

Seasonal and diel movements within the Namakan River suggest that lake sturgeon move through shallow rapids and falls equally during the day and night, with the exception of the fall season. The shorter daylight period in the fall may have contributed to increased movements during the night. In contrast, Parsley et al. (2008) found that white sturgeon moved to shallow water at night and showed greater activity, inferred by rates of movement, than during the daytime. White sturgeon were absent from river sections with high flow during the winter, consistent with our observations of lake sturgeon. On the Namakan River, the majority (45%) of fish movements through shallow rapids (n = 230) occurred during the summer season with no movement during the winter (December to March).

Daily movements of lake sturgeon in the Namakan River also suggest that the existing rapids and falls do not represent barriers to migration. Telemetry findings confirm movements through all natural constrictions in the system with the exception of Snake Falls and upstream movement at High Falls, which have an elevation change of 3.8 and 6.8 m respectively under average flow conditions. Although the Back Channel around Eva Island and High Falls has an elevation change of approximately 6.8 m, the numerous shallow rapids help dissipate this change over a distance of approximately 2 km. Lake sturgeon use this natural by-pass channel to migrate both upstream and occasionally downstream around High Falls. Movements occurred only when daily flows in the Namakan River exceeded 96 m^3/sec, which equates to 6 m^3/sec in the Back Channel.

The subsequent return of 21 adult fish that departed the river during the summer/fall in Year 1 (2007), and the upstream movement of another 26 fish from the reservoir since 2008 indicated a high degree of preference to the Namakan River. The return of individual fish and re-occupation of areas previously inhabited suggest that some lake sturgeon exhibit fidelity to this system, similar to white sturgeon (Parsley et al., 2008). In association with this study, a genetics evaluation by Welsh (2008) suggested that fish in the Namakan River upstream to Snake Falls represent a single population and that existing rapids/falls do not represent reproductive barriers. A similar and collaborative study was completed downstream in the Namakan Reservoir to evaluate population discreteness and distribution based on telemetry, tagging and genetics (Shaw, 2010; Shaw et al., 2012; Shaw et al., 2013).

In the Menominee River, MI, the lake sturgeon population was found to be fragmented by hydroelectric dams (Thuemler, 1997). Knights et al. (2001) also found that dams appeared to be intermittent barriers to upstream passage, since upstream passage events were fewer than downstream events. However, tagged fish did move both downstream and upstream of upper Mississippi River navigation dams. Haxton and Findlay (2008) reported that relative abundance of lake sturgeon was greater in un-impounded than impounded reaches in the Ottawa River, and that hydroelectric production appears to the primary factor affecting lake sturgeon in Ontario rivers (Haxton et al., 2014; 2015). Higher abundance in an unregulated system like the Namakan River is reflected in the high catch rates observed and the low proportion of tag recaptures since 2006 (n = 18 recaptures or 4.2%).

Duration and speed of travel were also evaluated for fish that moved in excess of 10 km and were detected at a minimum of 4 receiver locations. Both upstream and downstream movements over these distances occurred quickly over short durations ranging from 1.2 to 13.3 days. Mean travel speed for these extensive movements was 3.4 km/day, with a maximum of 9.9 km/day. Hatin et al. (2002) also used acoustic telemetry to determine that Atlantic sturgeon in the St. Lawrence River travelled a mean distance of 13.7 km/day with a mean speed of 1.6 km/hour. Adams et al. (2006) found a maximum movement rate for lake sturgeon of 0.80 km/day and a minimum movement rate of 0.17 km/day on Rainy Lake, while Knights et al. (2002) found a mean spring movement rate of 0.50 km/day on the Upper Mississippi River. Similarly, Rusak and Mosindy (1997) found the highest movement rates occurred in spring (0.84 km/day) and summer (0.76 km/day), with the lowest rate during the winter (0.11 km/day). Adult lake sturgeon larger than 900 mm displayed longer median daily linear movements and occupied larger home ranges than did juveniles smaller than 900 mm in Black Lake, MI (Smith and King, 2005).

In summary, documented movement patterns have revealed the extent to which lake sturgeon use the Namakan River. There is clear evidence that the rapids and falls between the Namakan Reservoir and Snake Falls do not currently present barriers to migration of lake sturgeon within the Namakan River system (Welsh, 2008; Welsh and McLeod, 2010). Together with direct visual observations of spawning events (Lac La Croix First Nation Traditional Ecological Knowledge, Bio Consulting 2009, MNRF, Lakehead University), aggregations of lake sturgeon at specific locations, and extensive upstream movements when water temperatures are suitable for spawning, strongly suggest the presence of spawning habitats throughout the river. Some adult lake sturgeon also chose to over-winter in the lake environments of Little Eva Lake, Bill Lake and Three Mile Lake.

This knowledge of movements and activity patterns is important to help identify and protect critical habitats for the continued sustainability of lake sturgeon in the Namakan River. Although there were minor gaps in the spatial coverage of fixed receivers, acoustic telemetry has increased our knowledge and will help to evaluate potential impacts of hydroelectric development. This study confirmed that lake sturgeon travel, spawn and feed throughout this system. These fish also share similar movement patterns and habitat use with other riverine populations in North America. At minimum, future water management decisions should account for and mitigate any impacts to migration, spawning, foraging and over-wintering of lake sturgeon in the Namakan River.

Lake sturgeon also inhabit and make extensive use of both the Namakan River and Namakan Reservoir, and truly represent a shared, international fish stock. Based on movements of lake sturgeon between Ontario and Minnesota waters, it is recommended that lake sturgeon management efforts continue to involve affected First nation communities, industry as well as provincial, state, and federal agencies.

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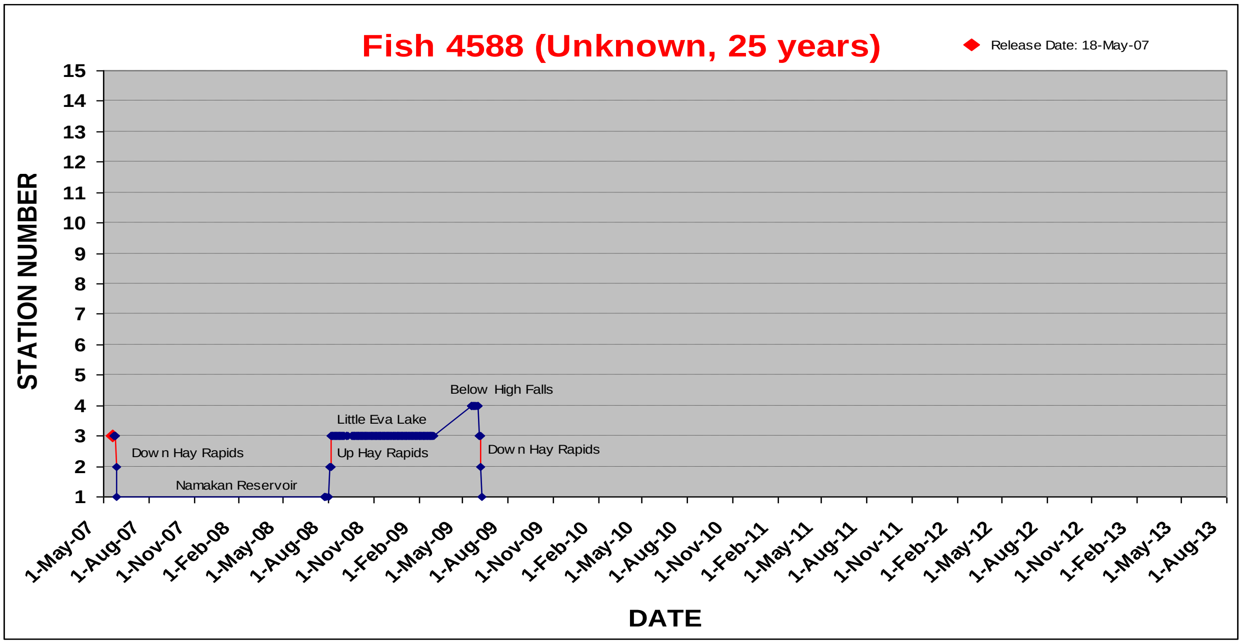
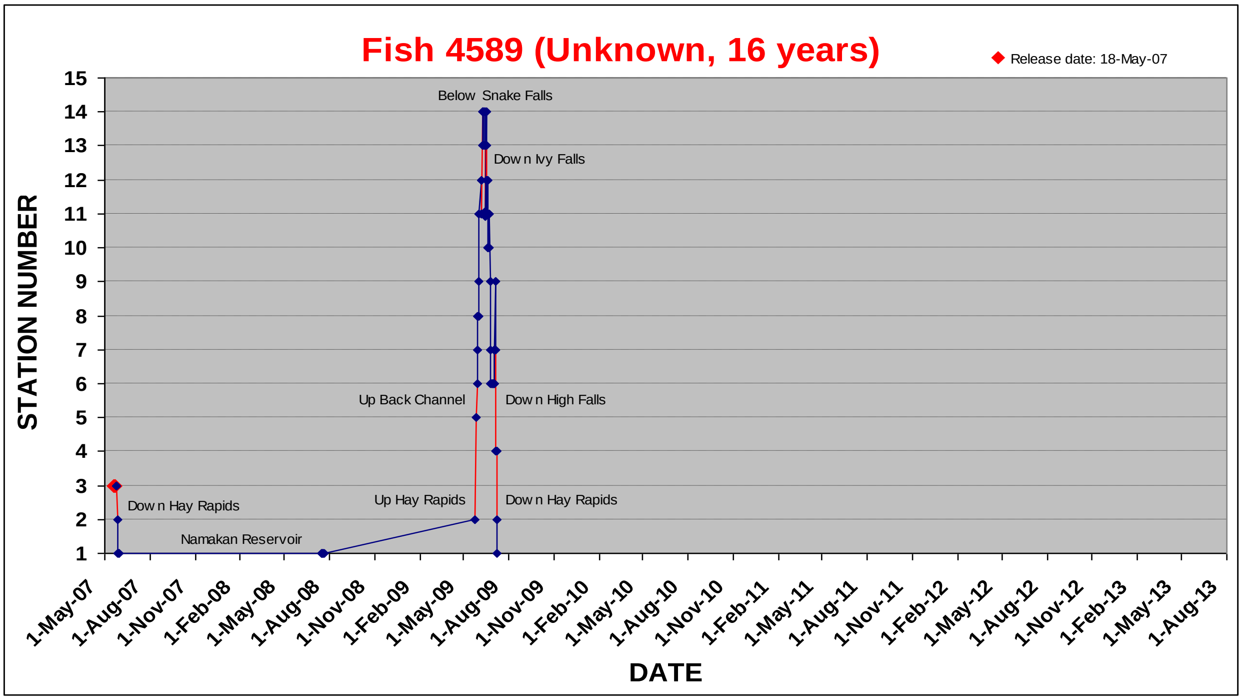
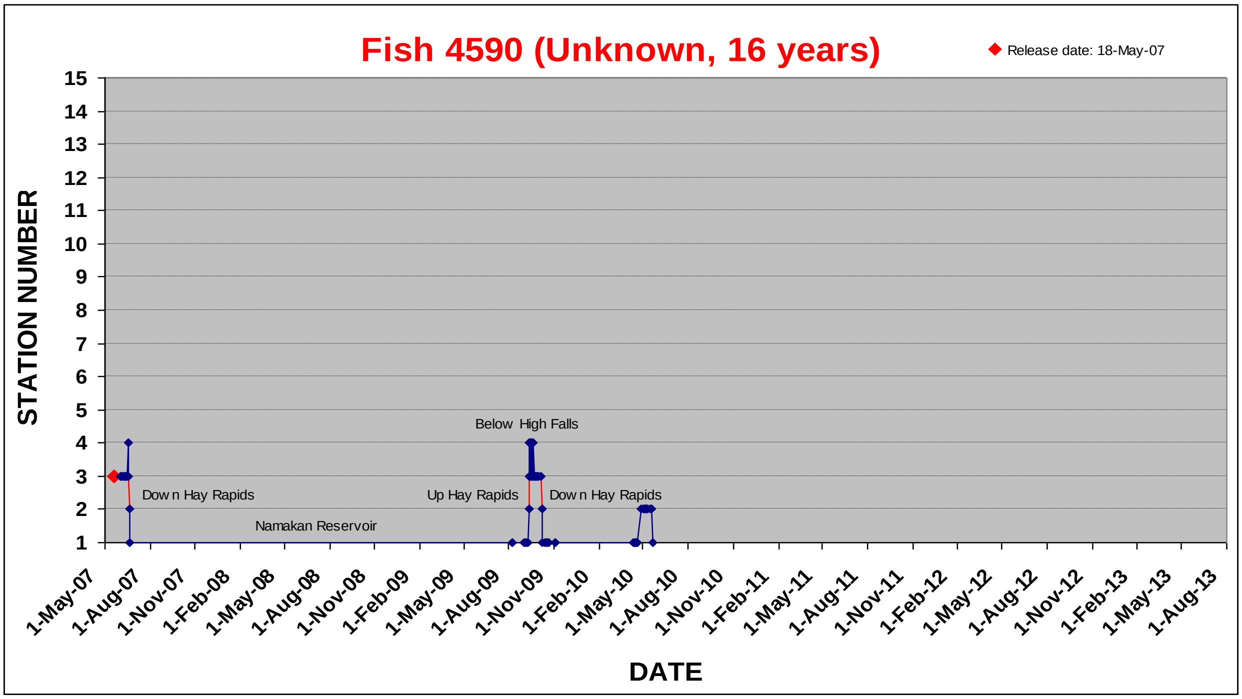
APPENDICES

Station #	Location Name
15	Above Snake Falls
14	Below Snake Falls
13	Above Ivy Falls
12	Below Myrtle Falls
11	Below Ivy/Myrtle Falls (Three Mile Lake)
10	Bearpelt Creek
9	Below Twisted Rapids
8	Quetico River
7	Above Quetico Rapids
6	Above Back Channel (Bill Lake)
5	Lower Back Channel
4	Below High Falls
3	Above Hay Rapids (Little Eva Lake)
2	Below Hay Rapids
1	Below Lady Rapids (Namakan Lake)

Appendix I: Movement of individual lake sturgeon released in 2007 within the Namakan River, Ontario. (Red line segments represent movement through proposed development sites)







Fish 4590 (Unknown, 16 years)
Release date: 18-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below High Falls
Dow n Hay Rapids
Up Hay Rapids
Dow n Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
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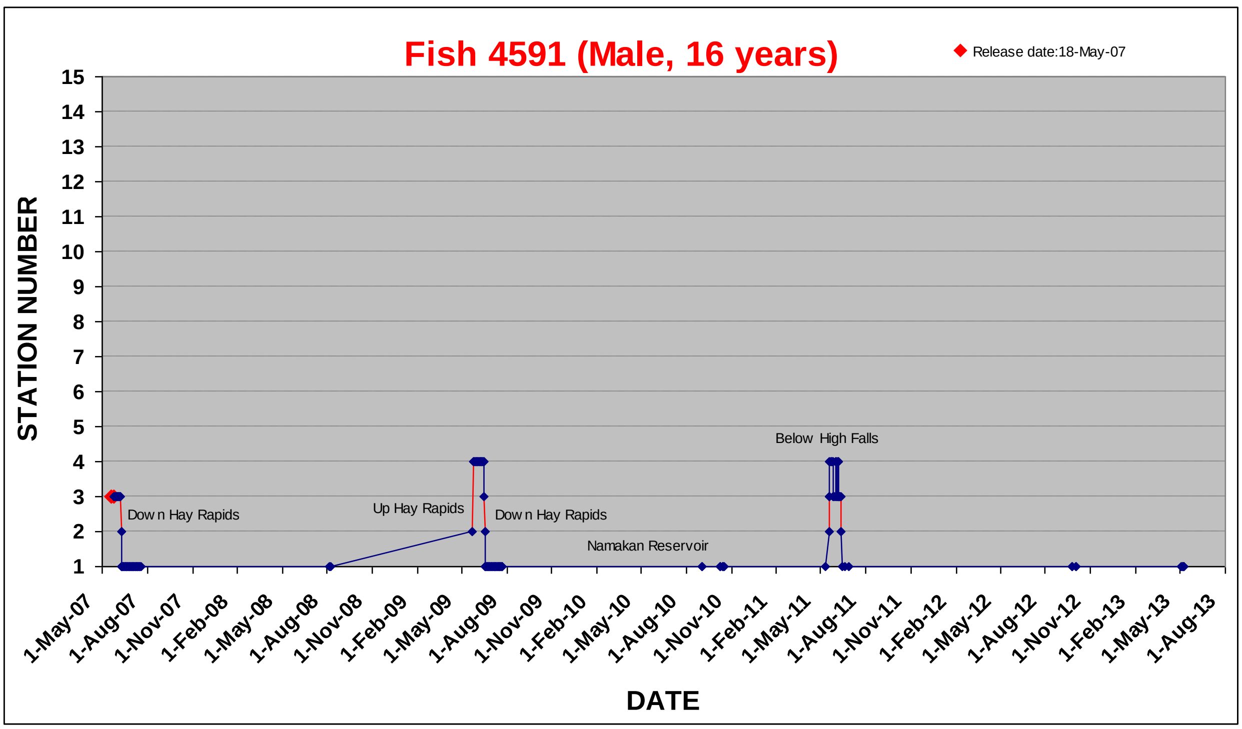
1-May-13
1-Aug-13
DATE



Fish 4591 (Male, 16 years)
Release date:18-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below High Falls
Up Hay Rapids
Dow n Hay Rapids
Dow n Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
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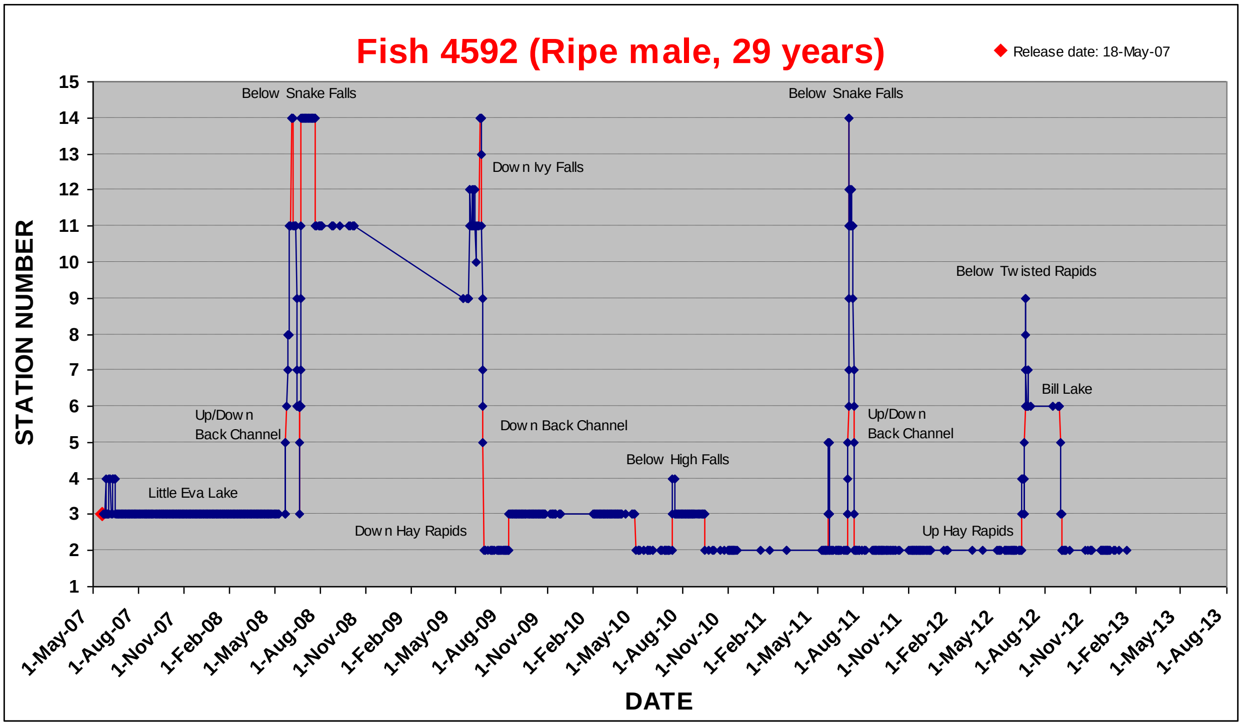
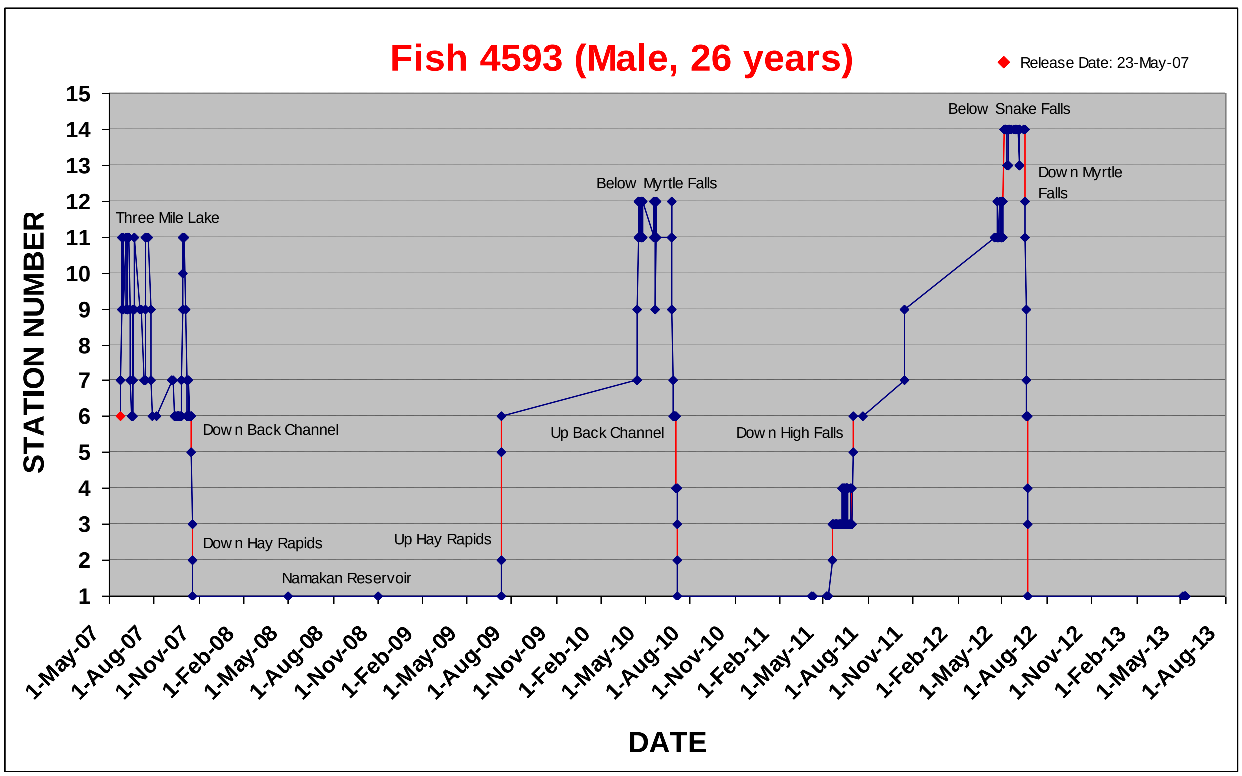
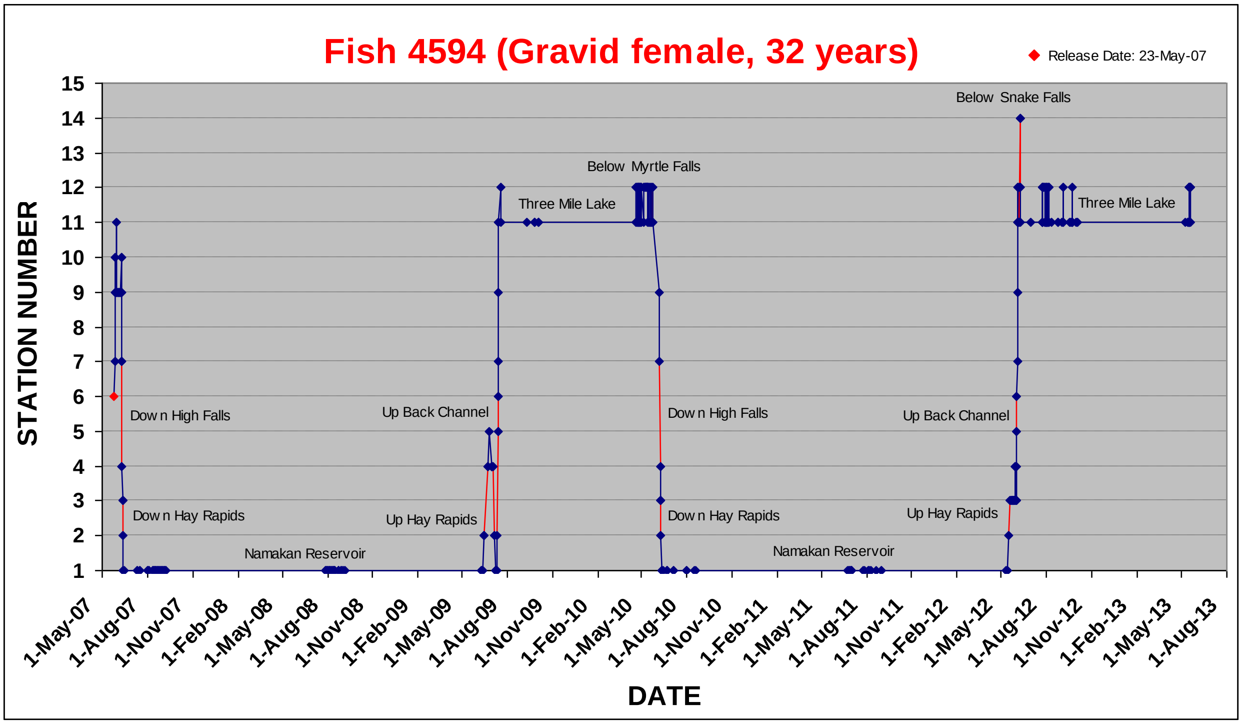
1-May-13
1-Aug-13
DATE

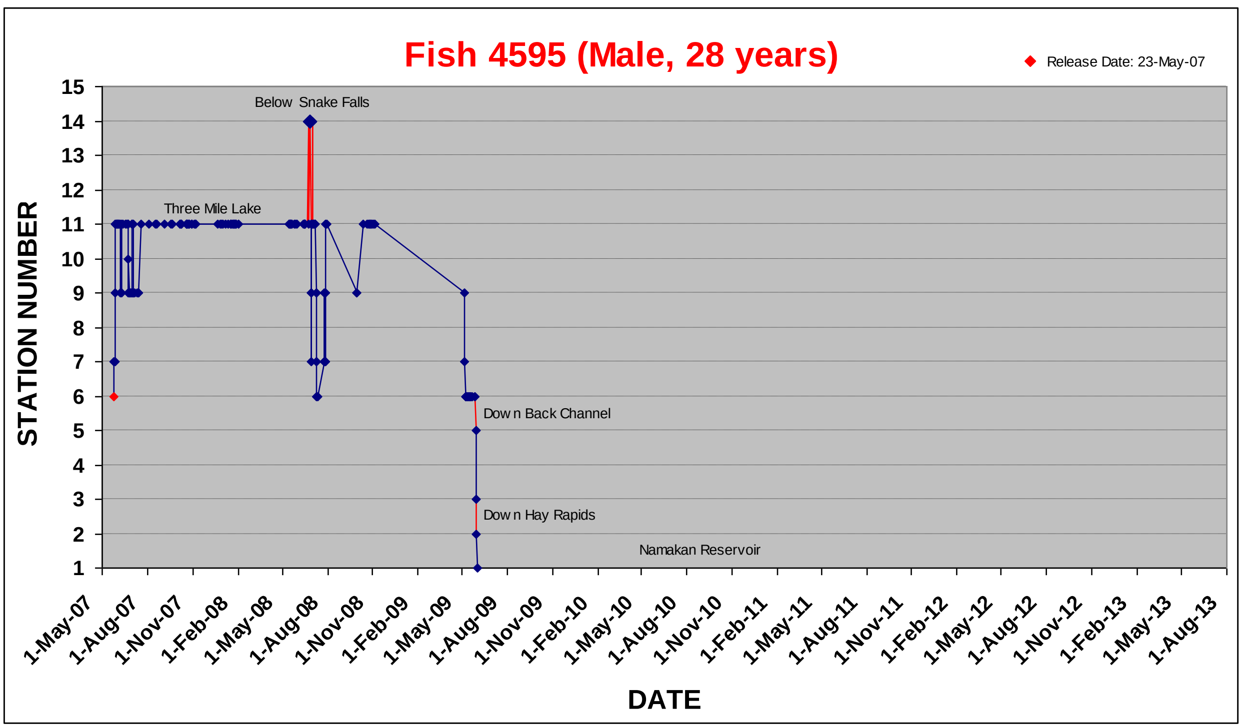


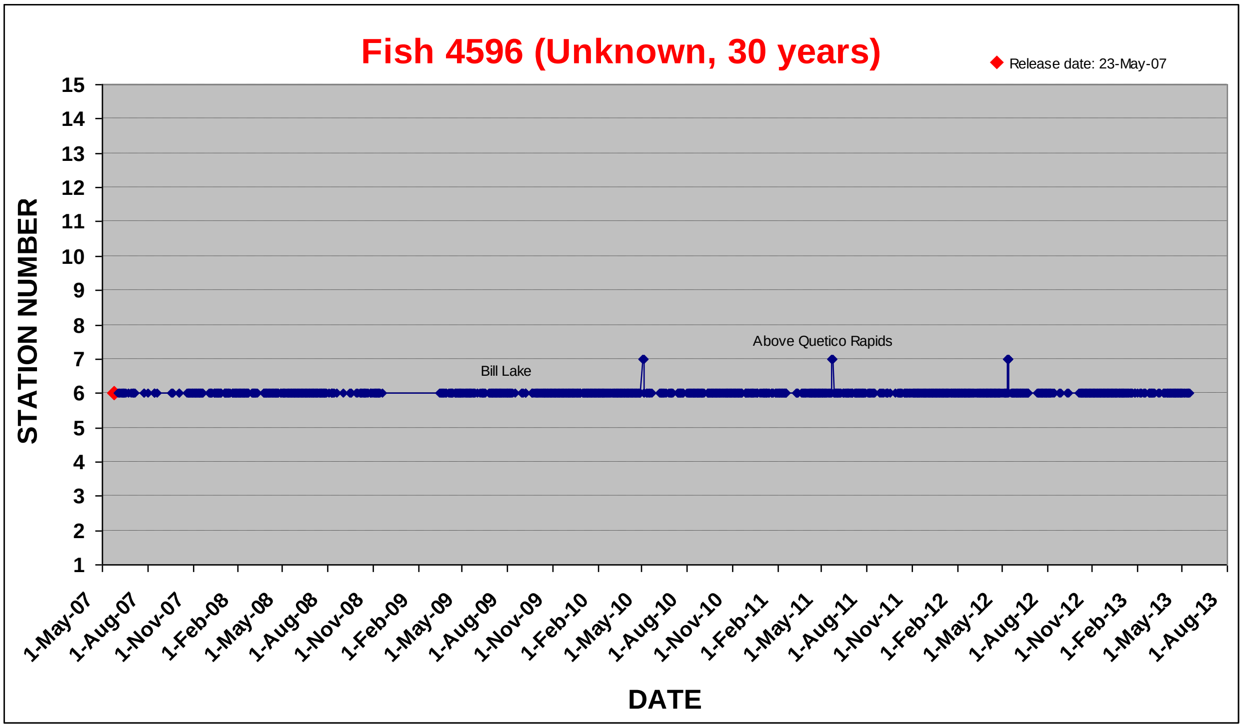
Fish 4592 (Ripe male, 29 years)
Release date: 18-May-07
STATION NUMBER
DATE
Below Snake Falls
Below Snake Falls
Down Ivy Falls
Below Twisted Rapids
Bill Lake
Up/Down Back Channel
Down Back Channel
Up/Down Back Channel
Below High Falls
Little Eva Lake
Down Hay Rapids
Up Hay Rapids

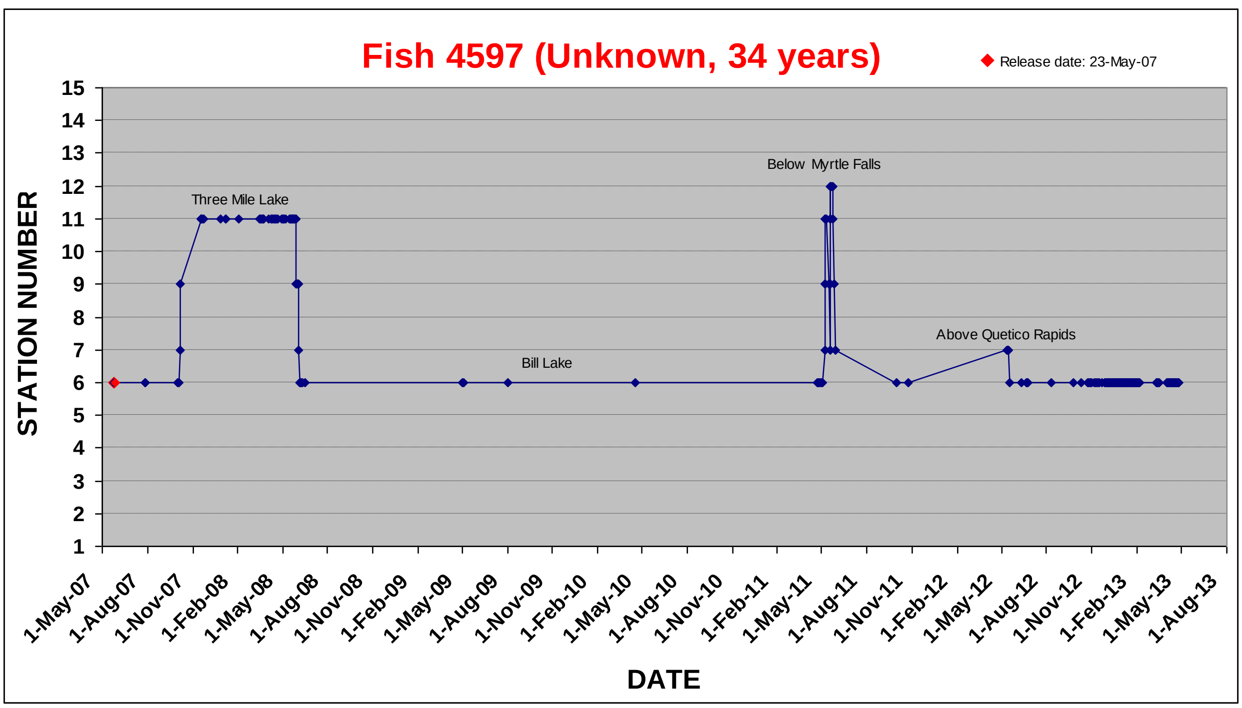


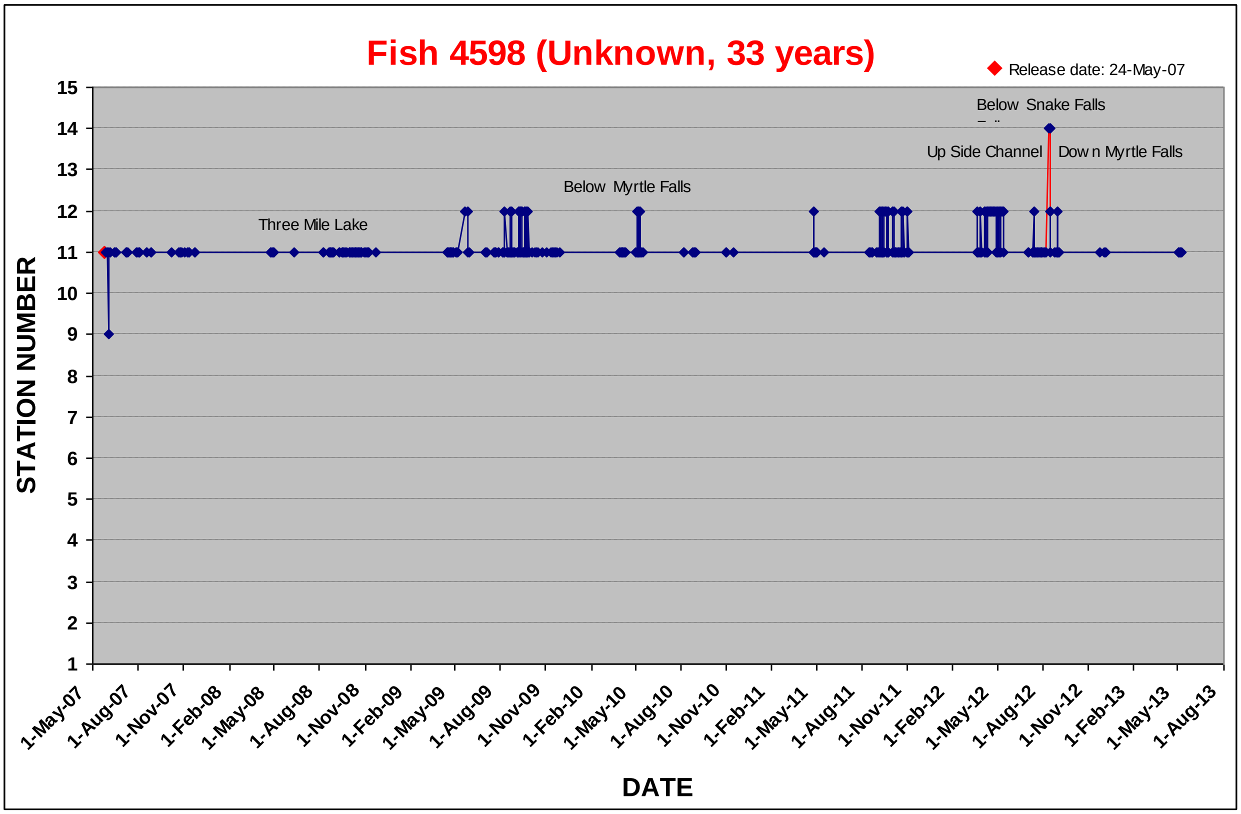
Fish 4593 (Male, 26 years)
Release Date: 23-May-07
STATION NUMBER
DATE
Below Snake Falls
Down Myrtle Falls
Below Myrtle Falls
Three Mile Lake
Down Back Channel
Up Back Channel
Down High Falls
Down Hay Rapids
Up Hay Rapids
Namakan Reservoir


