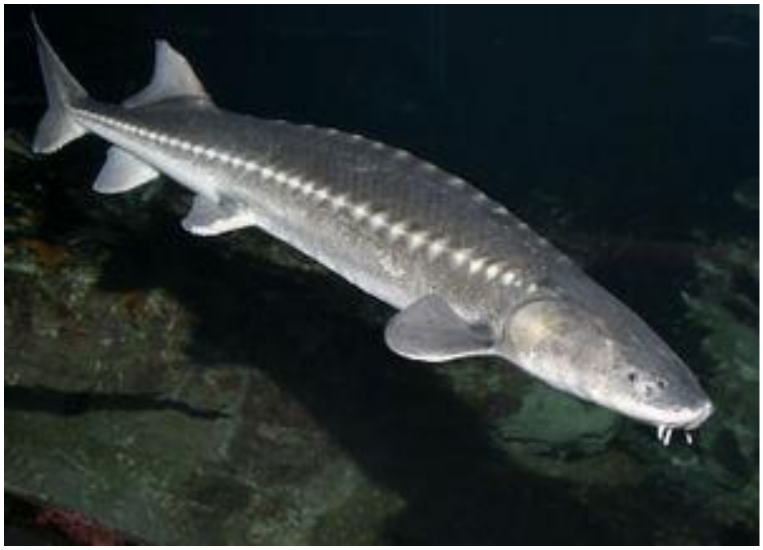


DISTRIBUTION AND MIGRATION OF SONIC-TAGGED STURGEON WITH REGARDS TO OVERWINTERING HABITAT IN THE LOWER FRASER RIVER, 2009-10

By:

Paul Neufeld

Kaid Teubert

Jeremy Mothus

British Columbia Institute of Technology

Fish, Wildlife and Recreation

May, 2010

DISTRIBUTION AND MIGRATION OF SONIC-TAGGED STURGEON WITH REGARDS TO OVERWINTERING HABITAT IN THE LOWER FRASER RIVER, 2009-10

By:

Paul Neufeld

Kaid Teubert

Jeremy Mothus

A REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DIPLOMA OF TECHNOLOGY

In

FISH, WILDLIFE, & RECREATION MANAGEMENT

RENEWABLE RESOURCES TECHNOLOGY

SCHOOL OF CONSTRUCTION AND THE ENVIRONMENT

We accept this report as conforming to the request standard

Supervisor

Program Head

BRITISH COLUMBIA INSTITUE OF TECHNOLOGY

May, 2010

Abstract

White sturgeon (*Acipenser transmontanus*) which were implanted with acoustic tags were tracked using mobile telemetry from the Sumas/Fraser river confluence to the Port Mann Bridge including the lower Pitt River, between November 2009 and January 2010. The study area was divided into four separate reaches to accommodate a given day of tracking to each portion of the study area. A VR 100 VEMCO receiver and VH 110 hydrophone were used to gather information on habitat utilization, migration distances, and locations of possible congregations of these endangered populations of sturgeon. The bulk of the sampling was done weekly during the months of November and January (1 day in December), to identify possible shifts in habitat use and congregation locations between the seasons, as this has yet to be fully understood for the Fraser river sturgeon population. In addition to detecting sturgeon locations the water depths at detection locations and water temperatures were also recorded during the sampling days. Water temperature ranged from an average of 7°C in November/December to an average of 5°C in January.

The main findings of this study are as follows: Of the 110 white sturgeon implanted with acoustic tags 62 individuals were detected in the study area, with the daily catches ranging from 0-24 fish. There was a 26% higher abundance of sturgeon observed in the fall compared to the winter within the study area. The detected sturgeon were scattered throughout the study area, with higher concentrations occurring in the lower Pitt River, below rKm 55 (Ernie's Hole), around Douglas Island (upstream Port Mann Bridge) and at the outlet of the Stave River near where fish were initially tagged. Of the 62 sturgeon observed, 26 were detected on multiple sampling days, showing movements between or within the different reaches. Movements of all 62 fish varied from 0.07 km to 65.78 km with the majority of the fish travelling <5 km, over the study period. When comparing distances travelled between juveniles (<1 m TL) and adults (>1 m TL), there was no significant difference. Also, there was no significant difference in distance traveled by fish which were tagged in the Fraser River and fish which were tagged in the Pitt River.

From the information gathered using mobile telemetry during the November to January period, it appears that many sturgeon are scattered throughout the study area over winter, with preferred sites being Ernie's Hole, around Douglas Island and at the outlet of the Stave River. These may be preferred year round locations, for many year classes of sturgeon regardless of season. Replication of this study, including sampling during the May-June period, before and during the freshet, is recommended to get more complete results on the extent of habitat utilization, migrations and locations of possible winter congregations of these threatened populations of lower Fraser River sturgeon.

Table of Contents

List of Figures

List of Tables

Acknowledgements

We express our sincere thanks to BCIT for funding and supporting this project. Many people contributed to this study and to whom we express our gratitude; these include: Dave Robichaud and Troy Nelson (LGL Limited) for help in securing the VEMCO receiver and supplying us with data on where the sturgeon were equipped with the sonic tags and the fishes lengths and girths; Rudy North (North Growth Foundation) for the contribution of his boat, which was used to complete the research on the river; Bob Gunn (BCIT Fish, Wildlife and Recreation) for outfitting the boat with all the needed supplies and securing insurance on the boat trailer; Marvin Rosenau (BCIT Fish, Wildlife and Recreation) provided a list of white sturgeon references, contacts, helped with editing and his support, interest and enthusiasm throughout the study; Jonathan Thar (Pacific Ocean Shelf Tracking) for his continued support and interest throughout the study, including providing the sonic tag (VEMCO) receiver.

1.0 Introduction

White sturgeon, (*Acipenser transmontanus*), is the largest freshwater fish in North America, inhabiting large streams and lakes as well as and marine environments along the Pacific coast of Canada and the United States from the Sacramento River to the Fraser River (MacPhail, 2007). Although most specimens of this species are less than 3 m long, they have been recorded over 3.5 m in length and can weigh up to 650 kg (MacPhail, 2007). While white sturgeon have been described as anadromous (Scott & Crossman, 1973), strictly freshwater populations do exist. For white sturgeon that utilize ocean habitats, the purpose of marine migration is not well understood (Billard & Guillaume, 2001) but may relate to feeding or dispersion.

The distribution of white sturgeon in British Columbia includes both the Columbia River drainage as well as the Fraser River (Figure 1). For the latter, white sturgeon are found in its lower, middle and upper main-stem upstream to McBride (RL&L, 2000). This species is also found in a number of tributary streams of the Fraser River including: the Nechako, Harrison, Lower Pitt, Thompson, McGregor and Trophy rivers, as well as many of the large lakes in the Fraser and Nechako basins (RL&L, 2000; Scott and Crossman, 1973).

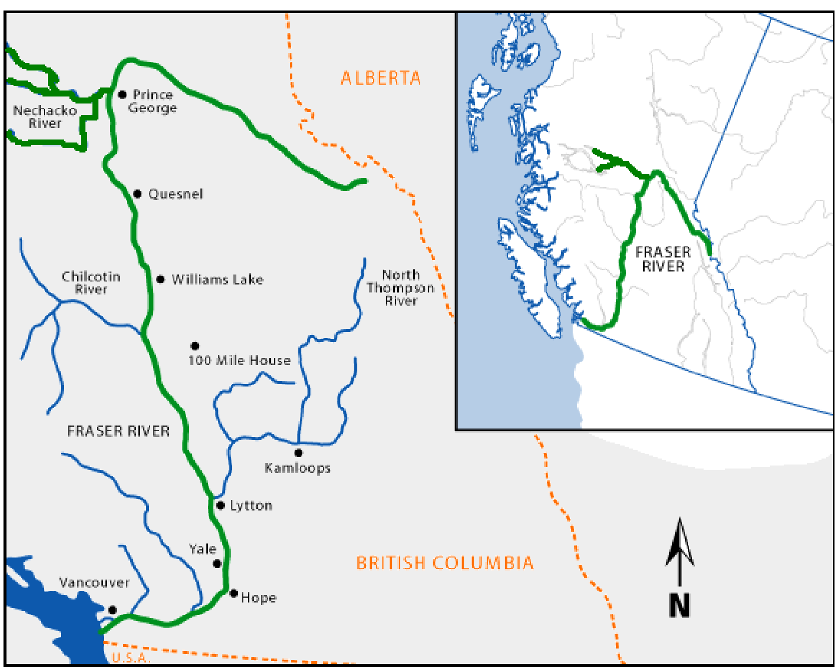


Figure 5. The known distribution of white sturgeon (*Acipenser transmontanus*) within the Fraser and Nechako rivers, British Columbia, is highlighted in green.

Currently, the Conservation Data Center (MOE) lists Fraser River white sturgeon as a "threatened" stock (the stock is "red" listed, classification S-2). Through November 2003, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed white sturgeon as a “species of special concern” (2003 COSEWIC). However, in June 2003 the Canadian Federal Government initiated the Species at Risk Act (SARA), which established COSEWIC as an advisory body. Under SARA, the government of Canada has listed lower Fraser River white sturgeon (Mission to Hope) as an “endangered” species (see 28 November 2003 COSEWIC press release: http://www.cosewic.gc.ca/eng/sct7/sct732e.cfm).

In general, white sturgeon populations in the Fraser River watershed are only modestly-well understood, although fish in the lower Fraser, downstream of Yale (Figure 2), have been monitored extensively since 1995 (ECL, 1992; Veinott et al. 1999, RL&L, 1994; RL&L, 2000; Nelson et al. 2008). This includes intensive stock assessment work over the last decade by the Fraser River Sturgeon Conservation Society (FRSCS). The FRSCS is a not-for-profit charitable organization dedicated to the conservation and restoration of Fraser River white sturgeon, and has been at the forefront of white sturgeon population monitoring and assessment in the lower Fraser River since 2000. Their highly successful Sturgeon Monitoring Program has produced the precise estimates of the abundance of white sturgeon in the lower Fraser downstream of the Mission Bridge by training volunteers to collect sample data.

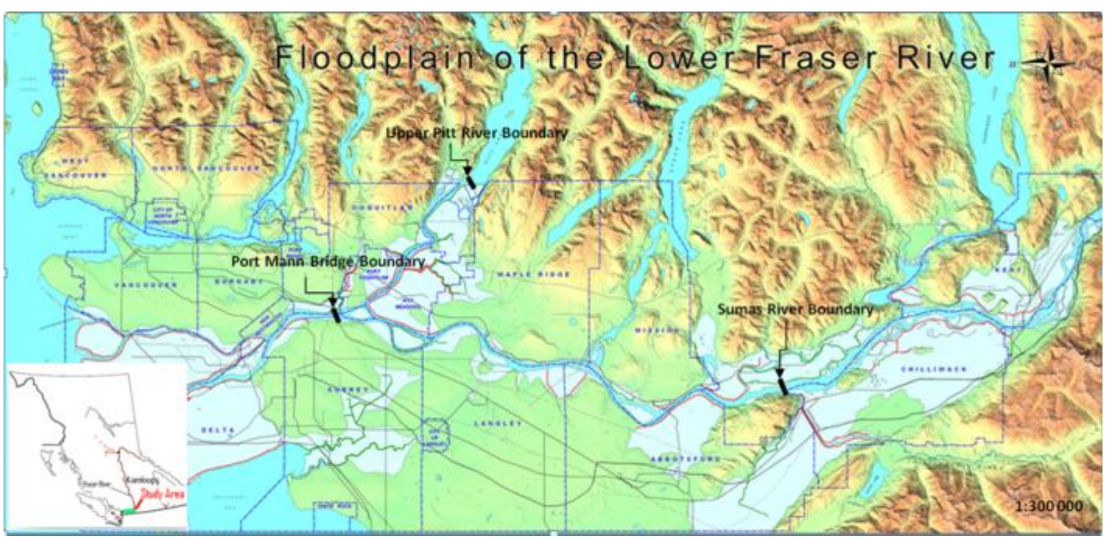


Figure 6. Lower Fraser River and study area boundaries. Study area extends upstream of Port Mann Bridge to Sumas River and the entire lower Pitt River to the upper Pitt River Boundary.

1.1 Population Assessments

More information is required to better understand the seasonal movement patterns of the Fraser River white sturgeon and to determine the frequency and duration of any potential marine migrations (Veinott et al., 1999). This can be accomplished in a number of ways including radio and sonic tracking, GPS tracking, and tagging-recapture studies. However, radio and sonic tracking studies are expensive and generally monitor only a small number of fish for 2-3 years (ECL, 1992; RL&L, 1994). Radio and sonic-tagging of sturgeon normally can only be used to track this species for a fraction of their lives as they are known to exceed100 years of age (Rien & Beamsderfer, 1994). In contrast, conventional tagging-recapture studies using Passive Induced Transponder (PIT), T-anchor, and spaghetti tags are labor-intensive, and recapture rates are generally low (Rien & Beamsderfer, 1994). This requires a considerable financial cost in order to get adequate sample sizes.

Although recaptures of PIT-tagged sturgeon confirm movements and migrations occur throughout the entire lower Fraser River (Nelson et al, 2008), little is known about the short-term, weekly and seasonal movements of this species.

In addition, understanding the movements of sturgeon outside their home streams has important implications for population assessments and development of successful management plans to conserve this species (Welch et al. 2006), as well as assess impacts to sturgeon habitat for projects such as bridge construction, gravel removal, dredging and riparian development. Understanding the migratory behavior in the lower Fraser River is particularly important as expanding human activities have the potential of profoundly reducing the survival and production of white sturgeon in this area of the watershed.

1.2 Current Status

To date there is substantial evidence that the white sturgeon subpopulation in the lower Fraser River is declining at a considerable rate (a 27% decline since 2003), with the greatest decrease occurring among juvenile year classes (Nelson et al. 2008). This apparent decrease in juvenile fish numbers is not well understood by the fisheries agencies or the FRSCS. One hypothesis may be habitat degradation at one or more life-history stages. Changes to the Fraser River white sturgeon habitat is the result of many activities relating to urbanization, on-going resource extraction, agriculture, and industrial development (Rosenau & Angelo, 2007).

1.3 Action Plan to Monitor Sturgeon Movements

One possible impact to sturgeon habitat may be a result of the development of expanded transportation infrastructure including the recent development of the Pitt River and Golden Ears Bridges, and the ongoing construction of the twinning of the Port Mann Bridge, in the lower Fraser River (LGL Ltd, 2008). In April 2008, as a result of these concerns, and in conjunction with LGL Limited, the FRSCS proposed a Partnership and Project Expansion between the Pacific Ocean Shelf Tracking (POST) program and FRSCS to monitor the migration patterns of white sturgeon in the areas of bridge construction (LGL Ltd. 2008). The POST project is a tool for tracking the movements of marine animals along the west coast of North America, using acoustic transmitters implanted in a variety of species, and a series of receivers running in lines across the continental shelf. To further understand the freshwater migration patterns of salmon, POST expanded their stationary receiver locations (also known as arrays) up the lower Fraser River, and these receivers can be used for other species as well. The agreement initiated amongst these groups was to incorporate an acoustic sturgeon telemetry study into this larger program in order to further understand the residency, movement and migration of lower Fraser River white sturgeon.

As part of the partnership project, the FRSCS expanded the extent of the Fraser River POST stationary arrays. A series of stationary VEMCO VR100 sonic tag signal receivers have now been placed in arrays throughout the lower Fraser and Pitt rivers, in the area of the Pitt, Port Mann and Golden Ears bridges construction projects (Figure 3). Individual tagged sturgeons are being detected by stationary VEMCO VR100 receivers capable of detecting the acoustic tags (LGL Ltd, 2008); however, once fish have passed the most upstream or downstream site, their migrations are unknown. In addition, the FRSCS study design did not provide for tracking the migratory behavior and habitat utilization of fish located between the receiver arrays,. In order to address this data gap, our study was designed to provide reliable information regarding the residency, timing, migration patterns, and habitat preferences of white sturgeon in the study areas between and beyond the existing sonic receiver arrays.

Figure 3. Location of ten deployed sonic-tag receiver's (blue circles) and one previous deployment (gray circle), which is out of commission. Numbers inside circles indicate river kilometre (i.e., approximate distance from Fraser mouth) except that receivers at the mouth of the Fraser were given unique designations (even if they were closer together) in order to distinguish them on movement plots in reports. Also shown are the six nearest POST receiver array locations (red circles). Tagging sites are shown in yellow (LGL, 2008).

As part of the study, 110 white sturgeon were captured above the Port Mann Bridge and in the lower Pitt River area (Table 1), by trained FRSCS volunteer's using recreational angling methods. The capture and sampling was undertaken as per society data collection requirements used in the FRSCS's primary Fraser River white sturgeon tagging program (LGL Ltd, 2009).

Table 6. Allocation of 110 acoustic tags placed on white sturgeon, by location, tagging period and fish size category.

Location		Sturgeon Tagged			
Tagging Location	Size Bin (FL, cm)	Summer 29-30 Aug	Fall 6-7 Oct	Spring 1-3 Jun	Total
Pitt River		1	34	23	58
	60 - 100	0	5	9	
	100 - 140	1	17	10	
	140 - 180	0	8	4	
	>180	0	4	0	
Port Mann Bridge		32	0	20	52
	60 - 100	15	0	11	
	100 - 140	11	0	7	
	140 - 180	6	0	2	
	>180	0	0	0	
Total					110

The process of tagging the white surgeon for this study was as follows. First a sturgeon was captured by angling and brought to the boat for surgery. Care was taken in the handling of the fish (please explain). Sturgeon caught during tagging periods were then anesthetised in an MS222 bath (125 mg per L of river water) until consciousness was lost. An incision was made on the ventral posterior side of the sturgeon, and a VEMCO (Model V16-4H) acoustic transmitter was implanted into the body cavity of the fish. The incisions were closed using multiple interrupted, absorbable sutures. Once the suturing was completed, the fish was placed in the river and held at the surface until full consciousness was regained, at which time it was released (LGL Ltd, 2009).

To determine the whereabouts of a tagged fish, the continuous ping, which is emitted from the acoustic tag at a frequency of 69 kHz, can be picked up by a directional hydrophone; the data received from the transmission signal contains the tag's specific ID number which is stored digitally in the VEMCO VR 100 receiver.

To expand on this project with mobile tracking, LGL Limited requested that the British Columbia Institute of Technology (BCIT) Fish, Wildlife and Recreation Program be involved in assisting the detection of sonic-tagged white sturgeon located between, or upstream of, existing stationary receivers. Therefore, a mobile acoustic receiver was obtained from POST and mounted on a boat to survey the study area. The area chosen for the BCIT study ranged from the Port Mann Bridge upstream to the confluence of the Fraser/Sumas rivers, as well as the lower Pitt River.

Our study aimed to :

- identify locations in the lower Fraser River, within the boundaries that we had chosen as our study area, that the acoustic-tagged white sturgeon were located during the months of November 2009 to March 2010,
- characterize habitat utilized by the acoustic-tagged white sturgeon during the study period, and
- determine migration distances of the acoustic-tagged white sturgeon throughout our study area in fall and winter in the lower Fraser River between the confleunce of the Vedder River and the Port Mann Bridge, as well as the Pitt River downstream of the Pitt Lake.

2.0 Attributes of the Fraser River

From its source at the Fraser Pass near Mount Robson, coursing across 1,375 km to its tidal estuary in the Georgia Strait, the Fraser River is the longest river contained solely within British Columbia. Water flows through the mainstem of this river unrestricted, undammed and drains a watershed area of approximately 233,000 km^2 (Ham, 2005). During the Fraser's yearly freshet, the peak of which occurs in late spring and early summer, the river swells in discharge from the snowmelt. Long-term discharge data from Water Survey of Canada (Canada, 2006) shows that peak discharge occurs from mid June to July (Figure 4). More than half of the Fraser's sediment load is also transported during this 2-3 month event (Milliman, 1980), and material deposition along the riverbed scours and fills the channel bed creating new channels and bars (Ham, 2005). The amount of material transported is strongly correlated with the magnitude of the freshet (Rosenau & Angelo, 2007). The lower Fraser River is divided into separate reaches by the composition of the bed substrate; thus, the gravel and sand reaches of the lower river are found from Mission to Sumas River confluence, and Sumas River confluence to Georgia Strait, respectively.

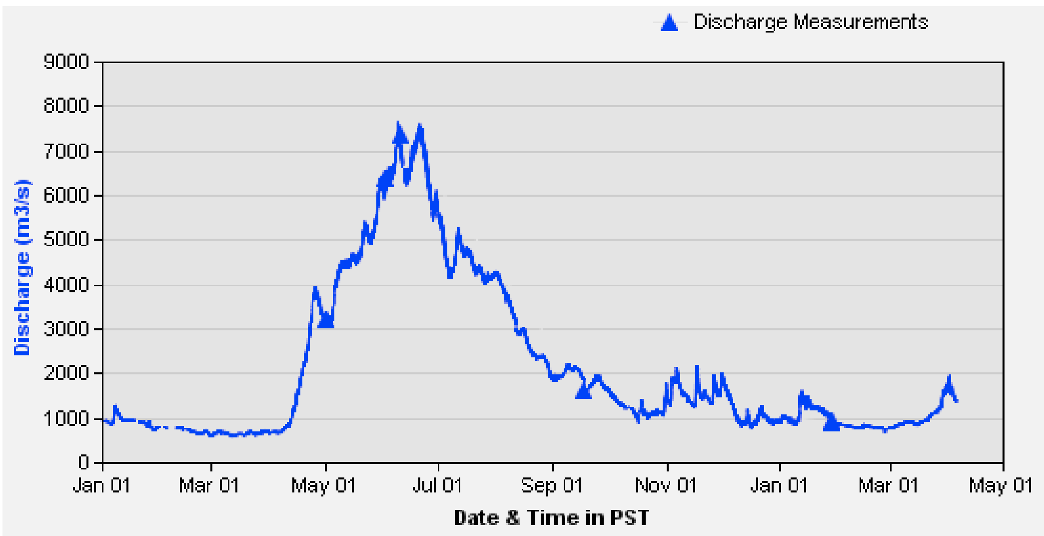


Figure 7. Fraser River at Hope (08MF005) hydrometric station Jan 1, 2009 to April 6, 2010 (Canada, 2006)

2.1 Gravel Reach

From Hope to the confluence of the Sumas River, the gravel reach's substrate consists of gravel, cobble and to a lesser extent, sand (Ham, 2005). Erosion and deposition along islands, channel banks, and sediment accumulation come together to form bars and create a wandering river type (Ham, 2005). Although relatively unaltered compared to many other large rivers that flow through urbanized areas, riverine infrastructure such as dykes and bank protection structures have been installed over the last century narrowing the floodplain. In addition, channel dredging and removal of woody debris has been utilized to reduce flood probability, altering the river's natural floodplain in areas adjacent to city municipalities (Ham, 2005) and, as a result, destroying fish habitat. Historically, this reach has been highly productive spawning and rearing habitat for sturgeon and Pacific salmon as well as providing a myriad of habitats for some 30 different fish species (Rosenau & Angelo, 2007).

2.2 Sand Reach

Along the sand reach from the confluence of the Sumas River at Mission, to the Georgia Strait, sand and silt become the dominant benthic substrate material (Ham, 2005). Channel width and gradient determine the amount of entrapped sediment that settles within the reach (Ham, 2005). The lower part of the sand reach is a heavily-used industrial area and commercial transportation route. The large amount of fine sediments that deposits in this reach causes navigational impediments and a portion of this material is dredged out for navigational purposes each year (FREMP, 2006). Many side channels have also been isolated from river flows due to extensive dyking.

The lower Pitt River is a meandering sand-bedded river channel and links the lower Fraser River and Pitt Lake. Water stage level can fluctuate 2 m in Pitt River within a tidal cycle (Ashley, 1980) and flows can reverse on the flood tide. The reversing Fraser River discharges in the lower Pitt River has caused entrained sediments to be carried upstream on a flood flow and deposited at the southern end of Pitt Lake. Increasingly smaller sediments are deposited further and further upstream along the riverbed towards Pitt Lake (Ashley, 1980). These deposits in the lower Pitt River show a predominance of flood-oriented bed forms in the river channel and have resulted in a 12 km^2 delta at the lower-draining end of the Pitt Lake (Ashley, 1980). The benthic stream-substrates present in the lower Pitt River are considered to comprise good eulachon (*Thaleichthys pacificus)* spawning habitat (Plate, 2009), which is an important source of food to sturgeon (Hatfield et al., 2005).