Fish 4594 (Gravid female, 32 years)
Release Date: 23-May-07
STATION NUMBER
DATE
Below Snake Falls
Below Myrtle Falls
Three Mile Lake
Three Mile Lake
Down High Falls
Up Back Channel
Down High Falls
Up Back Channel
Down Hay Rapids
Up Hay Rapids
Down Hay Rapids
Up Hay Rapids
Namakan Reservoir
Namakan Reservoir

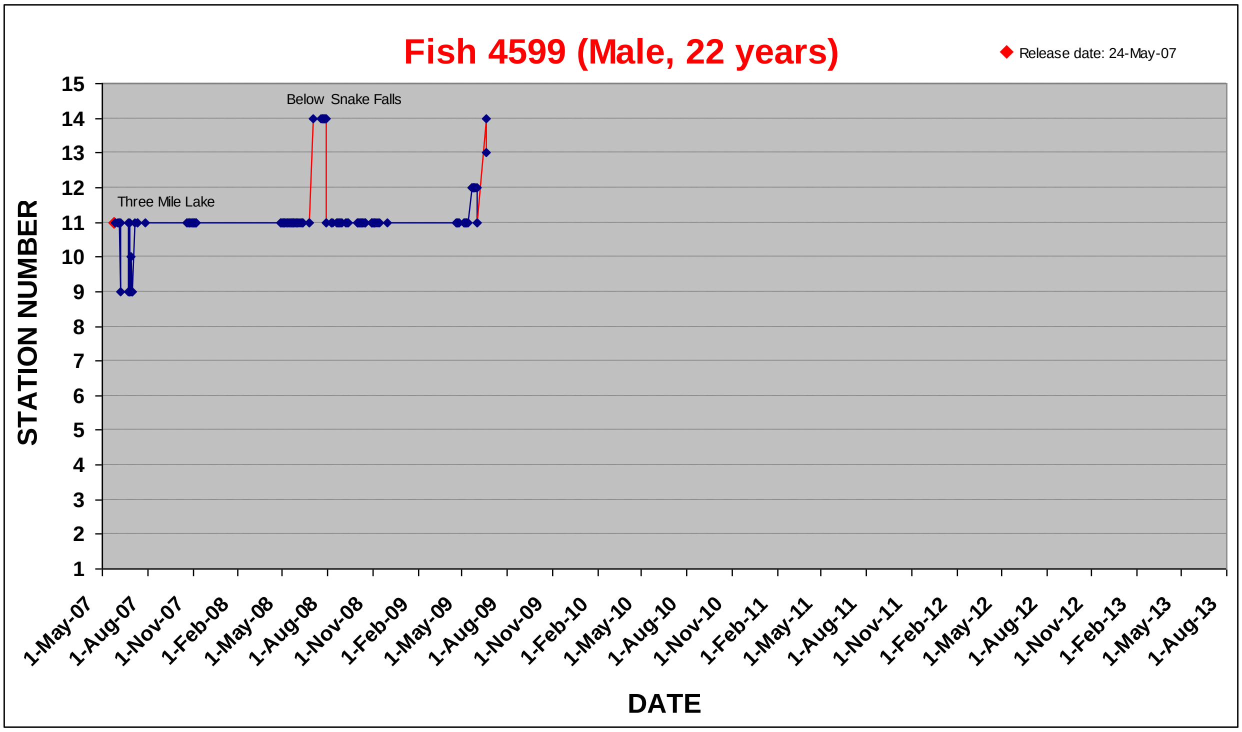

Fish 4595 (Male, 28 years)
Release Date: 23-May-07
STATION NUMBER
DATE
Below Snake Falls
Three Mile Lake
Down Back Channel
Down Hay Rapids
Namakan Reservoir


Fish 4596 (Unknown, 30 years)
Release date: 23-May-07
STATION NUMBER
DATE
Bill Lake
Above Quetico Rapids
1-May-07 1-Aug-07 1-Nov-07 1-Feb-08 1-May-08 1-Aug-08 1-Nov-08 1-Feb-09 1-May-09 1-Aug-09 1-Nov-09 1-Feb-10 1-May-10 1-Aug-10 1-Nov-10 1-Feb-11 1-May-11 1-Aug-11 1-Nov-11 1-Feb-12 1-May-12 1-Aug-12 1-Nov-12 1-Feb-13 1-May-13 1-Aug-13

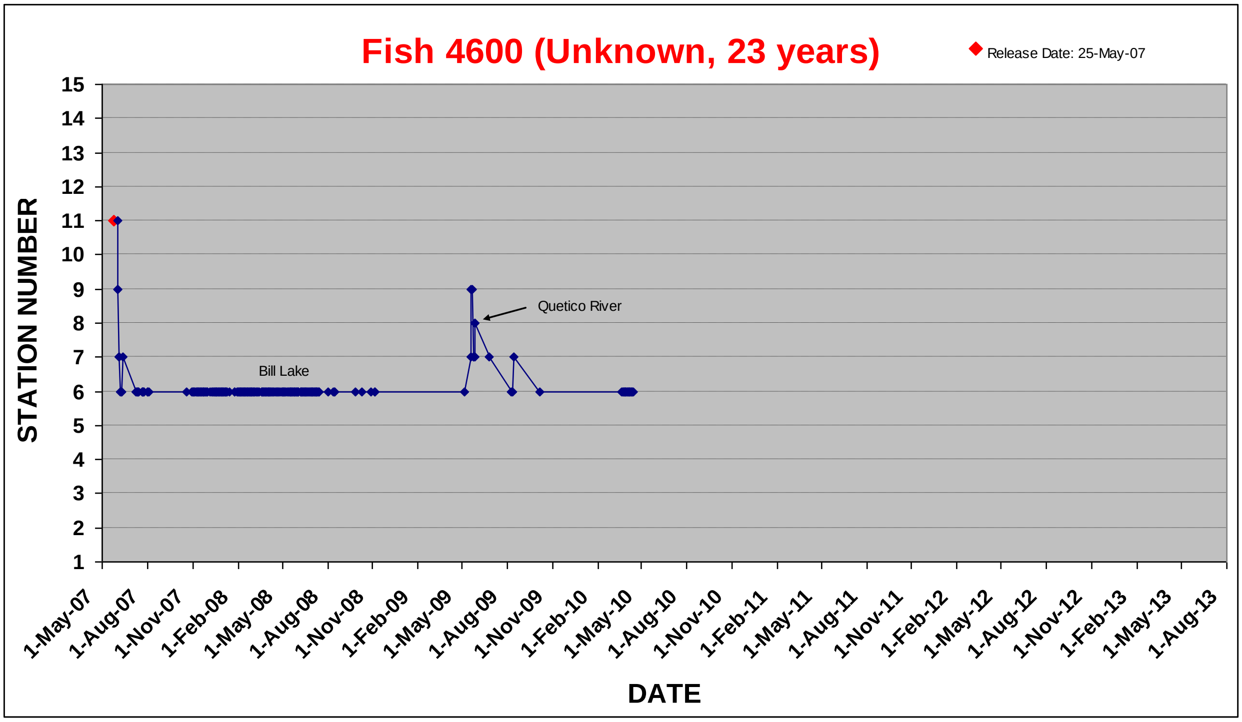

Fish 4597 (Unknown, 34 years)
Release date: 23-May-07
STATION NUMBER
DATE
Three Mile Lake
Below Myrtle Falls
Bill Lake
Above Quetico Rapids
1-May-07 1-Aug-07 1-Nov-07 1-Feb-08 1-May-08 1-Aug-08 1-Nov-08 1-Feb-09 1-May-09 1-Aug-09 1-Nov-09 1-Feb-10 1-May-10 1-Aug-10 1-Nov-10 1-Feb-11 1-May-11 1-Aug-11 1-Nov-11 1-Feb-12 1-May-12 1-Aug-12 1-Nov-12 1-Feb-13 1-May-13 1-Aug-13



Fish 4598 (Unknown, 33 years)
Release date: 24-May-07
STATION NUMBER
DATE
Three Mile Lake
Below Myrtle Falls
Below Snake Falls
Up Side Channel
Dow n Myrtle Falls



Fish 4599 (Male, 22 years)
Release date: 24-May-07
STATION NUMBER
DATE
Three Mile Lake
Below Snake Falls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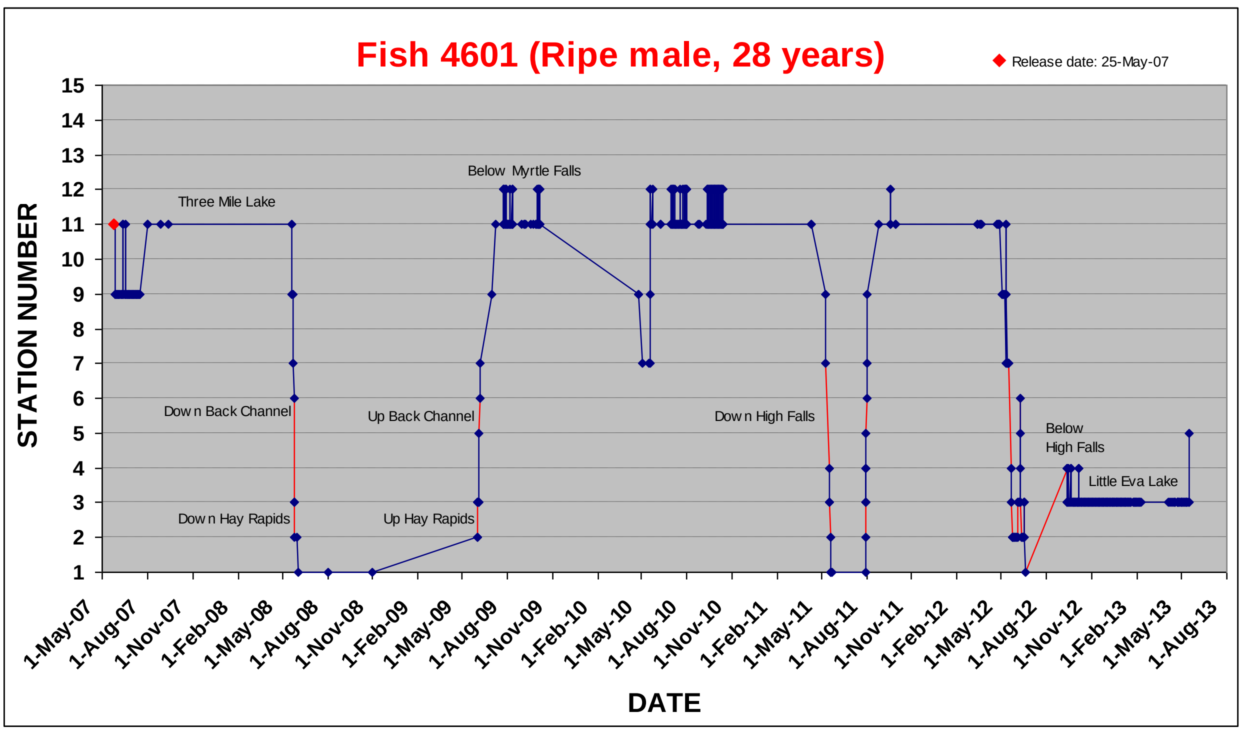
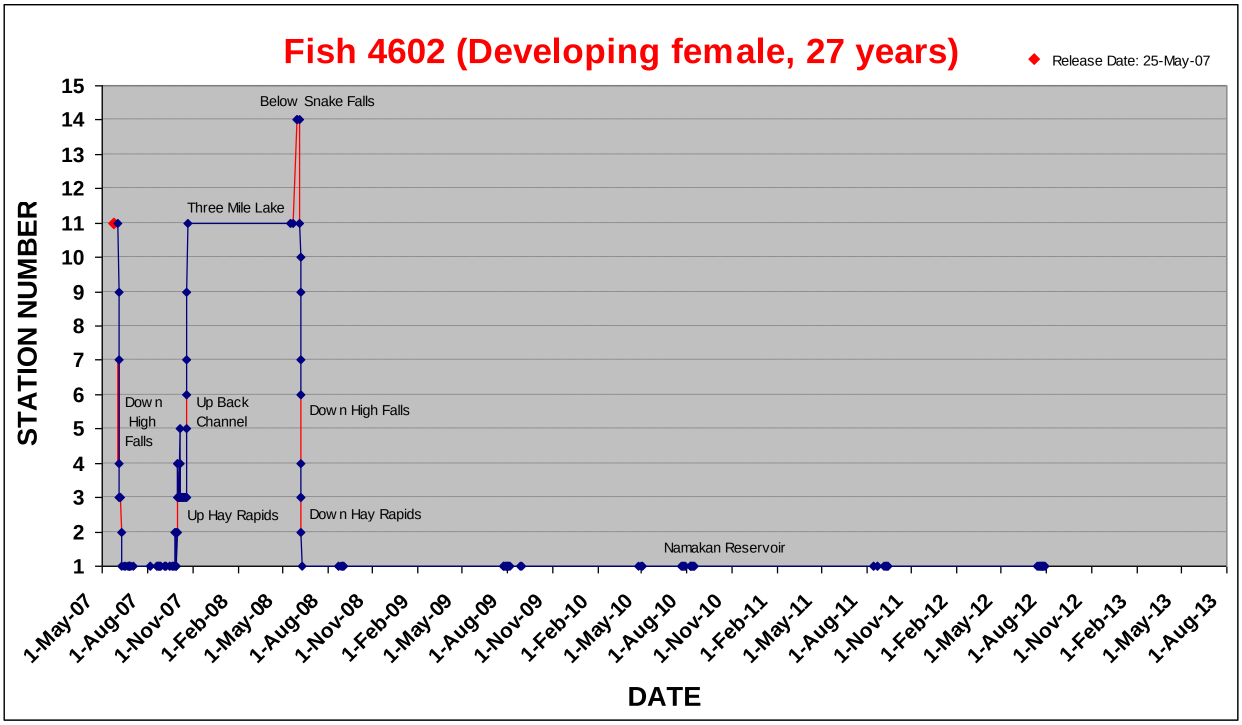
Release Date: 25-May-07
STATION NUMBER
Bill Lake
Quetico River
DATE


Fish 4601 (Ripe male, 28 years)
Release date: 25-May-07
STATION NUMBER
Three Mile Lake
Below Myrtle Falls
Down Back Channel
Up Back Channel
Down High Falls
Down Hay Rapids
Up Hay Rapids
Below High Falls
Little Eva Lake
DATE


Fish 4602 (Developing female, 27 years)
Release Date: 25-May-07
STATION NUMBER
DATE
Below Snake Falls
Three Mile Lake
Down High Falls
Up Back Channel
Down High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
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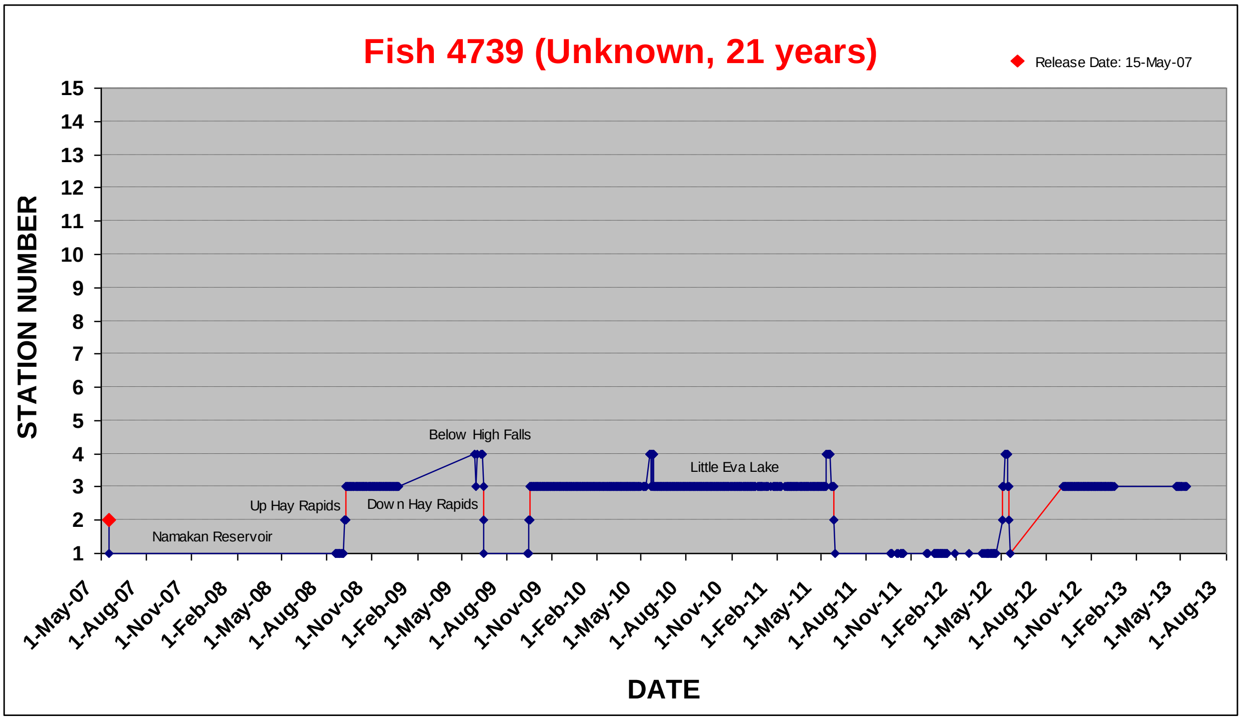
1-May-13
1-Aug-13


Fish 4739 (Unknown, 21 years)
Release Date: 15-May-07
STATION NUMBER
DATE
Below High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
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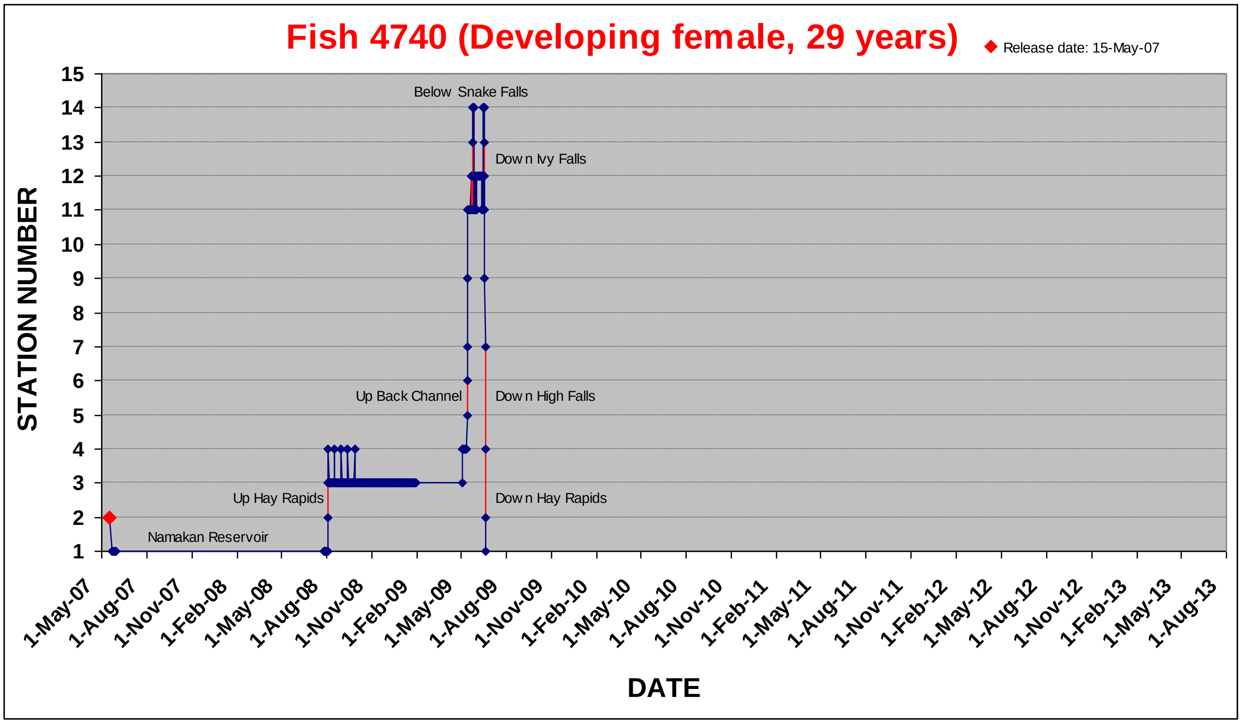
Fish 4740 (Developing female, 29 years)
Release date: 15-May-07
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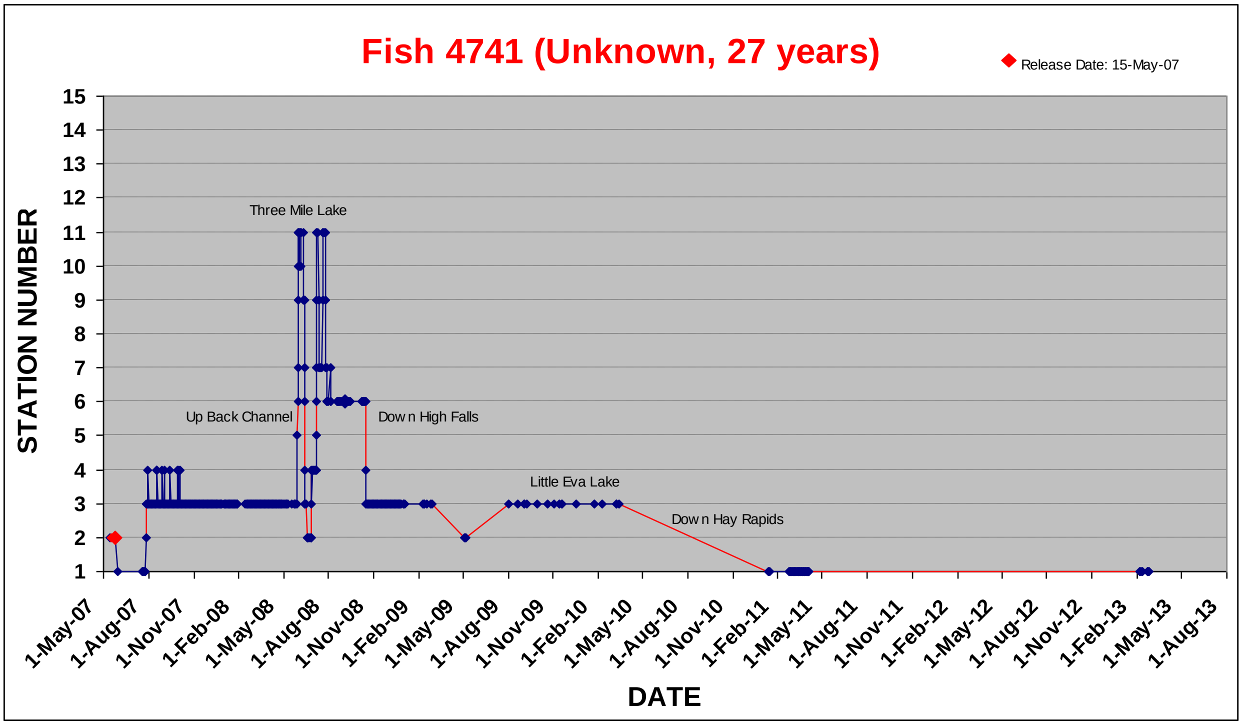
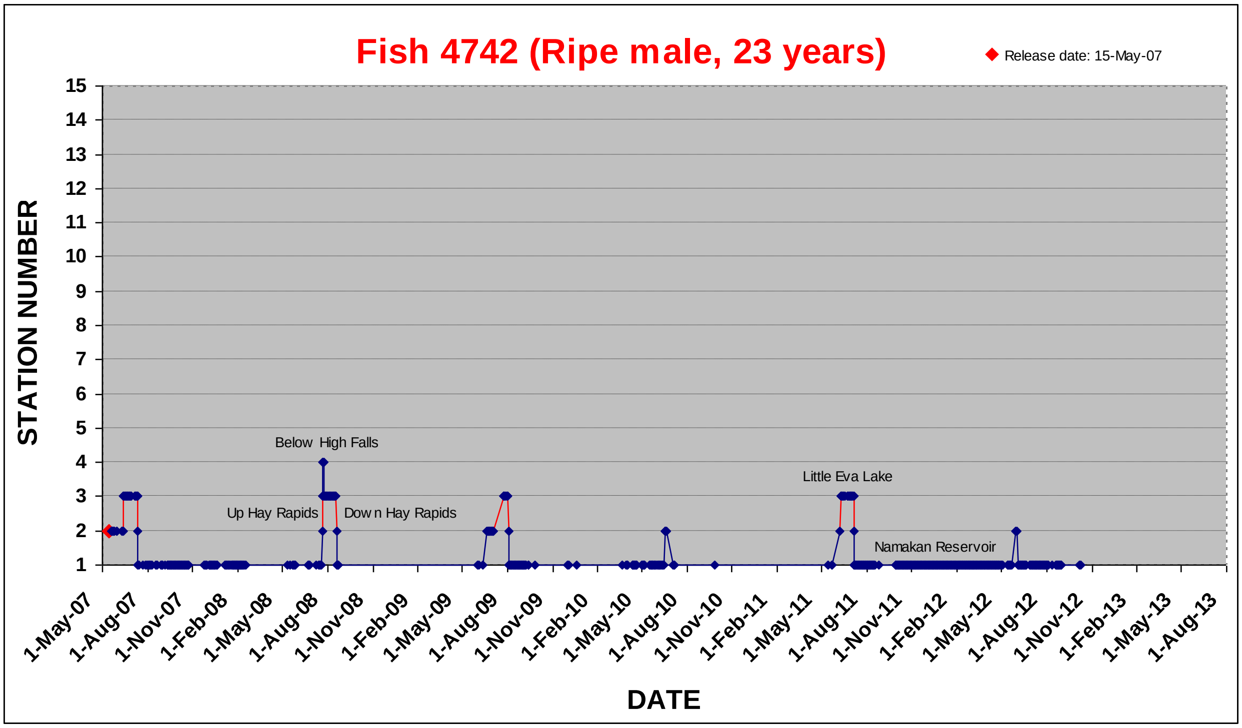
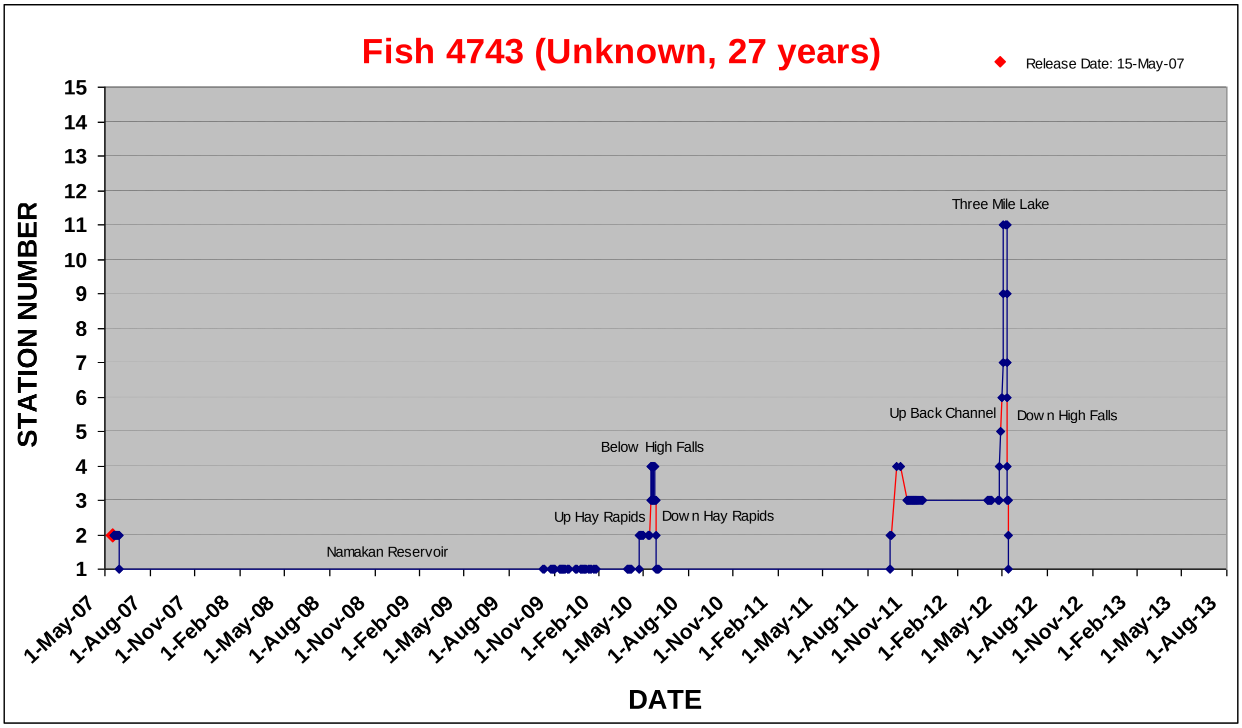
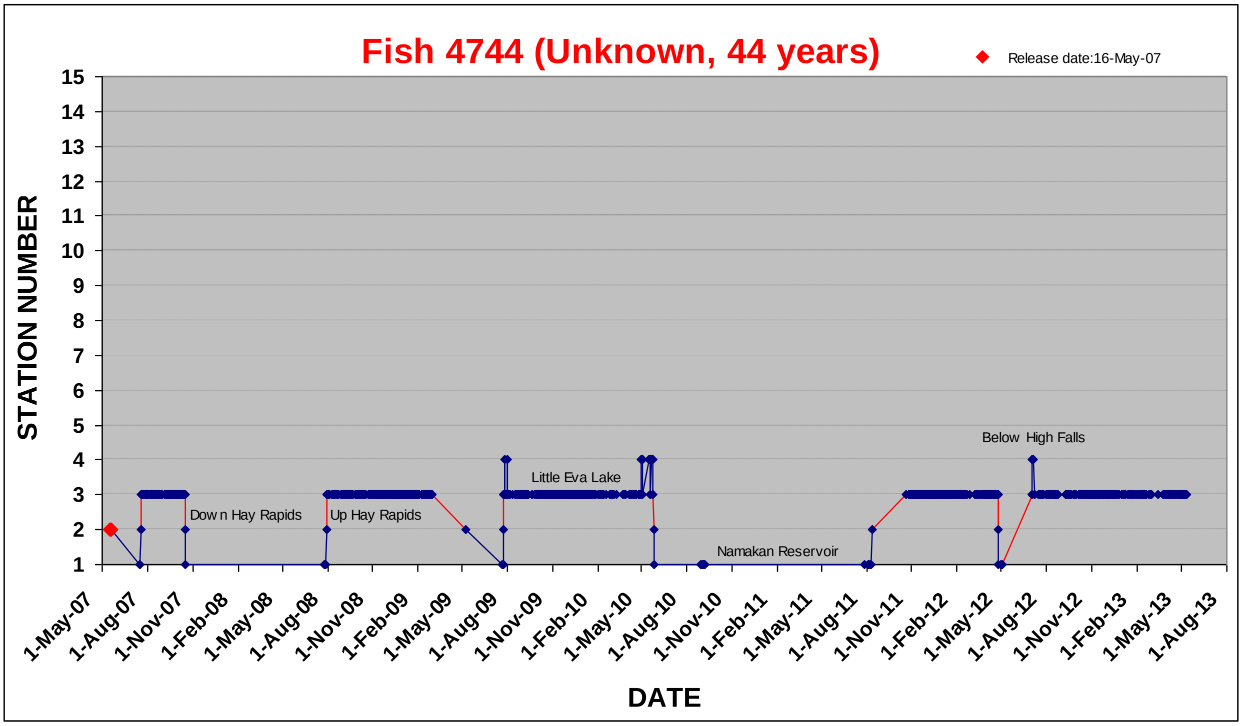
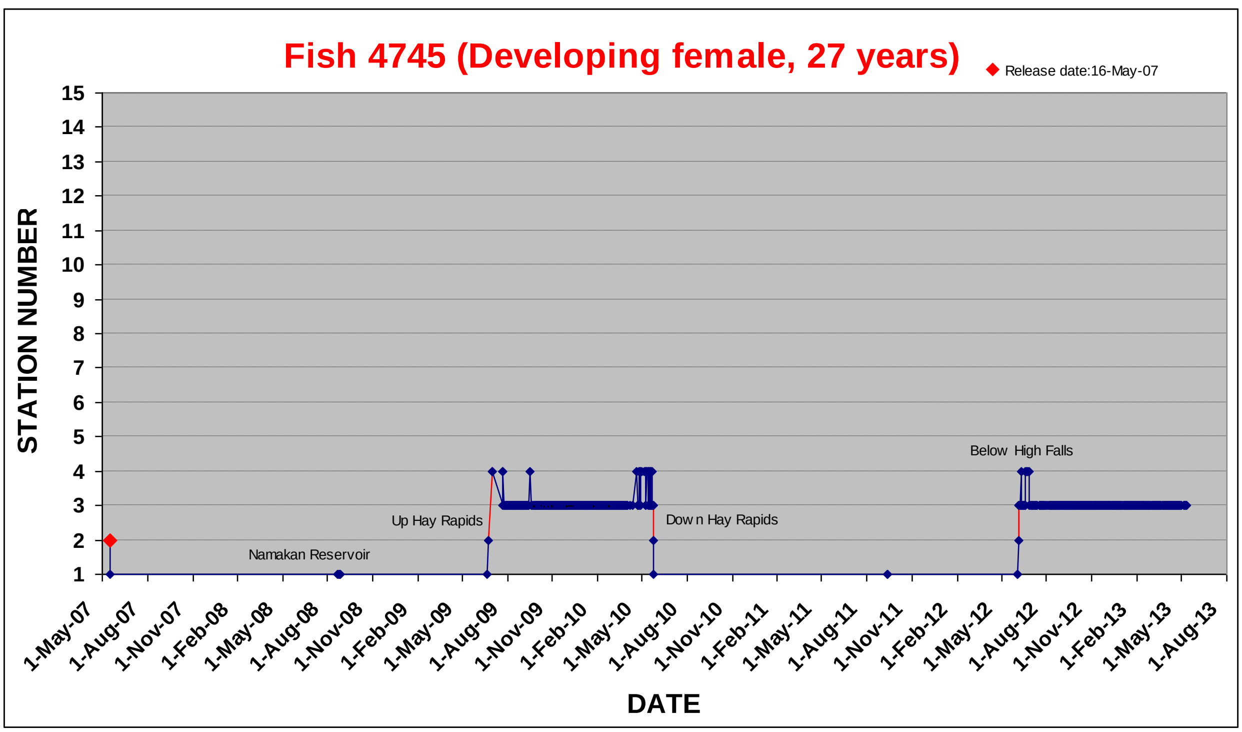
Below Snake Falls
Down Ivy Falls
Up Back Channel
Down High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir

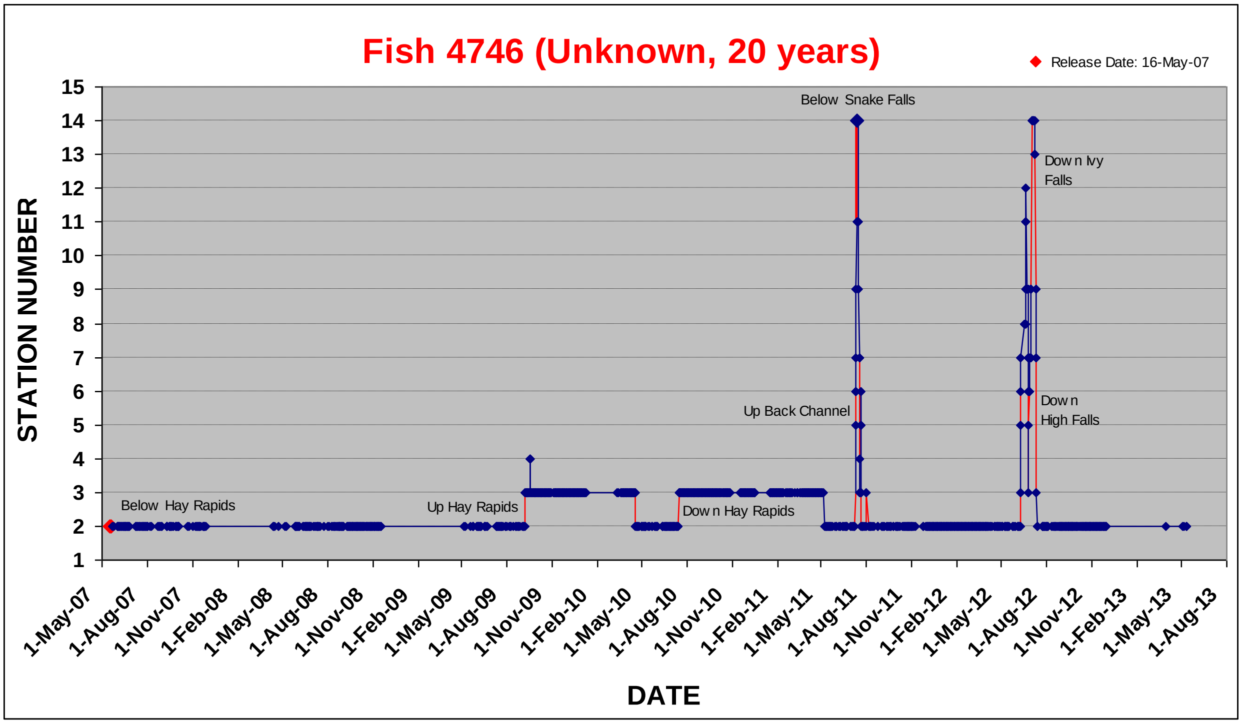

Fish 4741 (Unknown, 27 years)
Release Date: 15-May-07
STATION NUMBER
DATE
Three Mile Lake
Up Back Channel
Down High Falls
Little Eva Lake
Down Hay Rapids

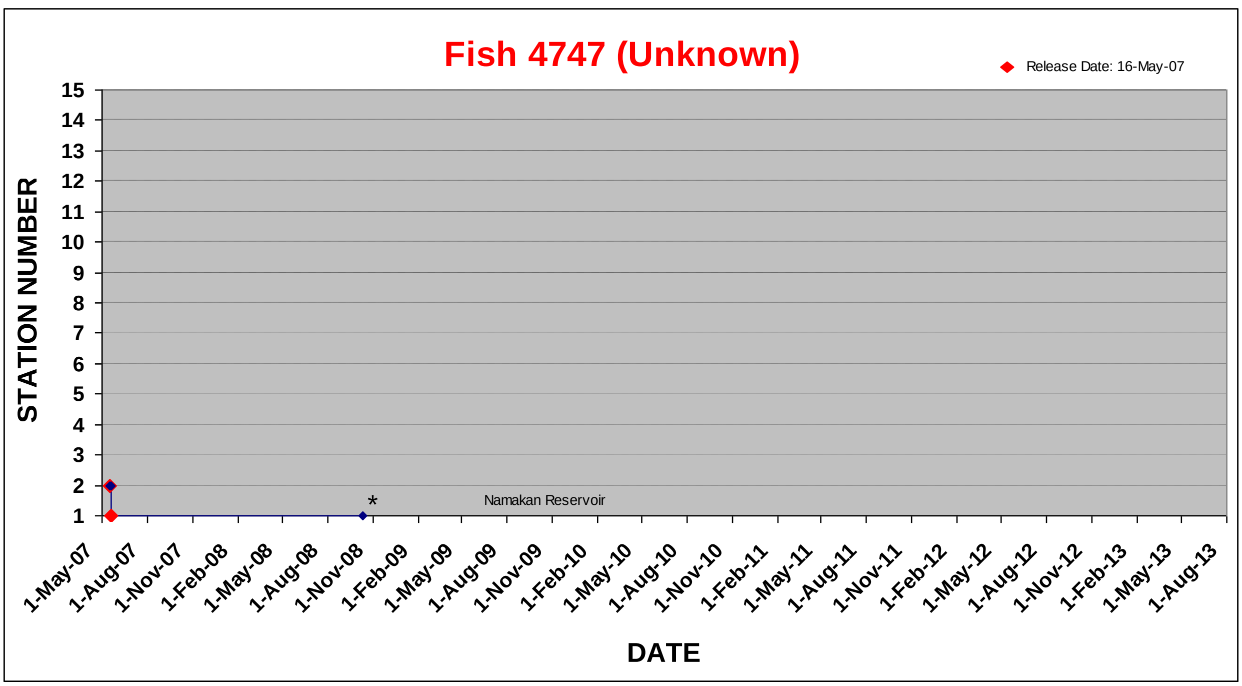

Fish 4742 (Ripe male, 23 years)
Release date: 15-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below High Falls
Up Hay Rapids
Down Hay Rapids
Little Eva Lake
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE


Fish 4743 (Unknown, 27 years)
Release Date: 15-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Three Mile Lake
Up Back Channel
Down High Falls
Below High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

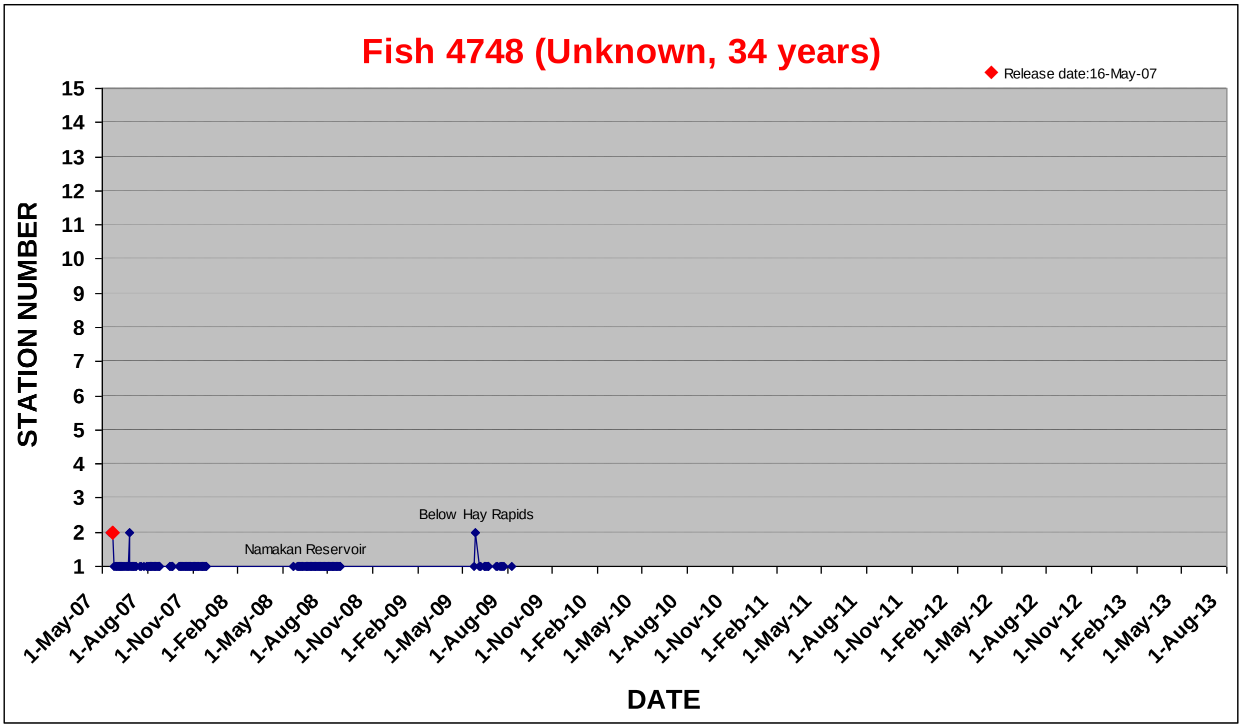

Fish 4744 (Unknown, 44 years)
Release date:16-May-07
STATION NUMBER
Down Hay Rapids
Up Hay Rapids
Little Eva Lake
Namakan Reservoir
Below High Falls
DATE

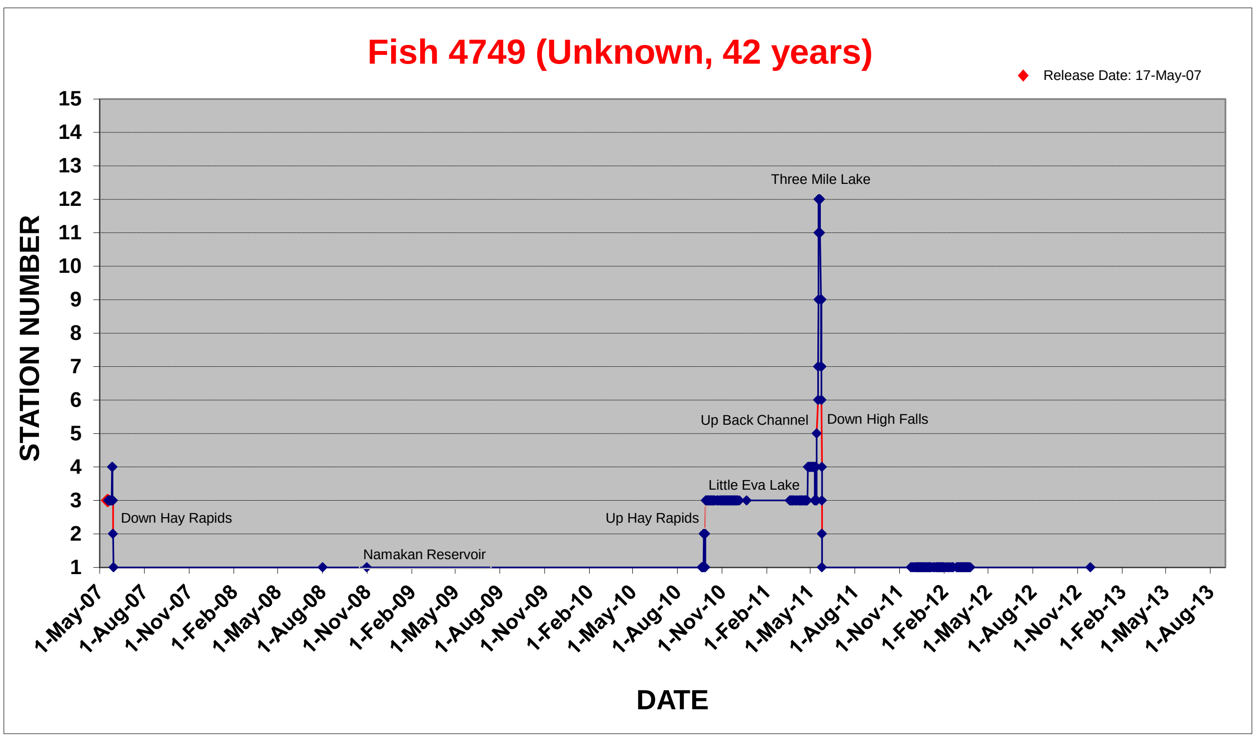

Fish 4745 (Developing female, 27 years)
Release date:16-May-07
STATION NUMBER
Namakan Reservoir
Up Hay Rapids
Down Hay Rapids
Below High Falls
DATE

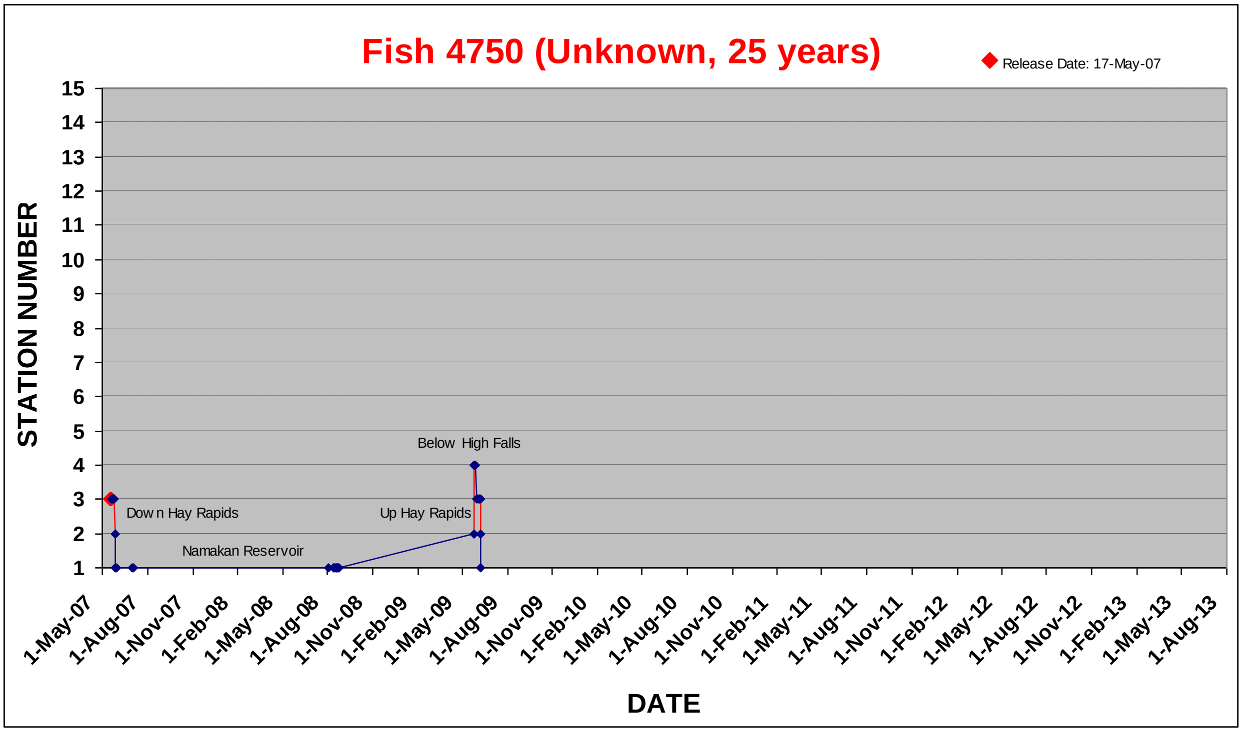


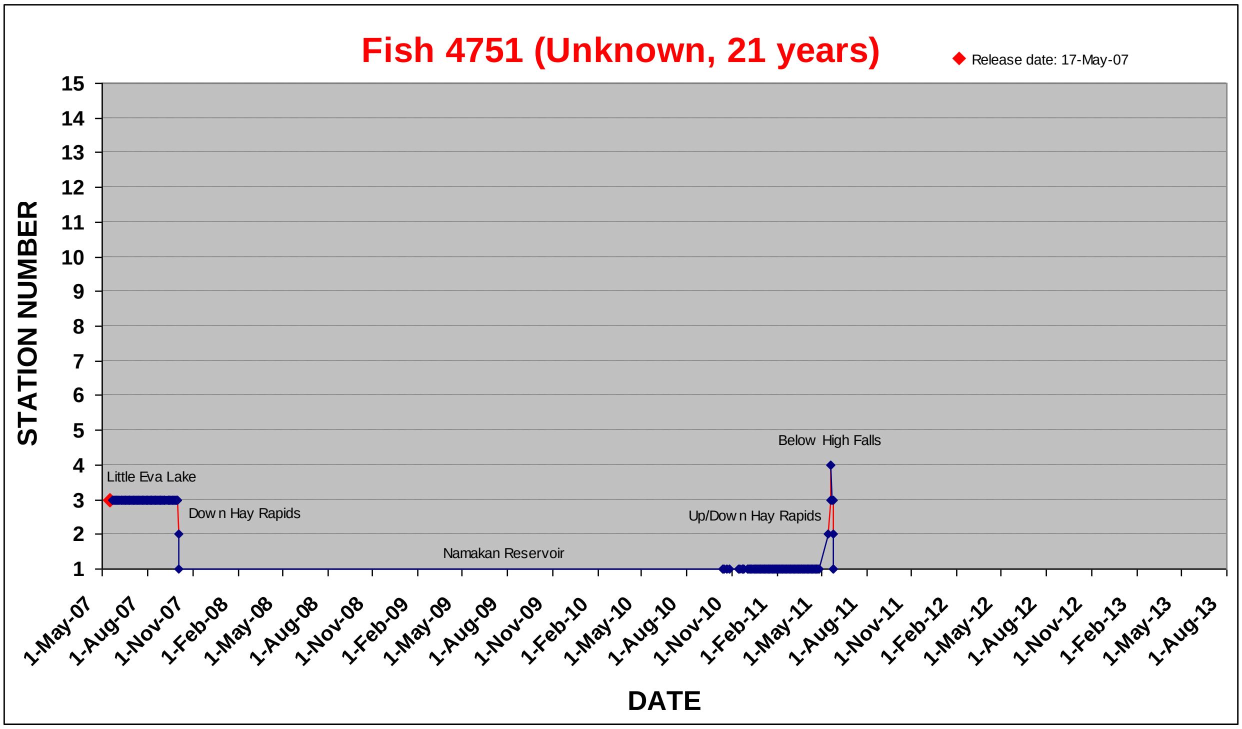


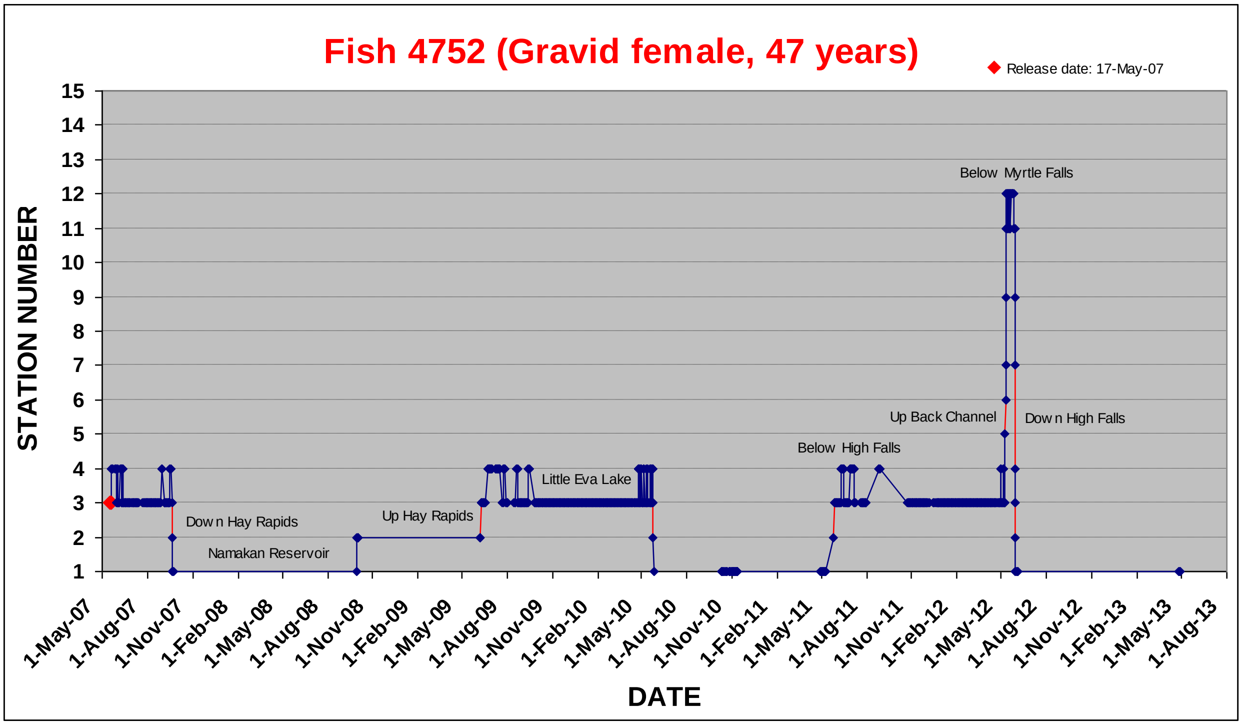
* Detected in Namakan Reservoir by the U.S. Namakan Reservoir receiver array.

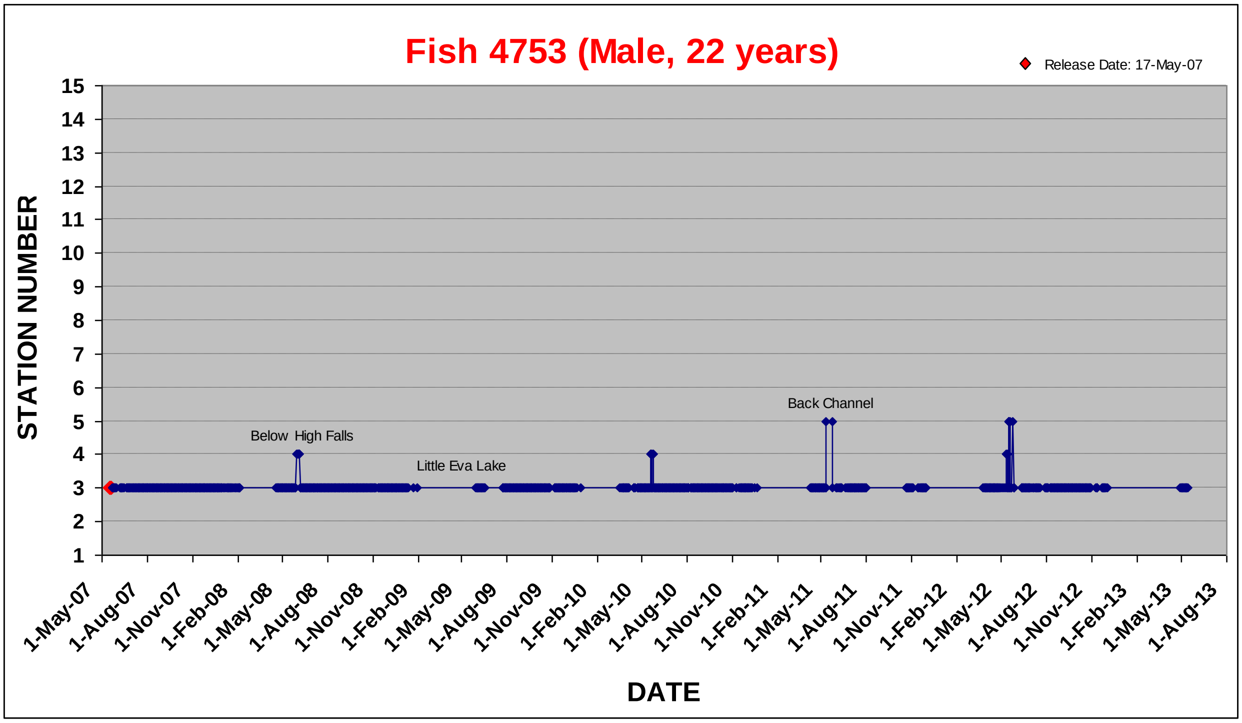

Fish 4748 (Unknown, 34 years)
Release date:16-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE


Fish 4749 (Unknown, 42 years)
Release Date: 17-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Three Mile Lake
Up Back Channel
Down High Falls
Little Eva Lake
Down Hay Rapids
Up Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

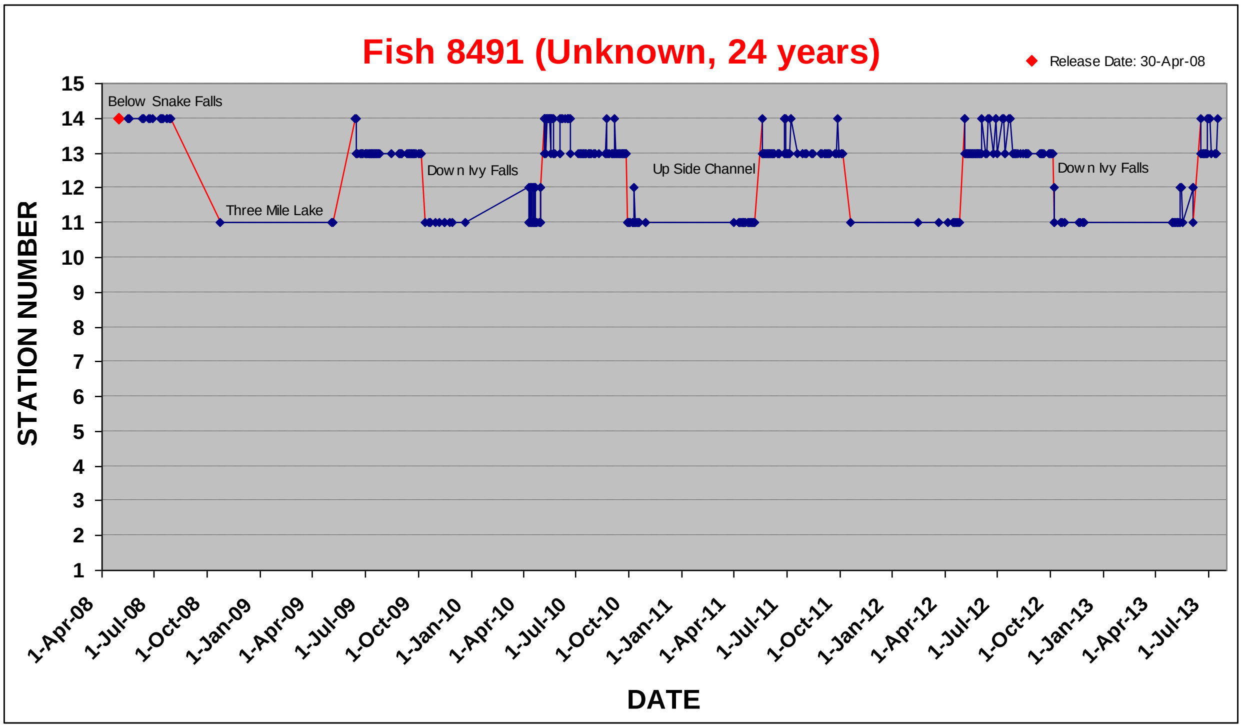

Fish 4750 (Unknown, 25 years)
Release Date: 17-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below High Falls
Dow n Hay Rapids
Up Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

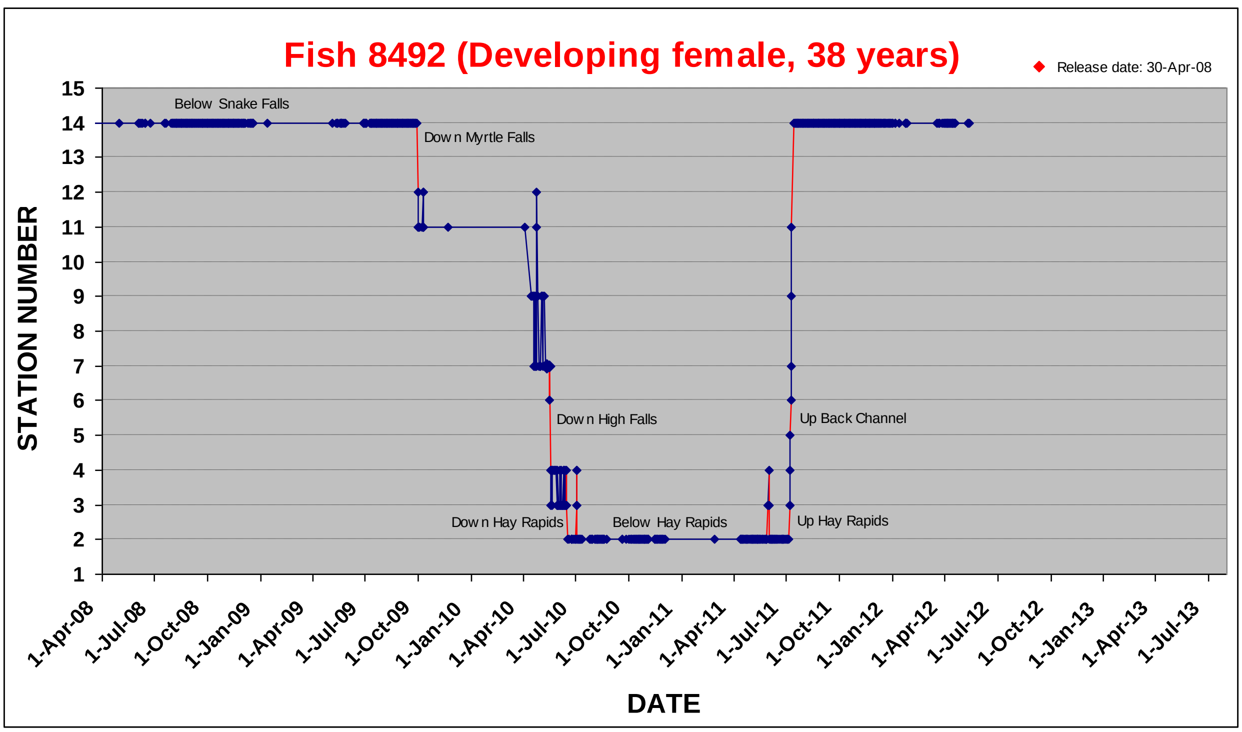

Fish 4751 (Unknown, 21 years)
Release date: 17-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below High Falls
Little Eva Lake
Dow n Hay Rapids
Up/Dow n Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

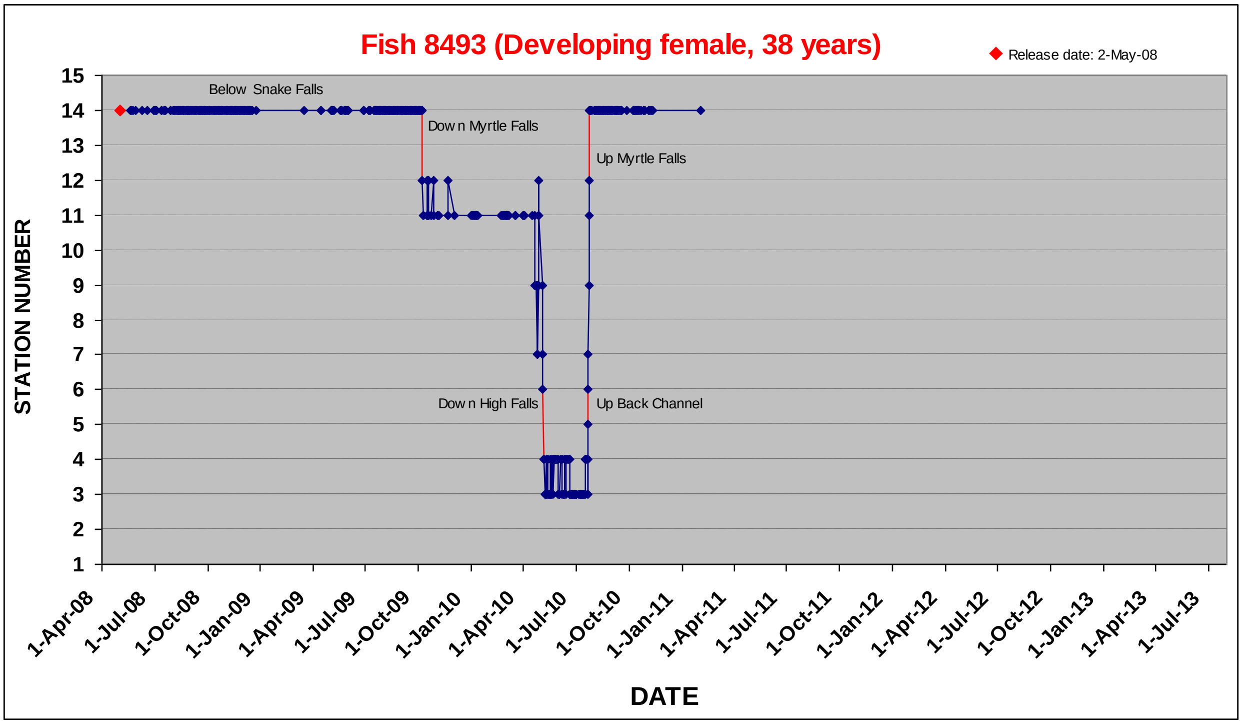

Fish 4752 (Gravid female, 47 years)
Release date: 17-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below Myrtle Falls
Up Back Channel
Down High Falls
Below High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

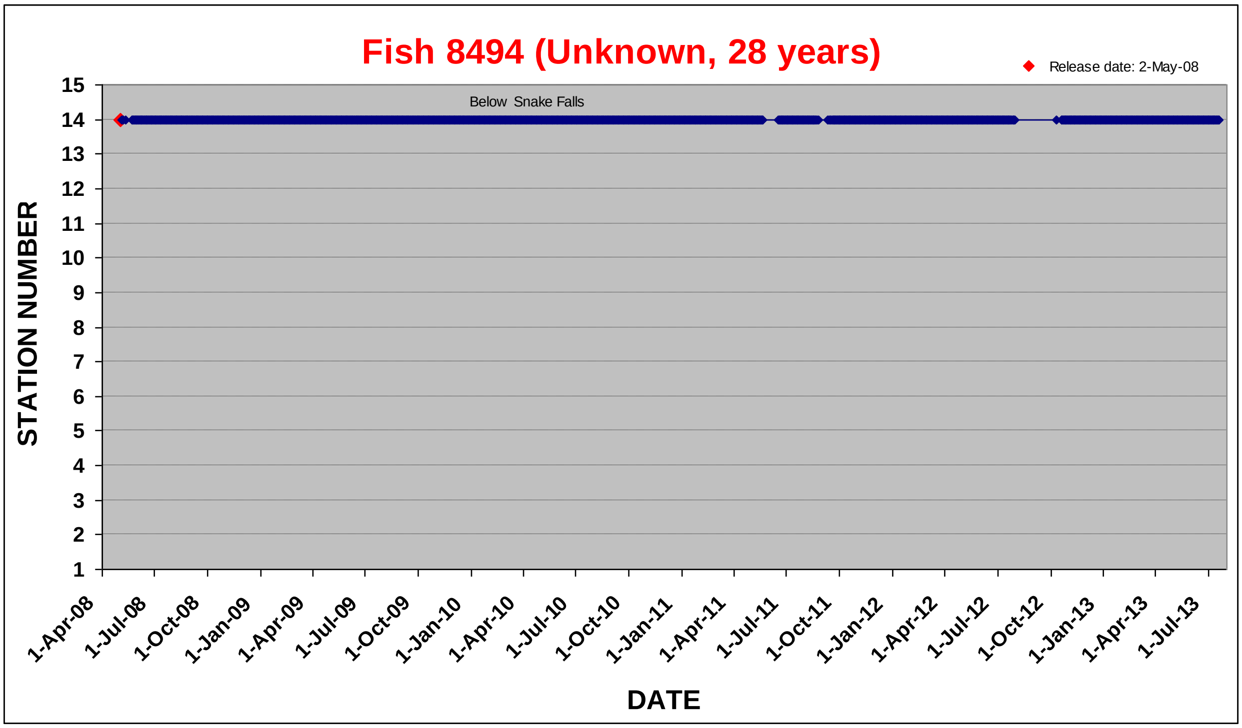

Fish 4753 (Male, 22 years)
Release Date: 17-May-07
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Back Channel
Below High Falls
Little Eva Lake
1-May-07
1-Aug-07
1-Nov-07
1-Feb-08
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

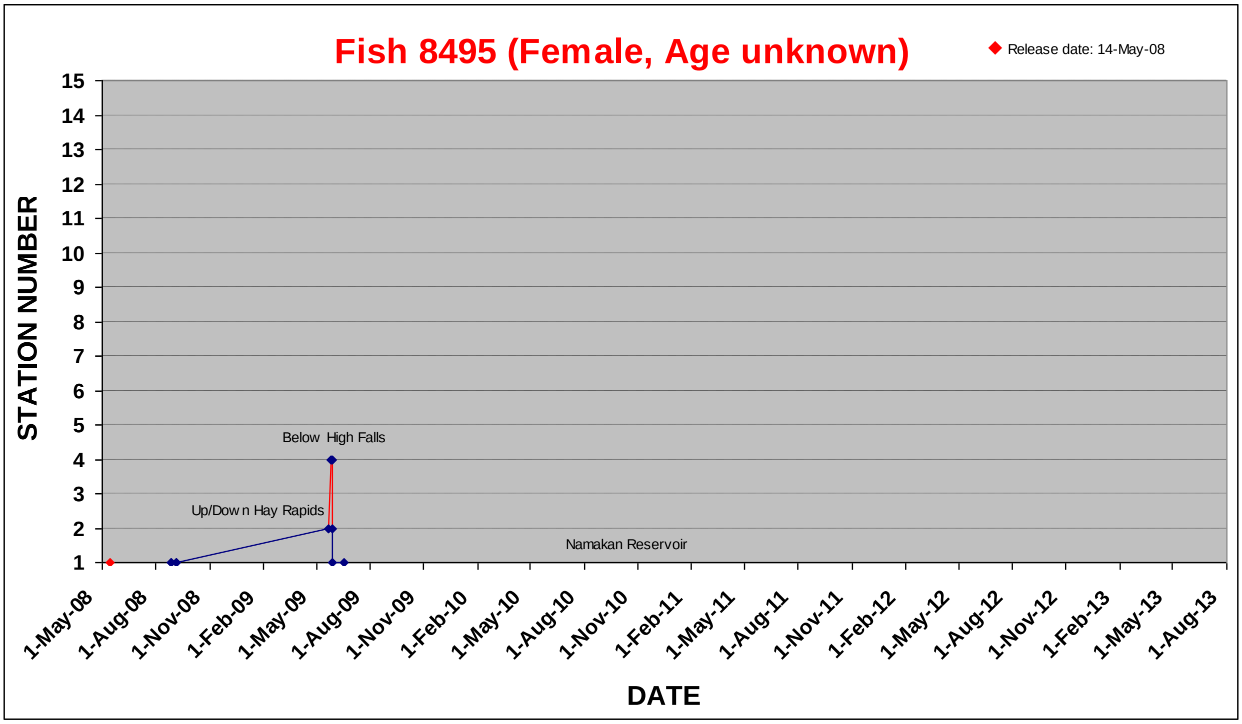
Appendix II: Movement of individual lake sturgeon released in 2008 within the Namakan River, Ontario.