2.3 Project Area Reaches

For the purposes of this study we have divided the Lower Fraser into separate reaches, based on how much of the study area we could survey in a day, within the Sand and Gravel reach of the Fraser River (Figure 5):

- Reach 1- Port Mann Bridge upstream to Golden Ears Bridge including the Pitt River to the Pitt River Bridge.
- Reach 2- Pitt Lake to Pitt River Bridge

- Reach 3- Golden Ears Bridge upstream to Mission Bridge.
- Reach 4- Sumas/Fraser river confluence to upstream end of Matsqui Channel

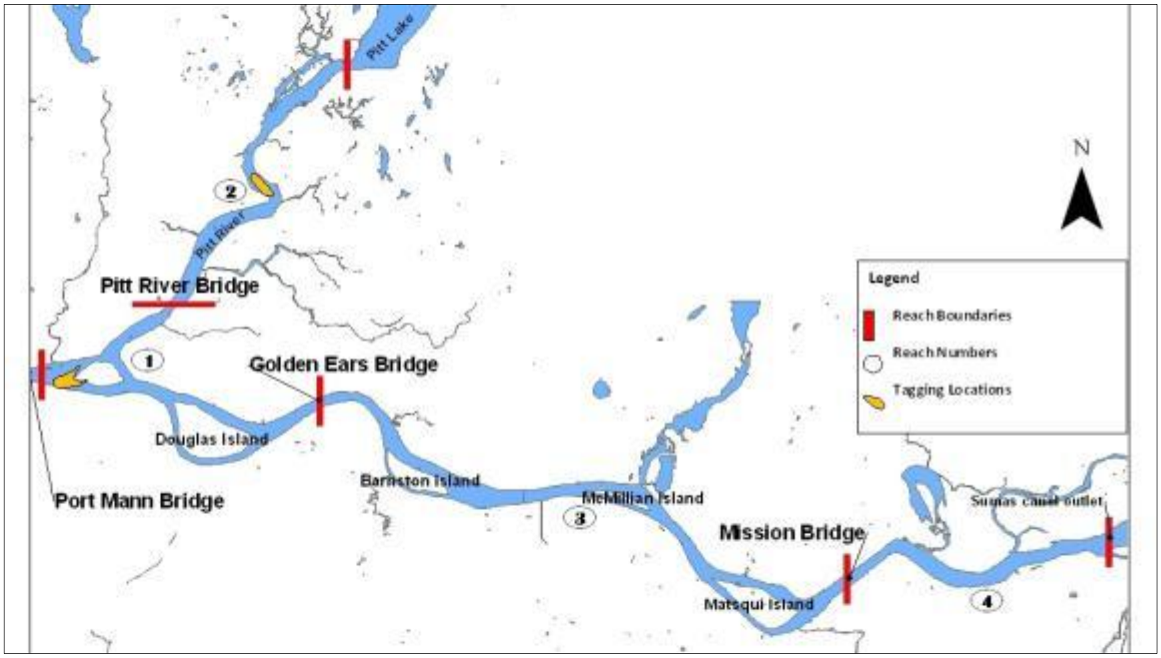


Figure 8. Map of study area reach boundaries, determined by how much could be surveyed in a day, divided into reaches for reference and survey purposes. Includes Reach Boundaries and numbers, yellow objects are the areas that sturgeon selected for the study were caught and tagged.

3.0 Methods

Our study consisted of mobile tracking the sonic-tagged sturgeon throughout our study area on the lower Fraser River using a boat-mounted receiver. The study area was monitored repeatedly, during the November 11, 2009 to January 20, 2010 period; that is, it was divided into pre-wintering (November 11, 2009 to December 2, 2009) and over-wintering (January 6, 2010 to January 20, 2010) time periods. In each time period, 4 surveys were made (each consisting of a single reach which could be surveyed in a given day), in order to covering the entire study area. Consequently each of these four reaches was studied once per period for a single study event. All surveys were conducted with acoustic transmitters, using a VEMCO VR 100 receiver equipped with a VH110 Directional Hydrophone mounted on a 16' fibreglass boat. To ensure that all parts of the river were surveyed equally, the boat was traversed at approximately 45° angles, from bank to bank, making sure that any transmissions from the acoustic tags would be received by the hydrophone. As each sturgeon was detected its tag number was recorded manually onto a data sheet along with the depth where the detection took place (Appendix A). Water temperature was also taken manually three times each day on each survey with a hand-held water thermometer at approximately 9 am, 12 noon, and 2 pm.

At the end of each monitoring session, the information that had been collected and stored in the receiver was downloaded on to a personal computer. These data, in turn, were plotted on study maps, to show the locations of the tagged white sturgeon throughout the study area and migration distances were determined using ARC GIS distance tools.

4.0 Results

4.1 Total Detections

Mobile tracking for the 110 sturgeon implanted with acoustic transmitters by the FRSCS was performed from the Port Mann Bridge upstream to the outlet of the Sumas canal, including the Pitt River upstream to the outlet of Pitt Lake. From November 11, 2009 to January 20, 2010, we monitored each individual reach once in the fall (November 11th to December 2nd, 2009) and once in the winter (January 6th to January 20th, 2010). During our period of study, we had 92 detections, of which 30 were repeat detections (detected >1 on separate survey days and winter repeat detections include fall detections) leaving 62 unique individual sturgeon. Thirty-six of the 62 unique individual detections were fish detected only once, while 22 were detected twice, and 4 were detected 3 separate times on different survey days. Note that fish that were observed more than once may have either moved between reaches or been detected multiple times within a single reach on separate monitoring days. The number of white sturgeon detected on each survey date varied from 0 to 25 (Table 2).

Table 7. Number of acoustic tag detections throughout the study area for each reach, November 11, 2009 to January 20, 2010, lower Fraser River, BC. Reach names were given to individual reaches for convenience purposes of this report. Names were delegated based on which city was in the vicinity of each reach for the exception of the Pitt River reach, which was named as a separate river.

Survey Date	Reach #	Reach Name	Reach Description	Number of Tags Detected
11-Nov-09	1	Port Mann	Port Mann Bridge upstream to Golden Ears Bridge including the Pitt River to the Pitt River Bridge	18
18-Nov-09	2	Pitt River	Pitt Lake to Pitt River Bridge	25
25-Nov-09	4	Mission	West tip of Matsqui Island upstream to the Sumas Canal outlet	3
02-Dec-09	3	Maple Ridge	Golden Ears Bridge upstream to Mission Bridge	8
06-Jan-10	1	Port Mann	Port Mann Bridge upstream to Golden Ears Bridge including the Pitt River to the Pitt River Bridge	10
13-Jan-10	2	Pitt River	Pitt Lake to Pitt River Bridge	19
17-Jan-10	4	Mission	West tip of Matsqui Island upstream to the Sumas Canal outlet	0
20-Jan-10	3	Maple Ridge	Golden Ears Bridge upstream to Mission Bridge	9
Total				**92**

4.2 Distribution of Sturgeon in Fall and Winter

In order to convey seasonal differences in the distribution, data presented for acoustic tagged white sturgeon in the lower Fraser River are shown separately for the November-December (fall) and January (winter) periods.

During our fall survey period, November 11th to December 2nd, 2009 (Table 3) we had 54 detections, of which only 3 were repeats. Reach 2, had the highest concentration, holding 47% of detected sturgeon during this study period and 22% of total 110 sturgeon selected for this study. Reach 3, held 33% of the sturgeon detected during the fall monitoring period, and 16% of the total sturgeon selected for this study. Reach 4 contained the lowest number of detections, with minimal contribution to the overall number of tagged sturgeon.

During the winter survey, January 6, 2010 to January 20, 2010 (Table 4), we had detections in 3 of the 4 reaches, including a total of 38 detections; 12 first time detections and 26 repeat detections from the fall study session (Table 4; Appendix E). Reach 2, had the highest concentration of tagged fish, with 19 individual detections, and making up over half of the total detections during this survey period and 18% of the total 110 sturgeon selected for this study. Our furthest upstream reach (4) had no acoustic tagged sturgeon present during the January 17th, 2010 survey day, again indicating minimal usage of this portion of the river.

Table 8 Detections of acoustic tagged sturgeon during the fall survey, November 11th to December 2nd 2009, lower Fraser River, BC.

Reach Number	Number of Detections	Repeat Detections[1]	Mean Water Temp. (^{o}C)[2]
1	18	0	7.4
2	25	2	7.0
3	8	0	5.6
4	3	1	6.7
Total	**54**	**3**	**$\underline{X}$ = 6.7**

[1] repeat detections were sturgeon detected >1 on different survey days.
[2] mean water temperature was calculated by averaging the temperature for the specific day of survey.\

Table 9 Detections of acoustic tagged sturgeon during winter survey, January 6th to January 20th, 2010, lower Fraser River, BC.

Reach Number	Number of Detections	Repeat Detections[1]	Mean Water Temp. (°C)[2]
1	10	7	3.9
2	19	14	5.0
3	9	5	4.8
4	0	0	4.8
Total	**38**	**26**	**$\bar{X}$ = 4.6**

[1] repeat detections were sturgeon detected >1 on different survey days, includes detections from fall survey period.
[2] mean water temperature was calculated by averaging the temperature for the specific day of survey.

After the fall survey period, 22 fish stayed in the study area, 12 immigrated in, and 23 migrated elsewhere. The direction and location of those 23 sturgeons is unknown.

During the period of study, water temperate ranged from high 7.4°C in November to a low 3.9°C in January. Mean water temperatures during the winter surveys were 4.6°C, which was 2.1°C colder than water temperatures in the fall.

During the fall and winter surveys combined there were 44 individual fish detected in reach 2 (Pitt River), indicating 40% of the total 110 tagged sturgeon used the Pitt River reach. In both reaches 1 and 3, 26 fish were detected indicating 20% of the total tagged individuals used each of these reaches. In reach 4, there were a total of 7 detections, making up 6% of the total individuals (Figure 6).

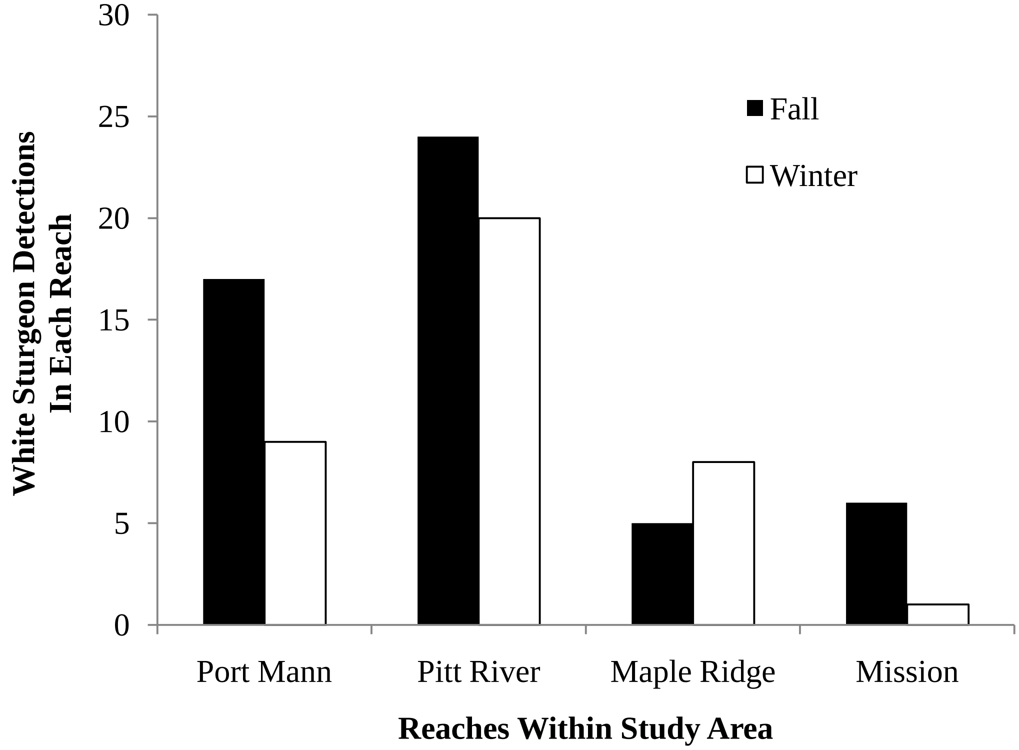


Figure 6. Number of sturgeon detections within each reach, for fall (November 11th to December 2nd, 2009) and winter (January 6th to January 20th, 2010) surveys, on the lower Fraser River.

Between the fall and winter surveys there was a 26% decrease in total detections of sturgeon within the study area**.** Reach 3, showed a slight increase in individual detections and reaches 1, 2, and 4 had a decrease in detections.

4.3 Movements

In total, 26 acoustic-tagged sturgeons were detected >1, during different survey days throughout both fall and winter, and showed movement within a specific reach or between neighbouring reaches (Appendix E). Of those 26 repeat detections 4 were detected a total of 3 times, during 3 different survey days. For these fish, minimum distance traveled was measured from initial tagging location to the point it was detected next in chronological order. For fish detected once, distance traveled was measured from original tagging location to the point it was detected next. Distances varied among the individual 62 detections from <1 km to 50+ km (Figure 7).

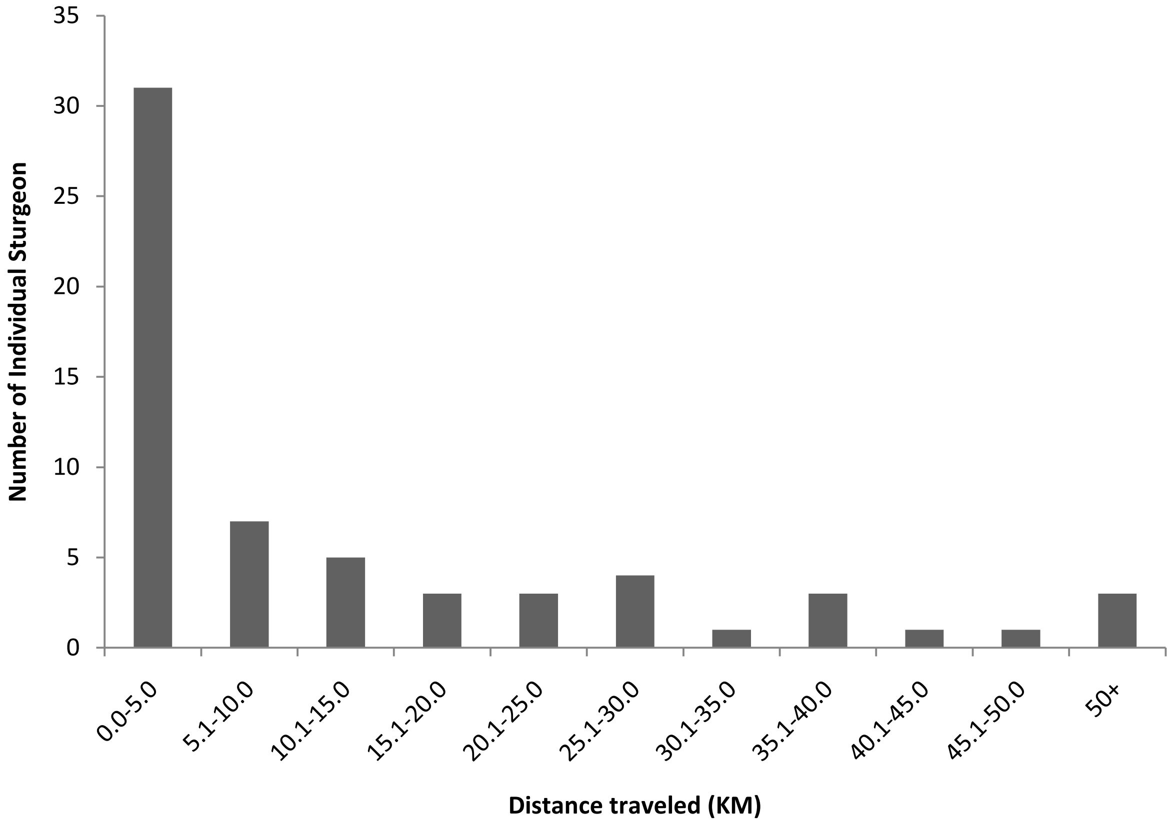


Figure 7. Minimum distance traveled by individual sturgeon repeatedly detected between tagging locations and locations of the next detection, over entire study period, lower Fraser River, BC 2009/10.

The majority of sturgeon detected moved < 5 km from the time of first detection to time of last detection suggesting site fidelity. The sturgeon that moved <5 km were generally located in areas with high abundance of other tagged sturgeon.

Tagged sturgeon were divided into size classes to represent juvenile sturgeon (<1 m FL) and adult (>1 m FL) sturgeon. Juvenile sturgeon traveled slightly further over the study period, an average of 14.9 km, compared to an average of 12.2 km for adults (Figure 8), but there was no statistical significance between the distance traveled and age/size of the sturgeon (t-test, t=0.5728, P >0.05). Sturgeon that were originally tagged in the Fraser were recorded traveling longer distances in between detections when compared to those sturgeon tagged in the Pitt River (Figure 9), again there was no statistical significance (t-test, t=1.1250, P >0.05).

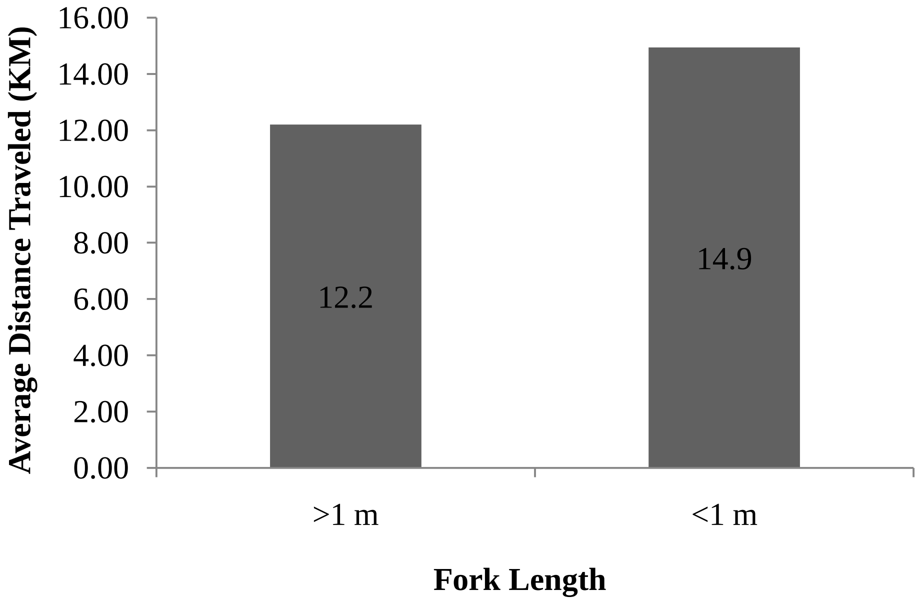


Figure 8. Average distance traveled by repeatedly detected adult (>1 m TL) {n=41} and juvenile (<1 m) {n=21} sturgeon. Distance travelled by an individual fish was the minimum distance between tagging location, and the next detected location. Adult and juvenile age classes compared to average distance traveled during entire study period, Lower Fraser River, 2009/2010.

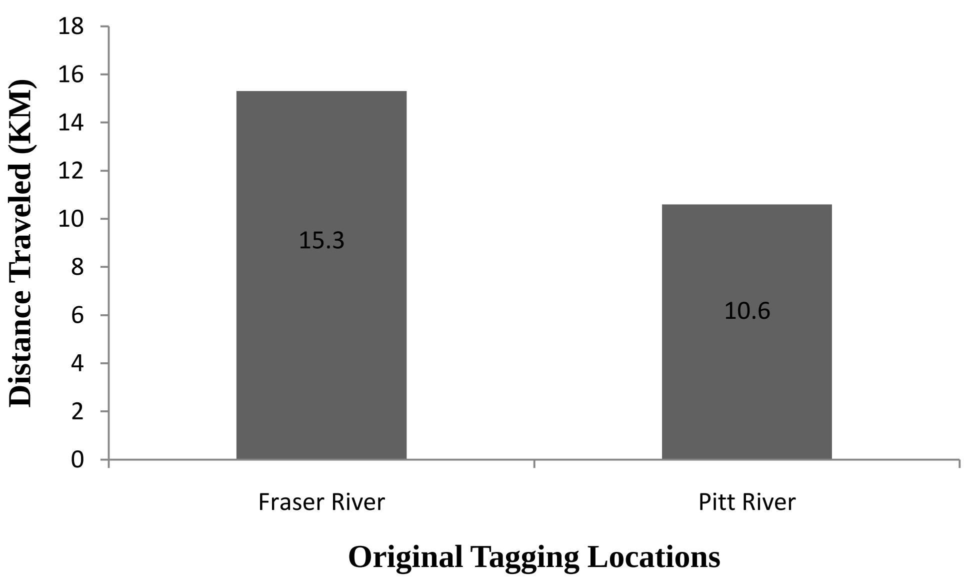


Figure 9. Total distance traveled of sturgeon tagged in the Fraser River {n=31} compared to sturgeon tagged in the Pitt River {n=31}, Lower Fraser River BC, 2009/2010.

4.4 Fall and Overwintering Locations

There were three locations identified in the study area where aggregations of sturgeon occurred throughout the fall and winter survey periods. They included (Figure 7):

1. Douglas Island,
2. Lower Pitt River, below rKm 55 (Ernie's Hole),
3. Confluence of the Stave and Fraser Rivers.

All three locations had >5 individual detections within a 2 km radius, and water characteristics including depths >8m, and apparent slower velocity than the main channel. The Douglas Island and Ernie's Hole locations held consistent numbers of sturgeon throughout both fall and winter surveys (Table 5).

Table 10. Locations of aggregated sturgeon during fall and winter surveys, November 2009 to January 2010, number of fish detected within <2 km radius of the locations is presented.

Location	Number of detections	
	Fall	Winter
Douglas Island	15	9
Ernie's Hole	17	16
Stave River outlet	0	5
Total	**32**	**30**

Ernie's Hole was of particular interest due to high concentrations of sturgeon throughout both survey periods, 17 in the fall and 16 in the winter (Table 5). This represented 69% and 82% of the sturgeon detected in the reach during the fall and winter, respectively. Overall, most (>69%) of the fish detected in these reaches were within 2 km of these locations. The exception to these high-concentration areas was during the fall survey when we had no detections around the Stave River, but 5 individuals located there during our winter survey, which represented 83% of the fish detected in reach 3 at that time. Fall (Figure 10) and winter (Figure 11) distributions varied in regards to abundance of sturgeon in different habitats. When comparing congregation over the fall and winter surveys we found that sturgeon during the winter survey congregated in tighter groups (Figure 11).

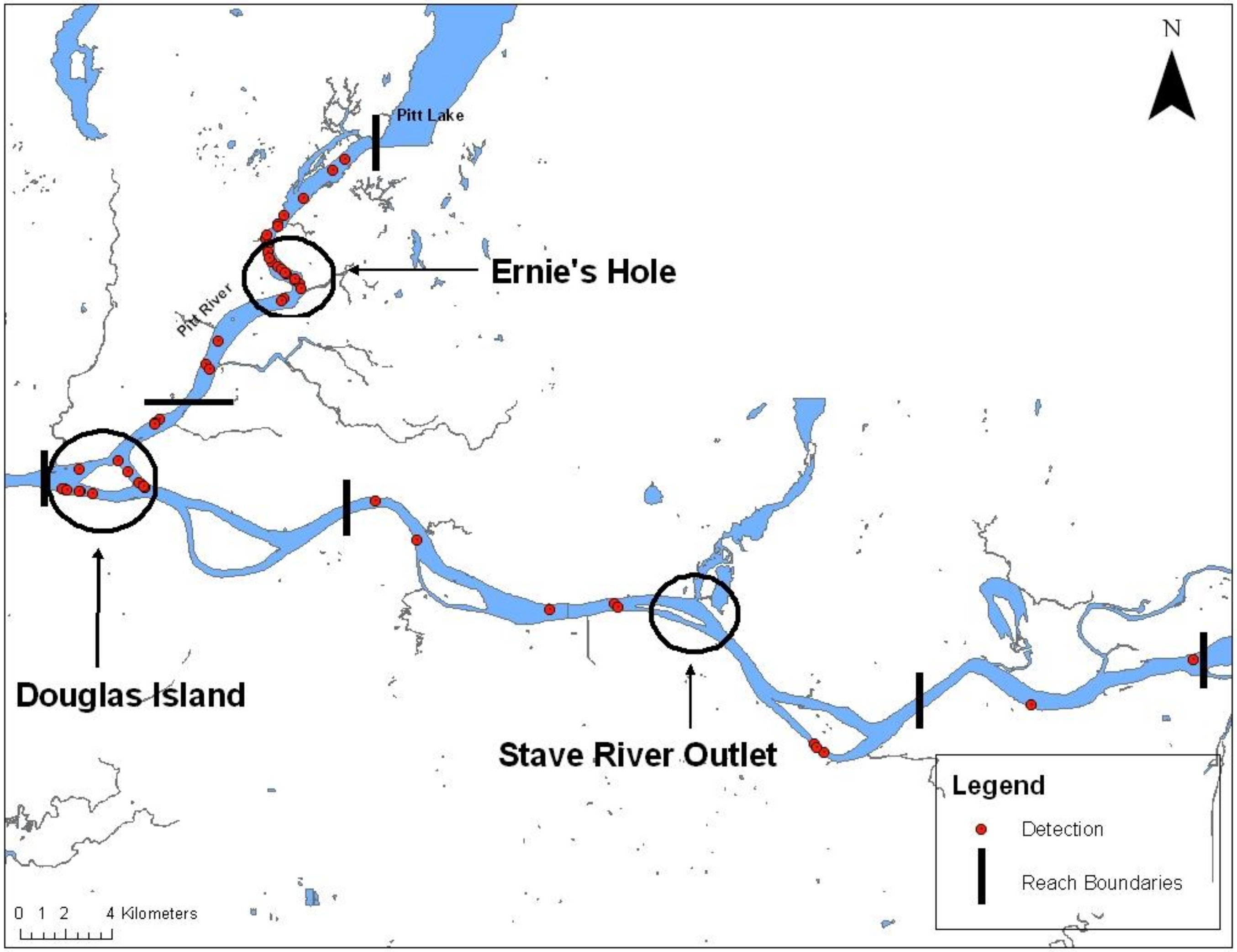


Figure 10. Total detections of acoustic tagged white sturgeon during the <u>fall survey period</u> (November 11th to December 2nd, 2009) throughout our study area, lower Fraser River, 2009/2010. Ernie's Hole, Douglas Island, and the Stave River outlet are identified inside the black circles.