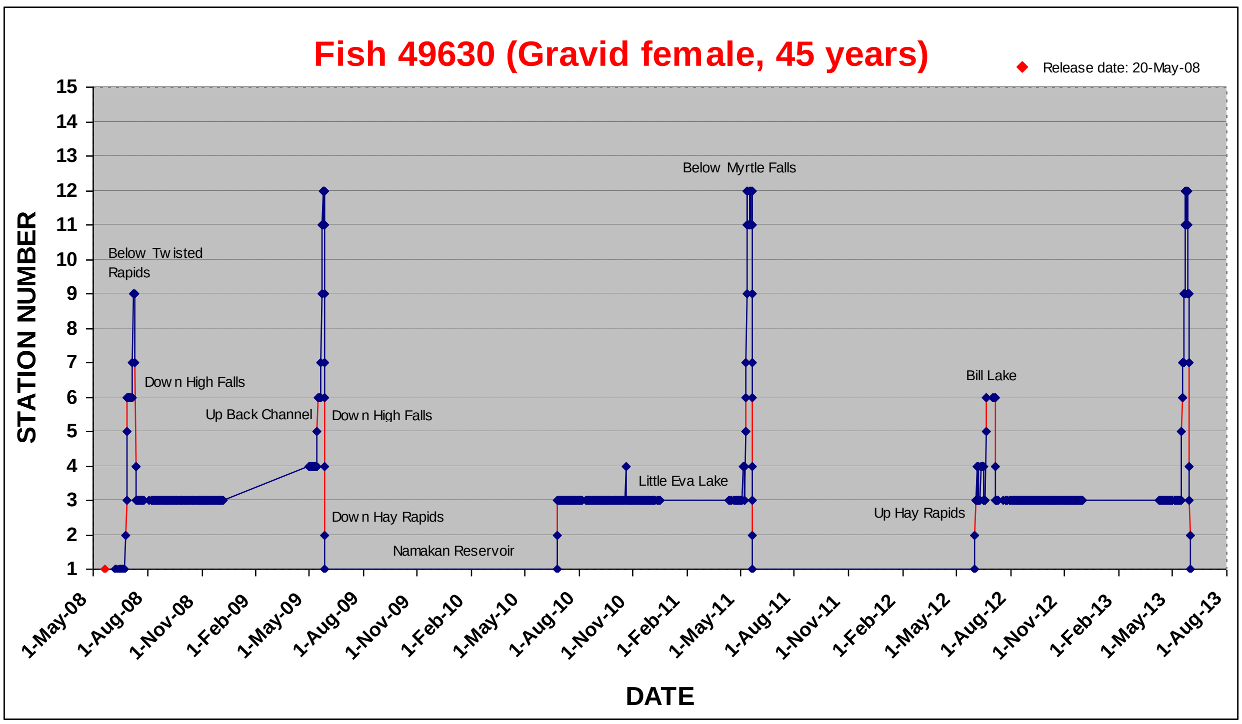


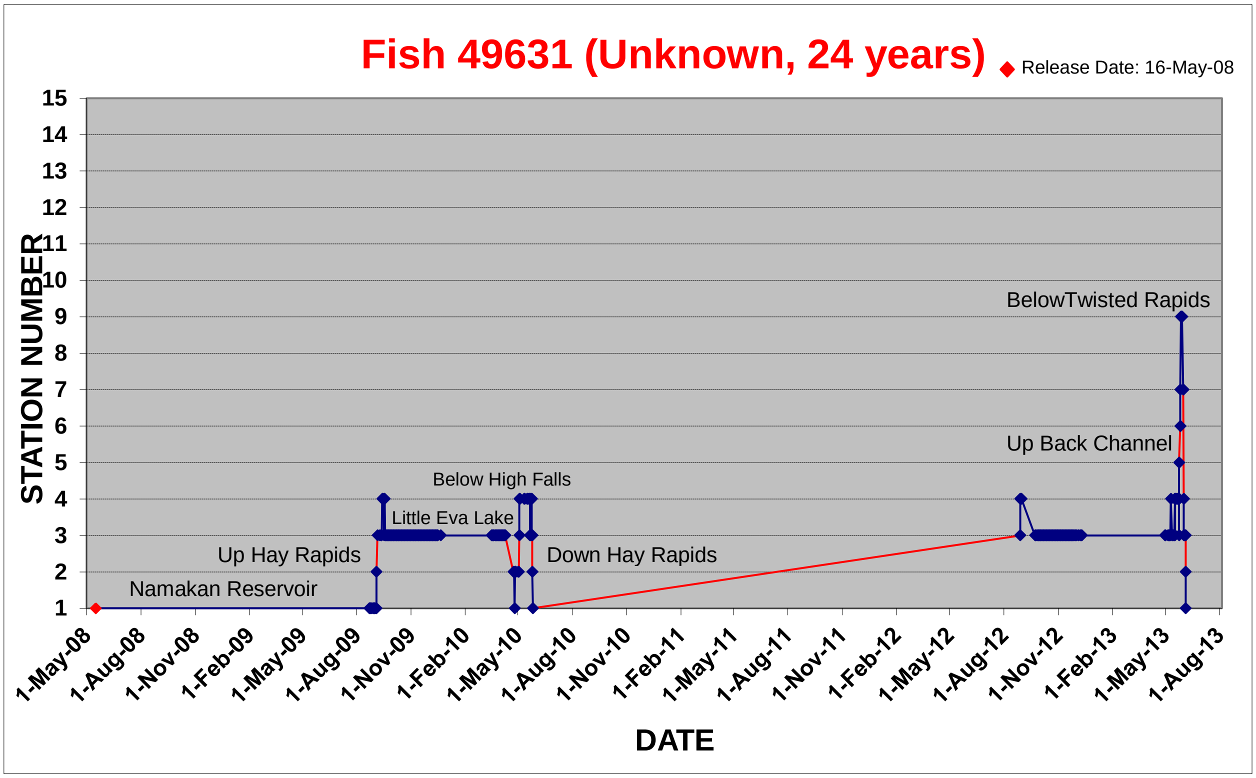


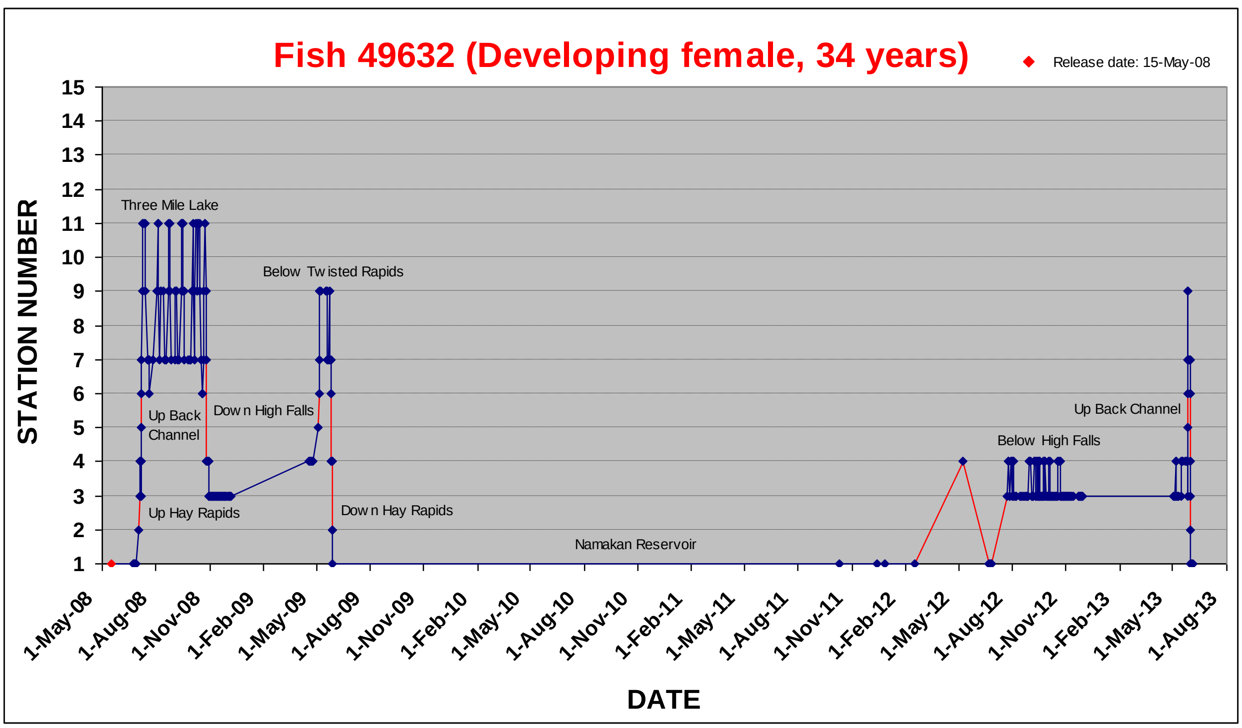

Fish 8493 (Developing female, 38 years)
Release date: 2-May-08
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below Snake Falls
Dow n Myrtle Falls
Up Myrtle Falls
Dow n High Falls
Up Back Channel
1-Apr-08
1-Jul-08
1-Oct-08
1-Jan-09
1-Apr-09
1-Jul-09
1-Oct-09
1-Jan-10
1-Apr-10
1-Jul-10
1-Oct-10
1-Jan-11
1-Apr-11
1-Jul-11
1-Oct-11
1-Jan-12
1-Apr-12
1-Jul-12
1-Oct-12
1-Jan-13
1-Apr-13
1-Jul-13
DATE

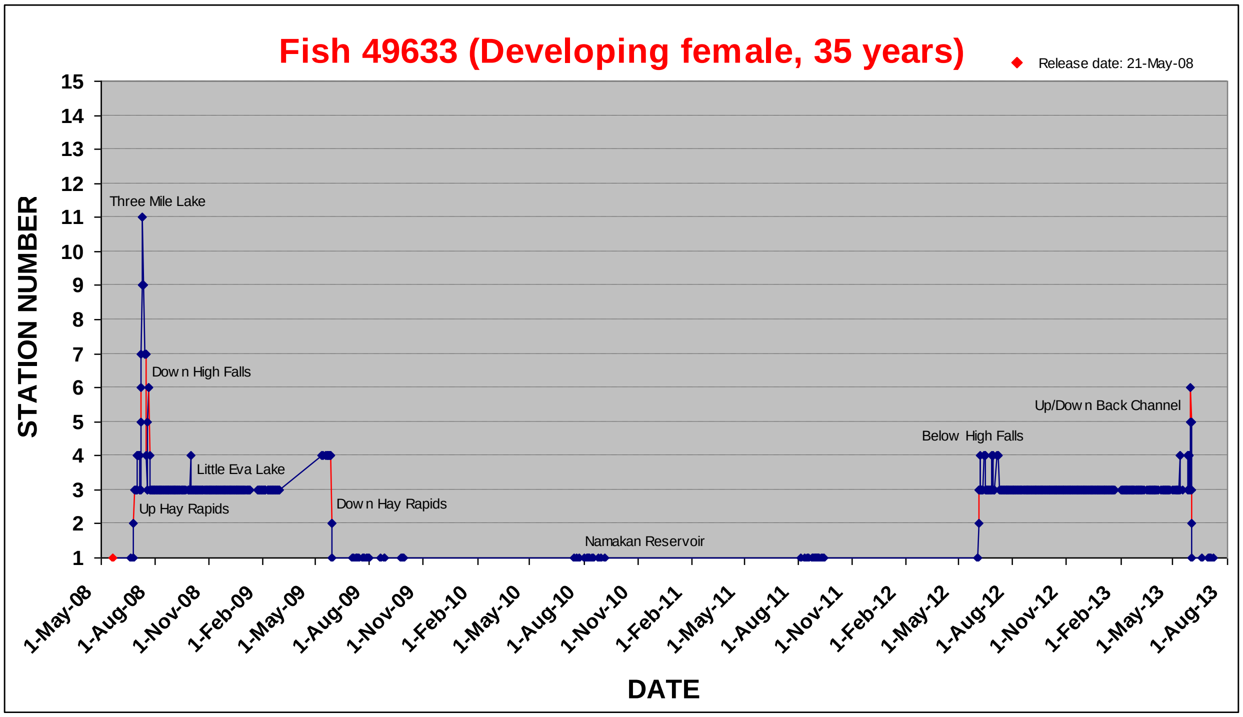

Fish 8494 (Unknown, 28 years)
Release date: 2-May-08
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below Snake Falls
1-Apr-08
1-Jul-08
1-Oct-08
1-Jan-09
1-Apr-09
1-Jul-09
1-Oct-09
1-Jan-10
1-Apr-10
1-Jul-10
1-Oct-10
1-Jan-11
1-Apr-11
1-Jul-11
1-Oct-11
1-Jan-12
1-Apr-12
1-Jul-12
1-Oct-12
1-Jan-13
1-Apr-13
1-Jul-13
DATE

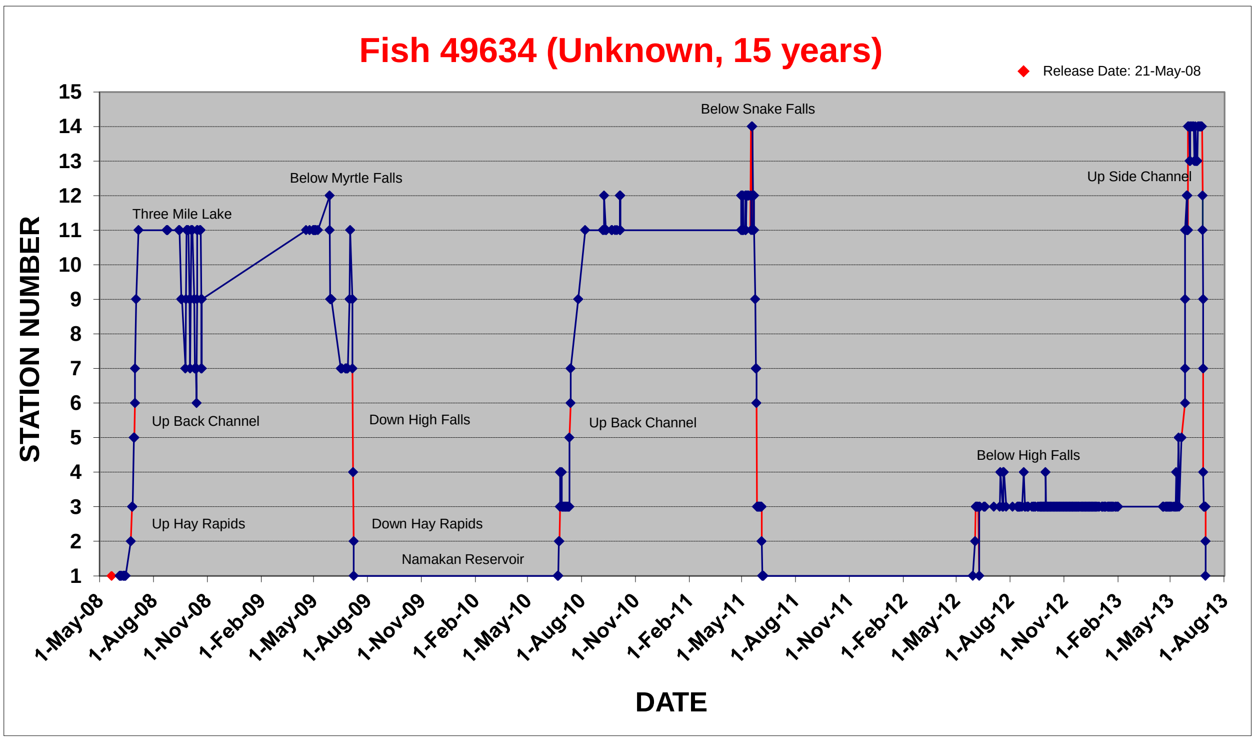

Fish 8495 (Female, Age unknown)
Release date: 14-May-08
STATION NUMBER
Below High Falls
Up/Down Hay Rapids
Namakan Reservoir
DATE

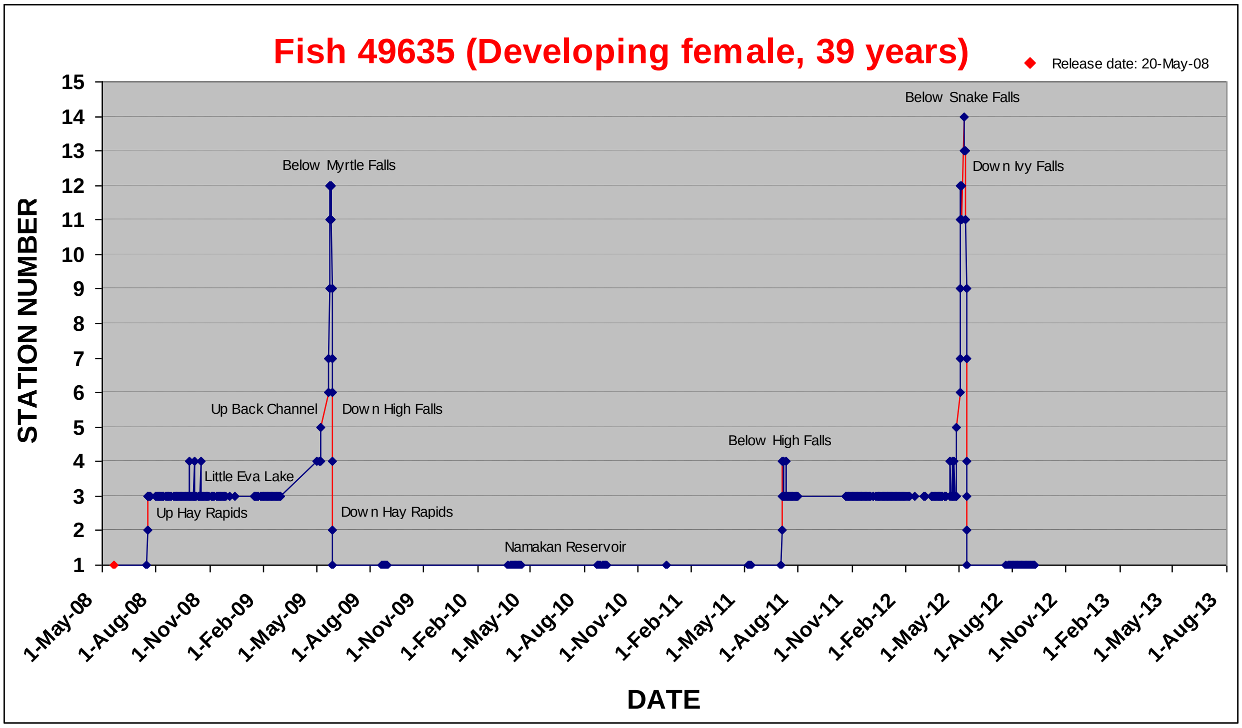

Fish 49630 (Gravid female, 45 years)
Release date: 20-May-08
STATION NUMBER
Below Twisted Rapids
Down High Falls
Up Back Channel
Down High Falls
Down Hay Rapids
Namakan Reservoir
Below Myrtle Falls
Little Eva Lake
Bill Lake
Up Hay Rapids
DATE

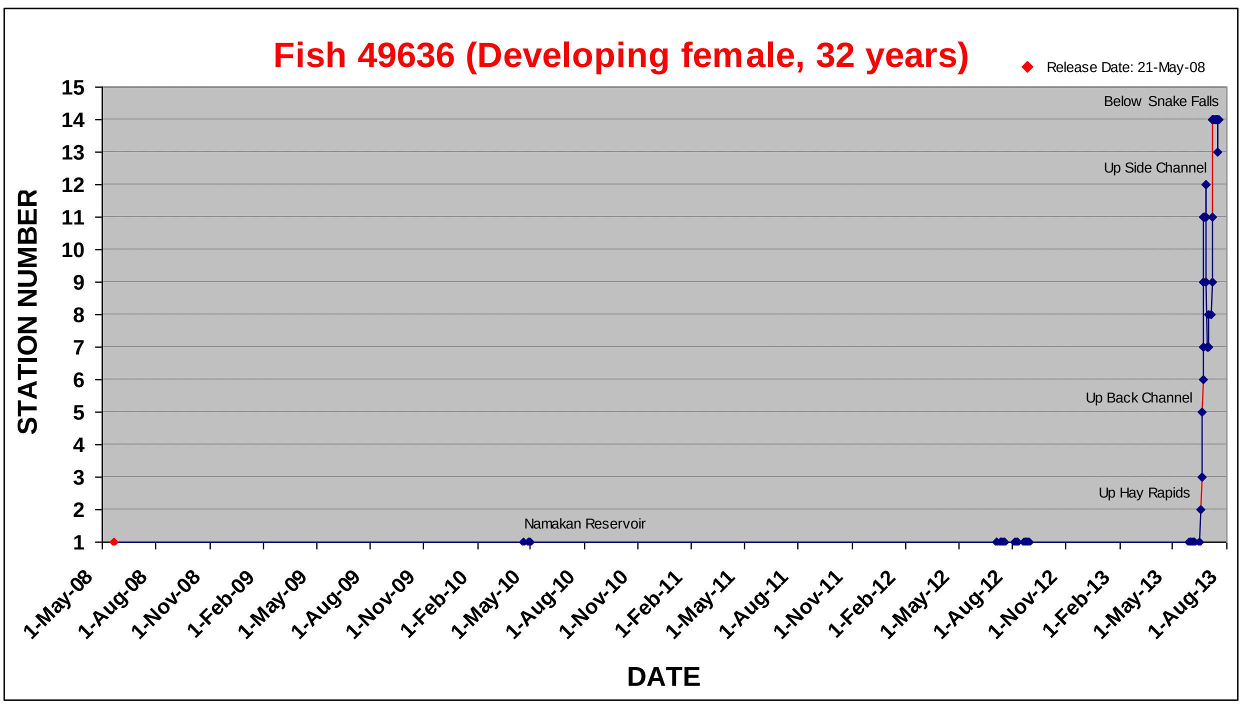

Fish 49631 (Unknown, 24 years)
Release Date: 16-May-08
STATION NUMBER
DATE
BelowTwisted Rapids
Up Back Channel
Below High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir

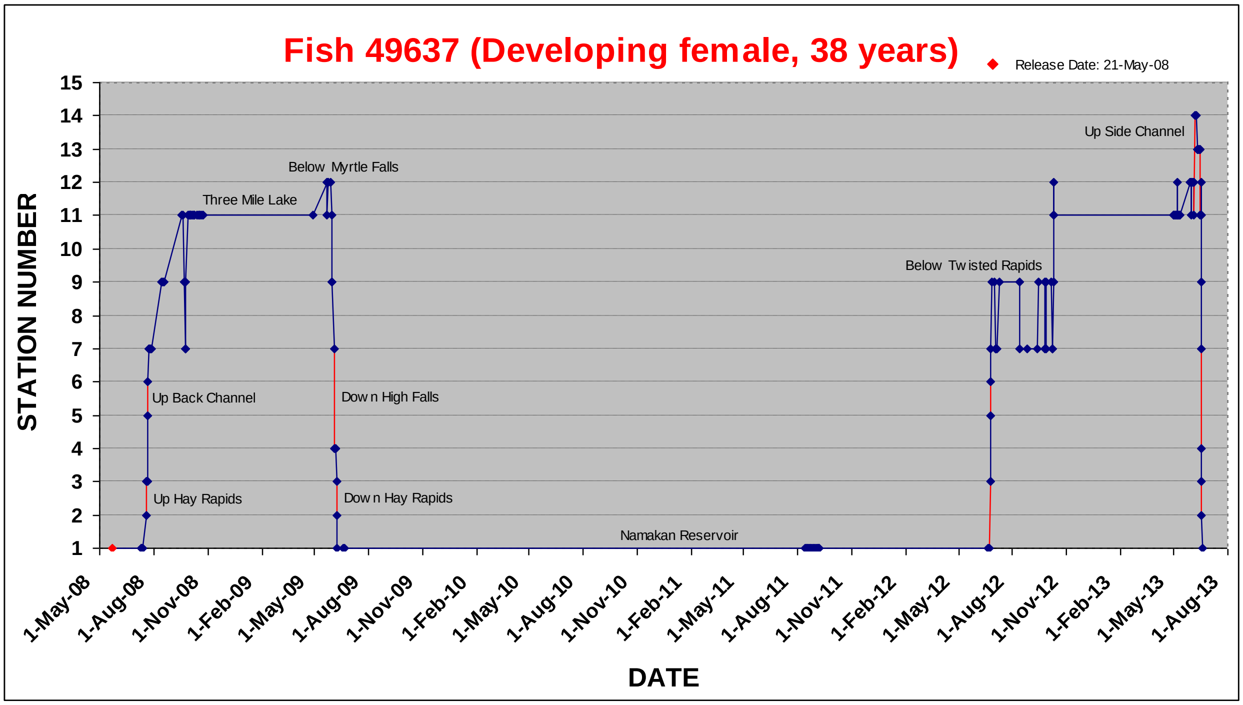

Fish 49632 (Developing female, 34 years)
Release date: 15-May-08
STATION NUMBER
DATE
Three Mile Lake
Below Twisted Rapids
Up Back Channel
Down High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
Up Back Channel
Below High Falls


Fish 49633 (Developing female, 35 years)
Release date: 21-May-08
STATION NUMBER
Three Mile Lake
Dow n High Falls
Little Eva Lake
Up Hay Rapids
Dow n Hay Rapids
Namakan Reservoir
Below High Falls
Up/Dow n Back Channel
DATE

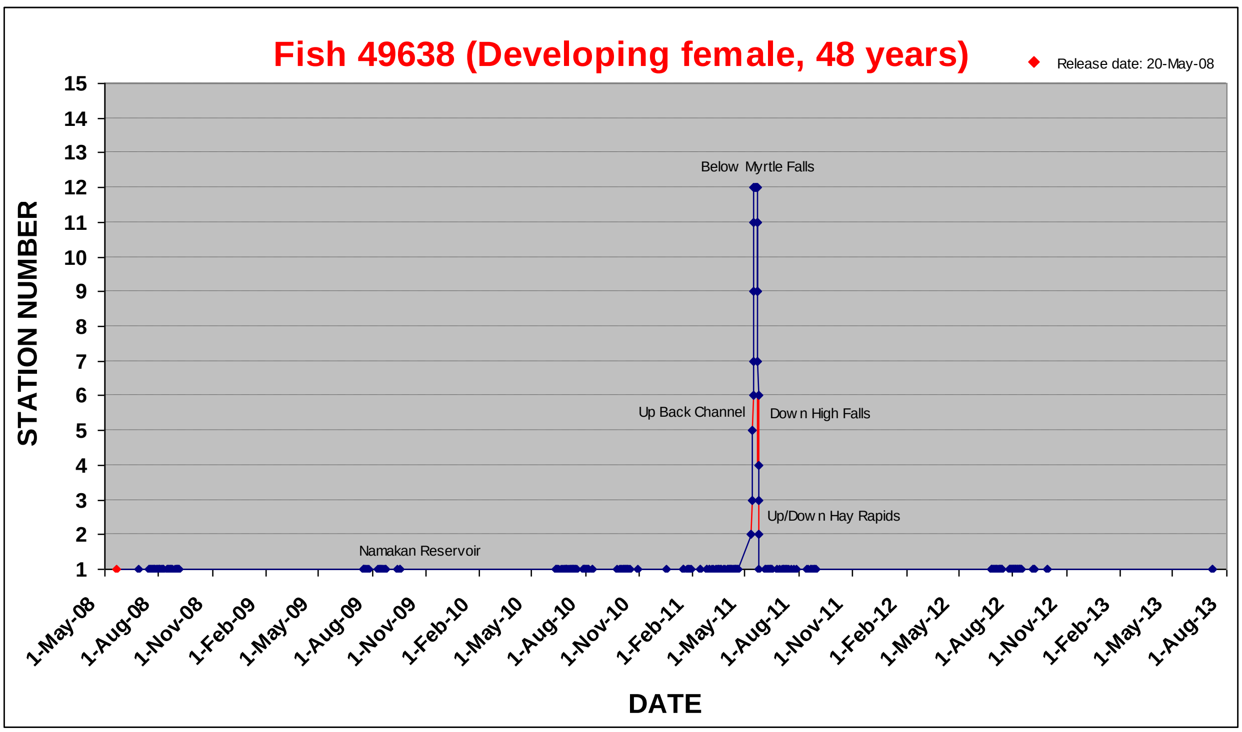

Fish 49634 (Unknown, 15 years)
Release Date: 21-May-08
STATION NUMBER
Below Snake Falls
Below Myrtle Falls
Three Mile Lake
Up Side Channel
Up Back Channel
Down High Falls
Up Back Channel
Below High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
DATE


Fish 49635 (Developing female, 39 years)
Release date: 20-May-08
STATION NUMBER
DATE
Below Snake Falls
Down Ivy Falls
Below Myrtle Falls
Up Back Channel
Down High Falls
Below High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13

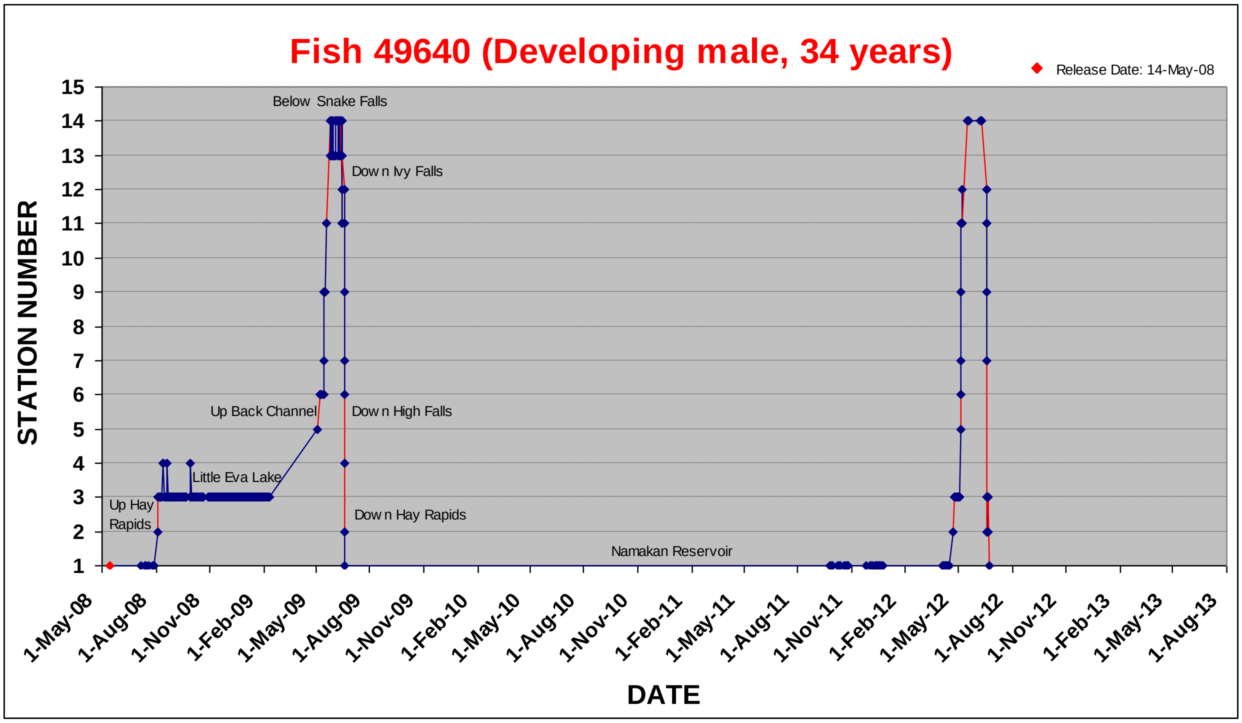

Fish 49636 (Developing female, 32 years)
Release Date: 21-May-08
STATION NUMBER
DATE
Below Snake Falls
Up Side Channel
Up Back Channel
Up Hay Rapids
Namakan Reservoir
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13

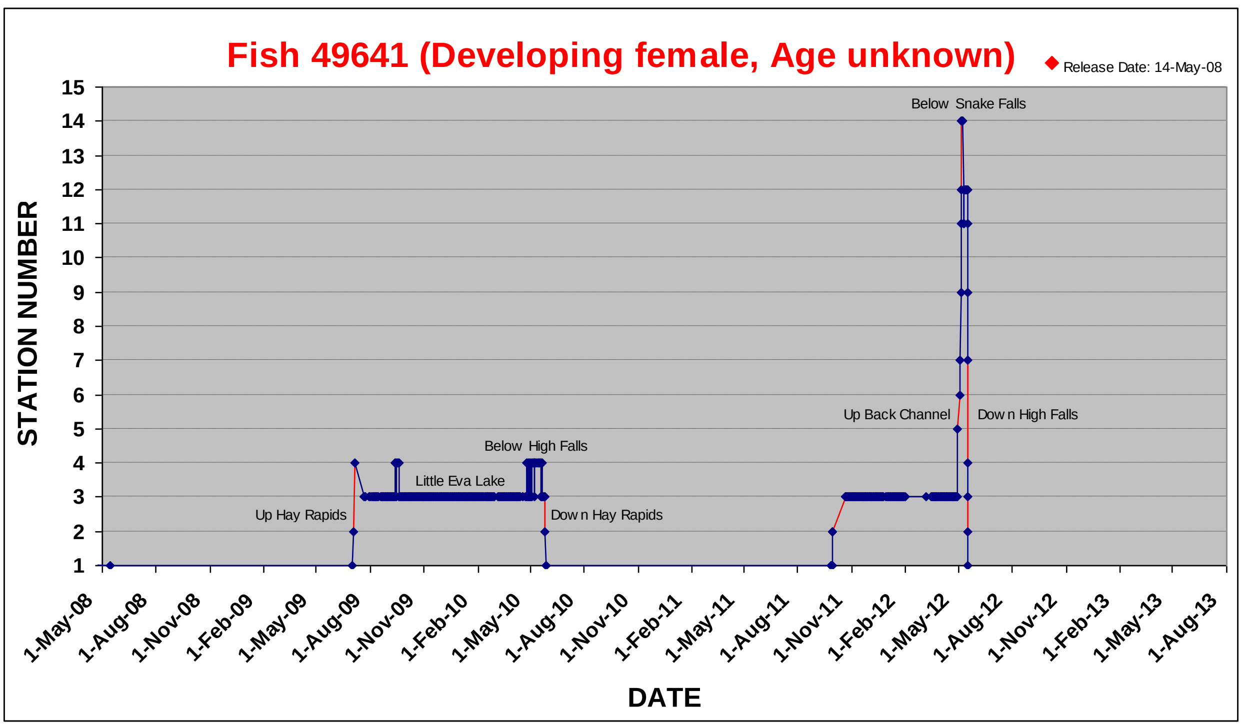


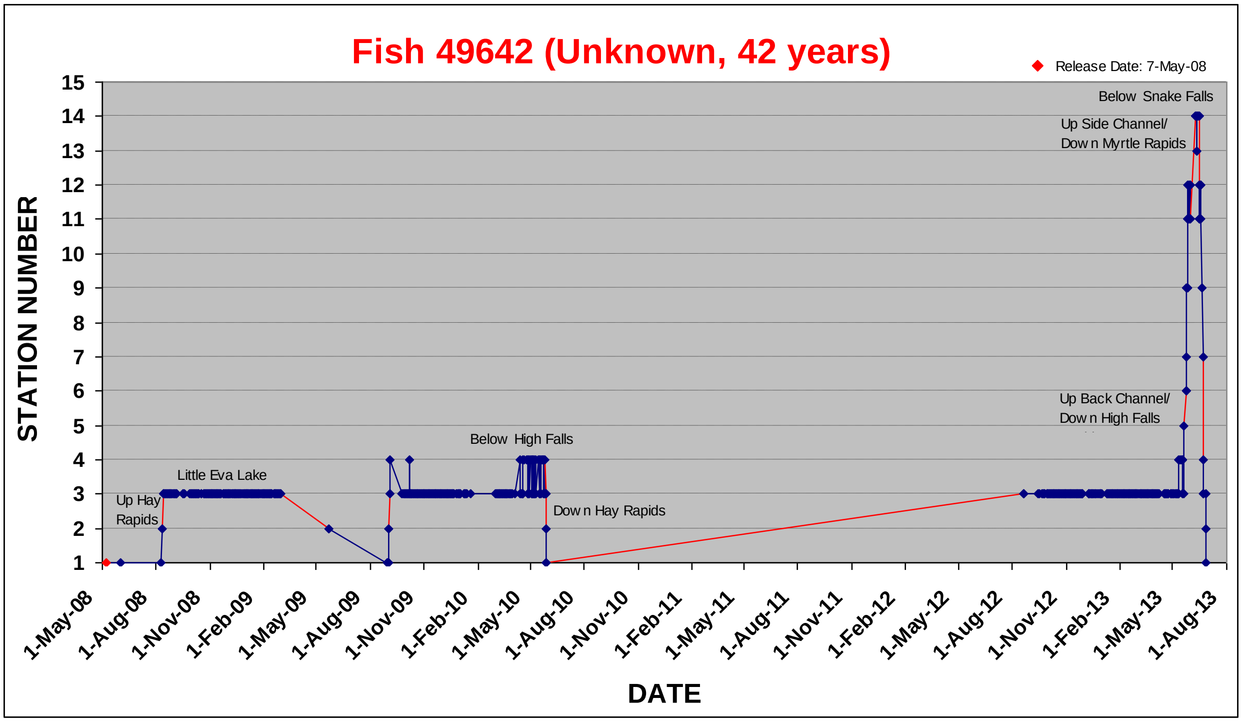
Fish 49637 (Developing female, 38 years)
Release Date: 21-May-08
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Up Side Channel
Below Myrtle Falls
Three Mile Lake
Below Twisted Rapids
Up Back Channel
Down High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

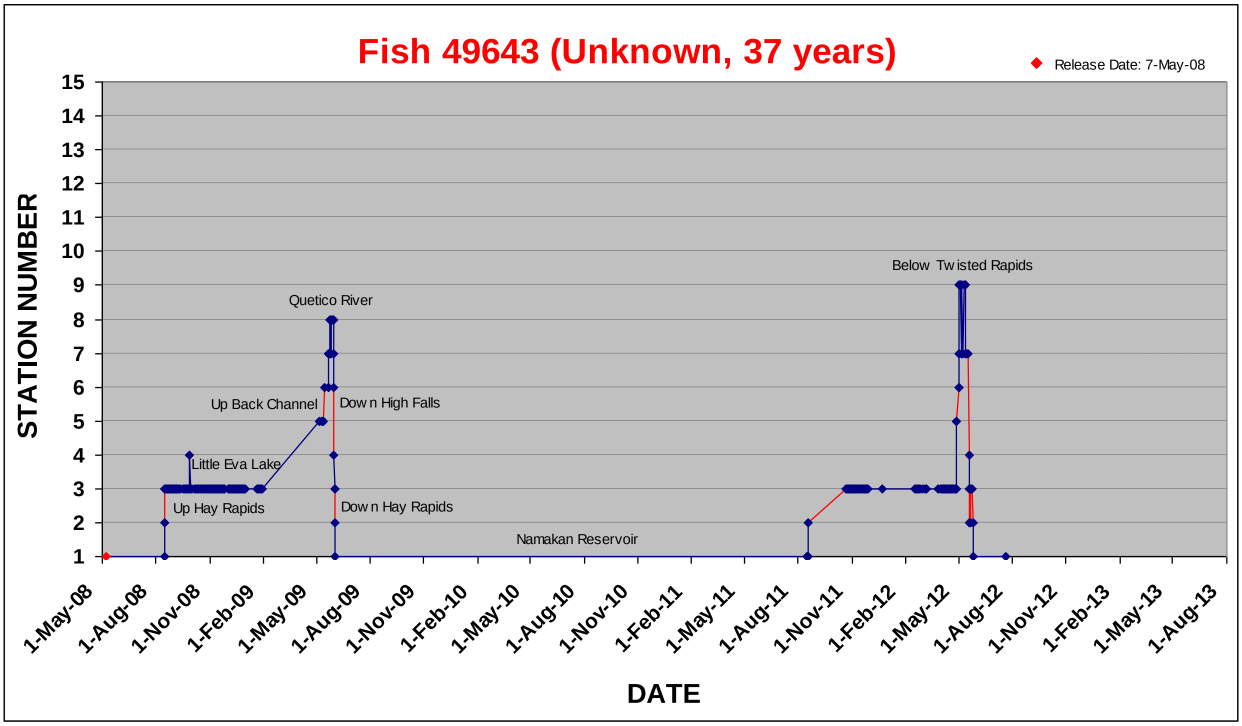


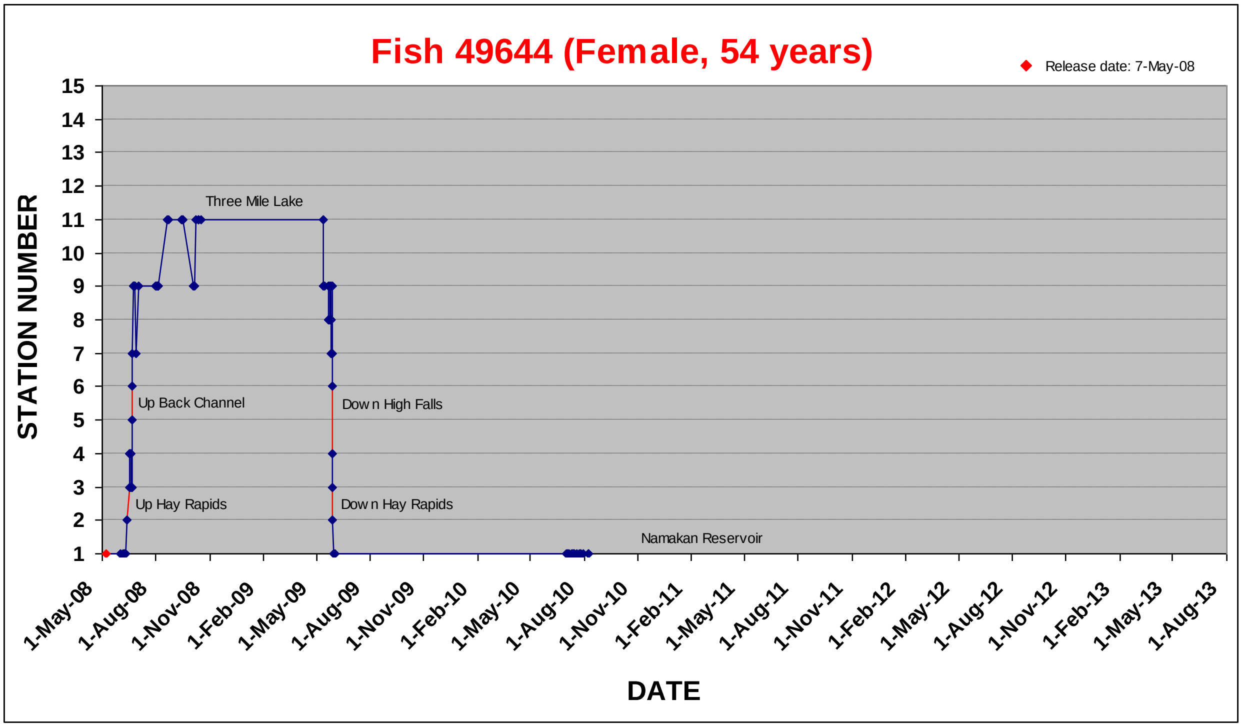
Fish 49638 (Developing female, 48 years)
Release date: 20-May-08
STATION NUMBER
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Below Myrtle Falls
Up Back Channel
Down High Falls
Up/Down Hay Rapids
Namakan Reservoir
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13
DATE

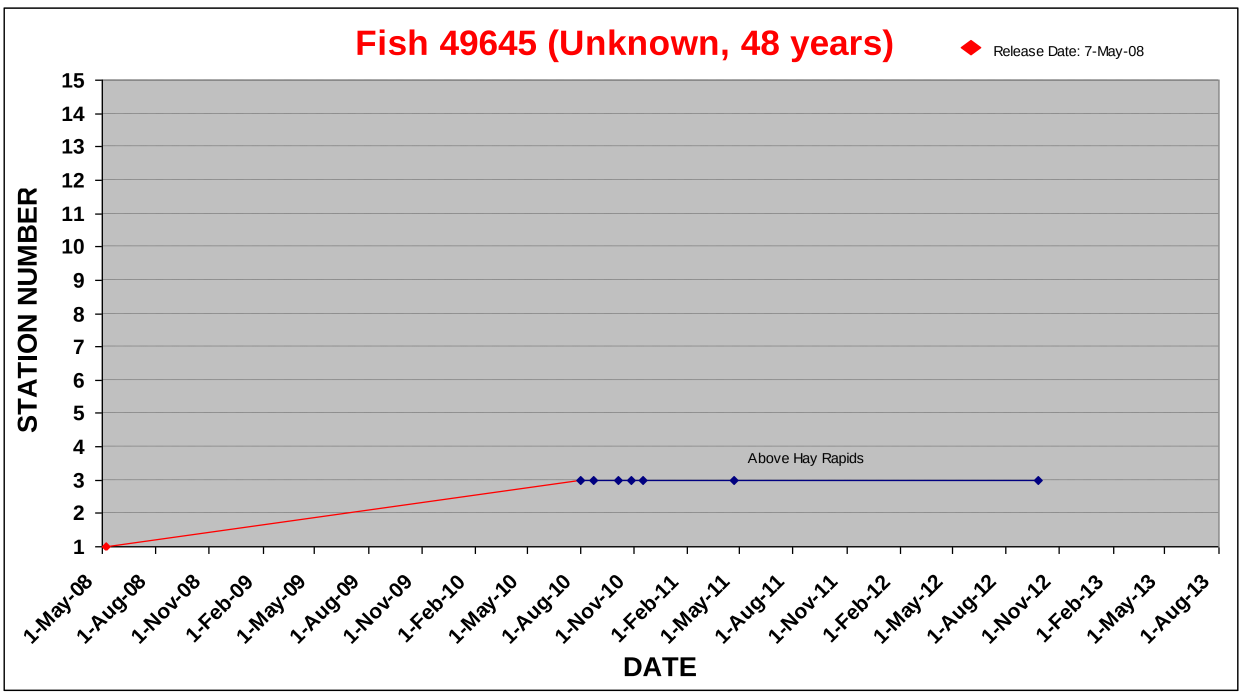

Fish 49640 (Developing male, 34 years)
Release Date: 14-May-08
STATION NUMBER
DATE
Below Snake Falls
Down Ivy Falls
Up Back Channel
Down High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir

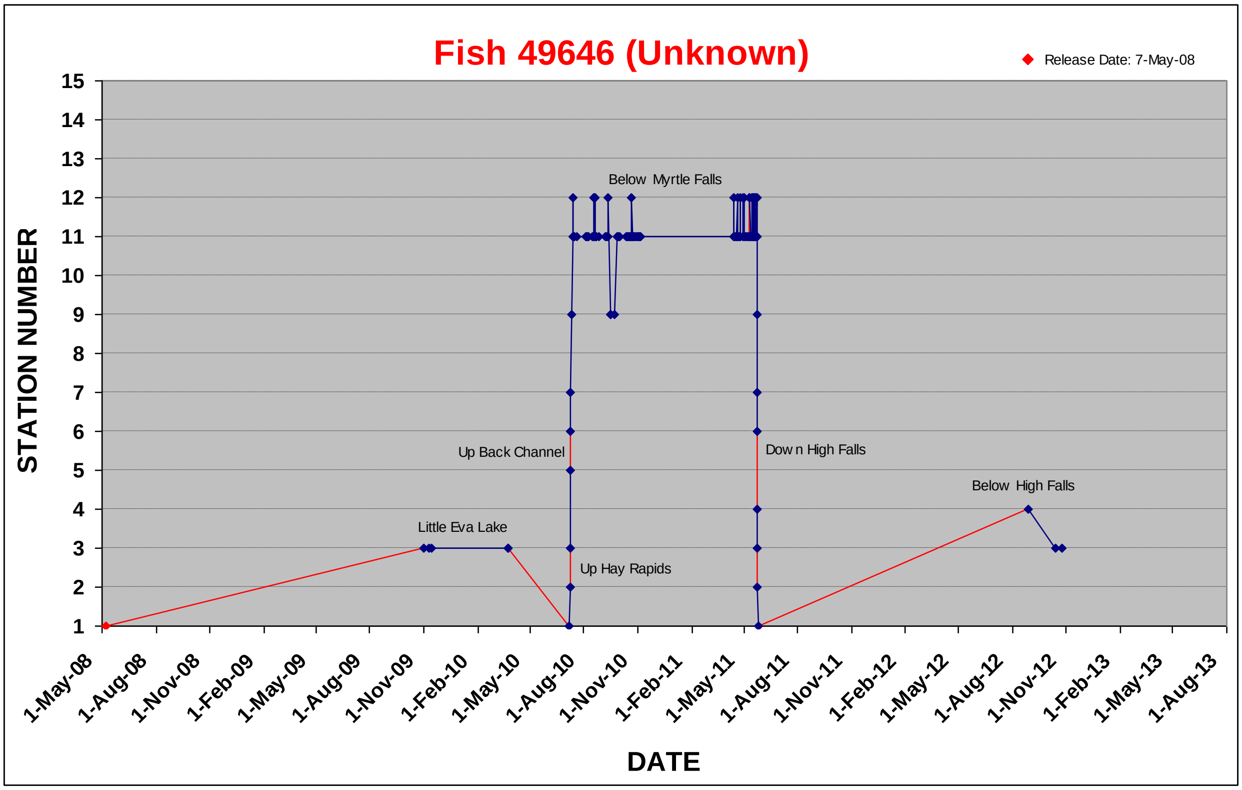

Fish 49641 (Developing female, Age unknown)
Release Date: 14-May-08
STATION NUMBER
DATE
Below Snake Falls
Up Back Channel
Down High Falls
Below High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids

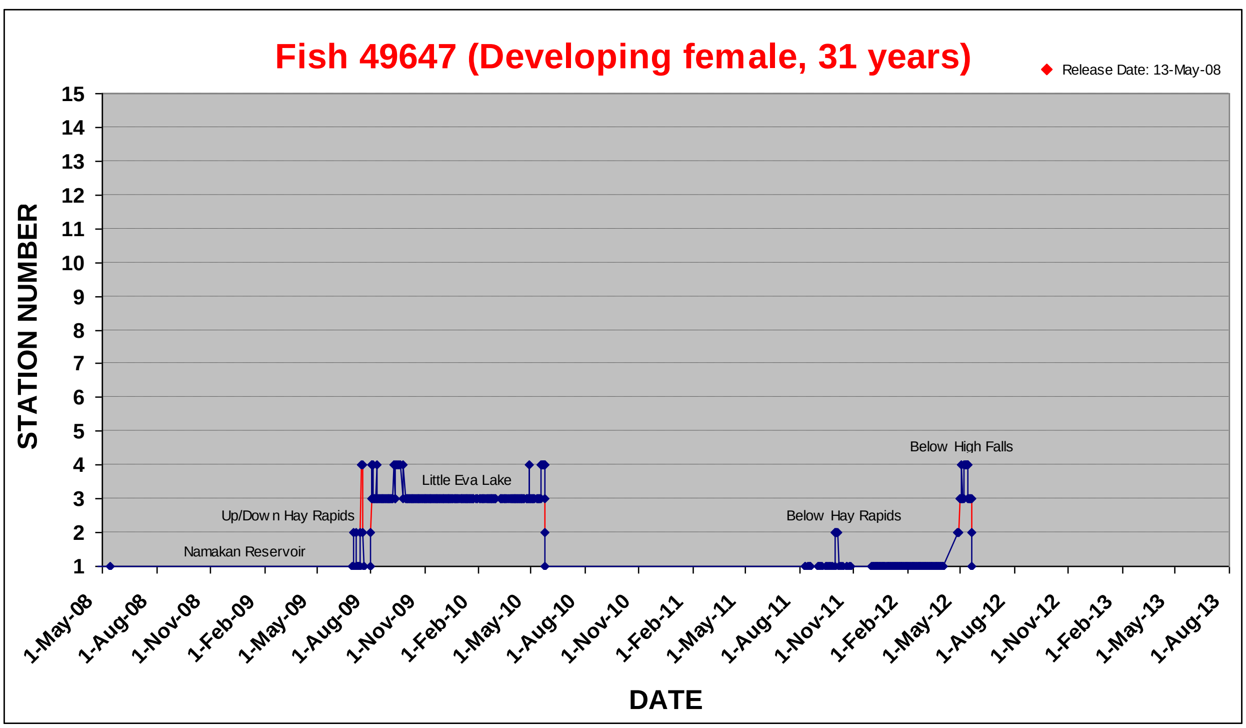

Fish 49642 (Unknown, 42 years)
Release Date: 7-May-08
STATION NUMBER
DATE
Below Snake Falls
Up Side Channel/
Down Myrtle Rapids
Up Back Channel/
Down High Falls
Below High Falls
Little Eva Lake
Up Hay
Rapids
Down Hay Rapids
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13

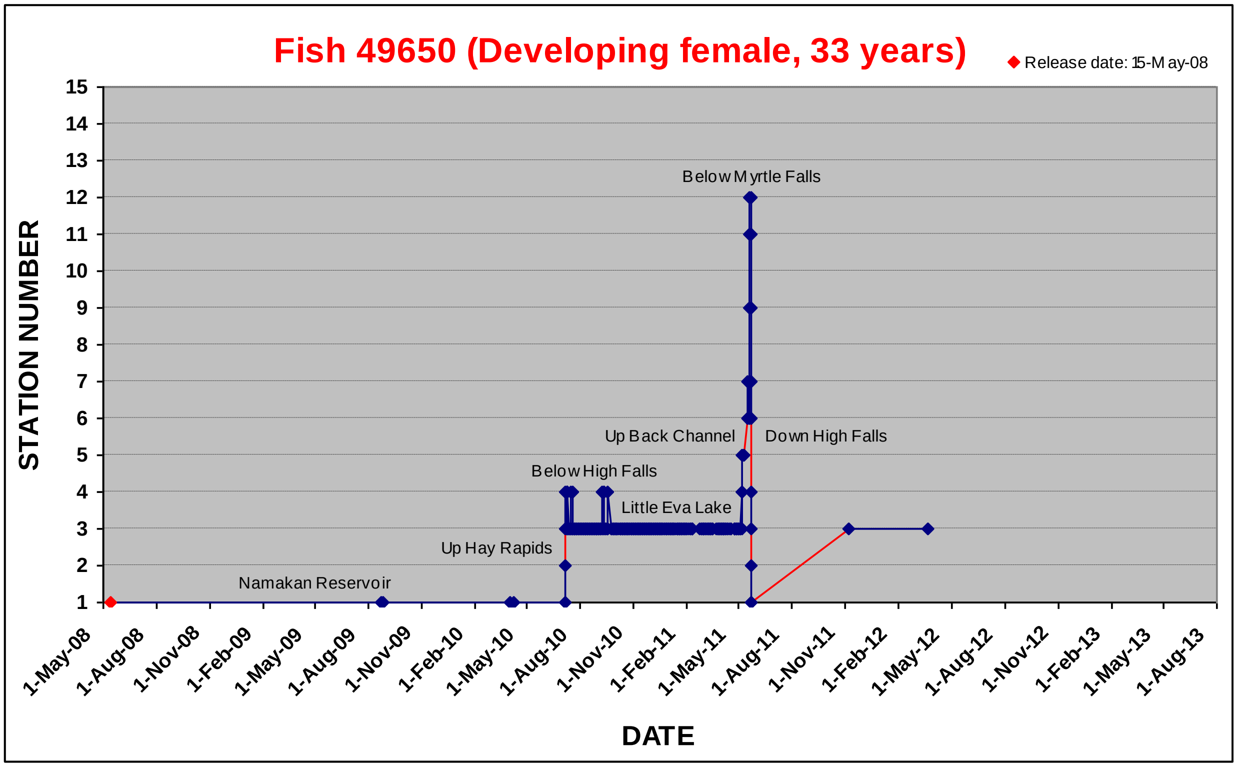

Fish 49643 (Unknown, 37 years)
Release Date: 7-May-08
STATION NUMBER
DATE
Below Twisted Rapids
Quetico River
Up Back Channel
Down High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
1-May-08
1-Aug-08
1-Nov-08
1-Feb-09
1-May-09
1-Aug-09
1-Nov-09
1-Feb-10
1-May-10
1-Aug-10
1-Nov-10
1-Feb-11
1-May-11
1-Aug-11
1-Nov-11
1-Feb-12
1-May-12
1-Aug-12
1-Nov-12
1-Feb-13
1-May-13
1-Aug-13


Fish 49644 (Female, 54 years)
Release date: 7-May-08
STATION NUMBER
Three Mile Lake
Up Back Channel
Dow n High Falls
Up Hay Rapids
Dow n Hay Rapids
Namakan Reservoir
DATE

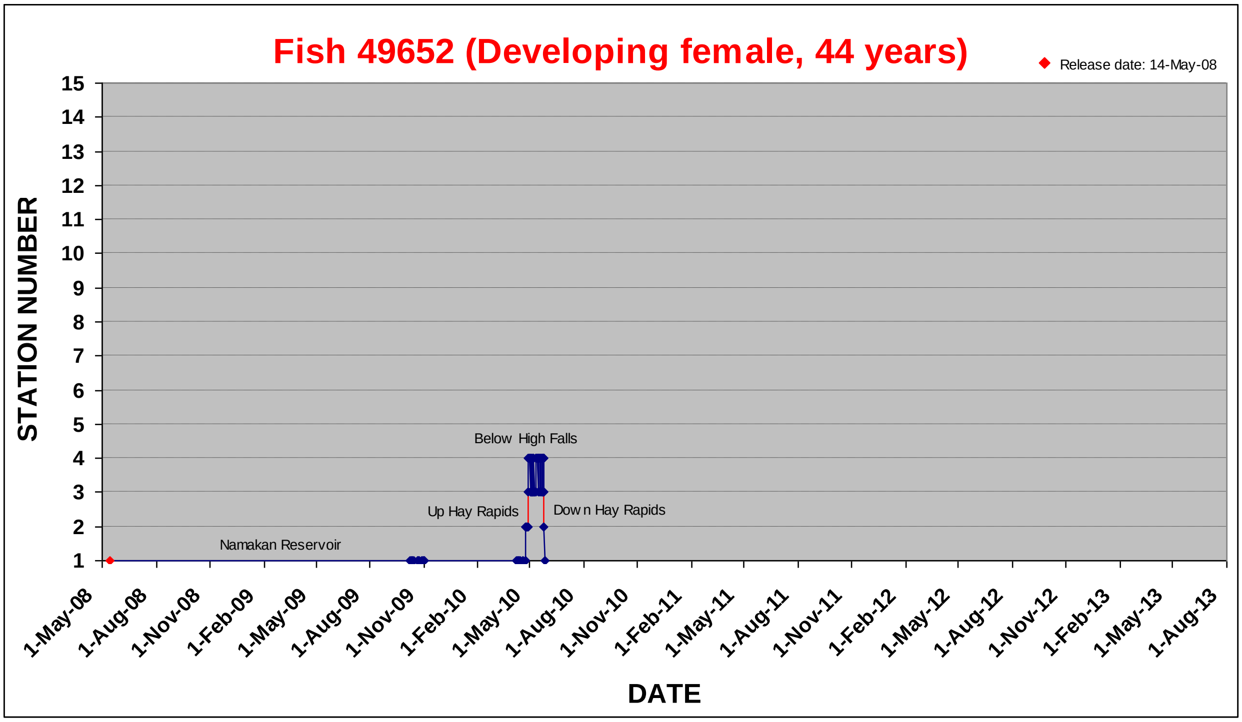

Fish 49645 (Unknown, 48 years)
Release Date: 7-May-08
STATION NUMBER
Above Hay Rapids
DATE


Fish 49646 (Unknown)
Release Date: 7-May-08
STATION NUMBER
DATE
Below Myrtle Falls
Up Back Channel
Down High Falls
Below High Falls
Little Eva Lake
Up Hay Rapids

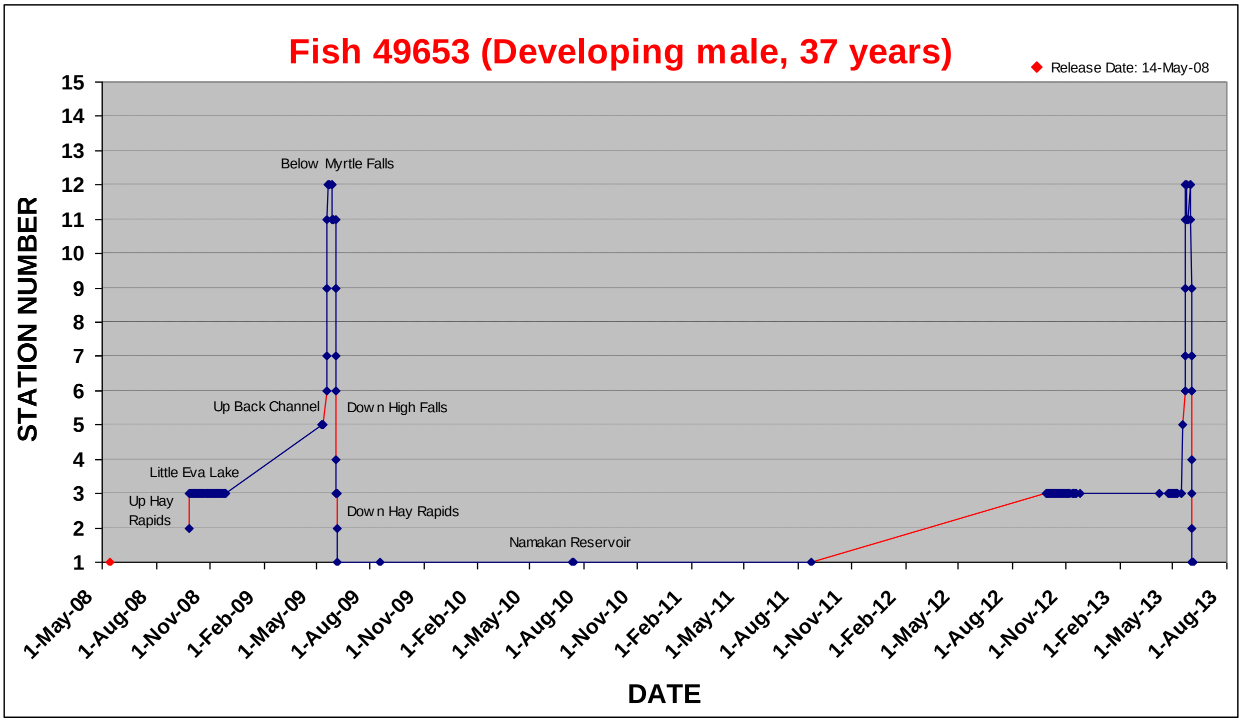

Fish 49647 (Developing female, 31 years)
Release Date: 13-May-08
STATION NUMBER
DATE
Below High Falls
Little Eva Lake
Up/Down Hay Rapids
Below Hay Rapids
Namakan Reservoir

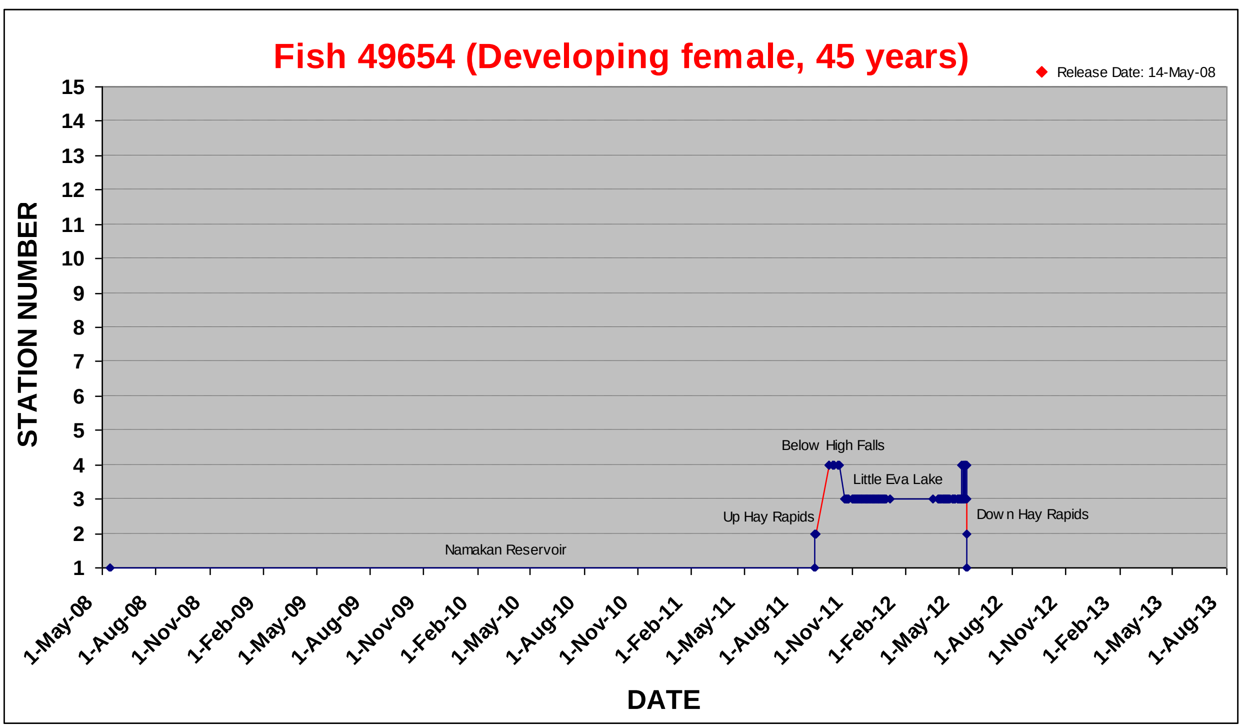


Fish 49650 (Developing female, 33 years)
Release date: 15-May-08
STATION NUMBER
DATE
Below Myrtle Falls
Up Back Channel
Down High Falls
Below High Falls
Little Eva Lake
Up Hay Rapids
Namakan Reservoir



Fish 49652 (Developing female, 44 years)
Release date: 14-May-08
STATION NUMBER
DATE
Below High Falls
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir


Fish 49653 (Developing male, 37 years)
Release Date: 14-May-08
STATION NUMBER
Below Myrtle Falls
Up Back Channel
Down High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
DATE


Fish 49654 (Developing female, 45 years)
Release Date: 14-May-08
STATION NUMBER
Below High Falls
Little Eva Lake
Up Hay Rapids
Down Hay Rapids
Namakan Reservoir
DATE

Appendix III: Movement of lake sturgeon through proposed hydro development sites (weir locations) on Namakan River, Ontario from 2007 to 2013. All flow values represent the main river flow based on reported outflow from Lac La Croix (05PA006). Estimated flows in the Back Channel are also provided based on flow distribution from Genivar, 2009 (Technical Note #2 Revision 3.0) and revised by Hatch, 2012.