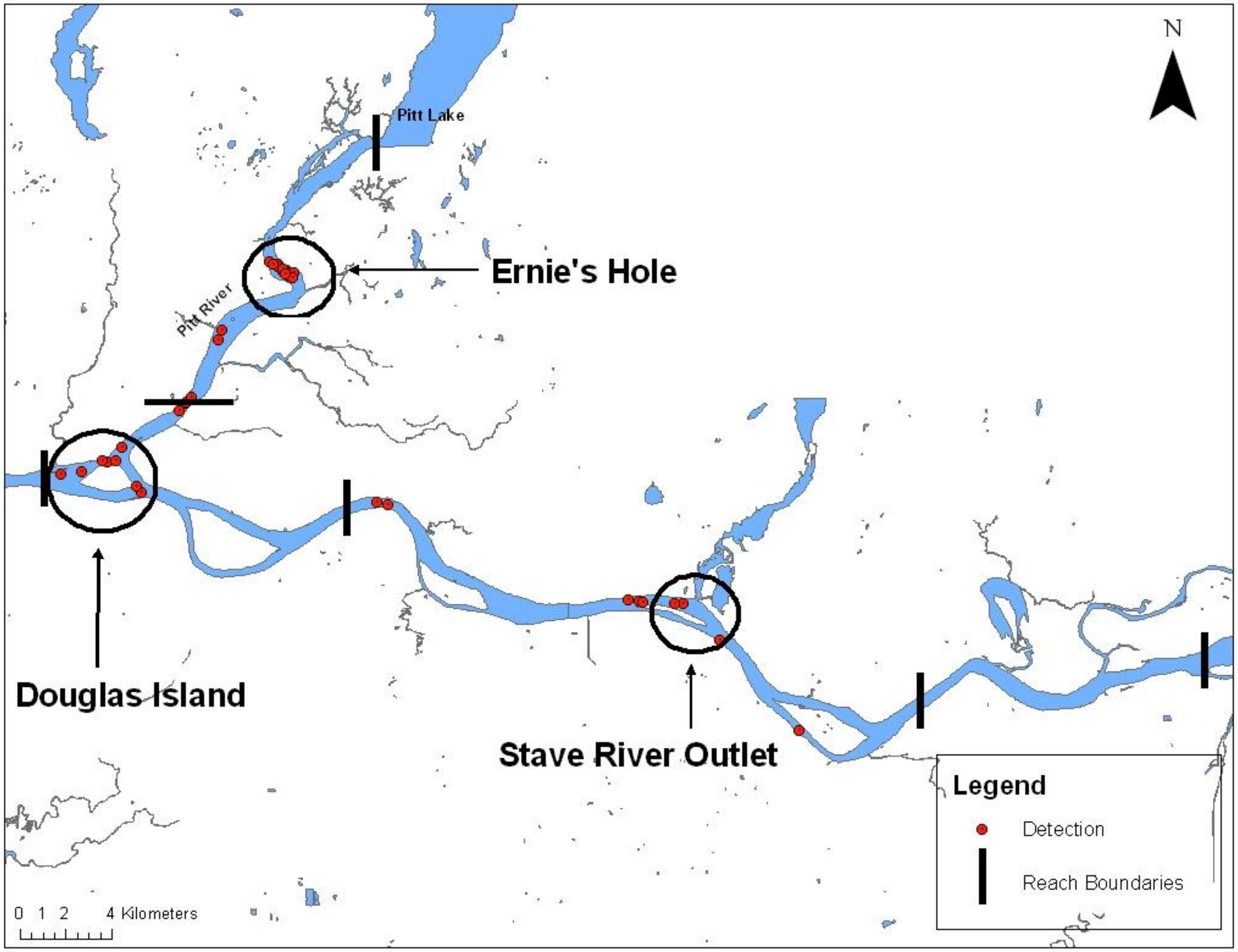


Figure 11. Total detections of acoustic tagged white sturgeon during the <u>winter survey period</u> (January 6th to January 20th, 2010) throughout our study area, lower Fraser River, 2009/2010. Ernie's Hole, Douglas Island, and the Stave River outlet are identified inside the black circles.

Of the sturgeon that we encountered, 24 of the 31 sturgeon originally tagged in the Fraser River were detected in the Fraser river during our fall and winter surveys. This indicates that these particular sturgeon reused or remained in the Fraser river one year to 6 months later. In comparison, 25 of the 31 sturgeon that we encountered that were originally tagged Pitt River were also detected again in the Pitt River over the fall and winter surveys. Interestingly, 5 of the 6 sturgeon that migrated into the Fraser River from the Pitt River were adult sturgeon (> 1m).

A total of 21 individual sturgeons migrated upstream in the Fraser River from their location after being tagged and released, while the remaining sturgeon either stayed in general tagging location or migrated downstream or within our study area. We observed smaller concentrations of sturgeon in the upstream portion of the study area (Reaches 3 and 4), including four just above the Golden Ears Bridge, nine near the Stave River, four in the southern channel of Matsqui Island (Matsqui Channel), and three were detected in various locations scattered throughout Reach 4.

A total of 48 sturgeon, or 44% of the total tagged, were not detected in the study area during the study period. The location of these fish not detected is unknown at present time; they may have migrated downstream or upstream through our study area.

5.0 Discussion

The concern for the future of white sturgeon in Lower Fraser River emphasizes the need to further understand their behavior, movements, and habitat needs. The emphasis in this study was to sample a sub-population in the lower Fraser and Pitt Rivers from the outlet of Sumas Canal (Chilliwack) downstream to the Port Mann Bridge including the lower Pitt River, to gather information on habitat utilization, small-scale migration distances, and locations of congregation.

5.1 Distribution

During our fall and winter surveys slow moving deep water in the main channel were the habitats utilized in both the Fraser and Pitt Rivers. However, the 62 unique detections in our study area in the fall were higher than in winter, which either could mean that some individuals migrated to a location not within our study area or were not detected by our receiver for an unknown reason. It is possible that the sturgeon that left our study area were heading to different overwintering outside of our study area. The majority of detections overall were within a 2-3 km radius of each individual sturgeon's original tagging location.

Of those fish tagged in the fall on the Pitt River, many returned or stayed within meters of that location, one year later. In comparison, sturgeon tagged at the Port Mann Bridge location (Fraser River) in the summer (2008) and spring (2009) also returned or stayed close to their original tagging location. The return or reuse of a previously occupied location strongly exhibits site fidelity in this region. The same behaviours were found in a study on the seasonal and diel movements of white sturgeon on the Lower Columbia River, where sturgeon tagged in the spring occupied the same location in the fall the following year (Parsley et al., 2008).

Variation in seasonal distribution of our sample may be caused by a decrease in water temperature during our winter survey. In a preliminary report on juvenile white sturgeon habitat use in the lower Fraser River, Glova et al. (2008) reported similar behaviour in 2007-2008, when water temperature dropped below 7 ^{o}C, but were largely sedentary during low winter temperatures (< 5 ^{o}C). The report indicated that movements were likely to travel more frequently when temperatures were >7^{o}C, and as the water temperature dropped, approximately (<5^{o}C), sturgeon reduced energy expenditure while food availability is low in the winter by stay in slow moving deep pools. Our results indicated that during winter surveys sturgeon congregated in densely spaced groups in both the Fraser and Pitt rivers, when compared to the fall distributions. The abundance of sturgeon congregating within a 2 km radius increased during the winter, which indicated a change in their behaviour when water temperatures decreased. During the fall surveys, the distribution patterns were noticeably spread out or less dense compared to the winter, which may have been the result of the sturgeon in a more mobile state possibly looking for an appropriate location to overwinter in.

5.3 Habitat Utilization

We identified three sites that were consistently utilized by sturgeon throughout fall and winter; Douglas Island, Ernie's Hole (Pitt River), and possibly the mouth of the Stave River. All three locations had from 5 to 18 individual detections in both the fall and winter, with a 2 km radius. Ernie`s hole was of particular interest because very little research has been conducted on the lower Pitt, and this area was not identified as a area of white sturgeon concentration until this study. However, the possibility of sturgeon overwintering in the Pitt river was hypothesised by Nelson et al (2004); after one sturgeon, that was tagged and released in June 2000 near the mouth of the Sumas River (Chilliwack), was recaptured the following February (2001) in the Pitt River near the outlet of Pitt Lake. In 2008, Nelson et al. identified Matsqui Channel and Hatzic Eddy as important sites for rearing, feeding and over-wintering of white sturgeon in the lower Fraser River. During our study, detections of our fish in these locations, in both fall and winter were very low, if any, in these locations. However, because tagging locations for these studies differed, a possibility is that sturgeon selected for this study (which were tagged down-river of the Nelson et al, 2008 sample) may stay down-river and have a "home range" that is preferred.

Almost half (43%) of the 58 sturgeon tagged in the Pitt River, remained or reused the same reach within the Pitt River. Similarity, half (46%) of sturgeon tagged in the Fraser River remained or reused in the Fraser from the time of tagging to our survey period, 6 months to a year later. This indicates that there was minimal mixing of the sturgeon tagged in the Pitt River and those that were tagged in the lower Fraser River, which suggests that some segments of the lower Fraser River sturgeon populations may not frequently intermingle.

5.4 Movements

A previous radio telemetry study done by RL&L (2000) stated that the majority of fish traveled <5 km, which was also a conclusion drawn by our 2009-2010 telemetry work. In both fall and winter surveys sturgeon showed localized behaviour, possibly already staging for the winter. Fish that migrated outside this 5 km "home range" did not show apparent grouping behaviour, as fish traveling smaller distances exhibited. One possible reason for this may be sturgeon that travel larger distances were moving to a spawning location outside the study area. However we could not draw any conclusions because there was no significant correlation between the size and age of these fish.

Variation in size did not relate to significant differences in migration distance from time of tagging to last detection (s). Although sturgeon have been reported to exhibit a spring spawning migration to spawning grounds (RL&L, 2000) this study did not address this question due to lack of reproductive data and time of year constraints. In 2000, RL&L also reported largest mean movement for female white sturgeon who were ready to spawn, and showed that the largest females exhibited the greatest range of movements from their release locations. During our study, fish traveled distances from 0.07 to 66 km between time of tagging and time of next detection(s). The distances traveled by our white sturgeon are not uncommon, as similar movements were recorded by RL&L (2000) from 1995-1999. RL&L documented several early-to-late reproductive males and pre-vitellogenic females exhibit extensive movements that exceeded 40 km and in some instances were more than 70 km between tracking events. Knowing that sturgeon have been known to travel large distances, depending on their reproductive stage, may provide reason to the variations seen in the movements of our study fish.

6.0 Recommendations and Conclusion

A Year 2 (2010-2011) repeat of this BCIT and LGL partnership study program should be considered with the investigation focusing on filling in the information gaps of the present study. As sampling did not get started in until November, and thus lacked a pre fall, spring/freshet and summer monitoring sessions, extending the time period would be of great interest. This could show greater confidence in our observations of site fidelity for this population. We suggest the following questions for continuation of this study:

- Do larger sturgeon in the tagged population move more than the other fish during the spring freshet during subsequent spawning upstream?
- Do sturgeon congregate during other times of the year, possibly during periods of high food abundance?
- How do sturgeon behave between both years' movements, in order to determine seasonal change in habitat utilized?
- Would adding a reach from the Port Mann Bridge down to locate more of the 110 fish?
- Would a night survey of known overwintering locations show if the fish move nocturnally during winter months?

Understanding the migration behaviour of white sturgeon in the lower Fraser River is important to initiate necessary actions for the conservation and protection of important sturgeon habitat.

These areas may constitute important feeding, rearing, and overwintering habitat, which sturgeon utilize on a seasonal basis. Accessing impacts to sturgeon habitat prior to projects such as bridge construction, gravel removal, dredging, or riparian alterations is important for the future of this endangered species.

Literature Cited

Ashley, G. M. (1980). Channel morphology and sediment movement in a tidal river, Pitt river, British Columbia. Earth Surface Processes , 348.

Auer, N. A. (1996). Importance of habitat and migration to sturgeons with emphasis on lake sturgeon. Can. J. Fish. Aquat. Sci. , 152 - 160.

Billard, R., and Guillaume, L. (2001). Biology and conservation of sturgeon and paddlefish. Reviews in Fish and Fisheries , 355-392.

Canada, E. (2006, March 16). Environment Canada water survey. Retrieved April 6, 2010, from Real Time Hydrometric Data: http://scitech.pyr.ec.gc.ca/waterweb/default.htm

Canada, G. o. (2009, November 2). Species at Risk Public Registry. Retrieved November 2, 2009, from http://www.sararegistry.gc.ca: http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=123

Echols, J. (1995). Review of Fraser River white sturgeon, (Acipenser transmontanus). Vancouver: Department of Fisheries and Oceans.

ECL, E. C. (1992). Fraser River white sturgeon radio tracking and tissue sampling 1989-1992.Report to Ministry of Environment, Lands and Parks. Surrey .

FREMP. (2006). Environmental management strategy for dredging in the fraser river estuary. Vancouver, BC: Fraser River Estuary Management Program.

Glova, G., Nelson, T., & Roberts, R. (2009). AN Interim report on the stewardship approach towards the habitat conservation and protection strategy in the lower Fraser river 2008-2009. Sidney, British Columbia: LGL Limited.

Ham, D. G. (2005). Morphodynamics and sediment transport in a wandering. Vancouver, BC: The University of British Columbia.

Hatfield, T., McAdam, S., & Nelson, T. (2005). Impacts to abundance and distribution of fraser river white sturgeon. Vancouver, BC: Fraser River Sturgeon Conservation Society.

Lovgren, S. (2009, November 2). Giant prehistoric fish rebounding in Canada. National Geographic News .

MacPhail, J. D. (2007). Freshwater fishes of British Columbia. The University of Alberta Press , 30-38.

McKenzie, S. (2000). Fraser River white sturgeon monitoring program. Edmonton AB: RL&L Environmental Services Ltd.

Milliman, J. (1980). Sedimentation in the Fraser River and its estuary, Southwestern British Columbia (Canada). Estuarine and Coastal Marine Science Vol 10, No 6 , p 609-633.

Nelson, T. (2008). Lower Fraser River white sturgeon acoustic telemetry project 2008-2010. Fraser River Sturgeon Conservation Society.

Nelson, T., Gazey, W., & English, K. (2008). Status of white sturgeon in the lower Fraser River.Report on the findings of the lower Fraser River white sturgeon monitoring and assessment program. Richmond: Fraser River Sturgeon Conservation Society.

Parsley, M., Popoff, N., Leeuw, B., & Wright, C. (2008). Seasonal and diel movements of white sturgeon in the lower Columbia River. American Fisheries Society 137 , 1007 - 1017.

Plate, E. (2009). Fraser River, Port Mann Bridge-Douglas Island eulachon study. Sidney, BC: LGL Limited environmental research associates .

R.L.&L, E. S. (1994). Status of white sturgeon in the Fraser River.Final report prepared for B.C. Hydro Environmental Affairs. Vancouver: R.L.&L, Environmental Services.

Rien, T., and Beamsderfer, R. (1994). Accuracy and precision of white sturgeon age estimates from pectoral fin rays. American Fisheries Society vol. 23 , 255-265.

RL&L Enviromental Services 1995-1999. (2000). Fraser River white sturgeon monitoring program-comprehensive report (1995 to 1999). Final Report Prepared for BC Fisheries. RL&L Report No.815F: 92 p +app.

RL&L, E. S. (2000). Fraser River white sturgeon monitoring program-Comprehensive Report 1995-1999. Final Report prepared for BC Fisheries. Vancouver: RL&L Environment Services.

Rosenau, M., and A. M. (2005). Conflicts between agriculture and salmon in the eastern Fraser Valley. Vancouver: Pacific Fisheries Resources Conservation Council Background Paper.

Rosenau, M., and Angelo, M. (2007). Saving the heart of the Fraser: addressing human impacts to the aquatic ecosystem of the Fraser River,Hope to Mission British Columbia. Vancouver, BC: Pacific Fisheries Resources Conservation Council Background paper.

Scott, W., and Crossman, E. (1973). Freshwater Fishes of Canada. Fisheries Resource Board Canada Bulletin , 96-100.

Smith, C. T., Nelson, R., Pollard, S., Rubidg, e. E., McKay, S. J., Rodzen, J., et al. (2002). Population genetic analysis of white sturgeon (*Acipenser transmontanus*) in the Fraser River. Journal of Applied Ichthology , 307 - 312.

Upper Columbia White Sturgeon Recovery Initiative. (2009, November 2). Retrieved November 2, 2009, from http://www.uppercolumbiasturgeon.org: http://www.uppercolumbiasturgeon.org

Veinott, G., N. T., Rosenau, M., & Evans, R. (1999). Concentrations of strontium in the pectoral fin rays of the white sturgeon (*Acipenser transmontanus*) by laser ablation sampling inductively coupled plasma mass spectrometry as an indicator of marine migrations. Canadian Journal of Fisheries and Aquatic Sciences , 1981-1990.

Welch, D., Turo, S., and Batten, S. (2006). Large scale marine and freshwater movements in white sturgeon. Transactions of the American Fisheries Society , 386-389.

Appendices

Appendix A

Manual data detection entry form

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date:		Area Monitored:				
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	Tag Number	Depth (ft)	Water Temp. (Celsius)	Time Start	Time End	Comments

Appendix B

Reference list of sturgeon tag number and identification number. Location where tags were implanted are listed under "river km tagged" (reference Figure 2) as well as the length and girth measurements of the sturgeon at time of capture. Sturgeon detected during our study are highlighted yellow.

No	Location of Tagging	Tag ID	Tag date	FL (cm)	Girth (cm)
1	between rKm 39 and Port Mann Bridge	23669	8/23/2008	85	31
2	between rKm 39 and Port Mann Bridge	23670	8/23/2008	107	38.5
3	between rKm 39 and Port Mann Bridge	23671	8/30/2008	71.5	26.5
4	between rKm 39 and Port Mann Bridge	23672	8/30/2008	172	67.5
5	between rKm 39 and Port Mann Bridge	23673	8/30/2008	62	23
6	between rKm 39 and Port Mann Bridge	23674	8/30/2008	90	32.5
7	between rKm 39 and Port Mann Bridge	23675	8/30/2008	70	25.5
8	between rKm 39 and Port Mann Bridge	23676	8/30/2008	105	43.5
9	between rKm 39 and Port Mann Bridge	23677	8/31/2008	152	57
10	between rKm 39 and Port Mann Bridge	23678	8/31/2008	88.5	33
11	between rKm 39 and Port Mann Bridge	23679	8/31/2008	105.5	39.5
12	between rKm 39 and Port Mann Bridge	23681	8/31/2008	97	38.5
13	between rKm 39 and Port Mann Bridge	23685	8/31/2008	150	60
14	between rKm 39 and Port Mann Bridge	23687	8/31/2008	80	28
15	between rKm 39 and Port Mann Bridge	23683	8/31/2008	144	56
16	between rKm 39 and Port Mann Bridge	23684	8/31/2008	93	35
17	between rKm 39 and Port Mann Bridge	23680	8/31/2008	133.5	54
18	between rKm 39 and Port Mann Bridge	23682	8/31/2008	115	43.5
19	between rKm 39 and Port Mann Bridge	23686	8/31/2008	146	58
20	between rKm 39 and Port Mann Bridge	23688	8/31/2008	92	32.5
21	between rKm 39 and Port Mann Bridge	23689	8/31/2008	107.5	43
22	between rKm 39 and Port Mann Bridge	23690	8/31/2008	99.5	43
23	between rKm 39 and Port Mann Bridge	23691	8/31/2008	112	40
24	between rKm 39 and Port Mann Bridge	23692	8/31/2008	118.5	48

No	Location of Tagging	Tag ID	Tag date	FL (cm)	Girth (cm)
25	between rKm 39 and Port Mann Bridge	23693	8/31/2008	117	44.5
26	between rKm 39 and Port Mann Bridge	23694	8/31/2008	140	52
27	between rKm 39 and Port Mann Bridge	23695	8/31/2008	117.5	46
28	between rKm 39 and Port Mann Bridge	23697	8/30/2008	99	37
29	between rKm 39 and Port Mann Bridge	23698	8/30/2008	96	36
30	between rKm 39 and Port Mann Bridge	23700	8/30/2008	74	26.5
31	between rKm 39 and Port Mann Bridge	23702	8/31/2008	99.5	38.5
32	between rKm 39 and Port Mann Bridge	23703	8/31/2008	131	50.5
33	just below rKm 55	23696	8/31/2008	103	40
34	just below rKm 55	23701	6/10/2008	184.5	86
35	just below rKm 55	23704	6/10/2008	116.5	47
36	just below rKm 55	23707	6/10/2008	171	69
37	just below rKm 55	23708	6/10/2008	129	48
38	just below rKm 55	23709	6/10/2008	155.5	61
39	just below rKm 55	23710	6/10/2008	131	52
40	just below rKm 55	23711	6/10/2008	142	52.5
41	just below rKm 55	23712	6/10/2008	186.5	77.5
42	just below rKm 55	23713	6/10/2008	114	43
43	just below rKm 55	23714	6/10/2008	203	81
44	just below rKm 55	23715	6/10/2008	101	36
45	just below rKm 55	23716	6/10/2008	124	51
46	just below rKm 55	23718	6/10/2008	108	40
47	just below rKm 55	23717	6/10/2008	131	50.5
48	just below rKm 55	23719	6/10/2008	166	66.5
49	just below rKm 55	23720	6/10/2008	108	40
50	just below rKm 55	23721	6/10/2008	101.5	38
51	just below rKm 55	23722	6/10/2008	163	57.5
52	just below rKm 55	23724	6/10/2008	82	30
53	just below rKm 55	23723	6/10/2008	149.5	59
54	just below rKm 55	23725	6/10/2008	130.5	45
55	just below rKm 55	23727	6/10/2008	132.5	51
56	just below rKm 55	23729	6/10/2008	130.5	52.5
57	just below rKm 55	23730	6/10/2008	182	64
58	just below rKm 55	23699	7/10/2008	109.5	45
59	just below rKm 55	23705	7/10/2008	100.5	37

No	Location of Tagging	Tag ID	Tag date	FL (cm)	Girth (cm)
60	just below rKm 55	23706	7/10/2008	96	37
61	just below rKm 55	23726	7/10/2008	93.5	37
62	just below rKm 55	23728	7/10/2008	108	40
63	just below rKm 55	23731	7/10/2008	71	29
64	just below rKm 55	23732	7/10/2008	144	53
65	just below rKm 55	23733	7/10/2008	79	29.5
66	just below rKm 55	23734	7/10/2008	153	63
67	just below rKm 55	23735	7/10/2008	132	50
68	just below rKm 55	23736	1/6/2009	101	38
69	just below rKm 55	23737	1/6/2009	139	56
70	just below rKm 55	23738	1/6/2009	130	48
71	just below rKm 55	23739	1/6/2009	111.5	44
72	just below rKm 55	23740	1/6/2009	87	31
73	just below rKm 55	23741	1/6/2009	79.5	30
74	just below rKm 55	23742	1/6/2009	120	44
75	just below rKm 55	23743	1/6/2009	106	45
76	between rKm 39 and Port Mann Bridge	23744	1/6/2009	151.5	59
77	between rKm 39 and Port Mann Bridge	23745	1/6/2009	67.5	25
78	between rKm 39 and Port Mann Bridge	23746	1/6/2009	74.5	28.5
79	between rKm 39 and Port Mann Bridge	23747	1/6/2009	92.5	34.5
80	just below rKm 55	23748	2/6/2009	108	39
81	just below rKm 55	23749	2/6/2009	167	62.5
82	just below rKm 55	23750	2/6/2009	90.5	35
83	just below rKm 55	23751	2/6/2009	141.5	53.5
84	just below rKm 55	23752	2/6/2009	69	29.5
85	just below rKm 55	23753	2/6/2009	177.5	71.5
86	just below rKm 55	23754	2/6/2009	166	60
87	just below rKm 55	23755	2/6/2009	98	39
88	between rKm 39 and Port Mann Bridge	23756	2/6/2009	88.5	30
89	between rKm 39 and Port Mann Bridge	23757	2/6/2009	100.5	39
90	between rKm 39 and Port Mann Bridge	23758	2/6/2009	78	29.5
91	between rKm 39 and Port Mann Bridge	23759	2/6/2009	139	53
92	between rKm 39 and Port Mann Bridge	23760	2/6/2009	78.5	30
93	between rKm 39 and Port Mann Bridge	23761	2/6/2009	133.5	48

No	Location of Tagging	Tag ID	Tag date	FL (cm)	Girth (cm)
94	between rKm 39 and Port Mann Bridge	23762	2/6/2009	81	32.5
95	between rKm 39 and Port Mann Bridge	23763	2/6/2009	64	25.5
96	between rKm 39 and Port Mann Bridge	23764	2/6/2009	138.5	57.5
97	just below rKm 55	23765	3/6/2009	101.5	38
98	just below rKm 55	23766	3/6/2009	93	34
99	just below rKm 55	23767	3/6/2009	100	40
100	just below rKm 55	23768	3/6/2009	94.5	34
101	just below rKm 55	26533	3/6/2009	62	26
102	just below rKm 55	26534	3/6/2009	131.5	54
103	just below rKm 55	26535	3/6/2009	71	27
104	between rKm 39 and Port Mann Bridge	26536	3/6/2009	117.5	42.5
105	between rKm 39 and Port Mann Bridge	26537	3/6/2009	85	31.5
106	between rKm 39 and Port Mann Bridge	26538	3/6/2009	96	36.5
107	between rKm 39 and Port Mann Bridge	26539	3/6/2009	141	53
108	between rKm 39 and Port Mann Bridge	26540	3/6/2009	101.5	35.5
109	between rKm 39 and Port Mann Bridge	26541	3/6/2009	105	41
110	between rKm 39 and Port Mann Bridge	26542	3/6/2009	91	36.5

Appendix C

Data sheets for each detection day

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Nov 11, 2009	**Area Monitored: Pitt Br to Pt Mann Br & Barnston Is to Pt Mann Br**					
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	**Tag Number**	**Depth (ft)**	**Water Temp. (Celsius)**	**Time Start**	**Time End**	**Comments**
20	23688	27.0	3	9:15		
12	23681	27.0				
11	23679	27.0				
14	23687	29.4				
79	23747	37.0				
93	23761	32.9				
13	23685	29.2				
30	23700	28.5				
16	23684	27.2				
19	23686	30.8				
23	23691	33.7				
81	23749	40.1	5			
83	23751	50.3				
32	23703	66.8				
2	23670	32.1				
26	23694	45.8				
104	26536	32.7				
89	23757	24.9			1:20	

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Nov 18, 2009	**Area Monitored: Pitt Lk to Pt Mann Br**					
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	**Tag Number**	**Depth (ft)**	**Water Temp. (Celsius)**	**Time Start**	**Time End**	**Comments**
75	23743	28.4	3	9:25		
5	23673	31.0				
76	23744	37.4				
55	23727	32.6				
31	23702	33.2				
101	26533	59.4	3			
70	26738	60.0				
19	23686	56.6				Detected at Pt Mann 11/11/09
63	23731	42.5				
62	23728	34.4				
67	23735	74.5				
58	23699	40.5				
83	23751	51.1				Detected at Pt Mann 11/11/09
36	23707	47.4				
38	23709	42.0				
61	23726	49.0				
35	23704	24.1				
59	23705	54.4				
49	23720	32.9				
8	23676	41.7				
39	23710	23.9				
99	23767	38.0				
65	23733	41.4				
46	23718	66.9				
45	23716	34.1	3.5		3:30	

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Nov 25, 2009		Area Monitored: Sumas Canal to top of Matsqui Channel				
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	**Tag Number**	**Depth (ft)**	**Water Temp. (Celsius)**	**Time Start**	**Time End**	**Comments**
57	23730	16.5	3	8:30		
29	23698	17.0				
43	23714	21.6				
7	23675	18.0	3		2:30	

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Dec 2, 2009		Area Monitored: Top of Matsqui Channel to Pt Mann Br				
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	**Tag Number**	**Depth (ft)**	**Water Temp. (Celsius)**	**Time Start**	**Time End**	**Comments**
92	23760	30.4	3	8:00		
7	23675	34				
47	23717	47.6				
4	23672	44.5				
9	23677	23.4				
105	26537	52.3				
41	23712	61.5			4:00	

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Jan 6, 2010		Area Monitored: Pt Mann Br to Golden Ear Br & Pt Mann to Pitt Br				
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	Tag Number	Depth (ft)	Water Temp. (Celsius)	Time Start	Time End	Comments
20	23688	29.1	1	8:00		
14	23687	38.0				
110	26542	27.9				
30	23700	32.3				
76	23744	62.0				
8	23676	18.2				
93	23761	20.4				
81	23749	23.6			4:00	

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Jan 13, 2010		Area Monitored: Pitt Lk to Pitt Br				
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	Tag Number	Depth (ft)	Water Temp. (Celsius)	Time Start	Time End	Comments
63	23731	24	1	8:00		
52	23724	29				
32	23703	49				
99	23767	50				
38	23709	50				
71	23739	47				
36	23707	46				
83	23751	46				
61	23726	49				
19	23686	48				
77	23745	51				
70	23738	50				
59	23705	54				
65	23733	77				
67	23735	50				
93	23761	44				
66	23734	46				
33	23696	60				
5	23673	24				
75	23743	40			4:00	

Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

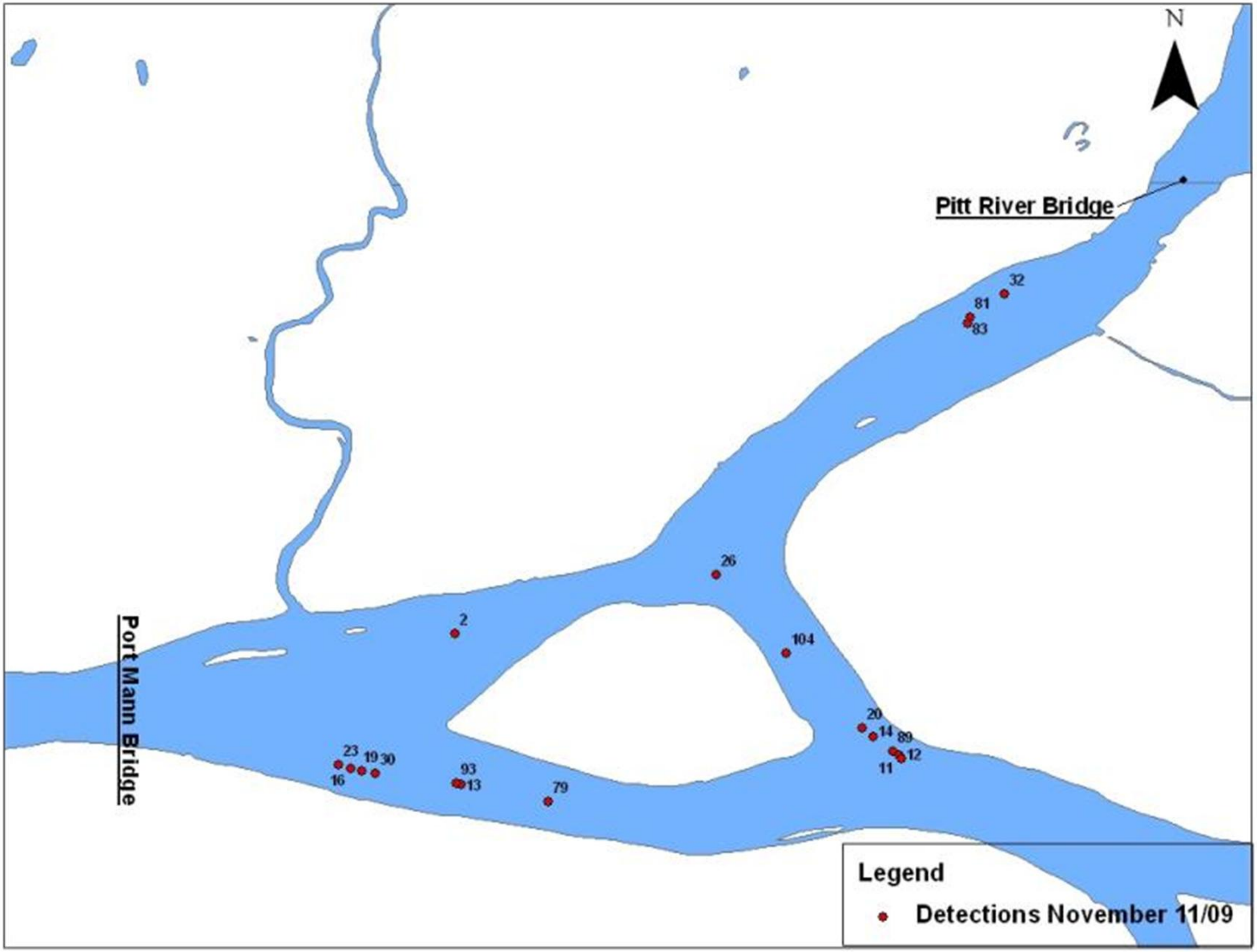
Date: Jan 17, 2010		Area Monitored: Sumas Canal to Bottom of Matsqui Channel				
Observers: Paul Neufeld, Jeremy Mothus						
Sturgeon Number	**Tag Number**	**Depth (ft)**	**Water Temp. (Celsius)**	**Time Start**	**Time End**	**Comments**
92	23760	19.2	1.5	9:00	4:00	

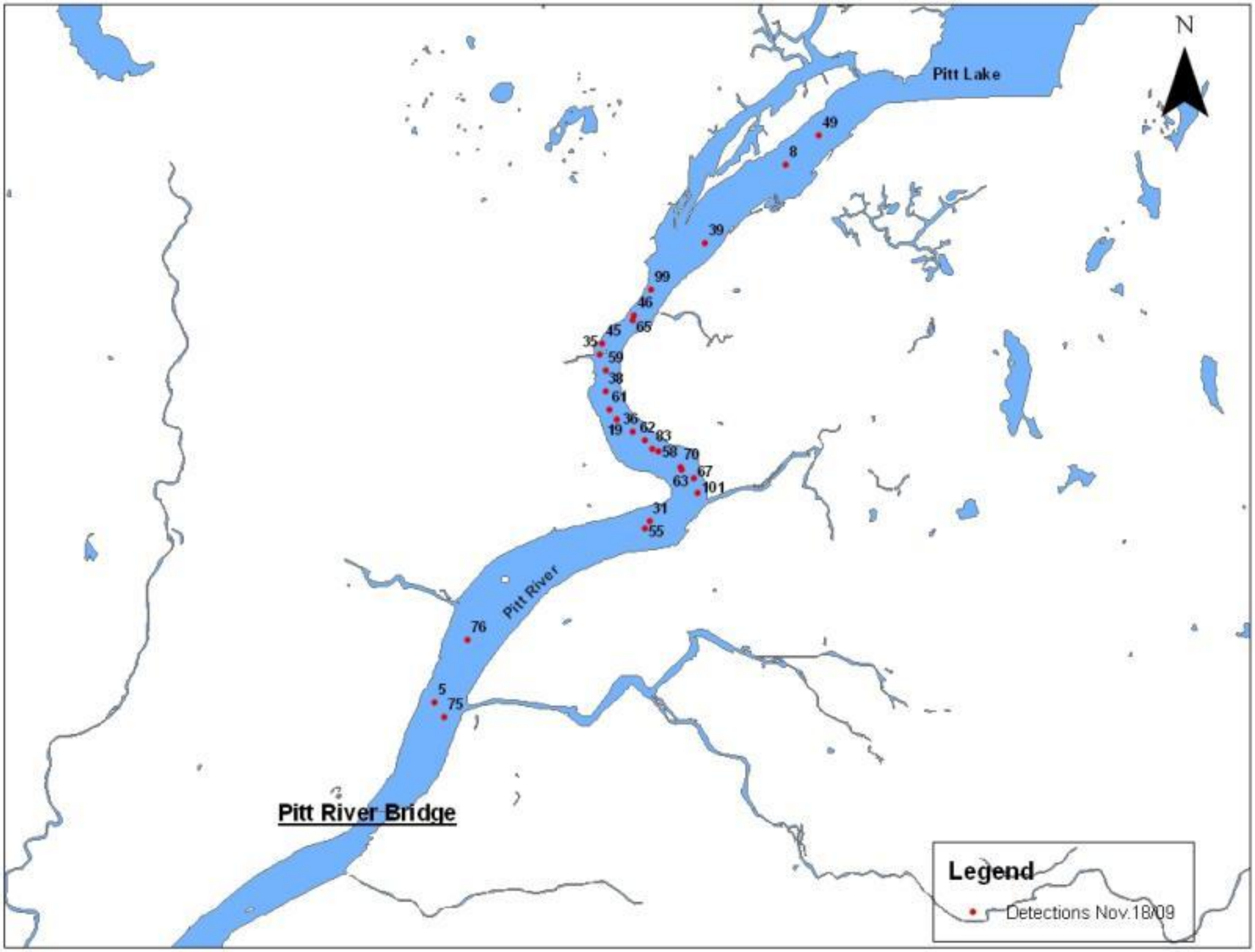
Sturgeon Mobile Telemetry Project 2009/2010 Data Collection Sheet

Date: Jan 20, 2010		Area Monitored: Mission Br to Golden Ears Br				
Observers: Paul Neufeld, Kaid Teubert, Jeremy Mothus						
Sturgeon Number	**Tag Number**	**Depth (ft)**	**Water Temp. (Celsius)**	**Time Start**	**Time End**	**Comments**
90	23758	47.8	1	8:30		
15	23683	40				
97	23765	41				
89	23757	40				
16	23684	40				
7	23675	50				
41	23712	45				
80	23748	60			4:00	

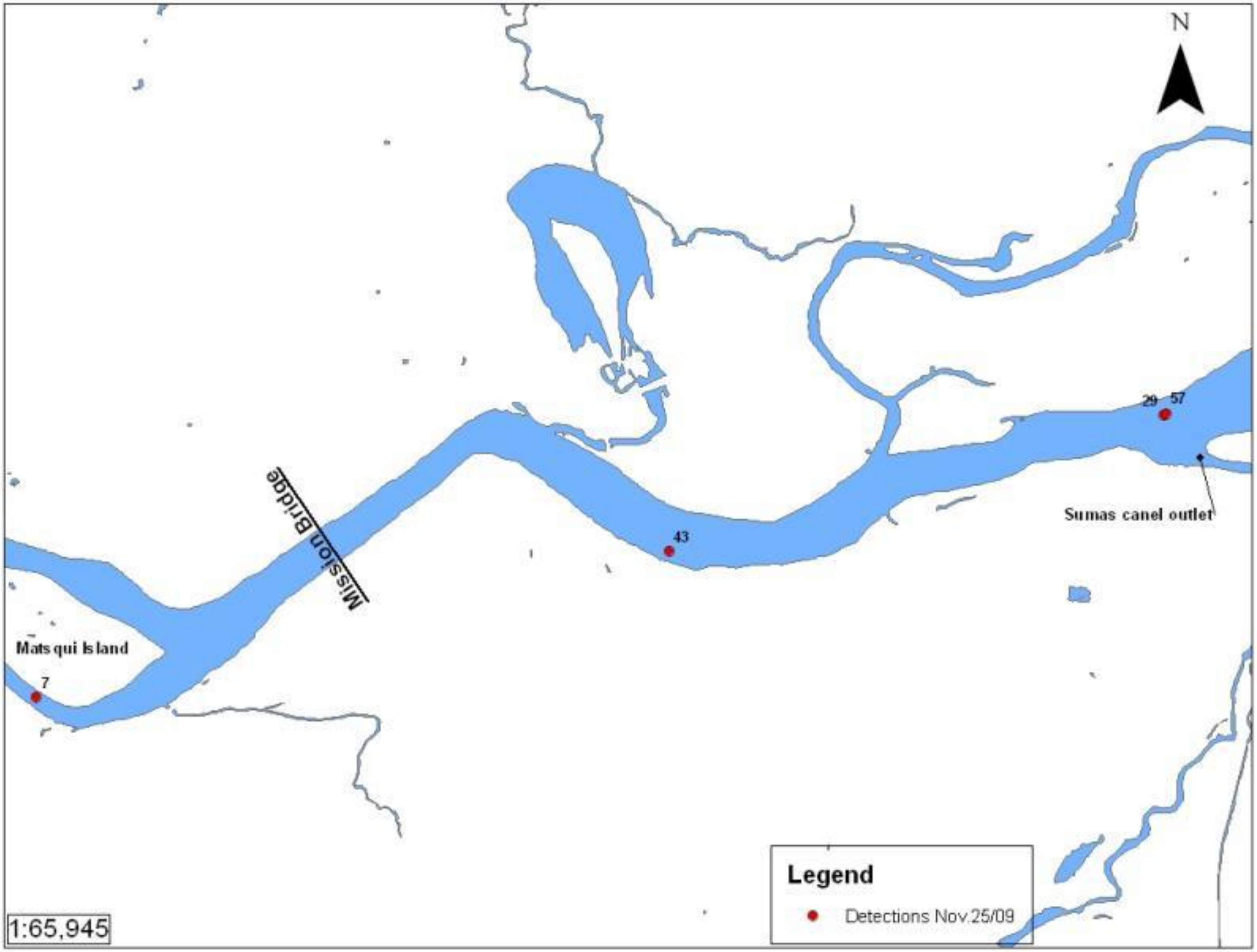
Appendix D

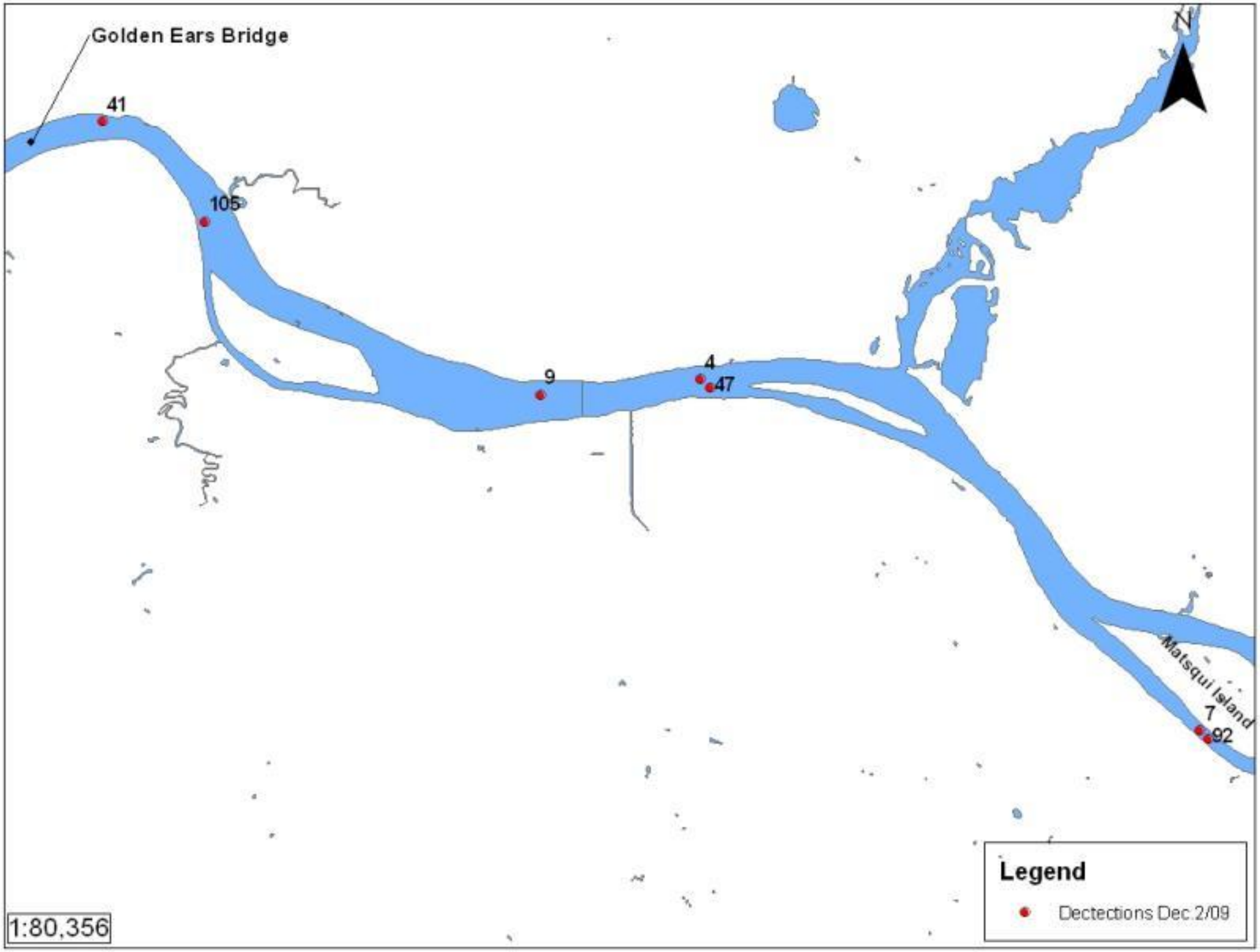
Maps of individual detections of acoustic tagged sturgeon throughout whole study period to date. Maps are divided into the 8 separate survey days (November 11th/2009 to January 20th/2010). The numbers beside the detections are the numbers that we have given each sturgeon; these numbers coincide with the tag numbers that were implanted. To match the detections on the map with the individual sturgeons data (location tagged, size, date, and tag number) use Appendix B.

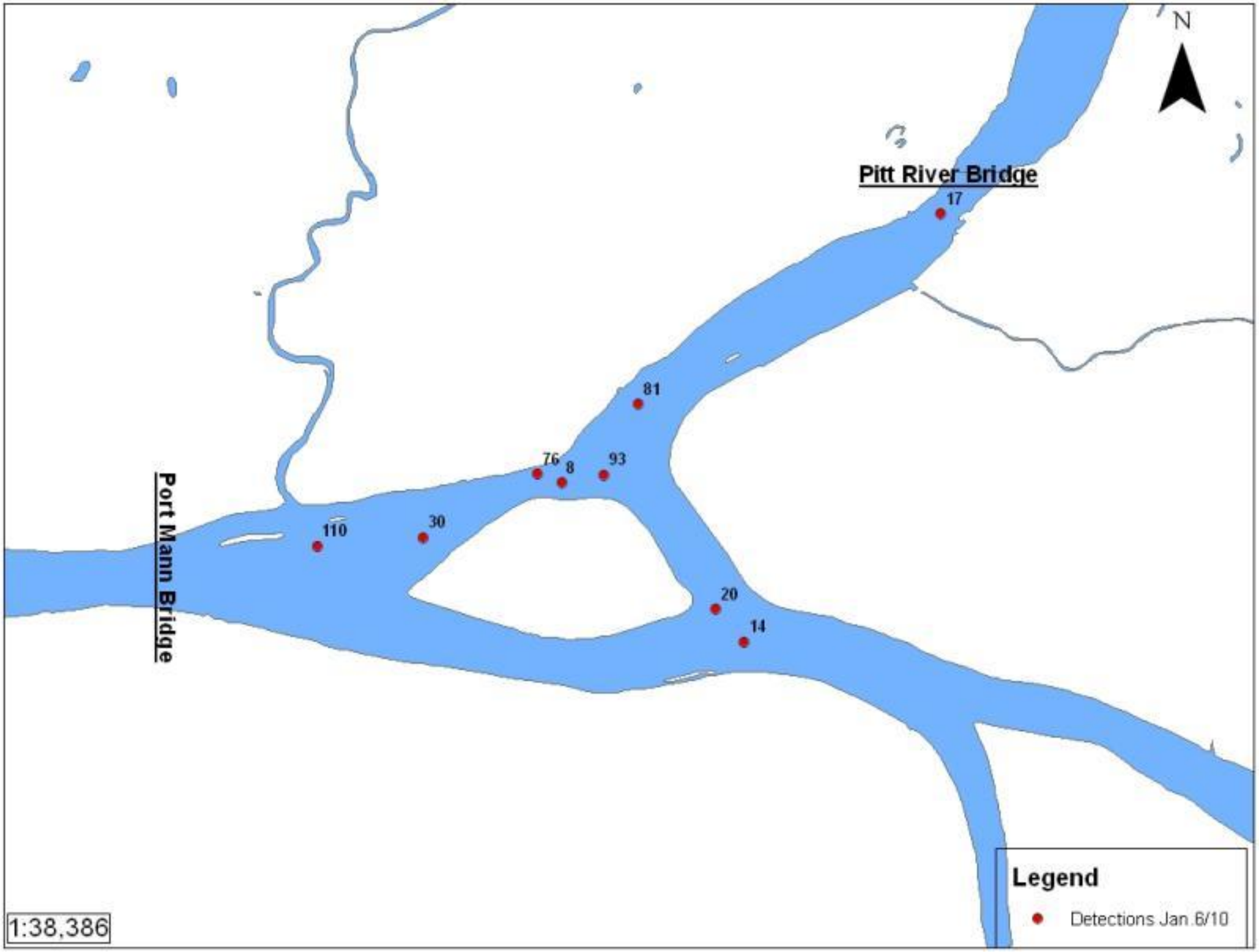

N
Pitt River Bridge
Port Mann Bridge
32
81
83
26
2
104
20
14
89
12
11
23
19
30
16
93
13
79
Legend
Detections November 11/09