Location Description	Transmitter ID Code	Direction of Movement	Date/Time of Movement START	Date/Time of Movement END	Temperature (°C)	Water Flow (m^3/s)
Ivy/Myrtle Falls [1]	4602	Downstream	Jun. 03, 2008 22:37	Jun. 04, 2008 22:07	12.6	409
	4592	Downstream	Jun. 06, 2008 07:38	Jun. 07, 2008 16:39	12.5	403
	4595	Downstream	Jun. 25, 2008 23:10	Jun. 28, 2008 00:46	18.2	384
	4595	Downstream	Jul. 01, 2008 21:24	Jul. 02, 2008 12:53	19.2	358
	4592	Downstream	Jul. 21, 2008 04:08	Jul. 21, 2008 13:37	20.4	238
	4599	Downstream	Jul. 27, 2008 20:33	Jul. 28, 2008 18:42	21.7	197
	8491	Downstream	Jul. 28, 2008 22:15	Oct. 21, 2008 02:21	19.5	109
	4602	Upstream	May 21, 2008 23:56	May 29, 2008 18:40	7.4	464
	4592	Upstream	Jun. 01, 2008 20:41	Jun. 02, 2008 19:50	12.2	431
	4592	Upstream	Jun. 22, 2008 13:24	Jun. 22, 2008 21:50	16.5	403
	4595	Upstream	Jun. 24, 2008 12:21	Jun. 24, 2008 21:30	17.4	396
	4599	Upstream	Jun. 25, 2008 00:13	Jul. 03, 2008 00:38	18.2	391
	4595	Upstream	Jun. 30, 2008 14:18	Jul. 01, 2008 13:07	18.8	373
	8491	Upstream	May 05, 2009 23:22	Jun. 13, 2009 23:10	6.8	313
	49640	Upstream	May 19, 2009 21:25	May 24, 2009 23:03	9.4	400
Ivy Falls	4589	Downstream	Jun. 14, 2009 20:28	Jun. 14, 2009 22:46	15.0	288
	49640	Downstream	Jun. 15, 2009 19:57	Jun. 18, 2009 13:56	15.5	282
	4589	Downstream	Jun. 16, 2009 02:07	Jun. 16, 2009 14:05	16.1	275
	4740	Downstream	Jun. 16, 2009 20:31	Jun. 17, 2009 07:24	16.1	275
	4592	Downstream	Jun. 21, 2009 18:24	Jun. 22, 2009 05:28	19.2	245
	8491	Downstream	Oct. 06, 2009 18:58	Oct. 12, 2009 06:19	12.5	54
	8491	Downstream	Sep. 26, 2010 15:14	Sep. 27, 2010 21:33	14.6	61
	8491	Downstream	Oct. 05, 2011 21:02	Oct 19, 2011 03:47	14.6	28
	49635	Downstream	May 13, 2012 16:38	May 13, 2012 19:47	12.7	169
	4746	Downstream	Jul. 8, 2012 01:11	Jul. 9, 2012 04:47	23.6	304
	8491	Downstream	Oct. 04, 2012 18:57	Oct. 06, 2012 07:34	11.5	41

	49637	Downstream	Jun. 16, 2013 18:34	Jun. 16, 2013 23:56	17.6	317
Myrtle Falls [2]	4740	Downstream	May 25, 2009 11:02	May 26, 2009 13:52	11.3	385
	49640	Downstream	Jun. 12, 2009 23:49	Jun. 13, 2009 06:46	14.3	294
	8492	Downstream	Sep. 27, 2009 23:14	Sep. 29, 2009 22:22	16.5	62
	8493	Downstream	Oct. 08, 2009 03:47	Oct. 08, 2009 23:04	11.4	51
	49634	Downstream	May 19, 2011 15:00	May 20, 2011 00:01	12.9	228
	4592	Downstream	Jul. 03, 2011 15:17	Jul. 03, 2011 21:21	20.7	143
	49641	Downstream	May 8, 2012 06:59	May 9, 2012 07:00	11.0	170
	4594	Downstream	Jun. 8, 2012 06:31	Jun. 9, 2012 01:04	20.0	274
	49640	Downstream	Jun. 10, 2012 03:15	Jun. 17, 2012 23:28	19.5	312
	4593	Downstream	Jun. 16, 2012 09:17	Jun. 16, 2012 20:37	19.2	304
	4598	Downstream	Aug. 16, 2012 16:48	Aug. 16, 2012 23:20	22.0	138
	49642	Downstream	Jun. 15, 2013 16:21	Jun. 15, 2013 20:22	16.7	325
	49634	Downstream	Jun. 24, 2013 21:13	Jun. 25, 2013 15:18	19.1	266
	4593	Upstream	May 2, 2012 15:58	May 4, 2012 04:41	10.0	152
	49641	Upstream	May 5, 2012 07:31	May 6, 2012 07:35	10.6	163
Side Channel	4746	Downstream	Jul. 14, 2011 21:46	Jul. 16, 2011 00:08	22.6	140
	4740	Upstream	May 22, 2009 02:58	May 23, 2009 15:57	10.6	394
	4599	Upstream	Jun. 01, 2009 07:45	Jun. 19, 2009 17:03	11.5	361
	4589	Upstream	Jun. 06, 2009 05:32	Jun. 07, 2009 08:56	12.7	334
	4740	Upstream	Jun. 14, 2009 00:13	Jun. 14, 2009 18:45	15.0	288
	49640	Upstream	Jun. 14, 2009 02:19	Jun. 14, 2009 17:56	15.0	288
	4589	Upstream	Jun. 15, 2009 07:19	Jun. 15, 2009 19:42	15.5	282
	4592	Upstream	Jun. 18, 2009 04:24	Jun. 18, 2009 18:44	17.6	262
	8491	Upstream	May 01, 2010 07:40	May 06, 2010 06:48	11.0	45
	8493	Upstream	Jul. 23, 2010 19:07	Jul. 24, 2010 14:49	23.4	163
	8491	Upstream	May 07, 2011 04:56	May 19, 2011 12:44	6.8	223
	49634	Upstream	May 17, 2011 18:53	May 18, 2011 15:54	10.5	233
	4592	Upstream	Jul. 01, 2011 23:21	Jul. 02, 2011 21:22	19.5	142
	8492	Upstream	Jul. 09, 2011 19:26	Jul 14, 2011 01:26	22.6	148
	4746	Upstream	Jul. 12, 2011 07:59	Jul. 13, 2011 05:41	23.2	144
	8491	Upstream	Apr. 25, 2012 00:00	May 4, 2012 22:48	7.7	120
	49635	Upstream	May 6, 2012 18:33	May 10, 2012 13:24	10.9	165
	49640	Upstream	May 7, 2012 17:42	May 16, 2012 05:18	11.0	167

	4598	Upstream	Aug. 7, 2012 17:09	Aug. 14, 2012 08:48	23.0	167
	4594	Upstream	Jun. 6, 2012 08:37	Jun. 7, 2012 22:33	17.8	248
	4746	Upstream	Jun. 30, 2012 00:29	Jul. 1, 2012 10:34	22.1	309
	49634	Upstream	May 31, 2013 09:34	May 31, 2013 14:11	12.7	362
	49637	Upstream	Jun. 5, 2013 04:09	Jun. 6, 2013 04:09	12.8	370
	49642	Upstream	Jun. 1, 2013 07:14	Jun. 9, 2013 13:27	14.1	367
	8491	Upstream	Jun. 4, 2013 14:01	Jun. 17, 2013 11:28	17.5	371
	49636	Upstream	Jul. 7, 2013 13:01	Jul. 7, 2013 22:11	22.8	216
High Falls	4602	Downstream	Jun. 03, 2007 18:24	Jun. 04, 2007 14:31	16.9	64
	4594	Downstream	Jun. 10, 2007 02:19	Jun. 11, 2007 01:41	17.9	77
	4602	Downstream	Jun. 07, 2008 07:04	Jun. 07, 2008 08:03	13.0	403
	4741	Downstream	Jun. 13, 2008 04:24	Jun. 13, 2008 10:41	13.6	406
	49630	Downstream	Jul. 11, 2008 18:46	Jul. 12, 2008 11:05	19.9	287
	49633	Downstream	Jul. 17, 2008 04:52	Jul. 17, 2008 12:48	19.6	260
	49633	Downstream	Jul. 21, 2008 02:44	Jul. 22, 2008 05:51	20.4	238
	4741	Downstream	Oct. 15, 2008 05:15	Oct. 16, 2008 02:28	11.8	99
	49632	Downstream	Oct. 26, 2008 02:35	Oct. 26, 2008 23:37	8.9	111
	49632	Downstream	May 27, 2009 20:50	May 27, 2009 21:31	11.1	383
	49630	Downstream	May 28, 2009 00:43	May 28, 2009 01:24	11.4	378
	49635	Downstream	May 28, 2009 07:25	May 28, 2009 08:10	11.4	378
	49644	Downstream	May 29, 2009 06:12	May 29, 2009 10:45	11.9	375
	49643	Downstream	May 31, 2009 12:16	May 31, 2009 13:33	11.8	367
	49637	Downstream	Jun. 03, 2009 06:03	Jun. 04, 2009 10:55	12.5	350
	49653	Downstream	Jun. 04, 2009 20:09	Jun. 04, 2009 21:15	12.7	343
	4740	Downstream	Jun. 18, 2009 03:40	Jun. 18, 2009 07:42	17.6	262
	49640	Downstream	Jun. 19, 2009 04:13	Jun. 19, 2009 06:54	18.2	256
	4589	Downstream	Jul. 05, 2009 09:16	Jul. 05, 2009 22:37	18.2	183
	49634	Downstream	Jul. 07, 2009 00:32	Jul. 07, 2009 11:48	18.8	174
	8493	Downstream	May 05, 2010 07:36	May 06, 2010 21:03	11.1	43
	8492	Downstream	May 16, 2010 21:30	May 17, 2010 15:47	11.6	42
	4594	Downstream	Jun. 06, 2010 03:13	Jun. 07, 2010 01:39	20.0	41
	4593	Downstream	Jul. 03, 2010 09:49	Jul. 04, 2010 21:28	22.7	50

	4601	Downstream	May 9, 2011 20:51	May 16, 2011 00:39	8.0	230
	49630	Downstream	May 21, 2011 23:40	May 22, 2011 00:16	13.5	227
	49650	Downstream	May 22, 2011 03:17	May 22, 2011 03:42	13.8	225
	49638	Downstream	May 23, 2011 07:22	May 23, 2011 13:32	14.1	223
	49646	Downstream	May 24, 2011 00:01	May 24, 2011 00:50	13.6	221
	4749	Downstream	May 24, 2011 22:41	May 24, 2011 23:56	13.6	221
	4746	Downstream	Jul. 17, 2011 19:29	Jul. 18, 2011 00:45	23.3	134
	4743	Downstream	May 11, 2012 07:03	May 11, 2012 21:09	11.8	170
	4601	Downstream	May 16, 2012 13:05	May 20, 2012 23:30	15.5	158
	49641	Downstream	May 16, 2012 15:43	May 16, 2012 18:14	13.4	166
	49643	Downstream	May 17, 2012 20:49	May 18, 2012 00:06	14.2	162
	4752	Downstream	May 28, 2012 15:04	May 28, 2012 21:11	14.6	176
	4601	Downstream	Jun. 7, 2012 22:56	Jun. 9, 2012 05:43	20.0	274
	49640	Downstream	Jun. 19, 2012 15:10	Jun. 19, 2012 18:52	19.5	319
	4593	Downstream	Jun. 21, 2012 02:33	Jun. 21, 2012 05:51	19.2	325
	49630	Downstream	Jul. 5, 2012 13:45	Jul. 6, 2012 03:35	24.0	310
	49630	Downstream	May 30, 2013 05:53	May 30, 2013 12:22	12.1	355
	49632	Downstream	May 31, 2013 15:25	May 31, 2013 20:00	12.7	362
	49631	Downstream	Jun. 1, 2013 00:13	Jun. 1, 2013 14:55	13.2	367
	49653	Downstream	Jun. 2, 2013 08:24	Jun. 2, 2013 10:13	12.9	369
	49637	Downstream	Jun. 17, 2013 14:54	Jun. 18, 2013 11:38	17.5	304
	49642	Downstream	Jun. 22, 2013 00:53	Jun. 22, 2013 02:39	18.8	278
	49634	Downstream	Jun. 26, 2013 17:52	Jun. 26, 2013 20:57	19.7	254
Back Channel	4593	Downstream	Oct. 15, 2007 22:48	Oct. 16, 2007 06:15	11.5	283 / 25
	4601	Downstream	May 23, 2008 21:05	May 24, 2008 17:01	8.5	467 / 48
	4592	Downstream	Jun. 19, 2008 01:41	Jun. 19, 2008 13:05	15.4	409 / 40
	4595	Downstream	May 28, 2009 19:59	May 29, 2009 14:51	11.4	375 / 35
	4592	Downstream	Jun. 23, 2009 18:32	Jun. 24, 2009 17:23	19.8	239 / 20
	49634	Downstream	May 27, 2011 00:22	-	13.3	212 / 17
	4592	Downstream	Jul. 11, 2011 23:42	Jul. 12, 2011 10:02	23.4	144 / 10
	4746	Downstream	Jul. 20, 2011 08:23	Jul. 20, 2011 21:52	24.5	128 / 9

	4746	Downstream	Jun. 25, 2012 03:53	Jun. 25, 2012 07:33	20.4	320 / 29
	4746	Downstream	Jul. 9, 2012 13:01	Jul. 11, 2012 01:06	24.1	291 / 26
	4592	Downstream	Aug. 29, 2012 00:08	Sep. 1, 2012 16:59	22.4	97 / 6
	49633	Downstream	May 31, 2013 13:41	Jun. 1, 2013 06:58	13.2	362 / 34
	4602	Upstream	Oct. 04, 2007 19:40	**Return to Little Eva Lake**	14.8	128 / 9
	4602	Upstream	Oct. 19, 2007 03:28	Oct. 19, 2007 20:27	11.1	320 / 29
	4592	Upstream	May 21, 2008 19:40	**Return to Little Eva Lake**	7.4	464 / 47
	4592	Upstream	May 23, 2008 00:35	May 25, 2008 03:34	8.5	467 / 47
	4741	Upstream	May 27, 2008 06:18	May 30, 2008 12:38	10.7	444 / 44
	4592	Upstream	Jun. 19, 2008 15:29	Jun. 20, 2008 00:41	15.4	407 / 40
	49644	Upstream	Jun. 20, 2008 17:16	Jun. 21, 2008 03:58	16.0	404 / 39
	49630	Upstream	Jun. 26, 2008 21:10	Jun. 27, 2008 21:55	18.9	383 / 36
	49634	Upstream	Jun. 28, 2008 23:50	Jun. 30, 2008 07:57	19.1	373 / 35
	49632	Upstream	Jul. 05, 2008 17:04	Jul. 06, 2008 13:44	19.9	321 / 29
	4741	Upstream	Jul. 07, 2008 00:30	Jul. 07, 2008 11:26	21.0	315 / 28
	49633	Upstream	Jul. 07, 2008 20:56	Jul. 08, 2008 14:52	21.0	302 / 27
	49633	Upstream	Jul. 19, 2008 23:20	Jul. 20, 2008 19:19	20.3	243 / 20
	49637	Upstream	Jul. 20, 2008 20:48	Jul. 22, 2008 15:59	20.2	232 / 19
	49632	Upstream	May 04, 2009 19:36	May 06, 2009 17:20	6.3	325 / 29
	49640	Upstream	May 04, 2009 22:39	May 08, 2009 10:22	6.3	344 / 32
	49643	Upstream	May 06, 2009 21:36	May 15, 2009 16:54	7.5	392 / 38
	49635	Upstream	May 09, 2009 12:44	May 22, 2009 08:32	7.9	394 / 38
	49653	Upstream	May 11, 2009 23:57	May 18, 2009 12:32	8.2	398 / 38
	4740	Upstream	May 13, 2009 00:28	May 13, 2009 13:26	9.0	383 / 36
	49630	Upstream	May 14, 2009 23:03	May 17, 2009 14:22	9.1	398 / 38
	4589	Upstream	May 25, 2009 01:54	May 29, 2009 16:49	11.5	375 / 35
	4601	Upstream	Jun. 05, 2009 19:54	Jun. 06, 2009 14:15	12.8	334 / 31
	4594	Upstream	Jun. 24, 2009 06:59	**Return to Little Eva Lake**	20.4	239 / 20
	4593	Upstream	Jul. 11, 2009 17:00	Jul. 12, 2009 04:19	19.8	149 / 11
	4594	Upstream	Jul. 12, 2009 20:43	Jul. 13, 2009 09:48	19.6	145 / 11
	49646	Upstream	Jul. 09, 2010 00:39	Jul. 09, 2010 20:31	23.6	105 / 7
	49634	Upstream	Jul. 11, 2010 23:26	Jul. 13, 2010 08:10	24.4	125 / 9
	8493	Upstream	Jul. 21, 2010 16:16	Jul. 22, 2010 08:45	23.3	162 / 12

	49650	Upstream	May 07, 2011 22:59	May 17, 2011 06:33	6.8	233 / 19
	49630	Upstream	May 09, 2011 22:28	May 11, 2011 04:45	8.0	233 / 19
	4753	Upstream	May 11, 2011 00:12	**Return to Little Eva Lake**	9.5	233 / 19
	49638	Upstream	May 12, 2011 20:12	May 14, 2011 17:28	10.0	236 / 19
	4749	Upstream	May 14, 2011 20:25	May 17, 2011 02:14	9.1	233 / 19
	4592	Upstream	May 23, 2011 02:42	**Return to Little Eva Lake**	14.1	223 / 18
	4753	Upstream	May 24, 2011 04:22	**Return to Little Eva Lake**	13.6	221 / 18
	4593	Upstream	Jun. 30, 2011 00:06	Jul. 01, 2011 01:44	18.7	142 / 10
	4592	Upstream	Jun. 30, 2011 21:21	Jul. 01, 2011 07:27	18.7	142 / 10
	8492	Upstream	Jul. 07, 2011 20:29	Jul. 09, 2011 01:49	22.3	148 / 11
	4746	Upstream	Jul. 10, 2011 09:57	Jul. 10, 2011 22:49	23.0	147 / 11
	4746	Upstream	Jul. 19, 2011 04:43	Jul. 20, 2011 06:24	24.3	128 / 9
	4601	Upstream	Aug. 1, 2011 03:02	Aug. 01, 2011 15:56	23.3	96 / 6
	49650	Upstream	Mar. 30, 2012 16:59	May 4, 2012 23:45	10.8	160 / 12
	4743	Upstream	Apr. 27, 2012 21:52	May 1, 2012 16:54	9.3	148 / 11
	49635	Upstream	Apr. 28, 2012 00:59	May 4, 2012 01:29	10.8	160 / 12
	49641	Upstream	Apr. 28, 2012 23:00	May 4, 2012 00:34	10.8	160 / 12
	49643	Upstream	Apr. 28, 2012 23:32	May 1, 2012 23:11	9.3	148 / 11
	49640	Upstream	May 4, 2012 01:49	May 4, 2012 16:57	10.8	160 / 12
	4752	Upstream	May 9, 2012 01:40	May 10, 2012 12:53	11.5	171 / 13
	4594	Upstream	Jun. 1, 2012 01:00	Jun. 1, 2012 22:34	15.2	205 / 16
	4601	Upstream	Jun. 7, 2012 03:17	Jun. 7, 2012 21:11	18.8	258 / 22
	4746	Upstream	Jun. 8, 2012 23:43	Jun. 9, 2012 17:25	20.0	274 / 24
	49630	Upstream	Jun. 20, 2012 02:13	Jun. 20, 2012 16:53	19.1	324 / 29
	4592	Upstream	Jun. 20, 2012 16:15	Jun. 21, 2012 01:04	19.1	325 / 30
	49637	Upstream	Jun. 24, 2012 02:20	Jun. 25, 2012 03:08	20.4	320 / 29
	4746	Upstream	Jun. 25, 2012 13:19	Jun. 26, 2012 10:19	20.8	318 / 29
	49630	Upstream	May 16, 2013 22:48	May 18, 2013 22:55	8.0	141 / 10
	49653	Upstream	May 18, 2013 19:20	May 23, 2013 00:32	8.6	160 / 12
	49642	Upstream	May 20, 2013 09:59	May 24, 2013 19:08	9.1	203 / 16
	49634	Upstream	May 20, 2013 17:52	May 26, 2013 10:27	10.2	203 / 16
	49631	Upstream	May 24, 2013 23:41	May 26, 2013 11:30	10.2	289 / 26
	49632	Upstream	May 26, 2013 13:57	May 27, 2013 24:28	11.0	319 / 29
	49633	Upstream	May 30, 2013 15:30	May 31, 2013 11:13	12.7	355 / 33

	49636	Upstream	Jun. 21, 2013 16:41	Jun. 22, 2013 04:27	18.8	285 / 25
Hay Rapids	4588	Downstream	May 24, 2007 22:27	May 25, 2007 23:12	14.9	56
	4750	Downstream	May 25, 2007 02:23	May 25, 2007 23:47	14.9	56
	4589	Downstream	May 25, 2007 03:02	May 27, 2007 02:13	14.1	58
	4749	Downstream	May 28, 2007 01:32	May 28, 2007 05:38	14.0	59
	4602	Downstream	Jun. 07, 2007 11:36	Jun. 08, 2007 05:51	17.7	71
	4591	Downstream	Jun. 07, 2007 12:53	Jun. 08, 2007 03:03	17.7	71
	4594	Downstream	Jun. 12, 2007 08:31	Jun. 12, 2007 17:53	19.1	83
	4590	Downstream	Jun. 18, 2007 05:53	Jun. 19, 2007 22:46	21.1	99
	4742	Downstream	Jul. 11, 2007 11:45	Jul. 12, 2007 00:24	21.4	106
	4752	Downstream	Sep.19, 2007 04:40	Sep. 20, 2007 23:57	14.7	42
	4751	Downstream	Sep. 30, 2007 19:24	Oct. 01, 2007 22:54	15.2	106
	4744	Downstream	Oct. 15, 2007 22:11	Oct. 16, 2007 13:41	11.2	283
	4593	Downstream	Oct. 17, 2007 00:49	Oct. 17, 2007 08:18	11.0	293
	4601	Downstream	May 24, 2008 20:57	May 25, 2008 13:28	10.2	464
	4602	Downstream	Jun. 08, 2008 06:06	Jun. 08, 2008 09:33	13.4	402
	4741	Downstream	Jun. 16, 2008 10:32	Jun. 17, 2008 01:32	14.4	411
	4742	Downstream	Aug. 17, 2008 02:05	Aug. 17, 2008 22:03	22.7	115
	4741	Downstream	Feb. 26, 2009 23:21	May 05, 2009 14:53	6.8	313
	49642	Downstream	Mar. 01, 2009 00:35	May 23, 2009 04:18	10.7	391
	4744	Downstream	Mar. 01, 2009 02:49	May 07, 2009 13:39	8.3	336
	49633	Downstream	May 27, 2009 10:31	May 28, 2009 23:40	11.4	378
	49630	Downstream	May 28, 2009 02:11	May 28, 2009 15:10 [4]	11.4	378
	8495	Downstream	May 28, 2009 02:54	May 28, 2009 12:21[4]	11.4	378
	49635	Downstream	May 28, 2009 08:27	May 29, 2009 11:54 [4]	11.9	375
	49632	Downstream	May 28, 2009 18:32	May 28, 2009 23:57 [4]	11.4	378
	49644	Downstream	May 29, 2009 13:53	May 29, 2009 18:52	11.9	375
	4595	Downstream	May 29, 2009 21:26	May 30, 2009 01:19	12.1	369
	49643	Downstream	Jun. 02, 2009 02:13	Jun. 02, 2009 05:04	11.9	355
	49653	Downstream	Jun. 05, 2009 04:03	Jun. 05, 2009 06:08	12.8	338
	4588	Downstream	Jun. 05, 2009 22:52	Jun. 06, 2009 22:10	12.7	334
	4750	Downstream	Jun. 06, 2009 02:28	Jun. 06, 2009 06:06	12.7	334
	49637	Downstream	Jun. 07, 2009 16:41	Jun. 08, 2009 23:08	12.9	324
	4739	Downstream	Jun. 14, 2009 22:22	Jun. 15, 2009 02:28	15.5	282

	4591	Downstream	Jun. 16, 2009 12:40	Jun. 17, 2009 05:22	17.0	268
	4740	Downstream	Jun. 18, 2009 07:58	Jun. 19, 2009 09:00 [4]	18.2	256
	49640	Downstream	Jun. 18, 2009 18:00	Jun. 19, 2009 13:59 [4]	18.2	256
	4592	Downstream	Jun. 24, 2009 17:23	Jun. 27, 2009 03:16 [4]	20.8	223
	4594	Downstream	Jul. 01, 2009 14:33	Jul. 06, 2009 13:30 [4]	18.6	178
	4589	Downstream	Jul. 06, 2009 01:38	Jul. 06, 2009 15:58 [4]	18.6	178
	49634	Downstream	Jul. 07, 2009 17:48	Jul. 08, 2009 02:10 [4]	19.0	169
	49647	Downstream	Jul. 17, 2009 02:51	Jul. 18, 2009 11:13 [4]	17.4	130
	4742	Downstream	Aug. 02, 2009 23:49	Aug. 03, 2009 04:33	19.0	108
	4590	Downstream	Oct. 05, 2009 17:55	Oct. 06, 2009 20:50	12.5	54
	4741	Downstream	Mar. 15 , 2010 21:21	-	-	-
	49646	Downstream	Mar. 25, 2010 23:52	Jul. 07, 2010 21:57	23.9	91
	49631	Downstream	Apr. 09, 2010 20:16	Apr. 23, 2010 13:15	10.1	48
	4746	Downstream	Apr. 18, 2010 22:57	Apr. 19, 2010 18:26	10.6	50
	4592	Downstream	Apr. 26, 2010 16:17	Apr. 29, 2010 08:35	12.1	46
	4752	Downstream	May 24, 2010 07:56	May 24, 2010 18:37	19.4	41
	4745	Downstream	May 24, 2010 13:27	May 25, 2010 03:59	20.0	41
	4744	Downstream	May 24, 2010 15:46	May 25, 2010 01:41	20.0	41
	49647	Downstream	May 24, 2010 17:19	May 25, 2010 06:24	20.0	41
	49631	Downstream	May 25, 2010 01:51	May 25, 2010 15:46	20.0	41
	49652	Downstream	May 25, 2010 10:31	May 25, 2010 16:55	20.0	41
	49641	Downstream	May 26, 2010 11:48	May 26, 2010 21:07	19.9	40
	4743	Downstream	May 26, 2010 16:12	May 26, 2010 23:11	19.9	40
	49642	Downstream	May 27, 2010 02:38	May 27, 2010 14:28	20.2	40
	4594	Downstream	Jun. 08, 2010 02:37	Jun. 08, 2010 19:32	20.4	41
	8492	Downstream	Jun. 15, 2010 17:17	Jun. 16, 2010 05:05	19.1	44
	8492	Downstream	Jul. 02, 2010 15:16	Jul. 03, 2010 01:12	22.7	50
	4593	Downstream	Jul. 05, 2010 22:39	Jul. 07, 2010 00:28	23.9	91
	4592	Downstream	Sep. 14, 2010 14:30	Sep. 14, 2010 22:59	16.9	62
	4746	Downstream	May 04, 2011 23:07	May 07, 2011 02:33	6.8	223
	4601	Downstream	May 17, 2011 01:30	May 19, 2011 00:25	12.1	229
	49650	Downstream	May 22, 2011 08:09	May 22, 2011 12:17	13.8	225
	49630	Downstream	May 22, 2011 10:48	May 22, 2011 15:39	13.8	225
	4592	Downstream	May 23, 2011 14:32	May 23, 2011 22:11	14.1	223

	49638	Downstream	May 23, 2011 20:43	May 24, 2011 01:11	13.6	221
	4751	Downstream	May 24, 2011 03:31	May 25, 2011 04:54	13.5	218
	49646	Downstream	May 24, 2011 15:37	May 24, 2011 18:22	13.6	221
	4749	Downstream	May 25, 2011 05:00	May 25, 2011 08:21	13.5	218
	4739	Downstream	May 27, 2011 00:55	May 27, 2011 23:48	13.3	212
	8492	Downstream	May 31, 2011 13:31	Jun. 01, 2011 22:35	14.0	194
	49634	Downstream	Jun. 04, 2011 01:25	Jun. 04, 2011 20:23	14.4	185
	4591	Downstream	Jun. 11, 2011 20:38	Jun. 12, 2011 05:34	16.4	160
	4742	Downstream	Jul. 05, 2011 13:30	Jul. 07, 2011 00:14	22.3	146
	4592	Downstream	Jul. 13, 2011 17:21	Jul. 13, 2011 22:50	22.9	143
	4746	Downstream	Jul. 21, 2011 07:25	Jul. 21, 2011 12:58	24.6	123
	4746	Downstream	Jul. 31, 2011 18:56	Aug. 05, 2011 00:06	24.7	88
	4744	Downstream	Apr. 24, 2012 01:14	Apr. 25, 2012 01:59	7.7	120
	4743	Downstream	May 13, 2012 02:07	May 13, 2012 05:53	12.7	169
	49654	Downstream	May 14, 2012 08:57	May 14, 2012 13:03	13.1	169
	49635	Downstream	May 14, 2012 15:06	May 14, 2012 18:01	13.1	169
	4739	Downstream	May 16, 2012 01:25	May 17, 2012 01:52	13.7	165
	49641	Downstream	May 16, 2012 23:50	May 17, 2012 02:39	13.7	165
	49647	Downstream	May 19, 2012 23:24	May 20, 2012 02:57	15.5	158
	49643	Downstream	May 20, 2012 11:31	May 20, 2012 17:02	15.5	158
	4601	Downstream	May 21, 2012 21:43	May 22, 2012 04:00	15.8	157
	49643	Downstream	May 24, 2012 22:24	May 25, 2012 02:37	15.6	161
	4752	Downstream	May 29, 2012 05:17	May 29, 2012 11:12	14.8	183
	4601	Downstream	Jun. 9, 2012 19:43	Jun. 10, 2012 04:37	20.6	280
	4601	Downstream	Jun. 17, 2012 03:16	Jun. 17, 2012 08:55	19.5	312
	49640	Downstream	Jun. 19, 2012 19:53	Jun. 19, 2012 22:45	19.5	319
	49640	Downstream	Jun. 20, 2012 20:29	Jun. 21, 2012 00:55	19.2	325
	49632	Downstream	May 9, 2012 16:22	Jun. 21, 2012 14:54	19.2	325
	49640	Downstream	Jun. 21, 2012 18:39	Jun. 22, 2012 19:52	19.4	325
	4593	Downstream	Jun. 21, 2012 20:46	Jun. 22, 2012 06:09	19.4	325
	4592	Downstream	Sep. 2, 2012 14:14	Sep. 2, 2012 22:22	22.3	94
	49630	Downstream	May 30, 2013 22:39	May 31, 2013 01:38	12.1	355
	49632	Downstream	Jun. 1, 2013 02:22	June 1, 2013 19:13	13.2	362
	49633	Downstream	Jun. 1, 2013 09:15	June 1, 2013 14:16	13.2	362

	49653	Downstream	Jun. 2, 2013 14:26	Jun. 3, 2013 00:14	12.6	369
	49631	Downstream	Jun. 4, 2013 12:32	Jun. 4, 2013 15:02	12.6	371
	49637	Downstream	Jun. 18, 2013 16:54	Jun. 18, 2013 19:33	17.8	304
	49634	Downstream	Jun. 30, 2013 00:24	Jun. 30, 2013 06:19	20.5	237
	4742	Upstream	Jun. 12, 2007 03:12	Jun. 12, 2007 14:52	19.1	83
	4744	Upstream	Jul. 19, 2007 09:37	Jul. 19, 2007 17:59	21.8	94
	4741	Upstream	Jul. 26, 2007 22:10	Jul. 27, 2007 10:02	24.9	80
	4602	Upstream	Sep. 29, 2007 23:22	Sep. 30, 2007 06:56	15.4	99
	49644	Upstream	Jun. 11, 2008 23:09	Jun. 16, 2008 10:49	14.3	411
	49634	Upstream	Jun. 23, 2008 16:00	Jun. 25, 2008 23:41	18.2	391
	49630	Upstream	Jun. 24, 2008 15:45	Jun. 26, 2008 09:52	18.9	386
	49633	Upstream	Jun. 25, 2008 23:21	Jun. 27, 2008 16:12	19.2	383
	4741	Upstream	Jun. 26, 2008 05:08	Jun. 27, 2008 00:45	19.2	383
	49632	Upstream	Jul. 02, 2008 19:27	Jul. 03, 2008 23:10	19.3	350
	49635	Upstream	Jul. 17, 2008 05:35	Jul. 17, 2008 11:57	19.6	260
	49637	Upstream	Jul. 18, 2008 18:21	Jul. 19, 2008 03:14	20.3	249
	4742	Upstream	Jul. 21, 2008 00:43	Jul. 21, 2008 15:22	20.4	238
	4744	Upstream	Jul. 29, 2008 20:41	Jul. 30, 2008 08:53	21.9	185
	4740	Upstream	Aug. 02, 2008 09:45	Aug. 02, 2008 17:35	22.0	173
	4588	Upstream	Aug. 03, 2008 21:37	Aug. 04, 2008 19:42	22.4	163
	49640	Upstream	Aug. 04, 2008 05:57	Aug. 04, 2008 11:40	22.4	163
	49642	Upstream	Aug. 10, 2008 20:22	Aug. 12, 2008 07:45	22.4	132
	49643	Upstream	Aug. 15, 2008 03:02	Aug. 15, 2008 11:15	22.3	122
	4739	Upstream	Sep. 06, 2008 22:44	Sep. 07, 2008 22:43	19.6	70
	49653	Upstream	Sep. 27, 2008 02:14	Sep. 27, 2008 06:36	16.5	67
	4741	Upstream	May 07, 2009 03:31	Aug. 02, 2009 21:16	19.0	109
	8495	Upstream	May 21, 2009 15:39	May 26, 2009 16:37	11.3	385
	4589	Upstream	May 22, 2009 13:12	May 25, 2009 16:49	11.5	386
	4591	Upstream	May 23, 2009 00:03	May 25, 2009 16:07	11.5	386
	4750	Upstream	May 25, 2009 16:35	May 25, 2009 21:43	11.5	386
	4601	Upstream	Jun. 01, 2009 02:38	Jun. 01, 2009 19:06	11.5	361
	4752	Upstream	Jun. 07, 2009 17:02	Jun. 09, 2009 23:06	12.8	319
	4594	Upstream	Jun. 15, 2009 00:26	Jun. 22, 2009 09:44	19.2	248
	4745	Upstream	Jun. 24, 2009 00:10	Jun. 30, 2009 03:04	17.9	208

	49641	Upstream	Jul. 03, 2009 22:28	Jul. 05, 2009 03:42	18.2	183
	4742	Upstream	Jul. 03, 2009 22:55	Jul. 23, 2009 22:11	19.2	119
	4593	Upstream	Jul. 10, 2009 23:23	Jul. 11, 2009 17:00	19.8	153
	4594	Upstream	Jul. 11, 2009 23:05	Jul. 12, 2009 20:43	19.6	149
	49647	Upstream	Jul. 14, 2009 08:19	Jul. 16, 2009 18:56	18.2	134
	4744	Upstream	Jul. 24, 2009 07:22	Jul. 24, 2009 21:14	19.5	118
	49647	Upstream	Aug. 01, 2009 21:32	Aug. 02, 2009 03:12	19.0	109
	4592	Upstream	Aug. 16, 2009 13:59	Aug. 16, 2009 22:36	22.4	101
	49642	Upstream	Sep. 02, 2009 22:14	Sep. 03, 2009 02:04	19.7	90
	49631	Upstream	Sep. 04, 2009 00:22	Sep. 05, 2009 00:15	20	88
	4746	Upstream	Sep. 05, 2009 08:17	Sep. 06, 2009 16:45	20.4	86
	4590	Upstream	Sep. 10, 2009 02:25	Sep. 11, 2009 02:12	21.4	80
	4739	Upstream	Sep. 16, 2009 23:24	Sep. 17, 2009 14:15	21.3	73
	49652	Upstream	Apr. 27, 2010 03:36	Apr. 28, 2010 06:14	12.8	46
	49631	Upstream	May 02, 2010 04:24	May 03, 2010 05:42	10.4	43
	4743	Upstream	May 15, 2010 17:08	May 17, 2010 08:22	13.3	41
	49634	Upstream	Jun. 24, 2010 18:54	Jun. 25, 2010 10:01	21.9	47
	49630	Upstream	Jun. 26, 2010 02:33	Jun. 26, 2010 19:04	22.7	48
	8492	Upstream	Jun. 30, 2010 23:54	Jul. 01, 2010 10:12	21.8	50
	49650	Upstream	Jul. 06, 2010 14:01	Jul. 07, 2010 02:27	23.9	91
	49646	Upstream	Jul. 08, 2010 07:59	Jul. 08, 2010 19:04	23.6	98
	4592	Upstream	Jul. 11, 2010 03:27	Jul. 11, 2010 13:35	24.4	115
	4746	Upstream	Jul. 14, 2010 19:56	Jul. 15, 2010 22:04	23.1	137
	4749	Upstream	Sep. 27, 2010 19:49	Sep. 28, 2010 12:41	14.4	61
	49638	Upstream	May 10, 2011 19:45	May 12, 2011 05:53	10.0	234
	4751	Upstream	May 14, 2011 14:48	May 20, 2011 00:22	12.9	228
	4593	Upstream	May 18, 2011 09:37	May 19, 2011 03:24	12.1	229
	4591	Upstream	May 19, 2011 00:45	May 19, 2011 21:30	12.1	229
	4592	Upstream	May 20, 2011 17:50	May 21, 2011 04:11	13.5	227
	4752	Upstream	May 26, 2011 11:07	May 27, 2011 16:52	13.3	212
	8492	Upstream	May 28, 2011 15:57	May 30, 2011 14:40	13.7	205
	4742	Upstream	Jun. 07, 2011 22:35	Jun. 09, 2011 07:17	16.0	172
	4592	Upstream	Jun, 29, 2011 05:26	Jun. 29, 2011 23:16	18.3	141

	8492	Upstream	Jul. 04, 2011 12:37	Jul. 06, 2011 17:19	22.0	146
	49635	Upstream	Jul. 04, 2011 23:40	Jul. 05, 2011 14:08	21.6	146
	4746	Upstream	Jul. 08, 2011 17:56	Jul. 10, 2011 00:55	23.0	147
	4601	Upstream	Jul. 29, 2011 21:59	Jul. 30, 2011 04:20	23.0	101
	4746	Upstream	Jul. 30, 2011 18:49	Jul. 31, 2011 06:05	23.3	98
	4743	Upstream	Sep. 18, 2011 01:58	-	16.6	35
	49641	Upstream	Sep. 28, 2011 04:14	Sep. 28, 2011 13:41	15.0	32
	49632	Upstream	Feb. 16, 2012 01:33	May 9, 2012 16:22	11.0	170
	4741	Upstream	April 5, 2012 01:38	July 7, 2012 10:08	23.6	44
	49640	Upstream	Apr. 22, 2012 21:53	Apr. 24, 2012 19:23	7.9	102
	49647	Upstream	Apr. 27, 2012 05:20	Apr. 29, 2012 11:45	8.5	132
	4744	Upstream	May 2, 2012 05:31	Jul. 1, 2012 15:19	22.1	152
	4739	Upstream	May 3, 2012 04:51	May 4, 2012 20:33	10.8	156
	4594	Upstream	May 15, 2012 23:58	May 19, 2012 14:08	15.0	166
	4739	Upstream	May 19, 2012 07:25	Sep.4, 2012 15:06	22.3	160
	49647	Upstream	May 20, 2012 20:22	Sep. 21, 2012 11:58	15.3	158
	49643	Upstream	May 21, 2012 20:15	May 22, 2012 01:54	15.8	157
	49630	Upstream	June 1, 2012 13:10	Jun. 2, 2012 00:58	15.2	205
	49634	Upstream	Jun. 2, 2012 22:45	Jun. 3, 2012 18:49	15.8	211
	49633	Upstream	Jun. 3, 2012 07:25	Jun. 4, 2012 00:40	16.3	219
	4601	Upstream	Jun. 3, 2012 17:50	Jun. 4, 2012 09:22	16.3	219
	4745	Upstream	Jun. 4, 2012 01:58	Jun. 5, 2012 04:09	16.8	228
	4746	Upstream	Jun. 8, 2012 03:54	Jun. 8, 2012 17:51	19.5	266
	4592	Upstream	Jun. 14, 2012 02:22	Jun. 15, 2012 06:25	18.9	298
	4601	Upstream	Jun. 15, 2012 14:08	Jun. 15, 2012 22:24	19.0	301
	4601	Upstream	Jun. 18, 2012 03:31	Sep. 10, 2012 04:59	19.8	315
	49640	Upstream	Jun. 20, 2012 11:28	Jun. 20, 2012 17:45	19.1	324
	49640	Upstream	Jun. 21, 2012 05:05	Jun. 21, 2012 11:40	19.2	325
	49637	Upstream	June 21, 2012 15:30	Jun. 23, 2012 16:50	19.2	325
	49632	Upstream	Jun. 26, 2012 11:01	Jul. 23, 2012 10:09	20.8	318
	49636	Upstream	Jun. 19, 2013 22:18	Jun. 20, 2013 22:38	17.9	297

Appendix IV: Movement of lake sturgeon through rapids not proposed for development on Namakan River, Ontario from 2007 to 2012. All flow values represent the main river flow based on reported outflow from Lac La Croix (05PA006).