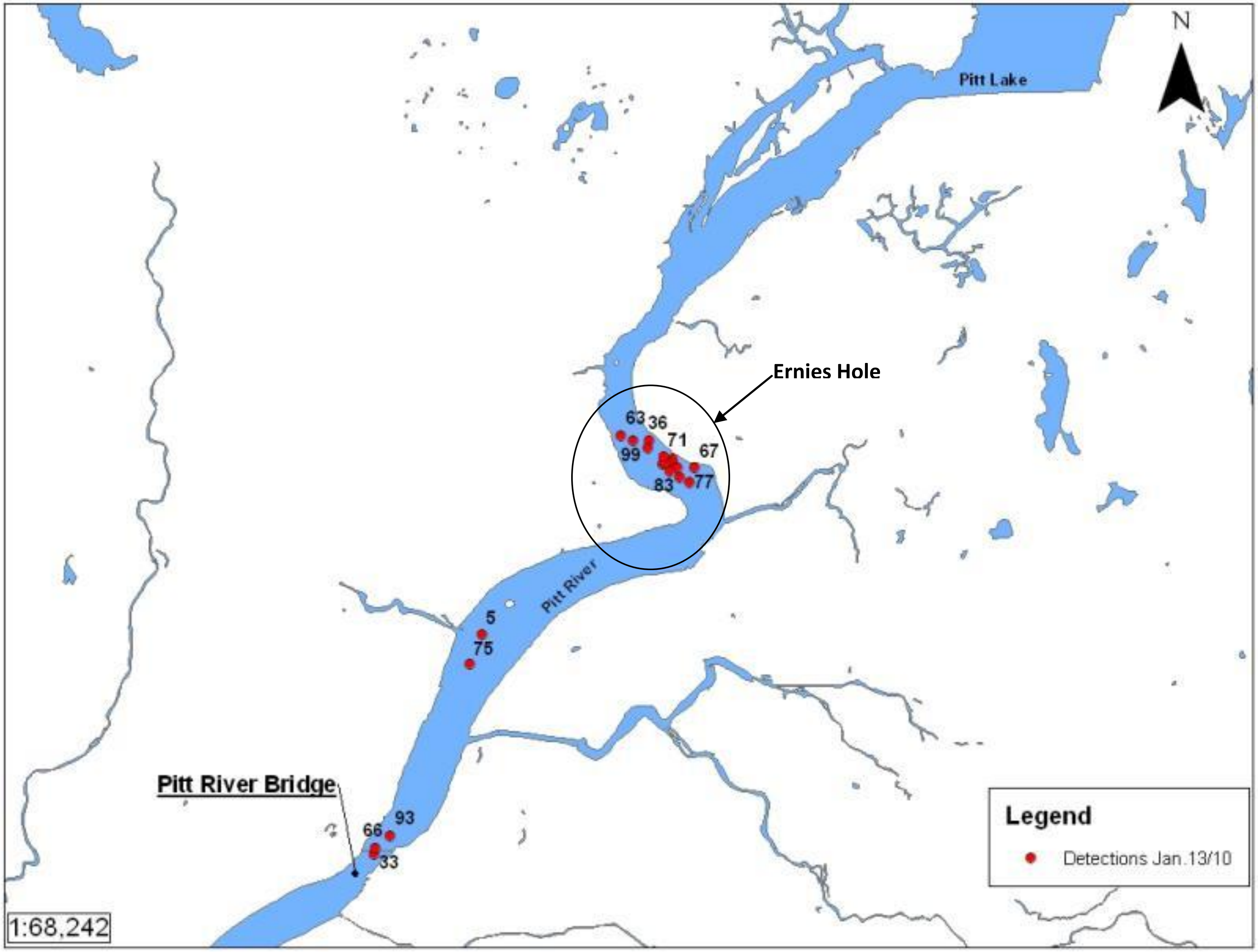


N
Pitt Lake
49
8
39
99
46
65
45
35
59
38
61
36
19
62
83
58
70
67
63
101
31
55
Pitt River
76
5
75
Pitt River Bridge
Legend
Detections Nov.18/09

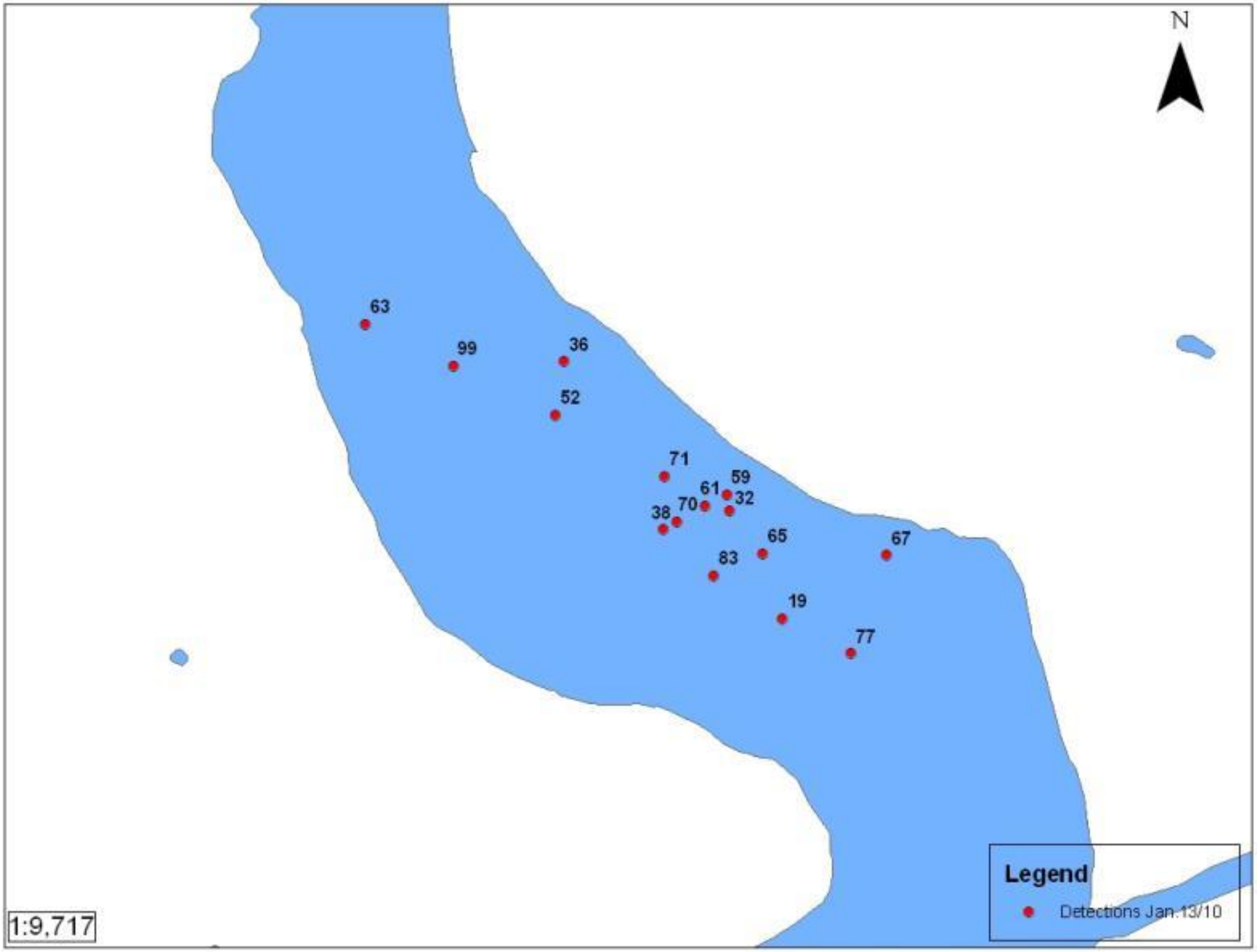

N
29
57
Sumas canel outlet
43
Mission Bridge
Mats qui Is land
7
Legend
Detections Nov.25/09
1:65,945

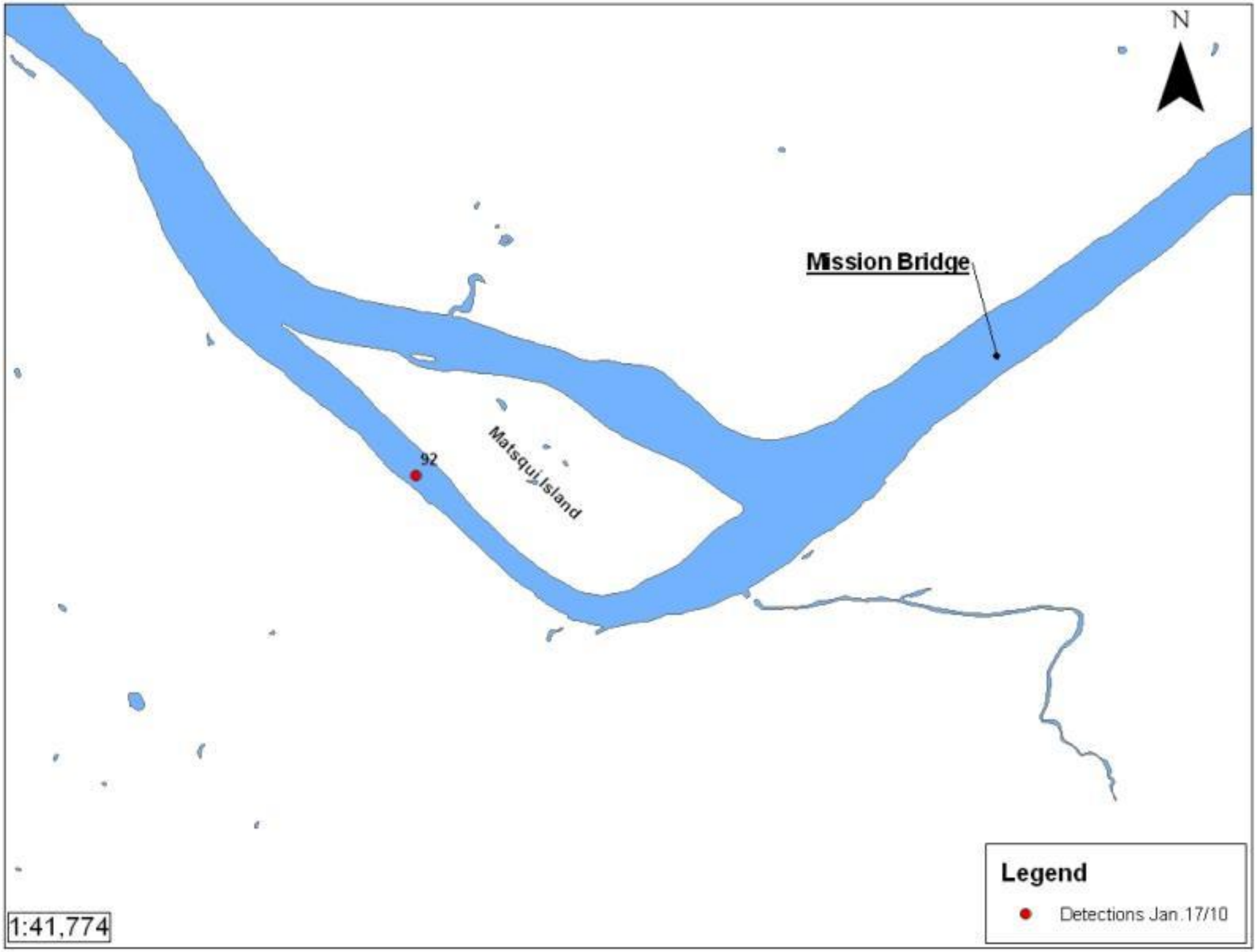

Golden Ears Bridge
41
105
9
4
47
N
Matsqui Island
7
92
Legend
Dectections Dec 2/09
1:80,356

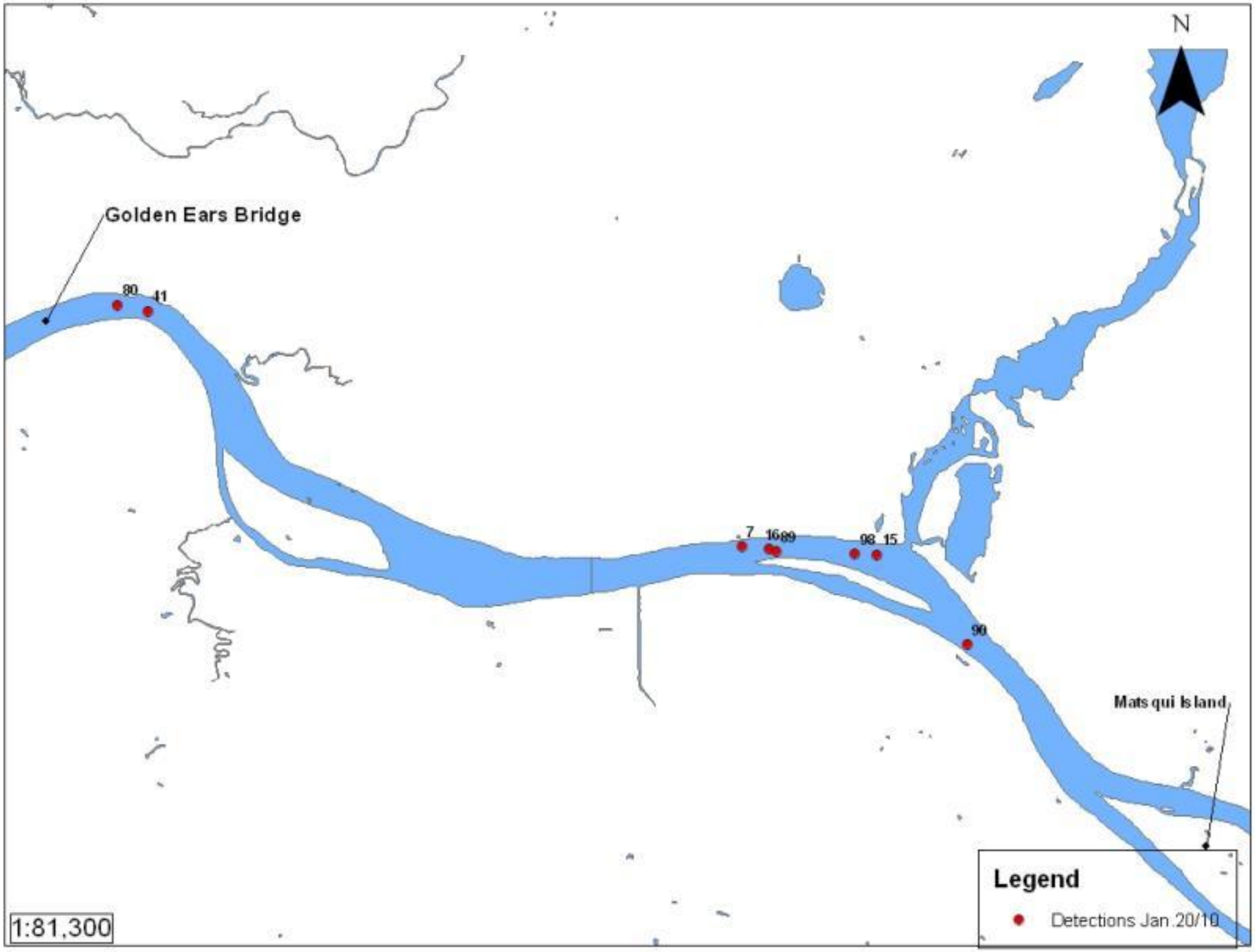

N
Pitt River Bridge
17
81
76
8
93
110
30
20
14
Port Mann Bridge
Legend
Detections Jan.6/10
1:38,386


N
Pitt Lake
Ernies Hole
63
36
71
67
99
83
77
Pitt River
5
75
Pitt River Bridge
93
66
33
Legend
Detections Jan.13/10
1:68,242

“Ernie’s Hole” magnified so sturgeon detection could be correlated with individual identification numbers

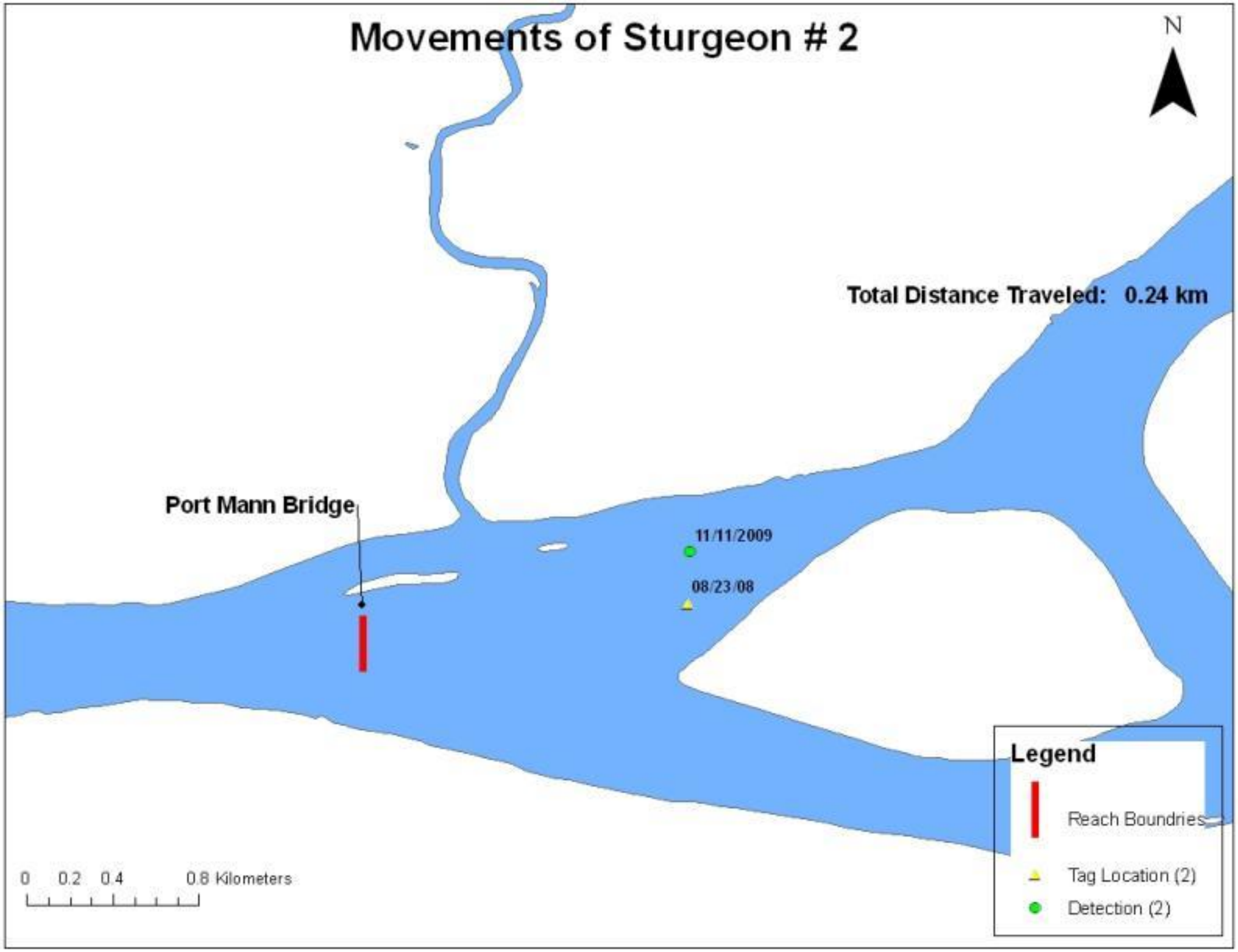


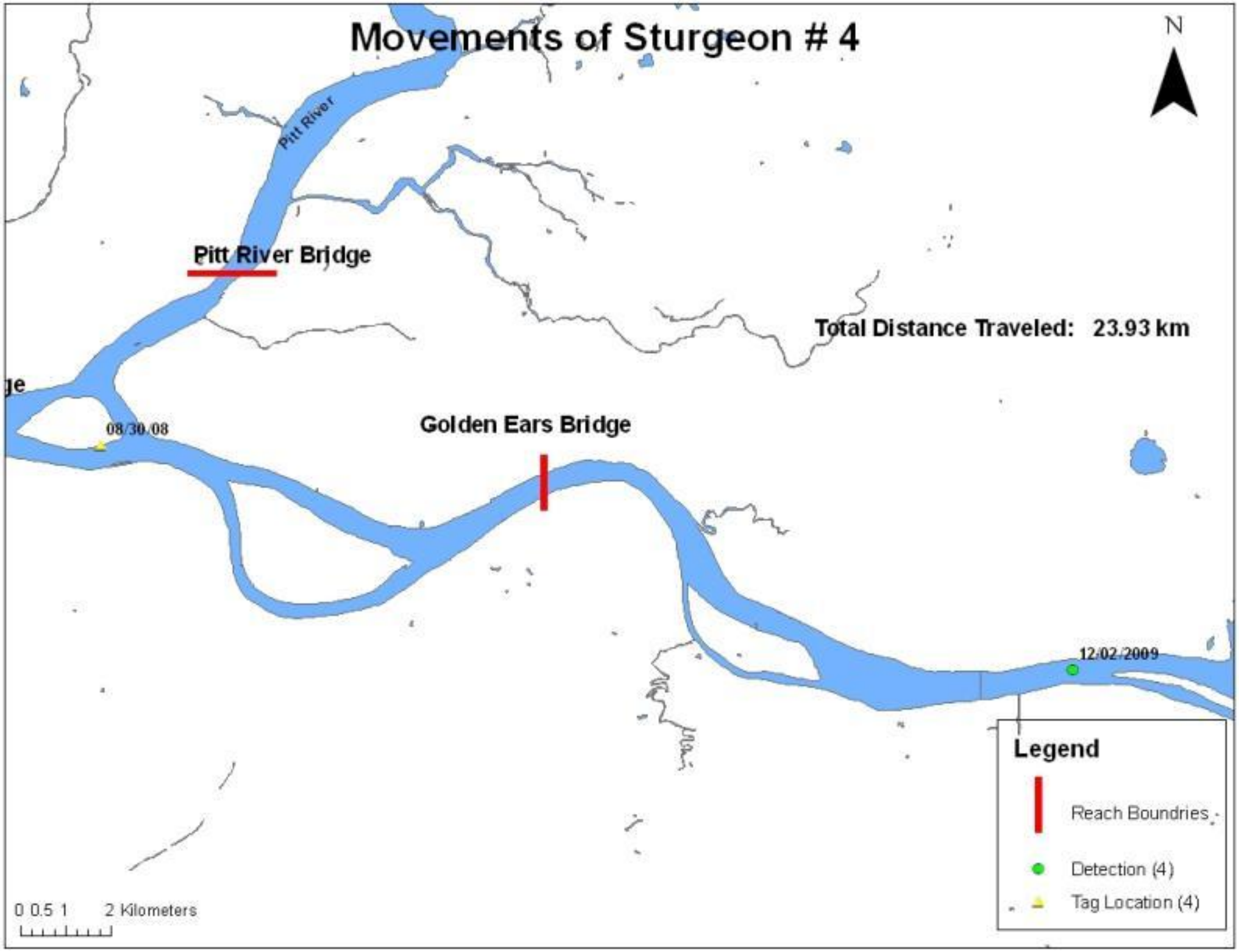

N
Mission Bridge
Matsqui Island
92
Legend
Detections Jan.17/10
1:41,774


N
Golden Ears Bridge
80
41
7
16
89
98
15
90
Mats qui Is land
Legend
Detections Jan.20/10
1:81,300

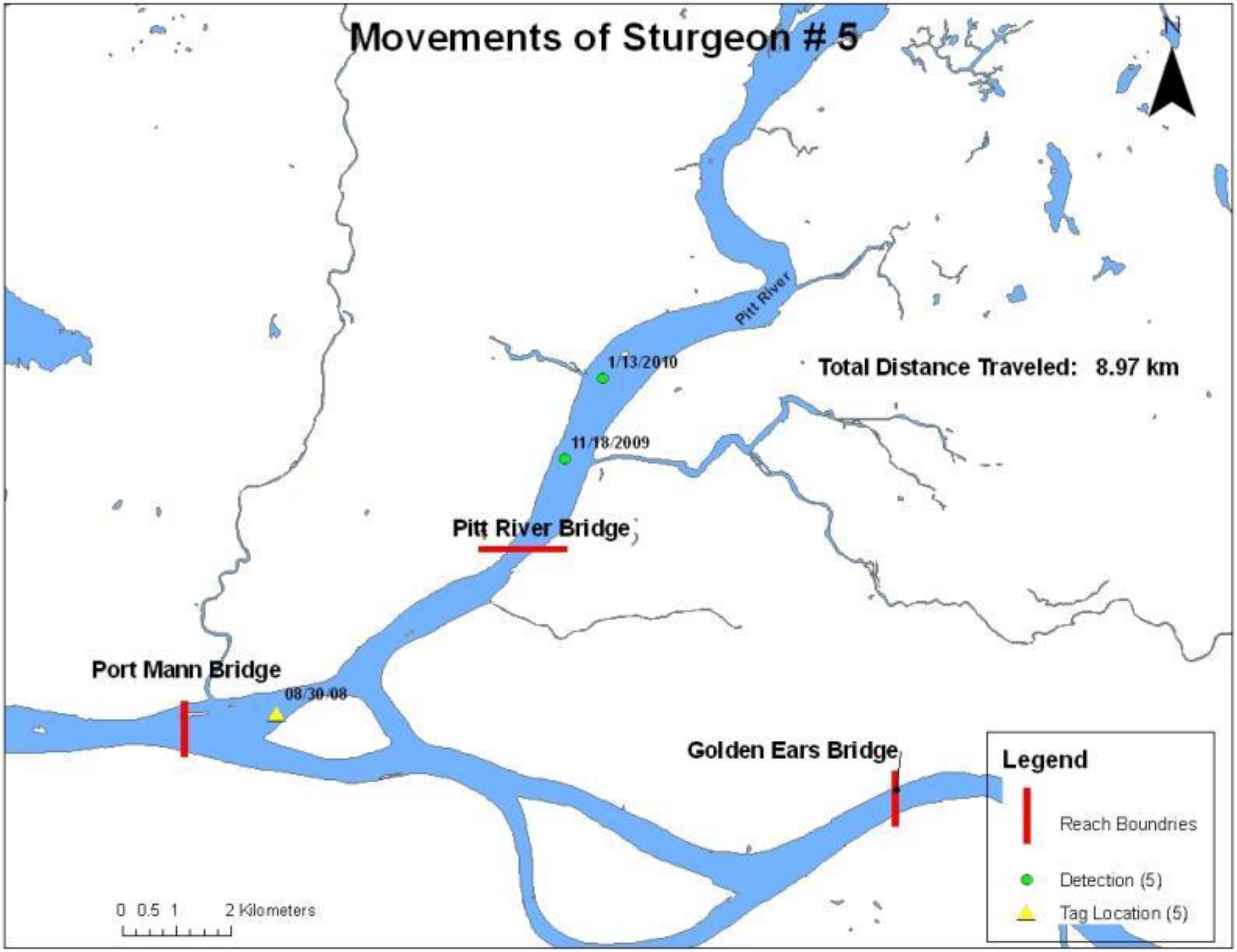
Appendix E

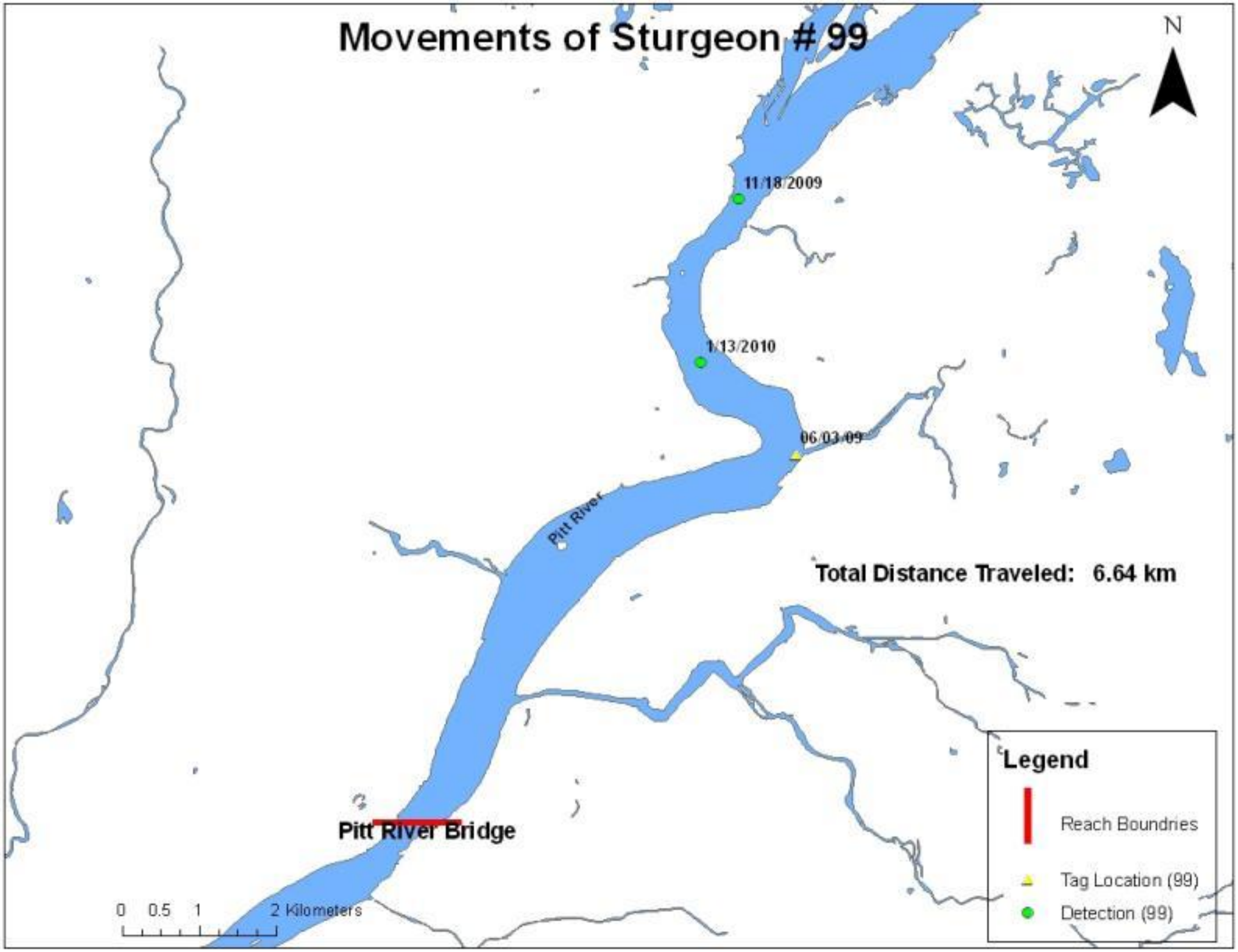
Movements of individual sturgeon that were detected during survey days, dates on detection locations are the dates that the sturgeon was detected. To match numbers on detection locations with acoustic tags applied to each fish, as well as the size, date and location when it was tagged use Appendix B.


Movements of Sturgeon # 2
N
Total Distance Traveled: 0.24 km
Port Mann Bridge
11/11/2009
08/23/08
Legend
Reach Boundries
Tag Location (2)
Detection (2)
0 0.2 0.4 0.8 Kilometers

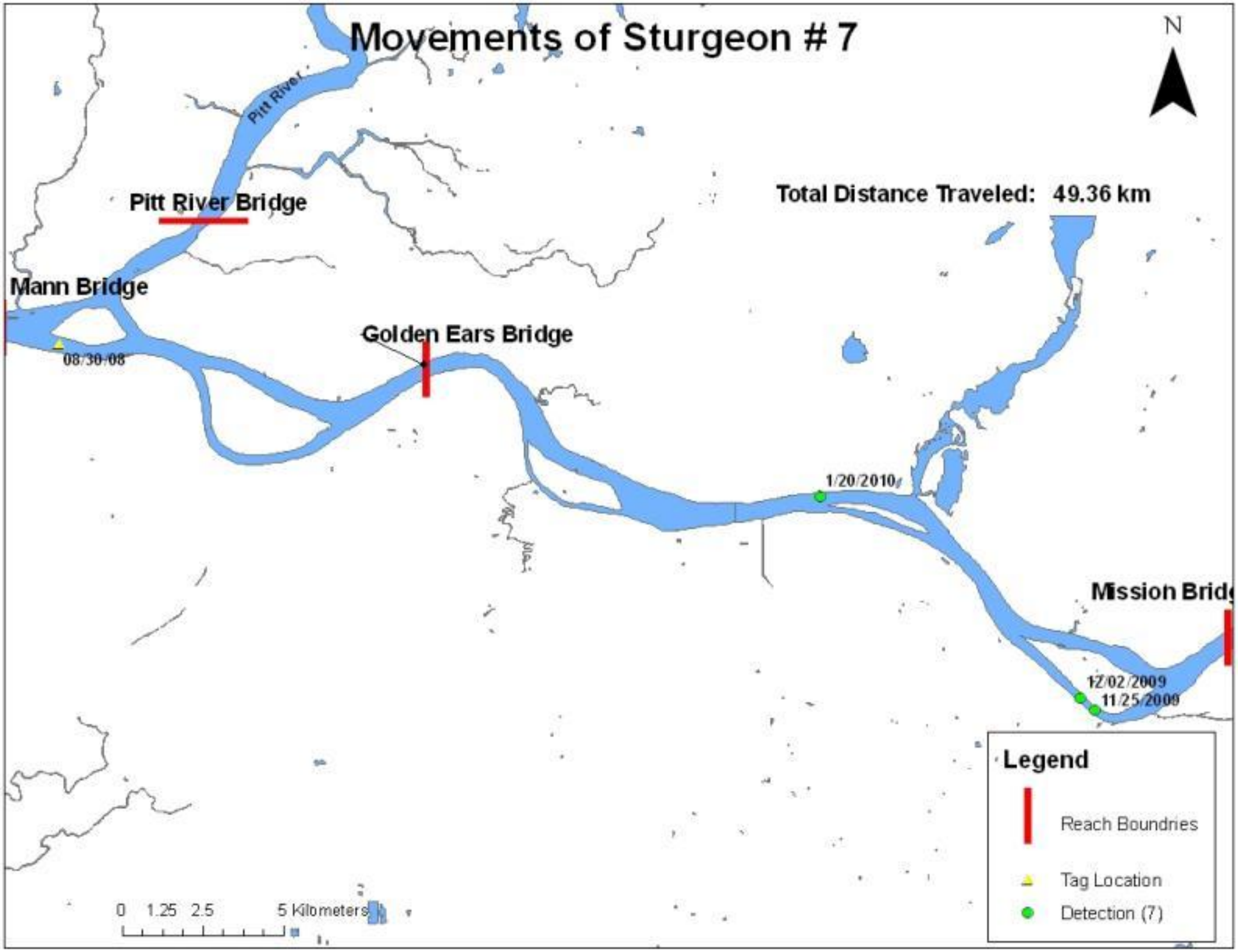


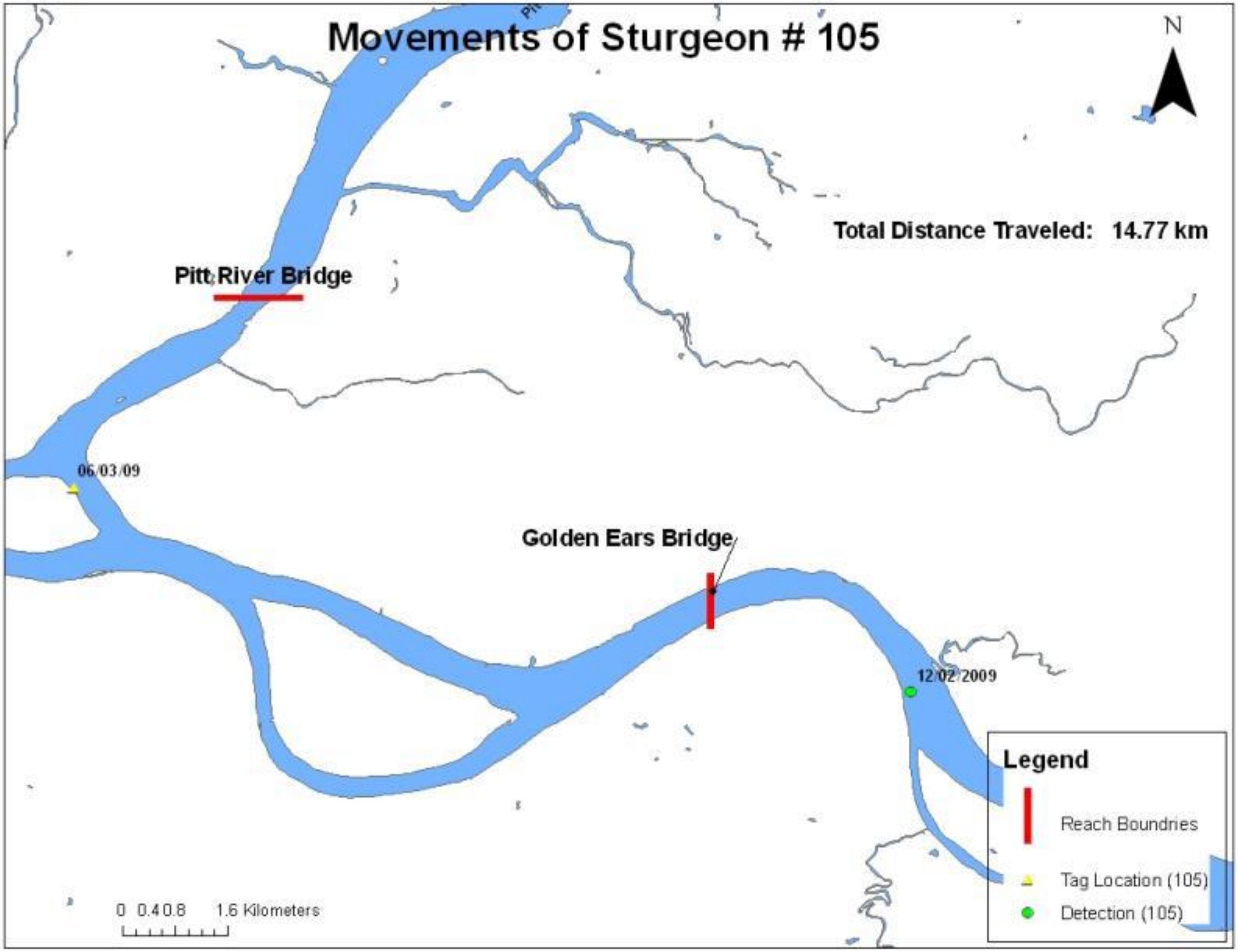
Movements of Sturgeon # 4
N
Pitt River
Pitt River Bridge
Total Distance Traveled: 23.93 km
ge
08/30/08
Golden Ears Bridge
12/02/2009
Legend
Reach Boundries
Detection (4)
Tag Location (4)
0 0.5 1 2 Kilometers

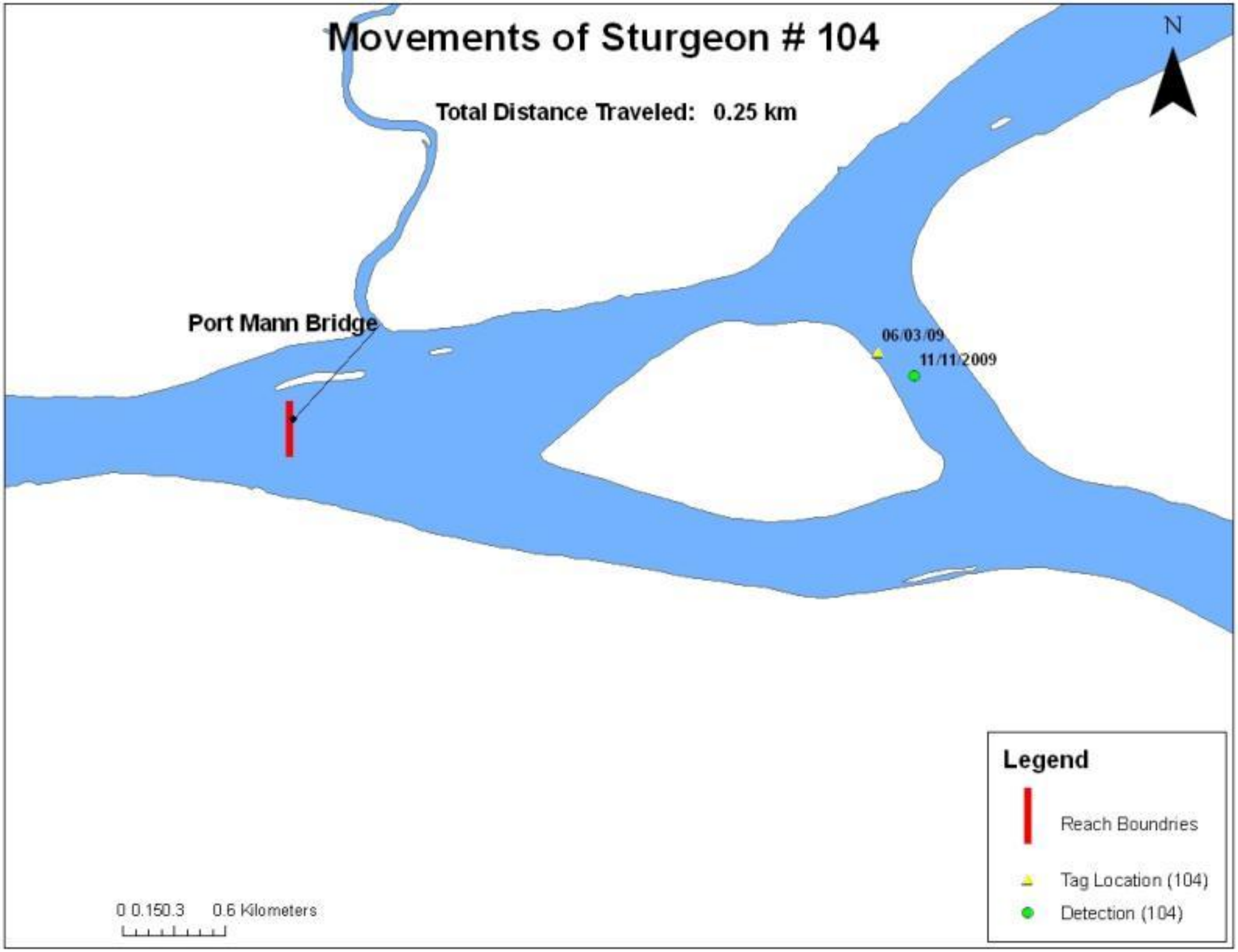

Movements of Sturgeon # 5
N
Pitt River
1/13/2010
11/18/2009
Total Distance Traveled: 8.97 km
Pitt River Bridge
Port Mann Bridge
08/30/08
Golden Ears Bridge
Legend
Reach Boundries
Detection (5)
Tag Location (5)
0 0.5 1 2 Kilometers



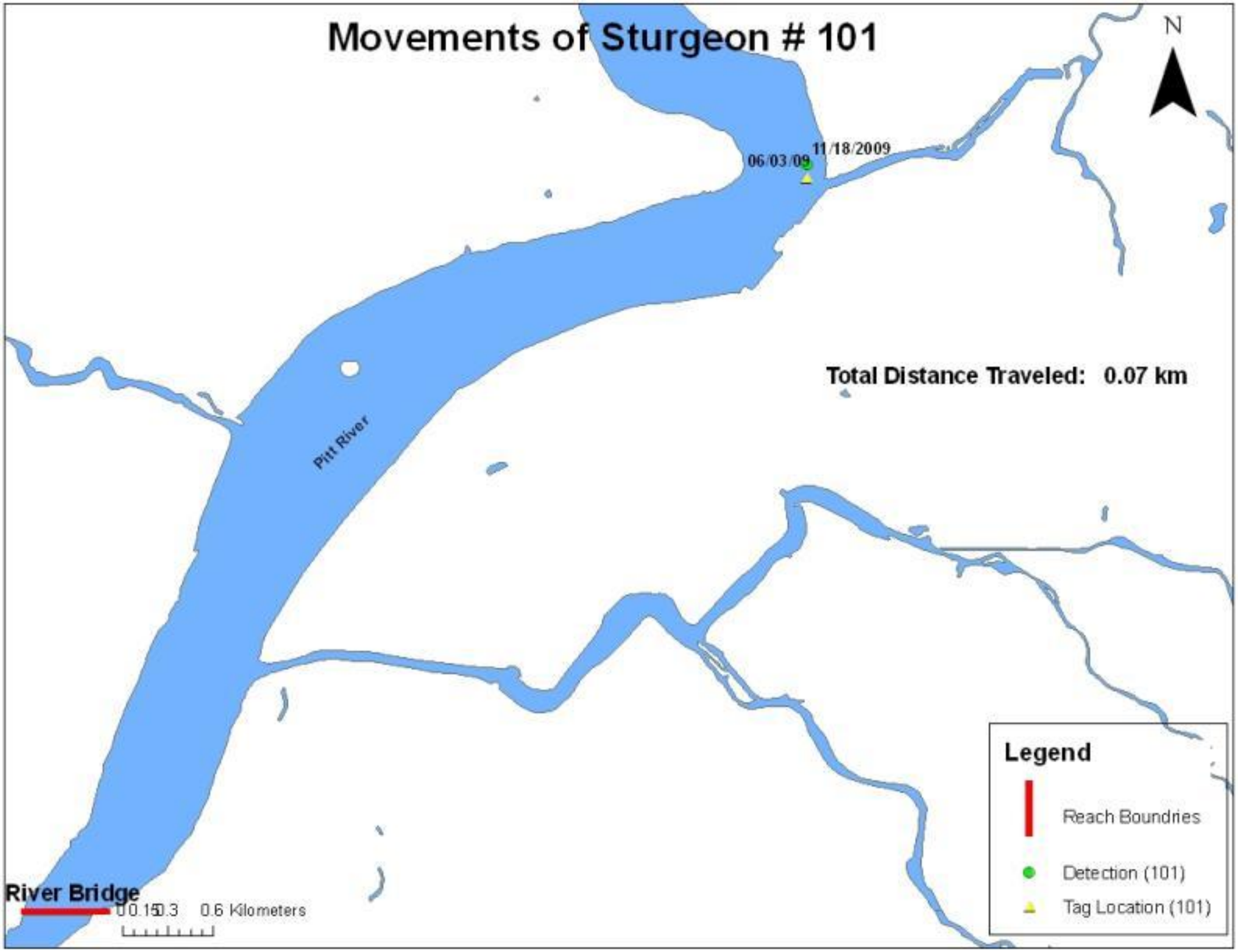
Movements of Sturgeon # 99
N
11/18/2009
1/13/2010
06/03/09
Pitt River
Total Distance Traveled: 6.64 km
Pitt River Bridge
Legend
Reach Boundries
Tag Location (99)
Detection (99)
0 0.5 1 2 Kilometers

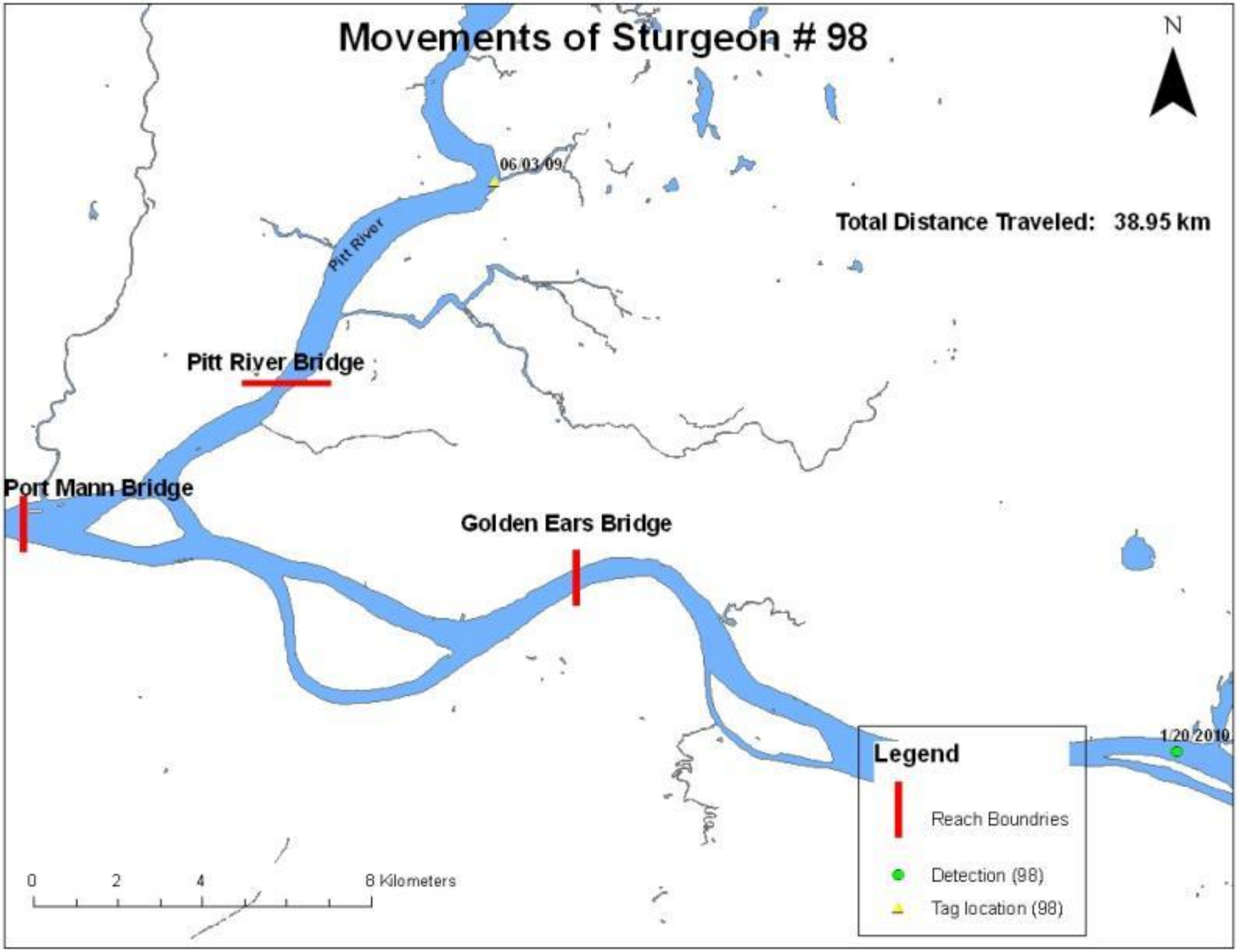

Movements of Sturgeon # 7
N
Pitt River
Pitt River Bridge
Total Distance Traveled: 49.36 km
Mann Bridge
Golden Ears Bridge
08/30/08
1/20/2010
Mission Brid
12/02/2009
11/25/2009
Legend
Reach Boundries
Tag Location
Detection (7)
0 1.25 2.5 5 Kilometers


Movements of Sturgeon # 105
N
Total Distance Traveled: 14.77 km
Pitt River Bridge
06/03/09
Golden Ears Bridge
12/02/2009
Legend
Reach Boundries
Tag Location (105)
Detection (105)
0 0.4 0.8 1.6 Kilometers