Location Description	Transmitter ID Code	Direction of Movement	Date/Time of Movement START	Date/Time of Movement END	Temperature (°C)	Water Flow (m^3/s)
Twisted Rapids	4600	Downstream	Jun. 02, 2007 04:29	Jun. 03, 2007 09:51	16.9	64
	4602	Downstream	Jun. 02, 2007 20:25	Jun. 03, 2007 17:09	16.9	64
	4594	Downstream	Jun. 09, 2007 04:13	Jun. 09, 2007 16:48	17.6	74
	4593	Downstream	Jun. 11, 2007 21:42	Jun. 12, 2007 05:50	19.1	83
	4593	Downstream	Jun. 18, 2007 07:22	Jun. 18, 2007 14:11	21.9	99
	4593	Downstream	Jul. 04, 2007 00:44	Jul. 10, 2007 07:27	22.6	108
	4593	Downstream	Jul. 23, 2007 23:54	Jul. 24, 2007 10:57	23.5	84
	4593	Downstream	Oct. 01, 2007 03:04	Oct. 03, 2007 23:13	14.9	121
	4597	Downstream	May 28, 2008 10:44	May 29, 2008 13:07	11.4	446
	4602	Downstream	Jun. 06, 2008 16:30	Jun. 06, 2008 22:38	12.5	407
	4741	Downstream	Jun. 10, 2008 12:47	Jun. 11, 2008 13:41	13.4	407
	4592	Downstream	Jun. 13, 2008 06:39	Jun. 14, 2008 05:19	14.1	407
	4595	Downstream	Jun. 28, 2008 02:24	Jun. 28, 2008 07:34	19.1	384
	4595	Downstream	Jul. 07, 2008 08:12	Jul. 07, 2008 23:10	21.0	315
	49633	Downstream	Jul. 10, 2008 00:38	Jul. 12, 2008 04:16	19.7	283
	4741	Downstream	Jul. 10, 2008 18:03	Jul. 11, 2008 17:11	19.9	287
	49632	Downstream	Jul. 12, 2008 03:06	Jul. 13, 2008 14:43	18.9	278
	4741	Downstream	Jul. 24, 2008 15:17	Jul. 25, 2008 06:27	21.7	213
	4595	Downstream	Jul. 29, 2008 17:39	Sep. 28, 2008 01:00	16.3	69
	49632	Downstream	Aug. 04, 2008 03:47	Aug. 04, 2008 11:32	22.4	163
	49632	Downstream	Aug. 23, 2008 08:09	Aug. 23, 2008 13:07	22.1	96
	49634	Downstream	Sep. 14, 2008 06:21	Sep. 17, 2008 22:34	16.9	65
	49644	Downstream	Sep. 15, 2008 02:41	Oct. 03, 2008 00:43	14.3	76
	49632	Downstream	Sep. 16, 2008 04:14	Sep. 16, 2008 15:47	16.8	65
	49637	Downstream	Sep. 19, 2008 00:59	Sep. 21, 2008 16:46	16.9	61
	49634	Downstream	Sep. 29, 2008 18:57	Oct. 01, 2008 19:15	15.0	73
	49632	Downstream	Oct. 02, 2008 23:09	Oct. 03, 2008 18:28	14.3	76

	49634	Downstream	Oct. 06, 2008 01:26	Oct. 09, 2008 07:02	12.9	83
	4592	Downstream	Oct. 08, 2008 10:29	May 15, 2009 21:30	8.5	392
	49632	Downstream	Oct. 09, 2008 22:46	Oct. 10, 2008 06:45	12.3	87
	49632	Downstream	Oct. 13, 2008 19:03	Oct. 14, 2008 21:33	12.1	98
	49634	Downstream	Oct. 20, 2008 03:53	Oct. 21, 2008 05:49	10.1	109
	49632	Downstream	Oct. 23, 2008 16:26	Oct. 24, 2008 00:03	9.3	111
	4595	Downstream	Nov. 04, 2008 12:23	May 05, 2009 19:49	6.8	313
	49644	Downstream	May 12, 2009 07:28	May 13, 2009 20:28	9.0	383
	49630	Downstream	May 27, 2009 17:16	May 27, 2009 18:35	11.1	383
	49635	Downstream	May 27, 2009 22:43	May 28, 2009 01:23	11.4	378
	49634	Downstream	May 28, 2009 10:12	May 29, 2009 00:10	11.9	375
	49637	Downstream	May 30, 3009 04:03	May 30, 2009 09:26	12.1	369
	49653	Downstream	Jun. 04, 2009 10:57	Jun. 04, 2009 14:30	12.7	343
	4740	Downstream	Jun. 17, 2009 14:20	Jun. 17, 2009 19:16	17.0	268
	49640	Downstream	Jun. 18, 2009 15:17	Jun. 18, 2009 21:35	17.6	262
	4589	Downstream	Jun. 22, 2009 03:27	Jun. 23, 2009 16:44	19.8	245
	4592	Downstream	Jun. 22, 2009 16:46	Jun. 23, 2009 02:04	19.8	245
	49634	Downstream	Jul. 02, 2009 11:36	Jul. 06, 2009 05:05	18.6	178
	4601	Downstream	Oct. 08, 2009 00:00	Apr. 24, 2010 22:00	11.6	48
	8492	Downstream	Apr. 02, 2010 04:30	Apr. 14, 2010 21:37	7.9	52
	8493	Downstream	Apr. 21, 2010 15:15	Apr. 21, 2010 23:58	10.9	49
	8492	Downstream	Apr. 25, 2010 02:23	Apr. 26, 2010 19:58	11.5	47
	8493	Downstream	Apr. 28, 2010 21:43	May 03, 2010 06:09	10.4	43
	4593	Downstream	May 21, 2010 18:55	May 22, 2010 01:21	20.3	41
	4593	Downstream	May 23, 2010 08:01	Jun. 25, 2010 22:25	21.9	47
	4594	Downstream	May 23, 2010 11:40	Jun. 05, 2010 15:33	19.9	40
	4601	Downstream	Apr. 10, 2011 02:10	May 08, 2011 04:43	7.2	227
	4597	Downstream	May 10, 2011 22:35	May 17, 2011 15:57	10.5	233
	49630	Downstream	May 21, 2011 05:12	May 21, 2011 11:28	13.5	227
	49638	Downstream	May 21, 2011 09:04	May 21, 2011 13:34	13.5	227
	4749	Downstream	May 21, 2011 14:20	May 23, 2011 04:13	14.1	223
	49650	Downstream	May 21, 2011 15:57	May 21, 2011 21:26	13.5	227
	49638	Downstream	May 22, 2011 14:31	May 22, 2011 18:29	13.8	225
	49634	Downstream	May 22, 2011 20:38	May 24, 2011 01:14	13.6	221

	49646	Downstream	May 23, 2011 09:22	May 23, 2011 15:47	14.1	223
	4597	Downstream	May 23, 2011 16:18	May 26, 2011 22:01	13.4	216
	4592	Downstream	Jul. 10, 2011 07:21	Jul. 10, 2011 21:05	23.0	147
	4746	Downstream	Jul. 16, 2011 03:15	Jul. 16, 2011 18:04	22.6	136
	4743	Downstream	May 10, 2012 02:05	May 10, 2012 04:31	11.5	171
	4601	Downstream	May 10, 2012 20:03	May 11, 2012 01:08	11.8	170
	49635	Downstream	May 14, 2012 00:39	May 14, 2012 03:57	13.1	169
	49641	Downstream	May 16, 2012 01:52	May 16, 2012 11:06	13.4	166
	4752	Downstream	May 28, 2012 00:18	May 28, 2012 05:35	14.6	176
	4593	Downstream	Jun. 17, 2012 16:22	Jun. 18, 2012 13:57	19.8	315
	49640	Downstream	Jun. 19, 2012 08:51	Jun. 19, 2012 11:16	19.5	319
	4746	Downstream	Jun. 20, 2012 22:18	Jun. 22, 2012 21:27	19.4	325
	4746	Downstream	Jun. 24, 2012 07:16	Jun. 24, 2012 11:21	20.1	322
	4746	Downstream	Jul. 8, 2012 01:11	Jul. 9, 2012 04:47	23.7	301
	49630	Downstream	May 27, 2013 10:46	May 27, 2013 15:12	11.0	331
	49653	Downstream	Jun. 1, 2013 11:16	Jun. 2, 2013 00:54	12.9	369
	49637	Downstream	Jun. 17, 2013 03:47	Jun. 17, 2013 07:24	17.5	312
	49642	Downstream	Jun. 19, 2013 10:33	Jun. 21, 2013 15:17	18.5	285
	49634	Downstream	Jun. 25, 2013 22:14	Jun. 26, 2013 13:37	19.7	254
	49636	Downstream	Jun. 27, 2013 04:09	Jun. 27, 2013 10:25	20.4	249
	4593	Upstream	May 23, 2007 21:21	May 25, 2007 22:17	14.7	55
	4595	Upstream	May 26, 2007 14:13	May 27, 2007 19:08	14.6	58
	4594	Upstream	May 27, 2007 07:44	May 27, 2007 22:40	14.1	58
	4593	Upstream	Jun. 17, 2007 22:46	Jun. 18, 2007 03:47	22.2	97
	4593	Upstream	Jun. 19, 2007 12:37	Jun. 19, 2007 18:39	21.1	99
	4593	Upstream	Jul. 13, 2007 08:00	Jul. 13, 2007 21:38	20.7	105
	4593	Upstream	Sep. 27, 2007 00:09	Sep. 27, 2007 07:58	15.4	78
	4597	Upstream	Oct. 06, 2007 20:34	Nov. 15, 2007 21:29	14.0	147
	4602	Upstream	Oct. 20, 2007 10:20	-	11.0	335
	4592	Upstream	May 30, 2008 21:05	May 31, 2008 05:35	11.7	444
	4741	Upstream	May 31, 2008 14:12	May 31, 2008 18:26	12.0	439
	4592	Upstream	Jun. 22, 2008 08:01	Jun. 22, 2008 12:54	16.5	403
	4595	Upstream	Jun. 29, 2008 12:50	Jun. 29, 2008 17:05	19.1	380
	49634	Upstream	Jul. 02, 2008 04:21	Jul. 06, 2008 04:50	19.5	358

	4741	Upstream	Jul. 08, 2008 02:51	Jul. 08, 2008 06:04	20.6	302
	49632	Upstream	Jul. 08, 2008 15:44	Jul. 09, 2008 01:22	20.6	302
	49633	Upstream	Jul. 09, 2008 01:59	Jul. 09, 2008 08:46	20.2	295
	4741	Upstream	Jul. 18, 2008 19:18	Jul. 19, 2008 05:23	20.1	253
	4595	Upstream	Jul. 27, 2008 21:42	Jul. 28, 2008 14:05	21.7	202
	49632	Upstream	Aug. 02, 2008 12:20	Aug. 03, 2008 16:01	22.0	173
	49644	Upstream	Aug. 05, 2008 22:01	Aug. 19, 2008 20:29	22.6	158
	49637	Upstream	Aug. 17, 2008 21:26	Aug. 18, 2008 22:27	22.7	115
	49632	Upstream	Aug. 21, 2008 22:17	Aug. 22, 2008 12:51	22.9	104
	49632	Upstream	Sep. 12, 2008 01:55	Sep. 12, 2008 23:17	17.7	69
	49637	Upstream	Sep. 24, 2008 22:11	Sep. 27, 2008 11:30	17.1	61
	49634	Upstream	Sep. 26, 2008 00:08	Sep. 26, 2008 10:33	16.7	63
	4595	Upstream	Sep. 29, 2008 10:30	Oct. 11, 2008 01:19	16.0	70
	49632	Upstream	Sep. 30, 2008 12:45	Oct. 02, 2008 00:53	15.5	72
	49634	Upstream	Oct. 03, 2008 19:43	Oct. 04, 2008 03:17	14.3	76
	49632	Upstream	Oct. 05, 2008 23:06	Oct. 08, 2008 02:20	13.7	79
	49644	Upstream	Oct. 06, 2008 05:01	Oct. 08, 2008 05:09	13.4	81
	49632	Upstream	Oct. 10, 2008 21:04	Oct. 12, 2008 09:02	12.3	87
	49634	Upstream	Oct. 14, 2008 05:40	Oct. 14, 2008 14:11	12.1	98
	49632	Upstream	Oct. 21, 2008 21:01	Oct. 23, 2008 11:16	10.1	109
	49634	Upstream	Oct. 22, 2008 19:57	Apr. 18, 2009 15:43	9.6	109
	4740	Upstream	May 14, 2009 08:24	May 14, 2009 16:05	9.1	386
	49640	Upstream	May 17, 2009 22:24	May 18, 2009 05:47	8.6	398
	49653	Upstream	May 19, 2009 05:54	May 19, 2009 15:04	9.4	400
	49630	Upstream	May 22, 2009 13:48	May 22, 2009 21:21	10.6	394
	49635	Upstream	May 23, 2009 18:34	May 23, 2009 21:26	10.7	391
	4592	Upstream	May 27, 2009 19:58	May 28, 2009 00:34	11.1	383
	4589	Upstream	May 31, 2009 00:21	May 31, 2009 05:29	11.8	367
	49634	Upstream	Jul. 01, 2009 03:23	Jul. 02, 2009 11:04	16.8	204
	4601	Upstream	Jul. 01, 2009 13:28	Jul. 07, 2009 02:00	16.8	204
	4594	Upstream	Jul. 13, 2009 19:06	Jul. 14, 2009 05:40	19.7	145
	4593	Upstream	Apr. 16, 2010 04:46	Apr. 17, 2010 01:31	7.0	50
	8492	Upstream	Apr. 24, 2010 01:07	Apr. 24, 2010 22:41	11.6	48
	8493	Upstream	Apr. 27, 2010 06:11	Apr. 27, 2010 12:55	12.3	46

	4601	Upstream	May 17, 2010 11:00	May 17, 2010 17:11	13.3	41
	4593	Upstream	May 22, 2010 21:04	May 23, 2010 00:38	20.3	41
	8493	Upstream	Jul. 23, 2010 01:07	Jul. 23, 2010 07:50	23.4	163
	4597	Upstream	May 08, 2011 01:15	May 08, 2011 11:14	7.2	227
	49630	Upstream	May 12, 2011 06:35	May 12, 2011 18:49	10.0	234
	49638	Upstream	May 15, 2011 02:38	May 15, 2011 08:03	9.2	235
	4749	Upstream	May 18, 2011 01:49	May 18, 2011 07:02	11.2	231
	4597	Upstream	May 18, 2011 22:43	May 19, 2011 03:58	11.2	231
	49650	Upstream	May 19, 2011 05:02	May 19, 2011 08:43	12.1	229
	49638	Upstream	May 21, 2011 21:37	May 22, 2011 09:39	13.5	227
	4592	Upstream	Jul. 01, 2011 18:08	Jul. 01, 2011 22:59	19.5	142
	8492	Upstream	Jul. 09, 2011 13:39	Jul. 09, 2011 18:20	22.6	148
	4746	Upstream	Jul. 11, 2011 21:32	Jul. 12, 2011 06:51	23.4	144
	4601	Upstream	Aug 01, 2011 16:31	Aug 26, 2011 04:47	23.5	96
	4743	Upstream	May 2, 2012 16:05	May 3, 2012 07:38	10.0	152
	49635	Upstream	May 4, 2012 08:47	May 4, 2012 13:01	10.8	160
	49641	Upstream	May 5, 2012 00:44	May 5, 2012 04:53	10.9	163
	49640	Upstream	May 5, 2012 02:37	May 5, 2012 07:23	10.9	163
	4601	Upstream	May 10, 2012 00:55	May 10, 2012 04:08	11.5	171
	4752	Upstream	May 10, 2012 22:55	May 11, 2012 03:09	11.5	171
	4594	Upstream	Jun. 2, 2012 08:38	Jun. 2, 2012 13:56	15.8	211
	4746	Upstream	Jun. 19, 2012 15:10	Jun. 19, 2012 20:57	19.5	319
	4746	Upstream	Jun. 30, 2012 00:29	Jul. 1, 2012 10:34	22.1	309
	49653	Upstream	May 23, 2013 13:51	May 23, 2013 20:33	8.6	270
	49630	Upstream	May 24, 2013 04:18	May 24, 2013 14:32	9.1	289
	49642	Upstream	May 26, 2013 06:36	May 26, 2013 11:30	10.2	320
	49634	Upstream	May 26, 2013 16:58	May 26, 2013 20:22	10.2	320
	49636	Upstream	Jun. 22, 2013 18:05	Jun. 23, 2013 16:51	18.6	278
	49636	Upstream	Jul. 7, 2013 03:34	Jul. 7, 2013 11:47	22.8	216
Quetico River	4592	Downstream	May 30, 2008 21:05	May 31, 2008 05:35	11.7	-
	49644	Downstream	May 23, 2009 16:00	May 24, 2009 03:26	10.7	-
	49643	Downstream	May 25, 2009 12:31	May 27, 2009 13:32	11.5	-
	49644	Downstream	May 26, 2009 04:30	May 27, 2009 14:46	11.3	-
	49644	Downstream	May 27, 2009 17:05	May 27, 2009 20:13	11.1	-

	4600	Downstream	May 28, 2009 13:49	Jun. 24, 2009 08:24	11.4	-
	49643	Downstream	May 30, 2009 20:20	May 30, 2009 22:21	12.1	-
	4589	Downstream	May 30, 2009 20:56	May 31, 2009 00:18	12.1	-
	4746	Downstream	Jun. 19, 2012 03:36	Jun. 19, 2012 14:42	19.5	-
	4592	Downstream	Jun. 21, 2012 10:51	Jun. 21, 2012 20:12	19.2	-
	49636	Downstream	Jul. 6, 2013 19:39	Jul. 7, 2013 03:24	22.8	-
	4592	Upstream	May 25, 2008 23:18	May 26, 2008 02:22	10.9	-
	49644	Upstream	May 21, 2009 04:55	May 21, 2009 20:42	10.2	-
	49644	Upstream	May 24, 2009 06:07	May 24, 2009 11:51	11.2	-
	49643	Upstream	May 24, 2009 18:32	May 24, 2009 20:47	11.2	-
	49644	Upstream	May 27, 2009 14:56	May 27, 2009 16:56	11.1	-
	49643	Upstream	May 27, 2009 15:35	May 27, 2009 18:31	11.1	-
	4600	Upstream	May 27, 2009 18:50	May 27, 2009 21:53	11.1	-
	4589	Upstream	May 29, 2009 20:43	May 29, 2009 23:16	11.9	-
	4746	Upstream	June 9, 2012 23:09	June 16, 2012 03:02	19.2	-
	4592	Upstream	June 21, 2012 05:29	June 21, 2012 10:19	19.2	-
	49636	Upstream	Jul. 1, 2013 00:28	Jul. 1, 2013 13:09	20.8	-
Quetico Rapids	4602	Downstream	Jun. 03, 2007 18:24	Jun. 04, 2007 14:31	16.9	64
	4600	Downstream	Jun. 04, 2007 00:34	Jun. 06, 2007 22:52	17.6	64
	4594	Downstream	Jun. 10, 2007 02:19	Jun. 10, 2007 13:41	17.9	77
	4593	Downstream	Jun. 12, 2007 06:42	Jun. 15, 2007 05:11	19.1	83
	4600	Downstream	Jun. 13, 2007 00:16	Jul. 09, 2007 13:14	19.9	85
	4593	Downstream	Jul. 24, 2007 11:25	Jul. 28, 2007 03:31	23.5	84
	4593	Downstream	Sep. 08, 2007 05:56	Sep. 11, 2007 04:38	19.6	36
	4593	Downstream	Oct. 05, 2007 03:37	Oct. 05, 2007 06:52	14.5	138
	4593	Downstream	Oct. 10, 2007 01:09	Oct. 11, 2007 16:09	12.7	205
	4601	Downstream	May 22, 2008 12:39	May 23, 2008 21:01	7.9	467
	4597	Downstream	Jun. 03, 2008 16:16	Jun. 04, 2008 00:33	12.6	417
	4602	Downstream	Jun. 07, 2008 04:52	Jun. 07, 2008 06:38	13.0	403
	4741	Downstream	Jun. 13, 2008 01:57	Jun. 13, 2008 04:06	13.6	406
	4592	Downstream	Jun. 14, 2008 12:13	Jun. 14, 2008 15:57	14.1	407
	4595	Downstream	Jul. 09, 2008 19:01	Jul. 10, 2008 04:55	20.2	295
	49630	Downstream	Jul. 11, 2008 18:46	Jul. 11, 2008 23:05	19.9	287
	49633	Downstream	Jul. 17, 2008 04:52	Jul. 17, 2008 05:48	19.6	260

	49632	Downstream	Jul. 20, 2008 12:55	Jul. 20, 2008 19:16	20.2	243
	4741	Downstream	Jul. 27, 2008 13:11	Jul. 27, 2008 19:32	21.7	202
	4741	Downstream	Aug. 05, 2008 13:18	Aug. 05, 2008 18:53	22.6	158
	49634	Downstream	Oct. 12, 2008 00:55	Oct. 13, 2008 00:02	12.3	94
	49632	Downstream	Oct. 16, 2008 22:27	Oct. 18, 2008 22:28	11.5	102
	49632	Downstream	Oct. 26, 2008 02:35	Oct. 26, 2008 23:37	8.9	111
	4595	Downstream	May 06, 2009 21:48	May 07, 2009 03:40	7.5	325
	49632	Downstream	May 26, 2009 23:37	May 27, 2009 03:53	11.3	385
	49630	Downstream	May 27, 2009 22:32	May 28, 2009 00:43	11.1	383
	49635	Downstream	May 28, 2009 05:35	May 28, 2009 07:25	11.4	378
	49644	Downstream	May 28, 2009 23:34	May 29, 2009 06:09	11.4	378
	49643	Downstream	May 30, 2009 22:35	May 31, 2009 12:15	12.1	369
	49637	Downstream	Jun. 03, 2009 06:03	Jun. 04, 2009 10:55	12.5	350
	49653	Downstream	Jun. 04, 2009 18:20	Jun. 04, 2009 20:09	12.7	343
	4740	Downstream	Jun. 18, 2009 03:40	Jun. 18, 2009 07:42	17.6	262
	49640	Downstream	Jun. 19, 2009 01:17	Jun. 19, 2009 04:11	18.2	256
	4592	Downstream	Jun. 23, 2009 12:18	Jun. 23, 2009 16:31	19.8	245
	4589	Downstream	Jun. 23, 2009 23:40	Jun. 25, 2009 02:20	19.8	245
	4600	Downstream	Jun. 24, 2009 17:21	Aug. 09, 2009 06:33	20.4	239
	4589	Downstream	Jul. 02, 2009 20:56	Jul. 03, 2009 00:45	16.7	199
	4589	Downstream	Jul. 05, 2009 09:16	Jul. 05, 2009 22:37	18.2	183
	49634	Downstream	Jul. 07, 2009 00:32	Jul. 07, 2009 11:48	18.8	174
	4600	Downstream	Aug. 15, 2009 19:11	Oct. 06, 2009 10:35	22.4	102
	8493	Downstream	May 04, 2010 23:11	May 05, 2010 07:36	10.7	43
	4596	Downstream	May 04, 2010 23:40	May 05, 2010 12:35	10.7	43
	8492	Downstream	May 16, 2010 00:15	May 16, 2010 11:52	11.6	42
	8492	Downstream	May 16, 2010 21:30	May 17, 2010 15:47	11.6	42
	4594	Downstream	Jun. 06, 2010 03:13	Jun. 07, 2010 01:39	20.0	41
	4593	Downstream	Jun. 26, 2010 08:49	Jun. 26, 2010 22:42	22.7	48
	4601	Downstream	May 09, 2011 20:51	-	8.0	230
	49650	Downstream	May 18, 2011 04:44	May 18, 2011 09:54	11.2	231
	49630	Downstream	May 21, 2011 16:52	May 21, 2011 23:04	13.5	227
	49650	Downstream	May 22, 2011 01:51	May 22, 2011 03:00	13.8	225
	49638	Downstream	May 22, 2011 23:43	May 23, 2011 07:22	13.8	225

	49646	Downstream	May 23, 2011 20:49	May 24, 2011 00:01	14.1	223
	4596	Downstream	May 24, 2011 19:19	May 25, 2011 22:35	13.6	221
	4749	Downstream	May 24, 2011 20:57	May 24, 2011 22:41	13.6	221
	49634	Downstream	May 26, 2011 17:48	May 26, 2011 23:20	13.4	216
	4597	Downstream	May 29, 2011 18:46	Oct 01, 2011 21:41	13.6	206
	4592	Downstream	Jul. 11, 2011 09:50	Jul. 11, 2011 17:38	23.4	144
	4746	Downstream	Jul. 17, 2011 19:29	Jul. 18, 2011 00:45	23.3	134
	4743	Downstream	May 10, 2012 21:22	May 11, 2012 05:47	11.5	171
	49635	Downstream	May 14, 2012 04:13	May 14, 2012 07:35	13.1	169
	4596	Downstream	May 15, 2012 00:15	May 15, 2012 19:07	13.4	166
	4597	Downstream	May 15, 2012 02:42	May 17, 2012 15:02	13.4	166
	49641	Downstream	May 16, 2012 15:43	May 16, 2012 18:14	13.4	166
	49643	Downstream	May 17, 2012 20:49	May 18, 2012 12:06	13.7	165
	4752	Downstream	May 28, 2012 06:58	May 28, 2012 09:11	14.6	176
	4593	Downstream	Jun. 19, 2012 05:53	Jun. 19, 2012 20:20	19.5	319
	49640	Downstream	Jun. 19, 2012 15:10	Jun. 19, 2012 18:52	19.5	319
	4592	Downstream	Jun. 23, 2012 13:30	Jun. 24, 2012 00:47	20.1	324
	4746	Downstream	Jun. 25, 2012 01:28	Jun. 25, 2012 03:33	20.4	320
	4592	Downstream	Jun. 26, 2012 19:50	Jun. 27, 2012 10:46	21.5	318
	4746	Downstream	Jul. 9, 2012 13:01	Jul. 11, 2012 01:06	23.7	301
	49630	Downstream	May 30, 2013 05:53	May 30, 2013 12:22	12.1	355
	49632	Downstream	May 31, 2013 10:16	May 31, 2013 13:20	12.7	362
	49631	Downstream	Jun. 1, 2013 00:13	Jun. 1, 2013 14:55	13.2	367
	49653	Downstream	Jun. 2, 2013 05:09	Jun. 2, 2013 08:15	12.9	369
	49637	Downstream	Jun. 17, 2013 14:54	Jun. 18, 2013 11:38	17.5	312
	49642	Downstream	Jun. 22, 2013 00:53	Jun. 22, 2013 02:39	18.8	278
	49634	Downstream	Jun. 26, 2013 17:52	Jun. 26, 2013 20:57	19.7	254
	4593	Upstream	May 23, 2007 14:00	May 23, 2007 18:36	14.7	55
	4600	Upstream	Jun. 09, 2007 06:01	Jun. 12, 2007 21:58	19.1	83
	4593	Upstream	Jun. 17, 2007 16:00	Jun. 17, 2007 21:19	22.2	97
	4593	Upstream	Sep. 25, 2007 05:43	Sep. 25, 2007 19:18	15.6	65
	4593	Upstream	-	Sep. 4, 2007 21:33	20.1	33
	4597	Upstream	Oct. 04, 2007 01:01	Oct. 06, 2007 03:29	14.0	147
	4593	Upstream	Oct. 07, 2007 23:07	Oct. 09, 2007 20:27	13.3	186

	4602	Upstream	Oct. 20, 2007 00:18	Oct. 20, 2007 03:35	11.0	335
	4592	Upstream	May 25, 2008 08:15	May 25, 2008 22:50	10.2	464
	4741	Upstream	May 30, 2008 15:21	May 31, 2008 07:33	12.0	439
	49644	Upstream	Jun. 21, 2008 05:27	Jun. 21, 2008 19:46	16.4	404
	4592	Upstream	Jun. 21, 2008 09:04	Jun. 22, 2008 01:58	16.5	403
	49634	Upstream	Jun. 30, 2008 09:01	Jun. 30, 2008 21:35	18.8	373
	49630	Upstream	Jul. 06, 2008 03:57	Jul. 06, 2008 11:01	20.7	321
	49632	Upstream	Jul. 06, 2008 14:45	Jul. 07, 2008 21:58	21.0	315
	4741	Upstream	Jul. 07, 2008 15:45	Jul. 07, 2008 18:41	21.0	315
	49633	Upstream	Jul. 08, 2008 16:23	Jul. 08, 2008 20:47	20.6	302
	4595	Upstream	Jul. 11, 2008 12:19	Jul. 24, 2008 09:44	21.4	220
	49632	Upstream	Jul. 20, 2008 20:30	Jul. 27, 2008 19:56	21.7	202
	49637	Upstream	Jul. 22, 2008 16:34	Jul. 23, 2008 08:24	21.3	226
	4741	Upstream	Jul. 30, 2008 12:41	Aug. 05, 2008 02:47	22.6	158
	49634	Upstream	Oct. 13, 2008 06:56	Oct. 13, 2008 23:42	12.5	96
	49632	Upstream	Oct. 19, 2008 07:04	Oct. 20, 2008 07:00	10.5	107
	4600	Upstream	May 05, 2009 06:17	May 19, 2009 14:38	9.4	400
	49632	Upstream	May 06, 2009 18:16	May 07, 2009 09:00	8.3	336
	49640	Upstream	May 13, 2009 09:38	May 13, 2009 21:20	9.0	383
	4740	Upstream	May 13, 2009 13:54	May 13, 2009 17:18	9.0	383
	49653	Upstream	May 18, 2009 13:28	May 18, 2009 21:06	9.2	398
	49630	Upstream	May 20, 2009 21:18	May 21, 2009 19:45	10.2	395
	49643	Upstream	May 21, 2009 01:15	May 21, 2009 05:38	10.2	395
	49635	Upstream	May 22, 2009 09:06	May 22, 2009 13:45	10.6	394
	4589	Upstream	May 29, 2009 17:37	May 29, 2009 20:15	11.9	375
	4601	Upstream	Jun. 06, 2009 15:35	Jun. 07, 2009 03:59	12.8	328
	4589	Upstream	Jul. 01, 2009 10:14	Jul. 01, 2009 21:28	16.8	204
	4589	Upstream	Jul. 03, 2009 00:45	Jul. 03, 2009 03:42	17.1	194
	4594	Upstream	Jul. 13, 2009 10:56	Jul. 13, 2009 13:44	19.7	145
	4600	Upstream	Aug. 10, 2009 08:59	Aug. 15, 2009 06:33	22.4	102
	4593	Upstream	Jul. 12, 2009 05:08	Apr. 14, 2010 22:16	7.9	52
	4596	Upstream	Apr. 28, 2010 12:34	May 1, 2010 00:20	11.0	45
	8492	Upstream	May 16, 2010 12:21	May 16, 2010 14:15	11.6	42
	49646	Upstream	Jul. 09, 2010 20:40	Jul. 09, 2010 23:16	23.6	105