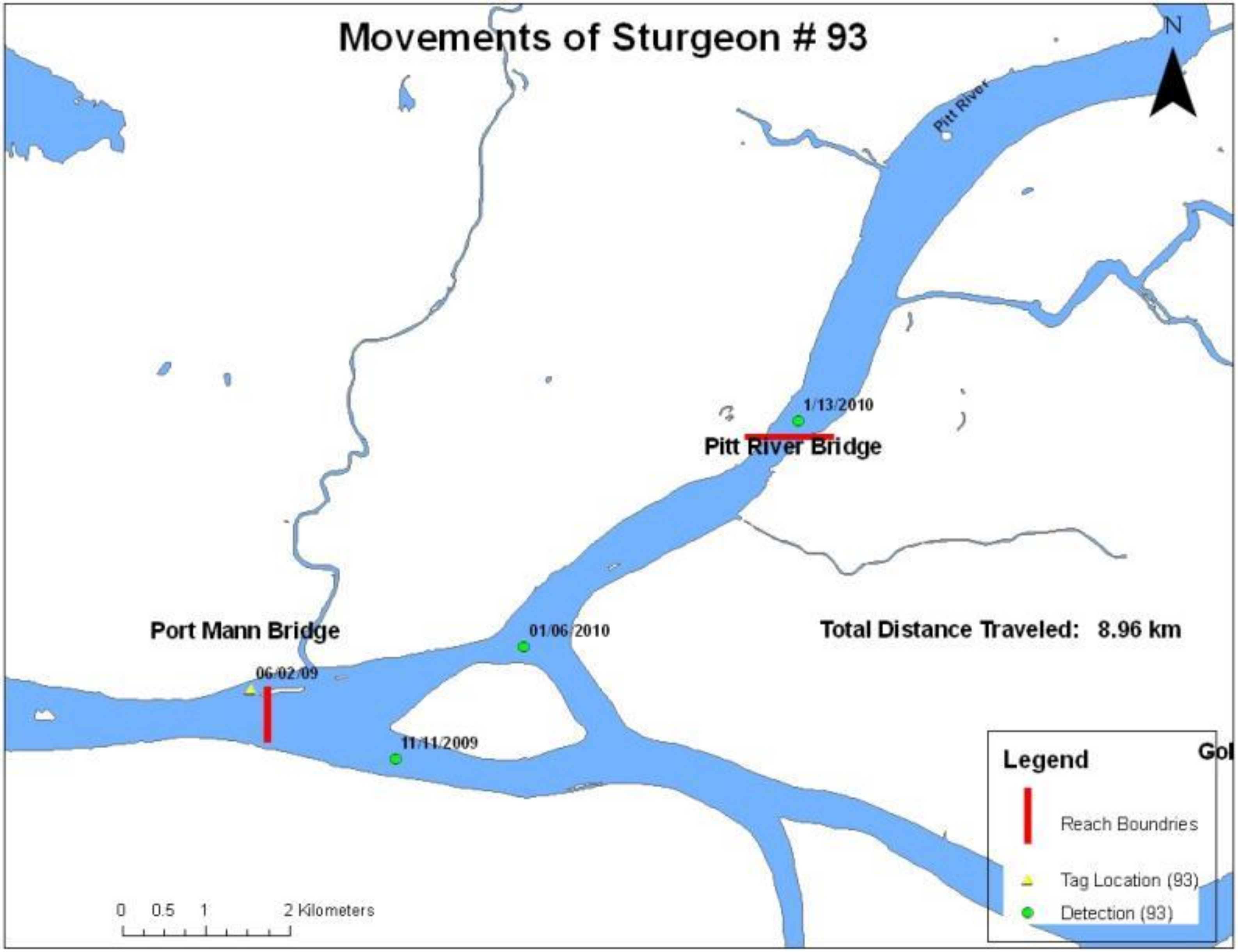


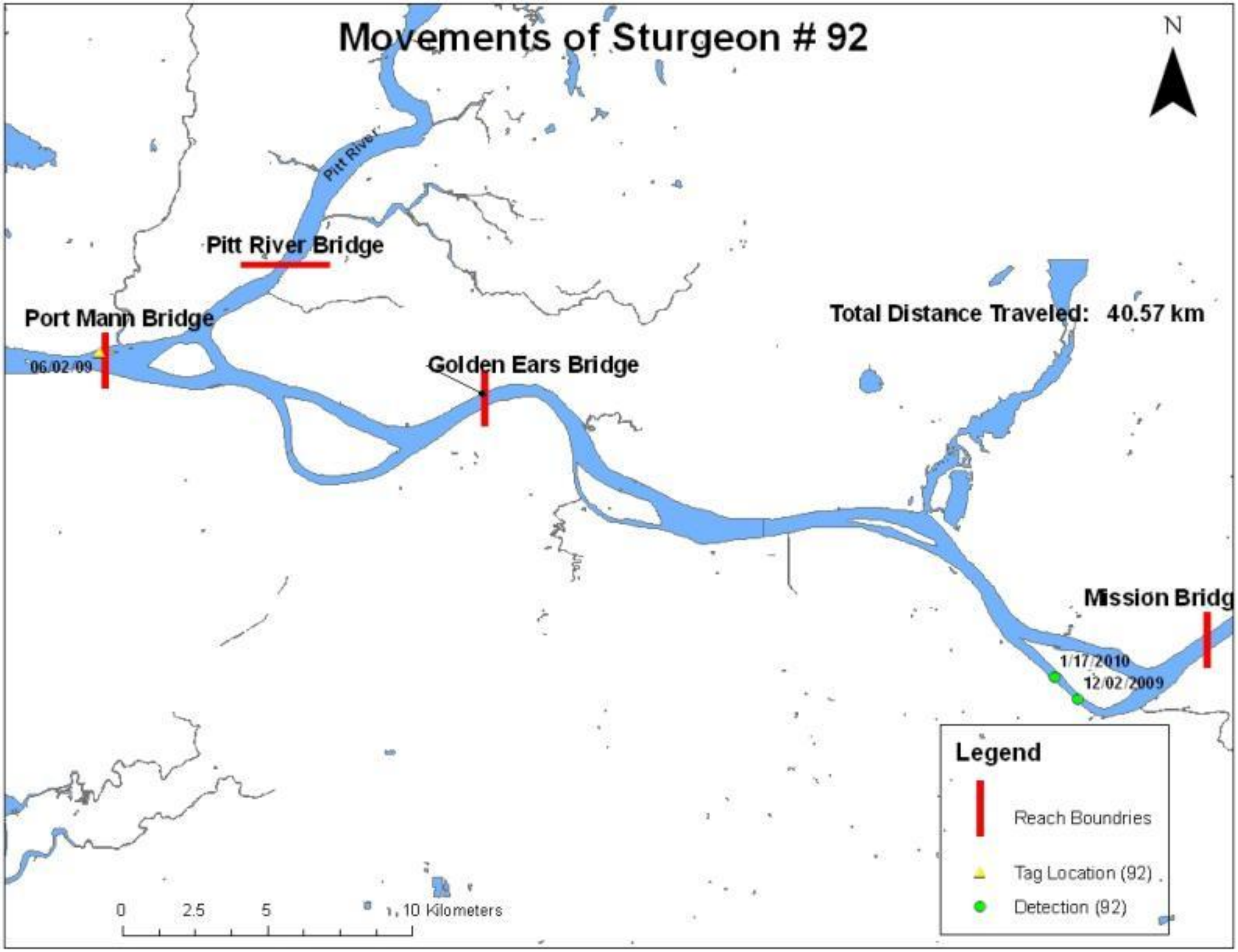
Movements of Sturgeon # 104
Total Distance Traveled: 0.25 km
N
Port Mann Bridge
06/03/09
11/11/2009
Legend
Reach Boundries
Tag Location (104)
Detection (104)
0 0.150.3 0.6 Kilometers

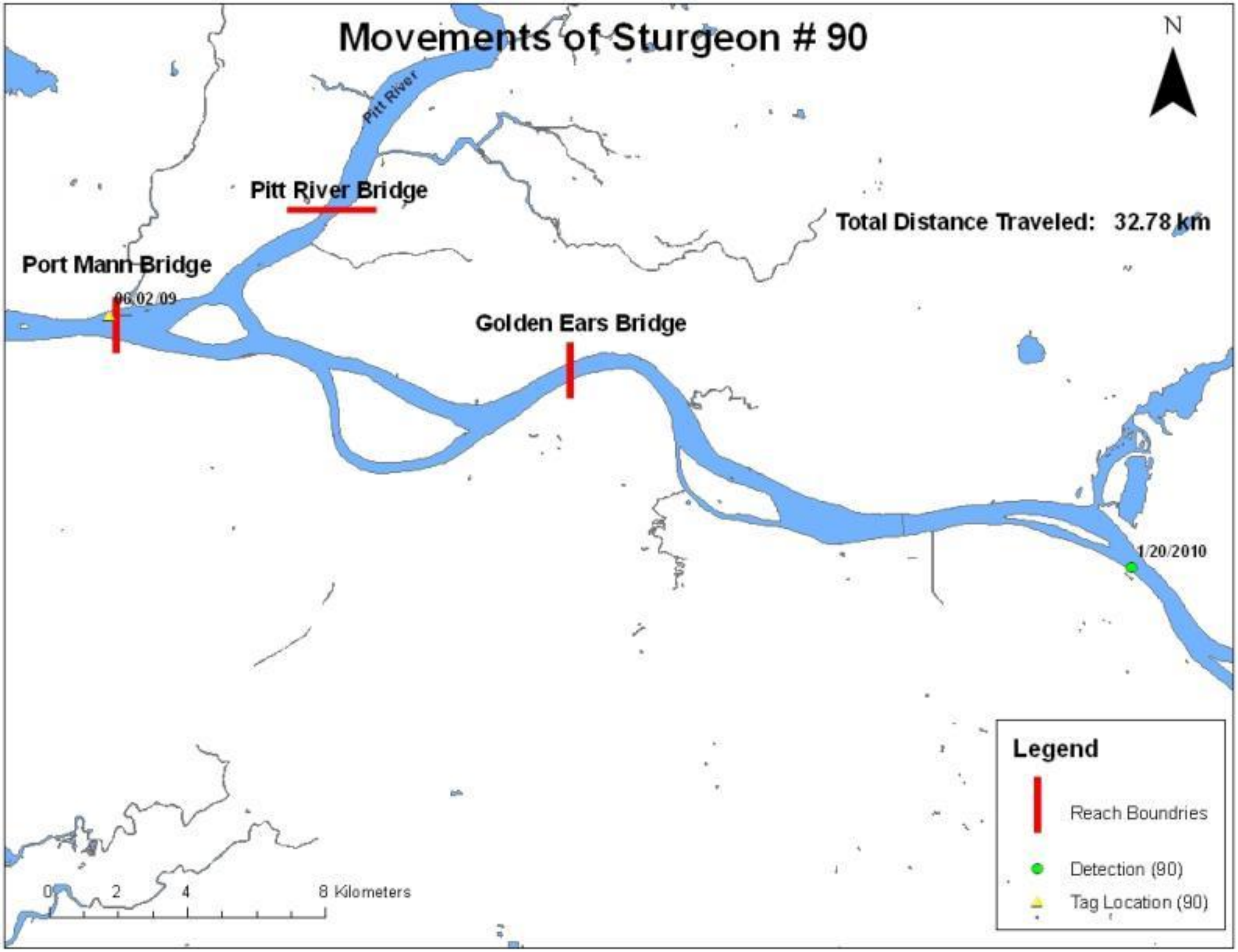

Movements of Sturgeon # 101
N
06/03/09
11/18/2009
Total Distance Traveled: 0.07 km
Pitt River
River Bridge
0 0.15 0.3 0.6 Kilometers
Legend
Reach Boundries
Detection (101)
Tag Location (101)

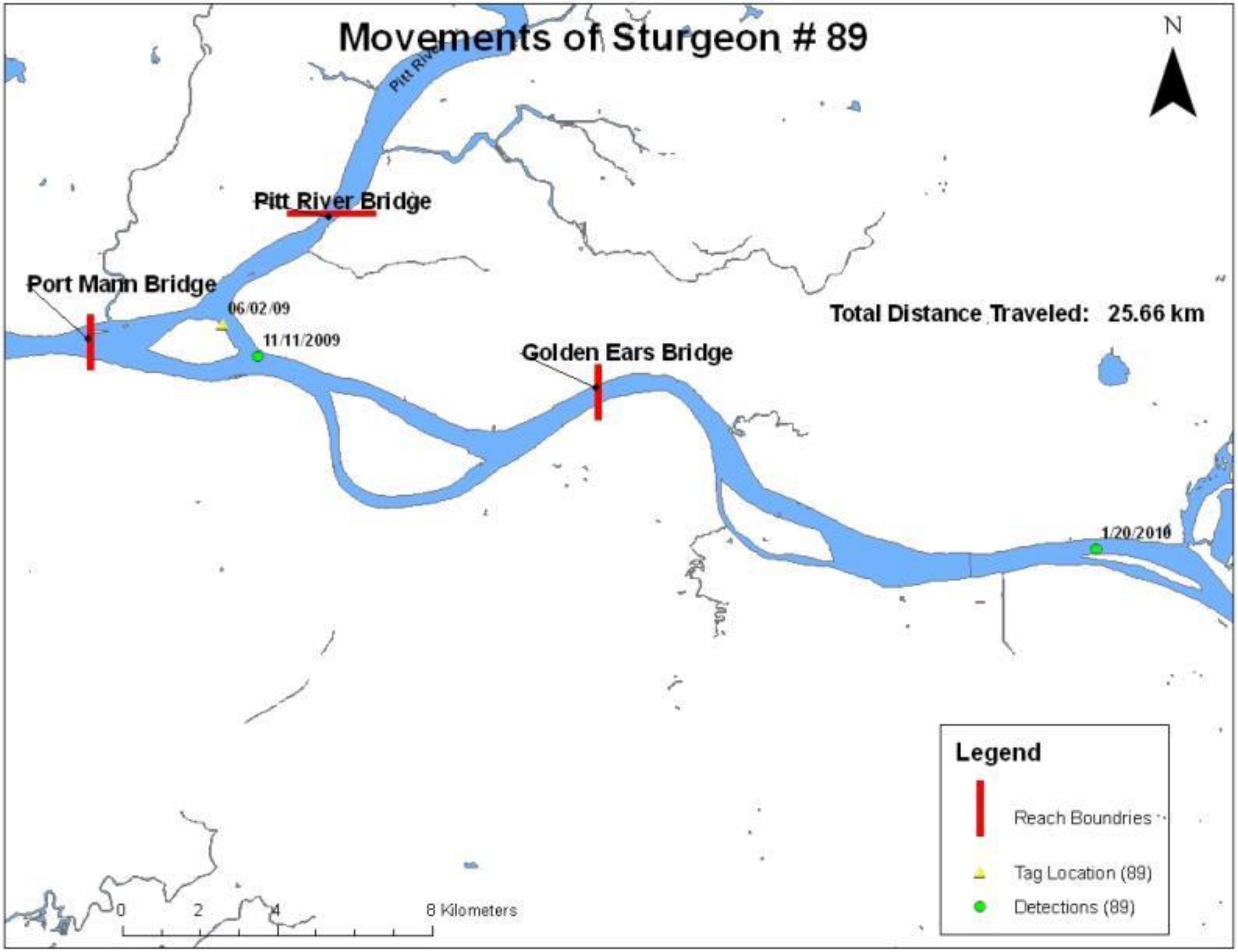


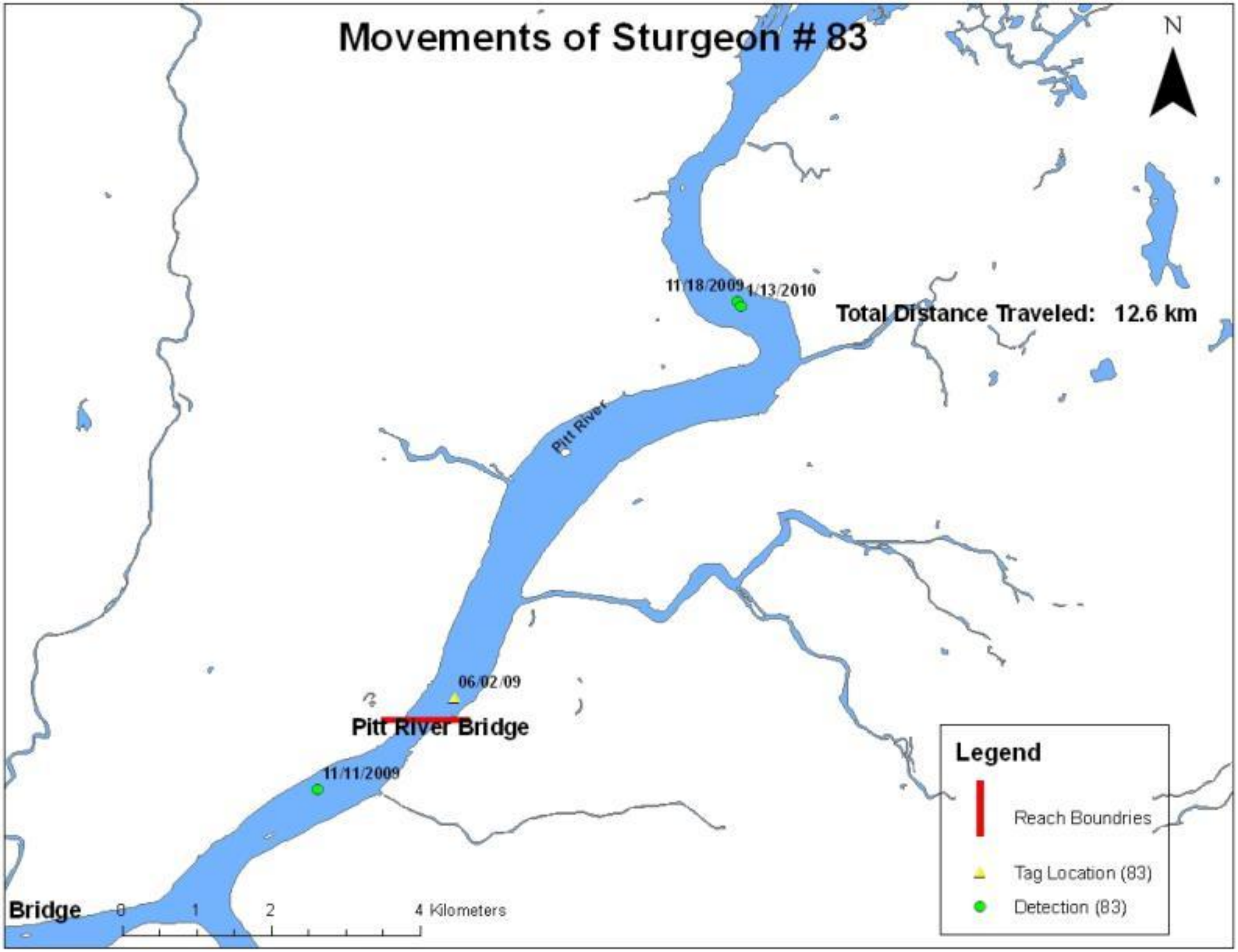
Movements of Sturgeon # 98
N
06/03/09
Pitt River
Total Distance Traveled: 38.95 km
Pitt River Bridge
Port Mann Bridge
Golden Ears Bridge
1/20/2010
Legend
Reach Boundries
Detection (98)
Tag location (98)
0
2
4
8 Kilometers

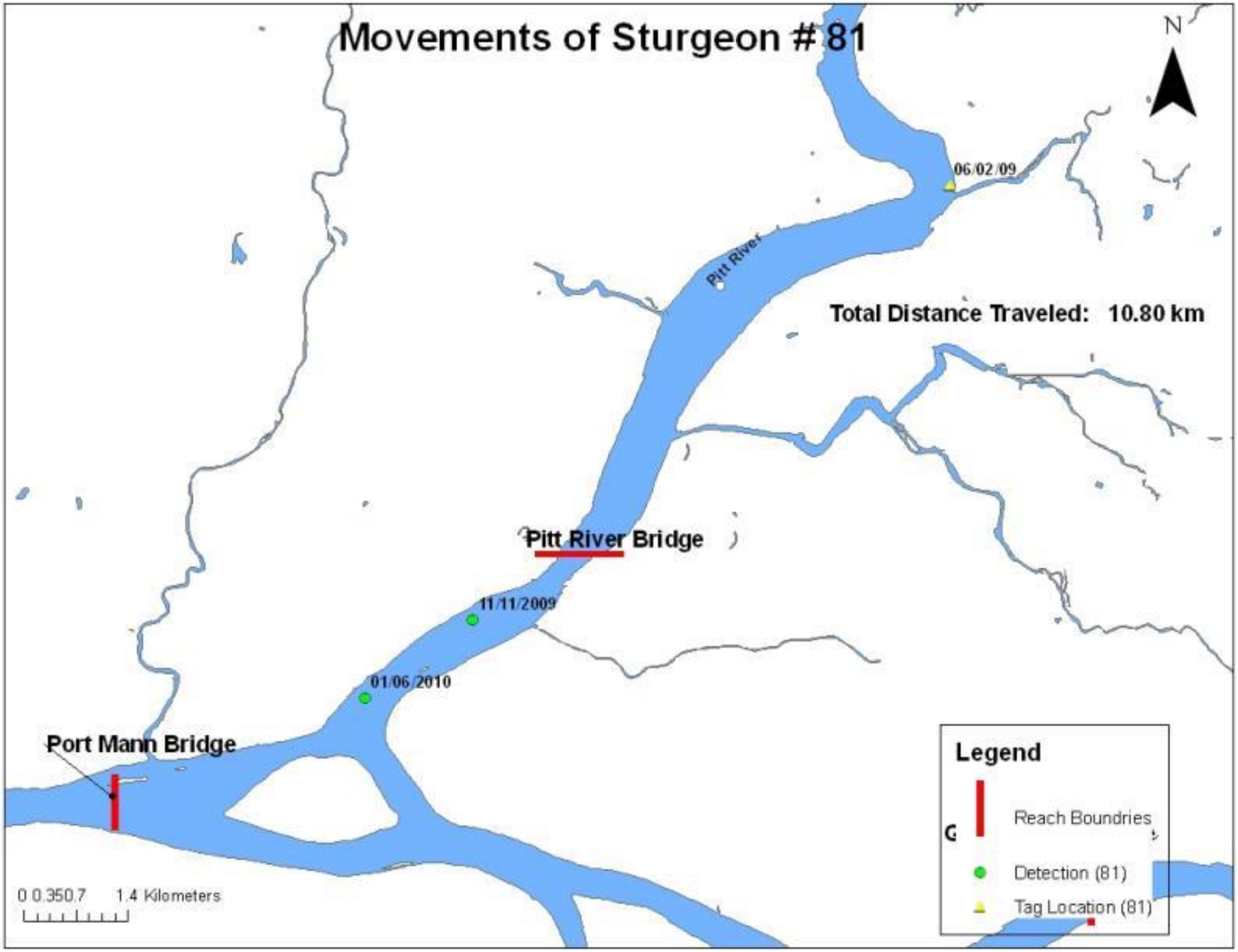

Movements of Sturgeon # 93
N
Pitt River
1/13/2010
Pitt River Bridge
Port Mann Bridge
01/06/2010
Total Distance Traveled: 8.96 km
06/02/09
11/11/2009
Legend
Reach Boundries
Tag Location (93)
Detection (93)
0 0.5 1 2 Kilometers

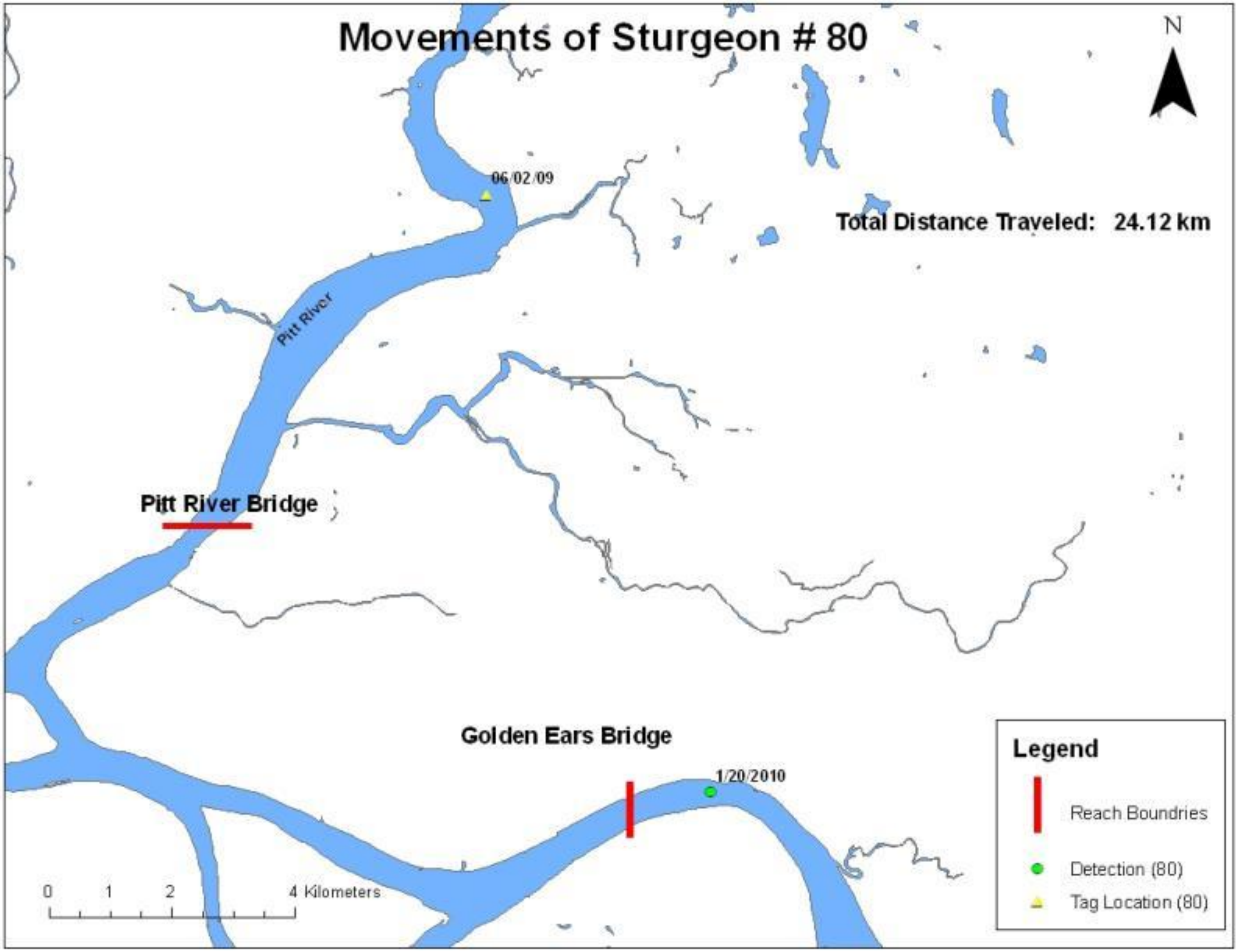

Movements of Sturgeon # 92
N
Pitt River
Pitt River Bridge
Port Mann Bridge
06/02/09
Golden Ears Bridge
Total Distance Traveled: 40.57 km
Mission Bridg
1/17/2010
12/02/2009
Legend
Reach Boundries
Tag Location (92)
Detection (92)
0
2.5
5
10 Kilometers