	49634	Upstream	Jul. 13, 2010 09:09	Jul. 13, 2010 16:35	25.1	125
	8493	Upstream	Jul. 22, 2010 09:17	Jul. 22, 2010 14:57	24.2	162
	4597	Upstream	May 02, 2011 23:00	May 07, 2011 16:00	6.8	223
	49630	Upstream	May 11, 2011 08:26	May 11, 2011 16:53	9.5	233
	49638	Upstream	May 14, 2011 18:20	May 14, 2011 20:57	9.1	236
	4749	Upstream	May 17, 2011 03:10	May 17, 2011 07:34	10.5	233
	49650	Upstream	May 17, 2011 10:46	May 17, 2011 12:32	10.5	233
	49650	Upstream	May 18, 2011 17:00	May 18, 2011 19:51	11.2	231
	4596	Upstream	May 20, 2011 21:22	May 21, 2011 14:09	13.5	227
	4592	Upstream	Jul. 01, 2011 08:05	Jul. 01, 2011 10:49	19.5	142
	8492	Upstream	Jul. 09, 2011 05:30	Jul. 09, 2011 08:57	22.6	148
	4746	Upstream	Jul. 11, 2011 08:48	Jul. 11, 2011 14:45	23.4	144
	4593	Upstream	Jul 21, 2011 15:16	Oct 13, 2011 17:16	15.2	29
	4601	Upstream	Aug 01, 2011 11:21	Aug 01, 2011 13:24	23.5	96
	49650	Upstream	Mar. 20, 2012 16:59	May 4, 2012 23:45	10.8	160
	4601	Upstream	Apr. 27, 2012 01:41	May 2, 2012 22:07	10.0	152
	4743	Upstream	May 1, 2012 21:44	May 2, 2012 05:24	10.0	152
	49643	Upstream	May 2, 2012 01:54	May 2, 2012 07:16	10.0	152
	49635	Upstream	May 4, 2012 02:10	May 4, 2012 04:52	10.8	160
	49641	Upstream	May 4, 2012 02:40	May 4, 2012 05:31	10.8	160
	49640	Upstream	May 4, 2012 17:30	May 4, 2012 20:18	10.8	160
	4752	Upstream	May 10, 2012 13:13	May 10, 2012 15:49	11.5	171
	4596	Upstream	May 12, 2012 04:10	May 12, 2012 17:08	12.2	171
	4594	Upstream	Jun. 1, 2012 23:25	Jun. 2, 2012 02:26	15.8	211
	4746	Upstream	Jun. 9, 2012 18:31	Jun. 9, 2012 22:08	20.0	274
	4592	Upstream	Jun. 21, 2012 01:59	Jun. 21, 2012 04:52	19.2	325
	49637	Upstream	Jun. 25, 2012 09:28	Jun. 25, 2012 14:30	20.4	320
	4592	Upstream	Jun. 26, 2012 00:44	Jun. 26, 2012 09:10	20.8	318
	4746	Upstream	Jun. 26, 2012 14:30	Jun. 26, 2012 19:15	20.8	318
	49630	Upstream	May 19, 2013 03:01	May 20, 2013 21:02	8.1	175
	49653	Upstream	May 23, 2013 01:43	May 23, 2013 05:48	8.6	270
	49642	Upstream	May 25, 2013 07:16	May 25, 2013 13:04	9.5	306
	49634	Upstream	May 26, 2013 11:35	May 26, 2013 13:44	10.2	320
	49631	Upstream	May 26, 2013 14:16	May 26, 2013 17:27	10.2	320

	49632	Upstream	May 27, 2013 01:05	May 27, 2013 07:11	11.0	331
	49636	Upstream	Jun. 22, 2013 05:37	Jun. 22, 2013 12:02	18.8	278
Lady Rapids	4745	Downstream	May 16, 2007 14:29	-	14.5	52
	4739	Downstream	May 16, 2007 15:46	-	14.5	52
	4740	Downstream	May 16, 2007 21:52	May 22, 2007 18:34	14.5	52
	4747	Downstream	May 18, 2007 21:17	-	14.7	53
	4744	Downstream	May 19, 2007 20:19	Jul. 16, 2007 13:45	14.6	54
	4748	Downstream	May 22, 2007 01:46	May 22, 2007 20:51	14.2	55
	4741	Downstream	May 24, 2007 14:49	May 30, 2007 03:55	15.0	56
	4588	Downstream	May 25, 2007 23:50	May 26, 2007 05:36	14.9	56
	4750	Downstream	May 26, 2007 00:12	May 26, 2007 03:29	14.6	58
	4589	Downstream	May 27, 2007 02:51	May 28, 2007 00:25	14.1	58
	4749	Downstream	May 28, 2007 06:57	May 28, 2007 21:00	14.0	59
	4743	Downstream	May 28, 2007 23:40	May 29, 2007 16:22	14.0	59
	4591	Downstream	Jun. 08, 2007 03:46	Jun. 08, 2007 11:48	17.7	71
	4602	Downstream	Jun. 08, 2007 06:48	Jun. 08, 20007 21:35	17.7	71
	4594	Downstream	Jun. 12, 2007 18:05	Jun. 13, 2007 07:04	19.1	83
	4590	Downstream	Jun. 20, 2007 02:24	Jun. 21, 2007 06:55	20.5	103
	4748	Downstream	Jun. 24, 2007 23:17	Jun. 26, 2007 00:56	21.0	113
	4742	Downstream	Jul. 12, 2007 01:05	Jul. 12, 2007 10:06	21.4	106
	4752	Downstream	Sep. 21, 2007 00:16	Sep. 21, 2007 10:11	14.7	44
	4602	Downstream	Sep. 26, 2007 20:07	Sep. 27, 2007 05:16	15.4	72
	4751	Downstream	Oct. 01, 2007 23:48	Oct. 02, 2007 21:00	15.2	106
	4744	Downstream	Oct. 16, 2007 14:45	Oct. 16, 2007 23:19	11.2	283
	4593	Downstream	Oct. 17, 2007 13:51	Oct. 18, 2007 03:46	11.0	293
	4601	Downstream	May 25, 2008 13:45	May 31, 2008 13:00	10.2	464
	4602	Downstream	Jun. 08, 2008 09:38	Jun. 08, 2008 21:27	13.4	402
	4742	Downstream	Aug. 17, 2008 22:39	Aug. 18, 2008 06:00	22.7	115
	4744	Downstream	May 07, 2009 20:19	Jul. 22, 2009 22:00	8.3	336
	49642	Downstream	May 23, 2009 05:41	Aug. 30, 2009 19:20	10.7	391
	4748	Downstream	May 28, 2009 11:10	Jun. 05, 2009 06:01	11.4	378
	8495	Downstream	May 28, 2009 12:46	May 28, 2009 19:58	11.4	378
	49630	Downstream	May 28, 2009 15:19	May 28, 2009 19:11	11.4	378
	49632	Downstream	May 29, 2009 00:42	May 29, 2009 05:01	11.9	375

	49633	Downstream	May 29, 2009 02:46	May 29, 2009 10:54	11.9	375
	49635	Downstream	May 29, 2009 12:25	May 29, 2009 16:30	11.9	375
	49644	Downstream	May 29, 2009 19:07	May 30, 2009 04:14	11.9	375
	4595	Downstream	May 30, 2009 08:53	May 31, 2009 03:17	12.1	369
	49643	Downstream	Jun. 02, 2009 05:58	Jun. 02, 2009 09:32	11.9	355
	49653	Downstream	Jun. 05, 2009 06:41	Jun. 05, 2009 09:40	12.8	338
	4750	Downstream	Jun. 06, 2009 06:44	Jun. 06, 2009 10:59	12.7	334
	4588	Downstream	Jun. 06, 2009 23:22	Jun. 07, 2009 10:59	12.7	334
	49637	Downstream	Jun. 08, 2009 23:33	Jun. 09, 2009 06:21	12.9	324
	4739	Downstream	Jun. 15, 2009 02:43	Jun. 15, 2009 14:19	15.5	282
	4591	Downstream	Jun. 17, 2009 05:41	Jun. 17, 2009 12:46	17.0	268
	4740	Downstream	Jun. 19, 2009 09:23	Jun. 19, 2009 21:22	18.2	256
	49640	Downstream	Jun. 19, 2009 14:09	Jun. 19, 2009 17:13	18.2	256
	4594	Downstream	Jul. 06, 2009 14:09	Jul. 07, 2009 10:26	18.6	178
	4589	Downstream	Jul. 06, 2009 16:05	Jul. 06, 2009 20:30	18.6	178
	49647	Downstream	Jul. 06, 2009 16:34	Jul. 07, 2009 00:18	18.6	178
	49634	Downstream	Jul. 08, 2009 02:20	Jul. 08, 2009 07:53	19.0	169
	49647	Downstream	Jul. 18, 2009 12:04	Jul. 19, 2009 08:37	17.4	130
	4742	Downstream	Aug. 03, 2009 05:19	Aug. 03, 2009 21:19	19.0	108
	4590	Downstream	Oct. 06, 2009 21:17	Oct. 10, 2009 05:42	12.5	54
	4741	Downstream	Mar. 15 , 2010 21:21	-	-	42
	49646	Downstream	Mar. 25, 2010 23:52	Jul. 07, 2010 21:57	5.2	48
	49631	Downstream	Apr. 24, 2010 17:19	Apr. 25, 2010 20:46	11.6	48
	4590	Downstream	May 17, 2010 04:58	May 20, 2010 07:10	13.3	41
	4752	Downstream	May 24, 2010 19:13	May 25, 2010 07:31	19.4	41
	4744	Downstream	May 25, 2010 01:55	May 25, 2010 08:47	20.0	41
	4745	Downstream	May 25, 2010 04:40	May 25, 2010 17:08	20.0	41
	49647	Downstream	May 25, 2010 06:56	May 25, 2010 17:40	20.0	41
	49631	Downstream	May 25, 2010 16:23	May 26, 2010 03:26	20.0	41
	49652	Downstream	May 25, 2010 17:25	May 26, 2010 01:56	20.0	41
	49641	Downstream	May 26, 2010 21:32	May 27, 2010 08:22	19.9	40
	4743	Downstream	May 26, 2010 23:52	May 27, 2010 13:40	19.9	40
	49642	Downstream	May 27, 2010 15:06	May 27, 2010 21:35	20.2	40
	4594	Downstream	Jun. 08, 2010 21:22	Jun. 10, 2010 17:39	20.4	41

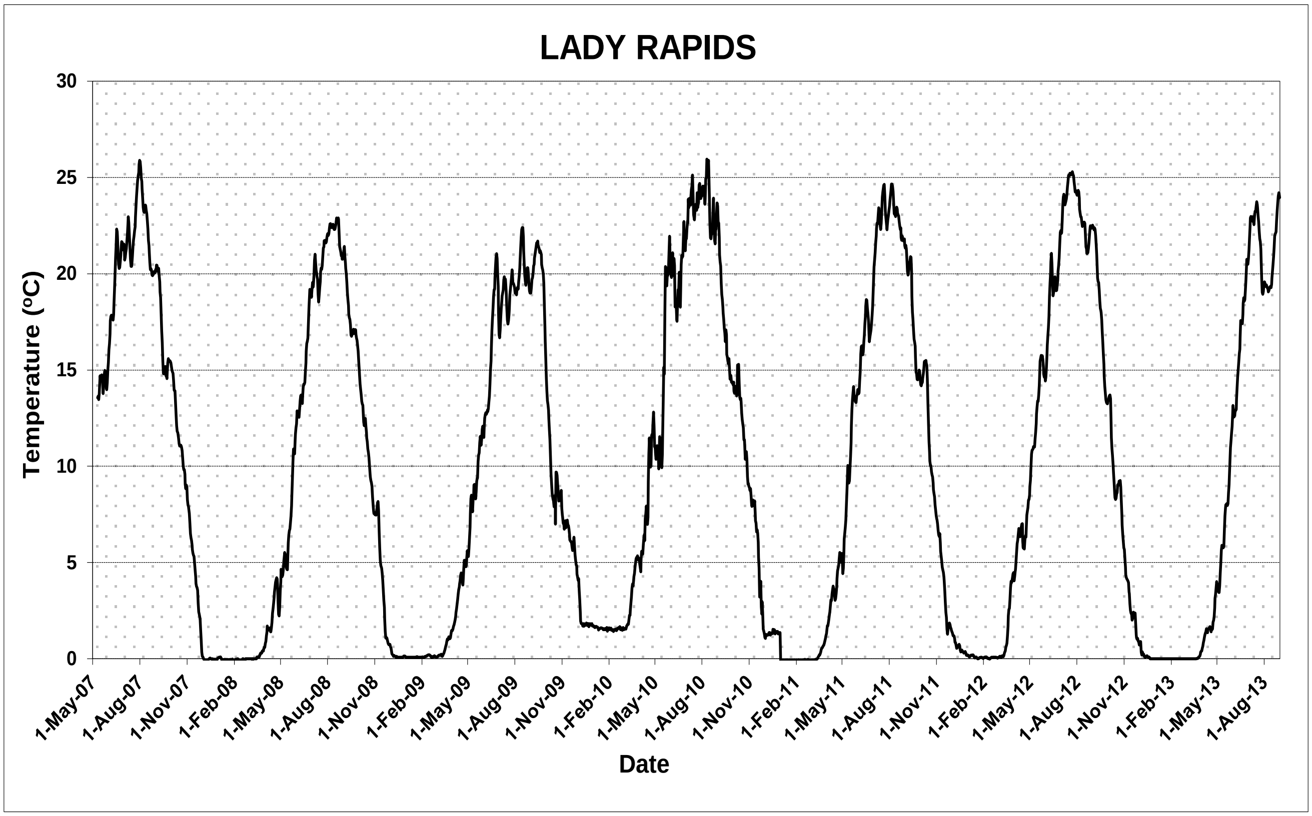
	4742	Downstream	Jun. 19, 2010 13:01	Jul. 04, 2010 04:14	18.3	44
	4593	Downstream	Jul. 07, 2010 02:20	Jul. 07, 2010 09:36	23.9	91
	4749	Downstream	Sep. 25, 2010 10:31	Sep. 26, 2010 05:01	14.7	62
	4601	Downstream	May 19, 2011 07:44	May 20, 2011 23:57	12.1	229
	49650	Downstream	May 22, 2011 12:25	May 22, 2011 21:20	13.8	225
	49630	Downstream	May 22, 2011 15:49	May 22, 2011 21:19	13.8	225
	49638	Downstream	May 24, 2011 01:57	May 24, 2011 10:41	13.6	221
	49646	Downstream	May 24, 2011 20:36	May 25, 2011 00:10	13.6	218
	4751	Downstream	May 25, 2011 06:10	May 25, 2011 19:18	13.5	218
	4749	Downstream	May 25, 2011 08:34	May 25, 2011 16:48	13.5	218
	4739	Downstream	May 28, 2011 00:24	May 29, 2011 00:29	13.3	209
	49634	Downstream	Jun. 04, 2011 20:33	Jun. 05, 2011 00:58	14.4	185
	4591	Downstream	Jun. 12, 2011 06:09	Jun. 14, 2011 09:01	16.4	160
	4742	Downstream	Jul. 06, 2011 00:53	Jul. 06, 2011 08:38	22.0	146
	49647	Downstream	Oct. 04, 2011 18:27	Oct. 07, 2011 02:08	14.4	29
	4744	Downstream	Apr. 25, 2012 02:25	Apr. 25, 2012 22:19	7.7	120
	49632	Downstream	May 9, 2012 04:22	Jun. 21, 2012 14:54	11.0	170
	4743	Downstream	May 13, 2012 06:17	May 13, 2012 11:31	12.7	169
	49654	Downstream	May 14, 2012 13:36	May 14, 2012 17:47	13.1	169
	49635	Downstream	May 14, 2012 18:07	May 15, 2012 01:10	13.1	169
	4739	Downstream	May 17, 2012 03:26	May 18, 2012 03:01	13.7	165
	49641	Downstream	May 17, 2012 03:32	May 17, 2012 10:24	13.7	165
	49647	Downstream	May 20, 2012 03:22	May 20, 2012 10:30	15.5	158
	49643	Downstream	May 25, 2012 03:03	May 26, 2012 05:38	15.6	161
	4752	Downstream	May 29, 2012 11:52	May 29, 2012 17:53	14.8	183
	4742	Downstream	Jun. 2, 2012 17:48	Jun. 3, 2012 19:35	15.8	211
	4601	Downstream	Jun. 17, 2012 19:26	Jun. 18, 2012 01:00	19.5	312
	49640	Downstream	Jun. 21, 2012 18:39	Jun. 22, 2012 19:52	19.2	325
	4593	Downstream	Jun. 21, 2012 20:46	Jun. 22, 2012 06:09	19.2	325
	49630	Downstream	May 31, 2013 01:43	May 31, 2013 06:21	12.7	362
	49633	Downstream	Jun. 1, 2013 15:00	Jun. 1, 2013 20:09	13.2	367
	49632	Downstream	Jun. 1, 2013 19:52	Jun. 1, 2013 23:20	13.2	367
	49653	Downstream	Jun. 3, 2013 00:36	Jun. 3, 2013 15:45	12.6	371
	49631	Downstream	Jun. 4, 2013 15:53	Jun. 4, 2013 19:00	12.6	371

	49637	Downstream	Jun. 18, 2013 19:53	Jun. 19, 2013 04:49	17.4	296
	49642	Downstream	Jun. 26, 2013 11:12	Jun. 26, 2013 17:23	19.7	254
	49634	Downstream	Jun. 30, 2013 07:10	Jun. 30, 2013 12:33	20.5	237
	4748	Upstream	Jun. 23, 2007 13:13	Jun. 24, 2007 17:12	21.0	113
	4744	Upstream	Jul. 16, 2007 22:16	Jul. 19, 2007 09:09	21.8	94
	4741	Upstream	Jul. 25, 2007 08:58	Jul. 26, 2007 20:43	24.5	81
	4602	Upstream	Sep. 25, 2007 15:26	Sep. 26, 2007 03:30	15.4	72
	4602	Upstream	Sep. 29, 2007 12:29	Sep. 29, 2007 22:58	15.4	92
	4601	Upstream	May 31, 2008 14:29	May 31, 2009 23:37	11.8	367
	49644	Upstream	Jun. 09, 2008 02:56	Jun. 11, 2008 21:37	13.4	407
	49634	Upstream	Jun. 14, 2008 20:19	Jun. 23, 2008 15:35	16.7	400
	49630	Upstream	Jun. 22, 2008 00:39	Jun. 24, 2008 15:06	17.4	396
	49633	Upstream	Jun. 24, 2008 00:28	Jun. 25, 2008 23:01	18.2	391
	49632	Upstream	Jun. 28, 2008 11:54	Jul. 02, 2008 18:45	19.5	358
	49637	Upstream	Jul. 14, 2008 00:38	Jul. 18, 2008 18:01	20.1	253
	49635	Upstream	Jul. 14, 2008 10:55	Jul. 17, 2008 04:57	19.6	260
	4742	Upstream	Jul. 17, 2008 03:02	Jul. 21, 2008 00:07	20.4	238
	4589	Upstream	Jul. 20, 2008 16:49	May 22, 2009 12:36	10.6	394
	4744	Upstream	Jul. 28, 2008 11:07	Jul. 29, 2008 19:54	21.7	191
	49640	Upstream	Jul. 29, 2008 00:42	Aug. 04, 2008 05:34	22.4	163
	4588	Upstream	Aug. 01, 2008 02:39	Aug. 02, 2008 23:57	22.0	173
	4740	Upstream	Aug. 01, 2008 03:40	Aug. 02, 2008 09:19	22.0	173
	4591	Upstream	Aug. 06, 2008 21:15	May 22, 2009 23:36	10.6	394
	49642	Upstream	Aug. 09, 2008 23:37	Aug. 10, 2008 20:00	22.4	139
	49643	Upstream	Aug. 14, 2008 11:30	Aug. 15, 2008 02:38	22.3	122
	4750	Upstream	Aug. 23, 2008 05:49	May 25, 2009 21:43	11.5	386
	4748	Upstream	Aug. 27, 2008 05:37	May 27, 2009 23:59	11.1	383
	8495	Upstream	Sept. 05, 2008 11:34	May 21, 2009 15:12	10.2	395
	4739	Upstream	Sept. 03, 2008 17:13	Sep. 04, 2008 19:39	20.5	74
	4752	Upstream	-	Sep. 28, 2008 19:59	16.3	69
	49653	Upstream	-	Sep. 27, 2008 01:41	16.5	67
	4742	Upstream	Jun. 12, 2009 10:24	Jun. 20, 2009 07:27	18.8	249
	4594	Upstream	Jun. 12, 2009 17:07	Jun. 14, 2009 23:11	15.0	288
	4745	Upstream	Jun. 20, 2009 15:22	Jun. 23, 2009 23:49	19.8	245

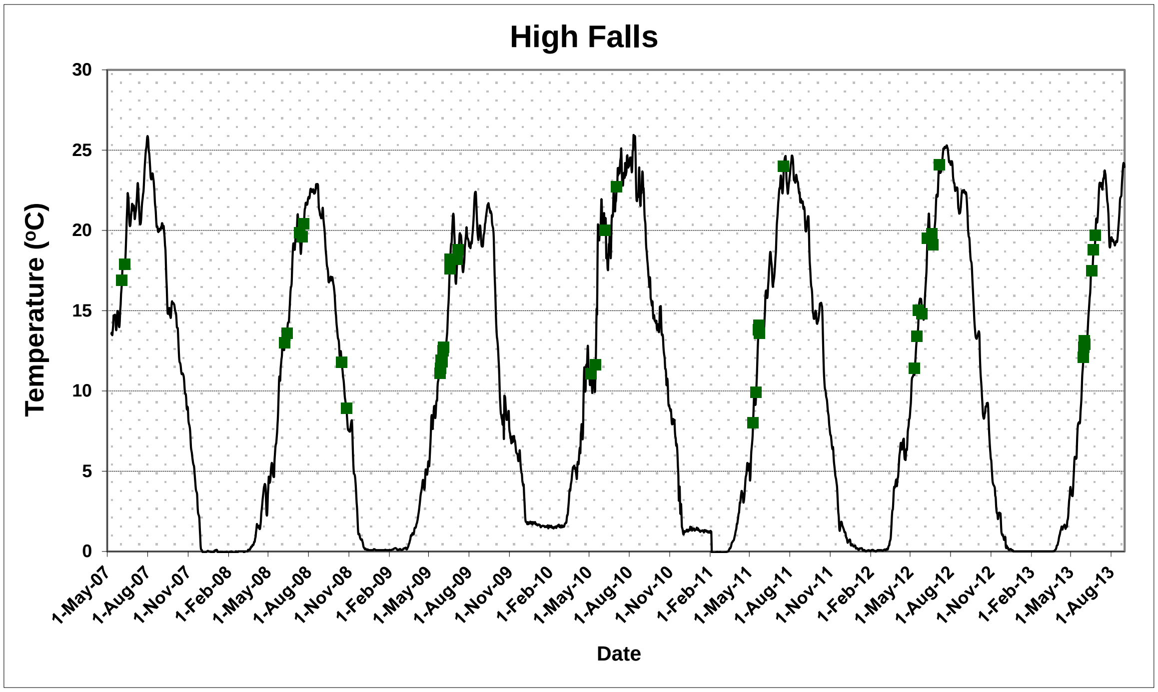
	49647	Upstream	Jul. 02, 2009 06:39	Jul. 03, 2009 11:41	17.1	194
	49641	Upstream	Jul. 02, 2009 17:21	Jul. 03, 2009 22:06	17.1	194
	4593	Upstream	Jul. 10, 2009 09:13	Jul. 10, 2009 23:09	19.7	158
	4594	Upstream	Jul. 10, 2009 20:15	Jul. 11, 2009 22:44	19.8	153
	49647	Upstream	Jul. 13, 2009 11:47	Jul. 14, 2009 05:22	19.5	143
	4744	Upstream	Jul. 23, 2009 03:46	Jul. 24, 2009 06:58	19.5	118
	49647	Upstream	Jul. 31, 2009 20:51	Aug. 01, 2009 19:43	19.0	108
	49642	Upstream	Sep. 02, 2009 04:44	Sep. 02, 2009 19:20	19.3	91
	49631	Upstream	Sep. 03, 2009 03:44	Sep. 03, 2009 23:32	19.7	90
	4590	Upstream	Sept. 09, 2009 15:04	Sep. 10, 2009 02:08	21.2	81
	4739	Upstream	Sep. 14, 2009 22:04	Sep. 15, 2009 18:33	21.5	77
	4590	Upstream	Apr. 19, 2010 23:05	Apr. 26, 2010 12:18	11.5	47
	4743	Upstream	Apr. 23, 2010 22:12	Apr. 24, 2010 17:45	11.6	48
	49652	Upstream	Apr. 24, 2010 07:39	Apr. 24, 2010 22:46	11.6	48
	49631	Upstream	Apr. 25, 2010 20:46	Apr. 26, 2010 13:53	11.5	47
	4742	Upstream	Jun. 14, 2010 13:50	Jun. 16, 2010 06:37	19.1	44
	49634	Upstream	Jun. 22, 2010 21:14	Jun. 23, 2010 12:30	20.8	46
	49630	Upstream	Jun. 25, 2010 12:19	Jun. 26, 2010 02:03	22.7	48
	49650	Upstream	Jul. 06, 2010 02:59	Jul. 06, 2010 13:42	23.4	82
	49646	Upstream	Jul. 07, 2010 22:16	Jul. 08, 2010 07:54	23.6	98
	4749	Upstream	Sep. 23, 2010 14:07	Sep. 24, 2010 09:09	14.5	60
	4749	Upstream	Sep. 27, 2010 04:45	Sep .27, 2010 18:57	14.4	61
	49638	Upstream	Apr. 19, 2011 04:20	May 10, 2011 19:07	8.7	233
	4751	Upstream	Apr. 26, 2011 02:36	May 14, 2011 10:23	9.1	236
	4752	Upstream	May 09, 2011 06:34	May 26, 2011 09:43	13.4	216
	4593	Upstream	May 10, 2011 02:41	May 18, 2011 09:02	11.2	231
	4591	Upstream	May 11, 2011 16:16	May 19, 2011 00:21	12.1	229
	4742	Upstream	May 22, 2011 15:02	Jun. 07, 2011 11:12	16.2	179
	49635	Upstream	Jul. 03, 2011 22:09	Jul. 04, 2011 23:18	21.1	144
	4601	Upstream	Jul. 29, 2011 02:00	Jul. 29, 2011 12:08	22.8	103
	4744	Upstream	Aug. 10, 2011 04:11	Aug. 11, 2011 14:19	23.1	76
	49643	Upstream	Aug 18, 2011 04:32	Aug. 18, 2011 20:00	23.1	68
	4743	Upstream	Sep. 16, 2011 16:28	Sep 17, 2011 03:39	17.0	36
	49641	Upstream	Sep. 28, 2011 04:14	Sep. 28, 2011 13:41	15.0	32

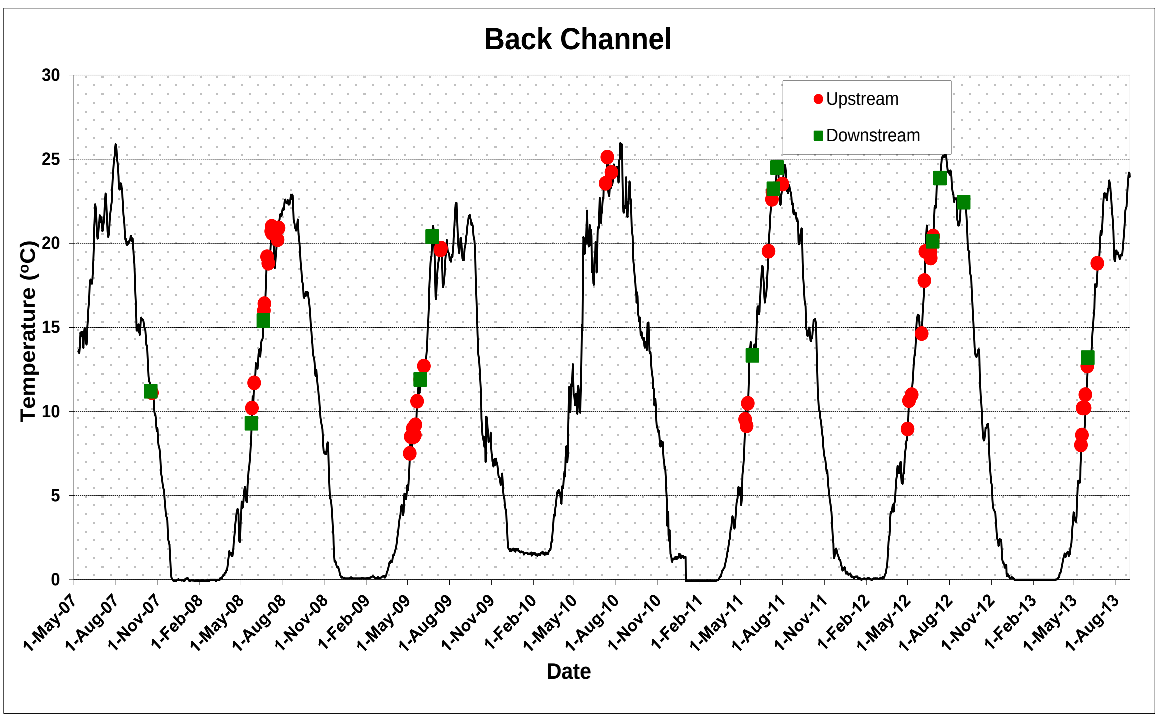
	49647	Upstream	Sep. 29, 2011 17:24	Sep. 30, 2011 10:43	14.5	31
	49632	Upstream	Feb. 16, 2012 01:33	May 9, 2012 04:22	11.0	170
	49647	Upstream	Apr. 2, 2012 21:29	Apr. 26, 2012 21:02	7.9	126
	4741	Upstream	Apr. 5, 2012 01:38	July 7, 2012 10:08	23.6	307
	49640	Upstream	Apr. 15, 2012 00:49	Apr. 22, 2012 21:15	6.3	102
	4739	Upstream	Apr. 20, 2012 04:12	May 3, 2012 04:27	10.6	156
	4744	Upstream	May 2, 2012 05:31	Jul. 1, 2012 15:19	22.1	309
	4594	Upstream	May 13, 2012 23:25	May 15, 2012 23:30	13.4	166
	4739	Upstream	May 19, 2012 07:25	Sep.4, 2012 15:06	22.3	89
	49647	Upstream	May 20, 2012 20:22	Sep. 21, 2012 11:58	15.3	57
	4742	Upstream	May 21, 2012 11:56	May 29, 2012 00:55	14.8	183
	49634	Upstream	May 29, 2012 23:32	Jun. 2, 2012 21:01	15.8	211
	49630	Upstream	May 31, 2012 12:38	Jun. 1, 2012 11:18	15.2	205
	49633	Upstream	Jun. 2, 2012 03:11	Jun. 3, 2012 06:42	16.2	219
	4745	Upstream	Jun. 2, 2012 07:29	Jun. 4, 2012 01:26	16.8	228
	4601	Upstream	Jun. 18, 2012 03:31	Sep. 10, 2012 02:48	19.6	78
	49637	Upstream	Jun. 21, 2012 15:30	Jun. 23, 2012 16:50	19.7	324
	49632	Upstream	Jun. 26, 2012 11:01	Jul. 23, 2012 10:09	25.2	324
	49636	Upstream	Jun. 16, 2013 12:57	Jun. 19, 2013 21:05	17.4	317

Appendix V: Mean daily water temperature recorded at Lady Rapids in Namakan River, Ontario from May, 2007 to August, 2013.

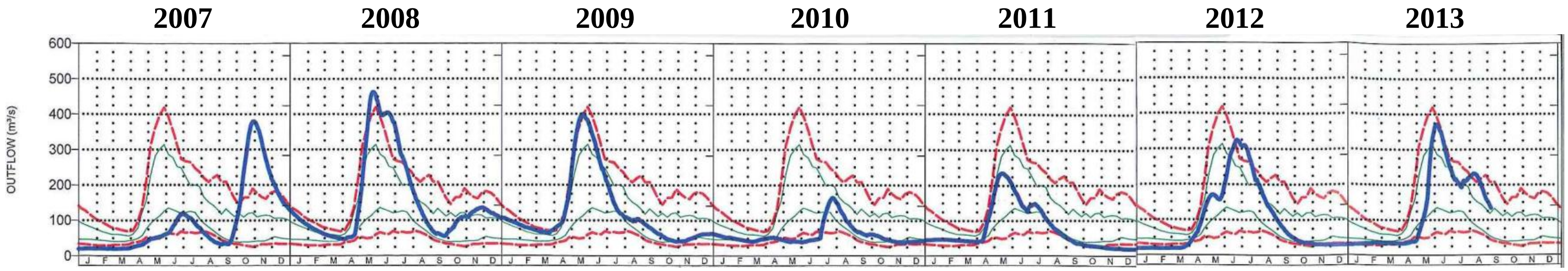


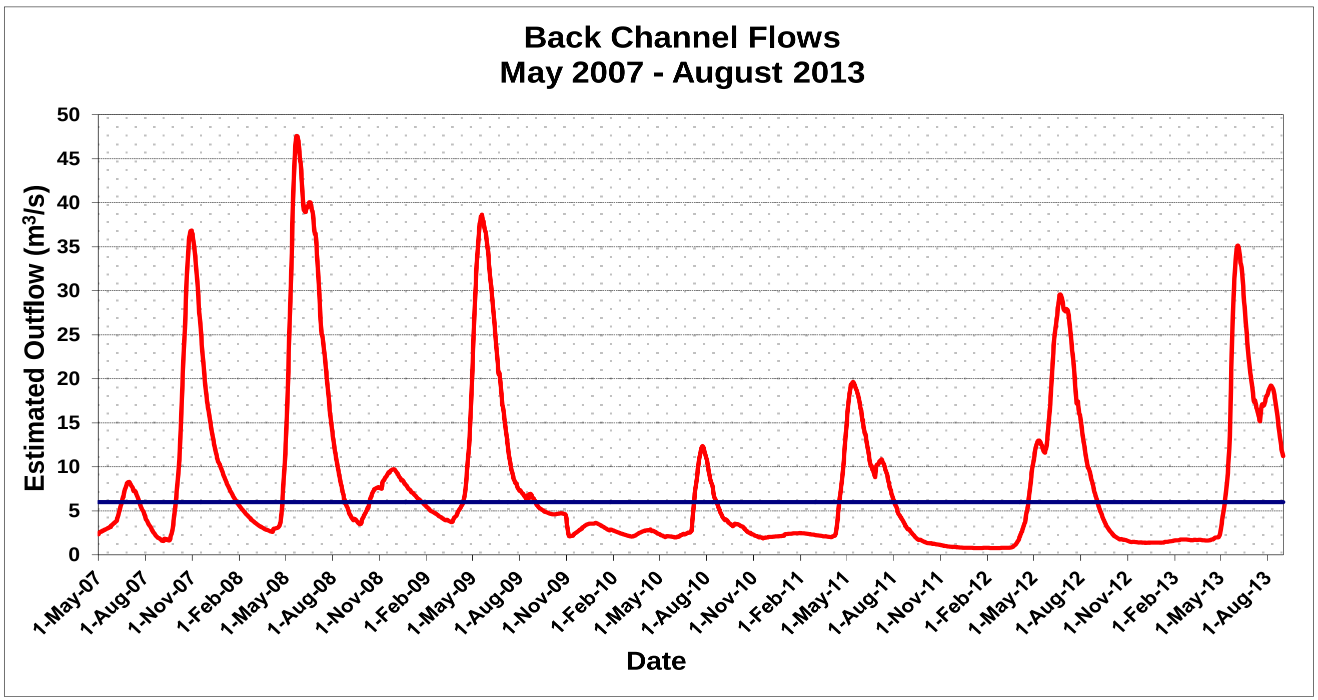
Appendix VI: Movements of lake sturgeon through High Falls and Back Channel in relation to daily water temperatures in the Namakan River, Ontario.





Appendix VII: Estimated water flow in Namakan River, Ontario from January, 2007 to August, 2013. Data reported as the daily mean outflow from Lac La Croix including 10%, 25%, 75% and 90% percentile flows.





Appendix VIII: Movement of lake sturgeon through High Falls and Back Channel in relation to daily water flows in the Namakan River, Ontario.