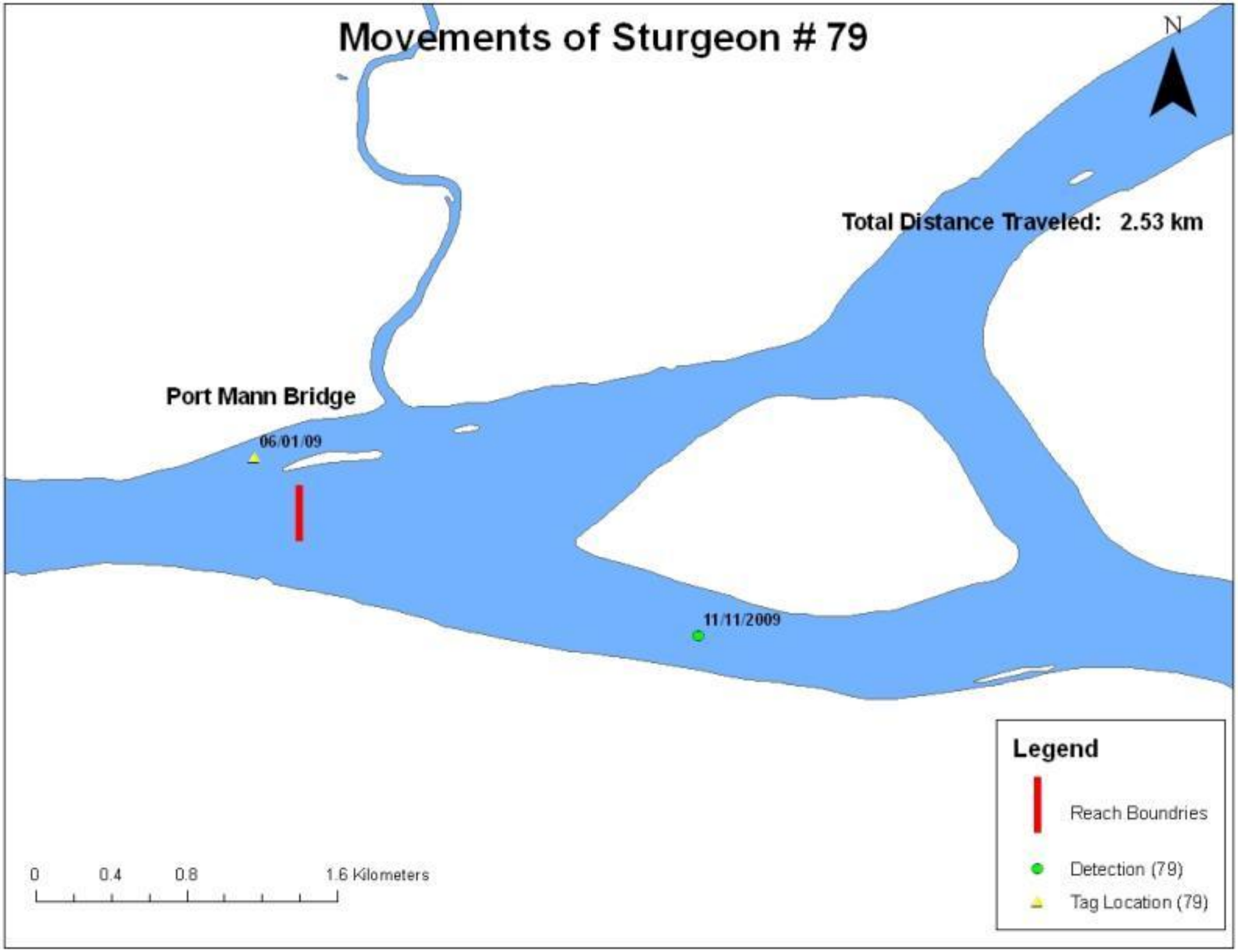

Movements of Sturgeon # 90
N
Pitt River
Pitt River Bridge
Total Distance Traveled: 32.78 km
Port Mann Bridge
06/02/09
Golden Ears Bridge
1/20/2010
0 2 4 8 Kilometers
Legend
Reach Boundries
Detection (90)
Tag Location (90)

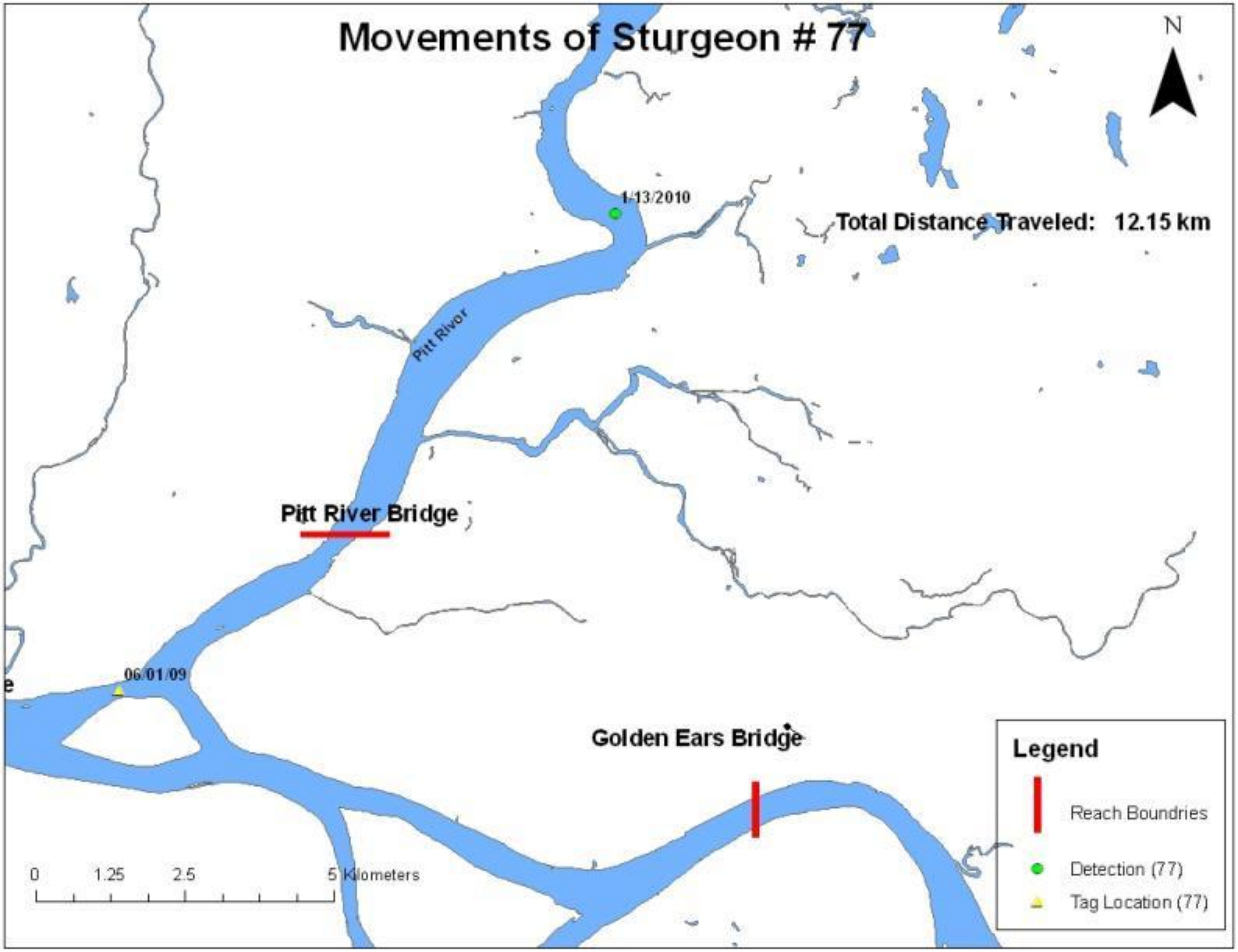

Movements of Sturgeon # 89
N
Pitt River
Pitt River Bridge
Port Mann Bridge
06/02/09
11/11/2009
Golden Ears Bridge
Total Distance Traveled: 25.66 km
1/20/2010
Legend
Reach Boundries
Tag Location (89)
Detections (89)
0
2
4
8 Kilometers


Movements of Sturgeon # 83
N
11/18/2009
1/13/2010
Total Distance Traveled: 12.6 km
Pitt River
06/02/09
Pitt River Bridge
11/11/2009
Bridge
0
1
2
4 Kilometers
Legend
Reach Boundries
Tag Location (83)
Detection (83)

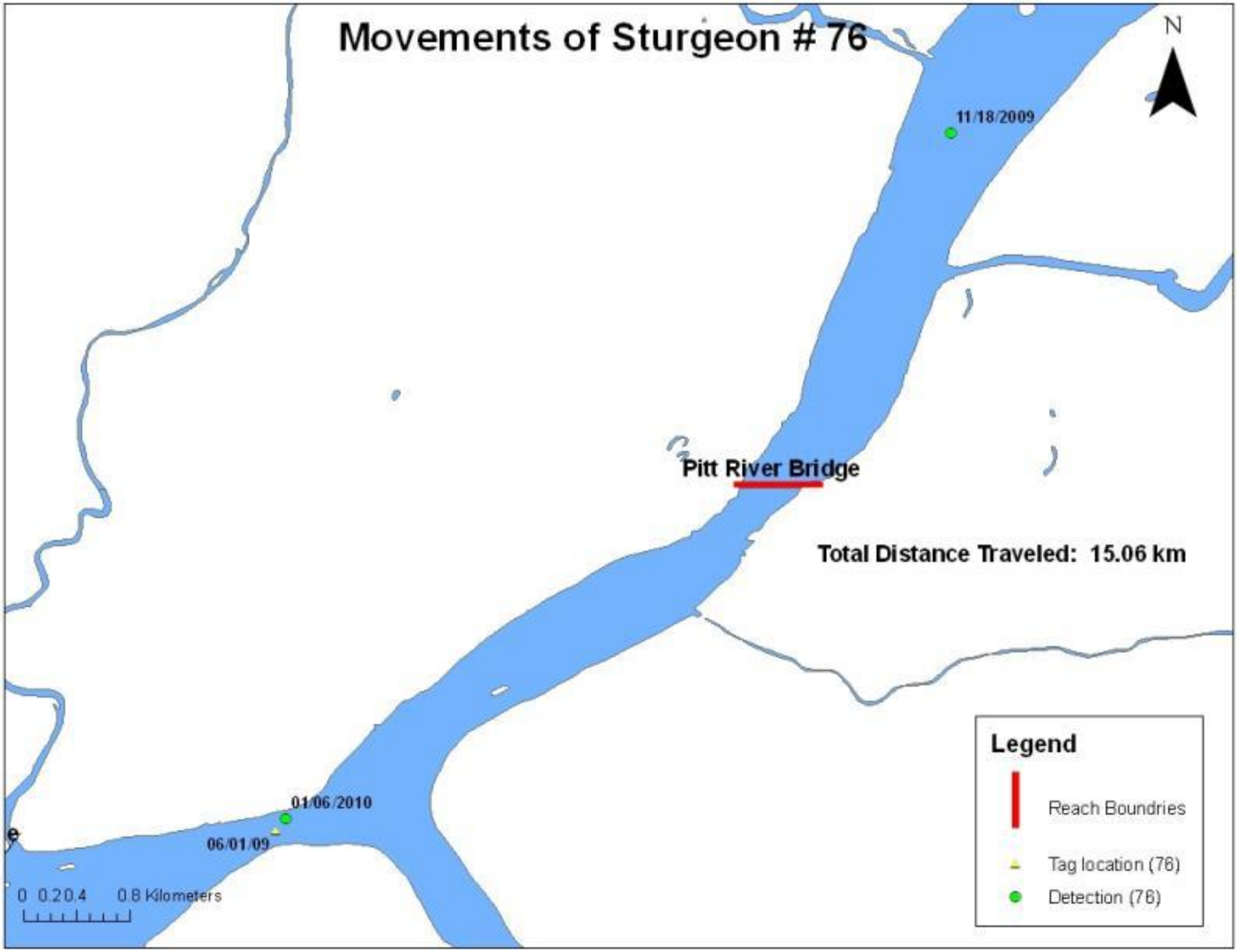

Movements of Sturgeon # 81
N
06/02/09
Pitt River
Total Distance Traveled: 10.80 km
Pitt River Bridge
11/11/2009
01/06/2010
Port Mann Bridge
0 0.350.7 1.4 Kilometers
Legend
Reach Boundries
Detection (81)
Tag Location (81)

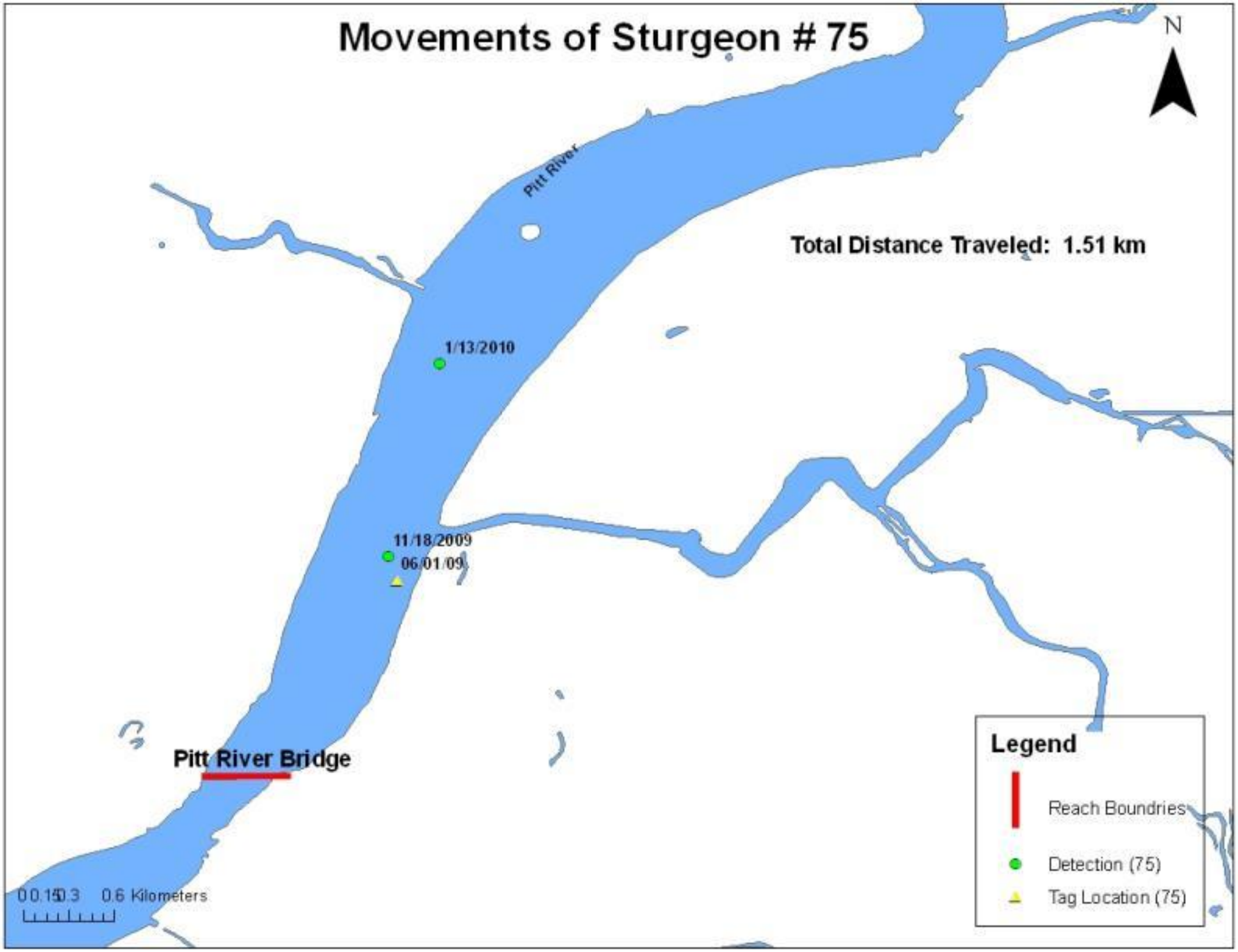

Movements of Sturgeon # 80
N
06/02/09
Total Distance Traveled: 24.12 km
Pitt River
Pitt River Bridge
Golden Ears Bridge
1/20/2010
Legend
Reach Boundries
Detection (80)
Tag Location (80)
0 1 2 4 Kilometers

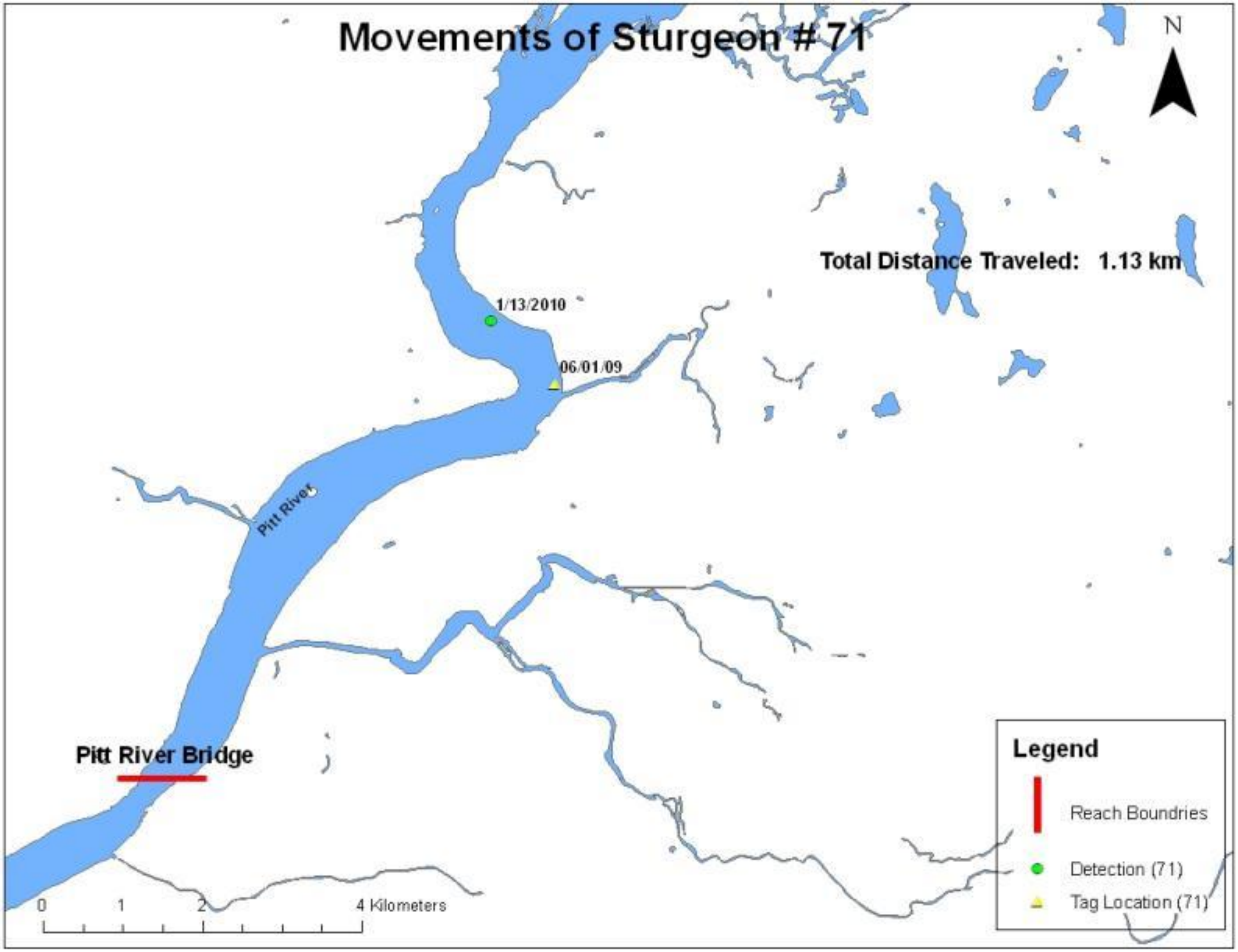

Movements of Sturgeon # 79
N
Total Distance Traveled: 2.53 km
Port Mann Bridge
06/01/09
11/11/2009
Legend
Reach Boundries
Detection (79)
Tag Location (79)
0
0.4
0.8
1.6 Kilometers



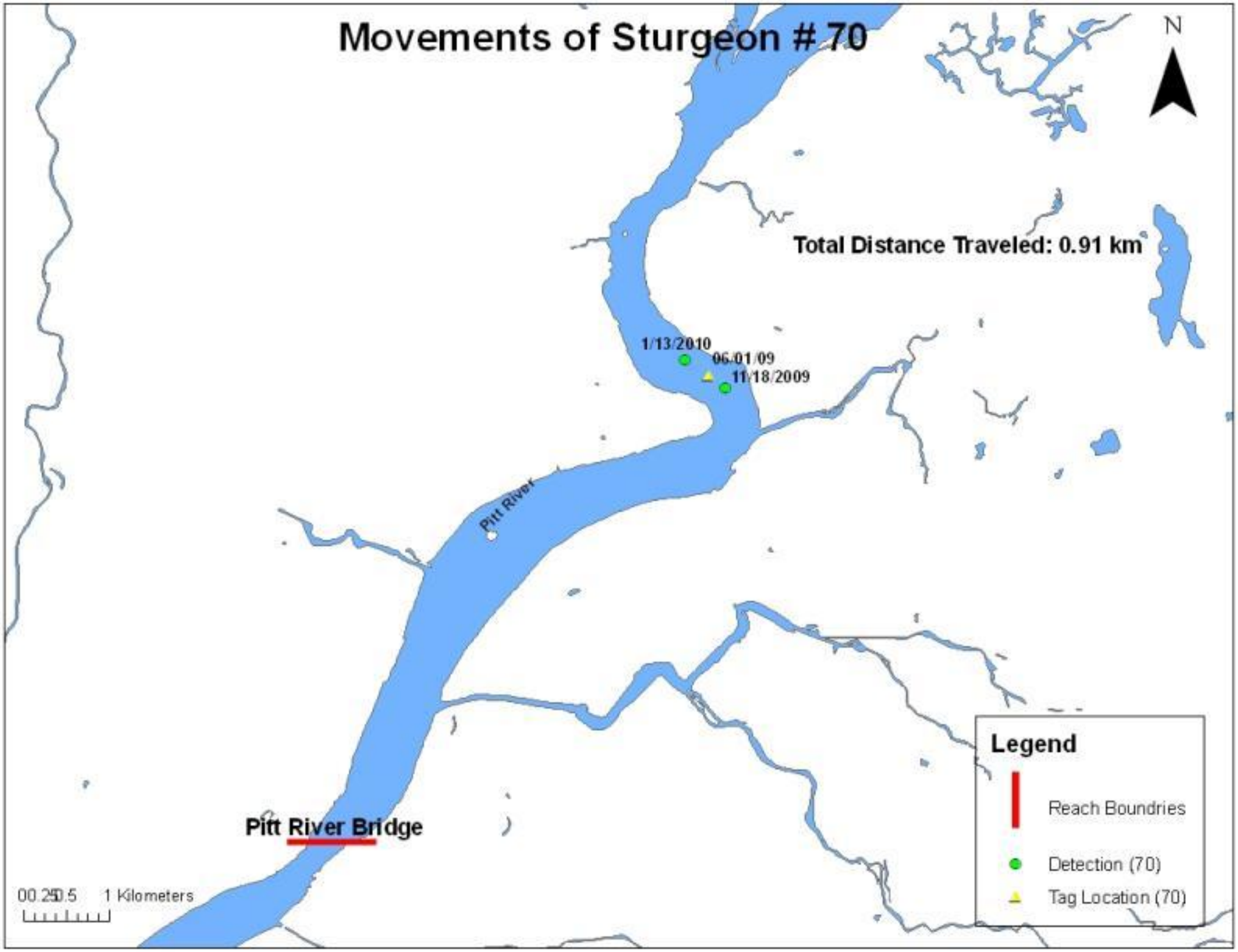
Movements of Sturgeon # 77
N
1/13/2010
Total Distance Traveled: 12.15 km
Pitt River
Pitt River Bridge
06/01/09
Golden Ears Bridge
Legend
Reach Boundries
Detection (77)
Tag Location (77)
0
1.25
2.5
5 Kilometers


Movements of Sturgeon # 76
N
11/18/2009
Pitt River Bridge
Total Distance Traveled: 15.06 km
01/06/2010
06/01/09
0 0.2 0.4 0.8 Kilometers
Legend
Reach Boundries
Tag location (76)
Detection (76)

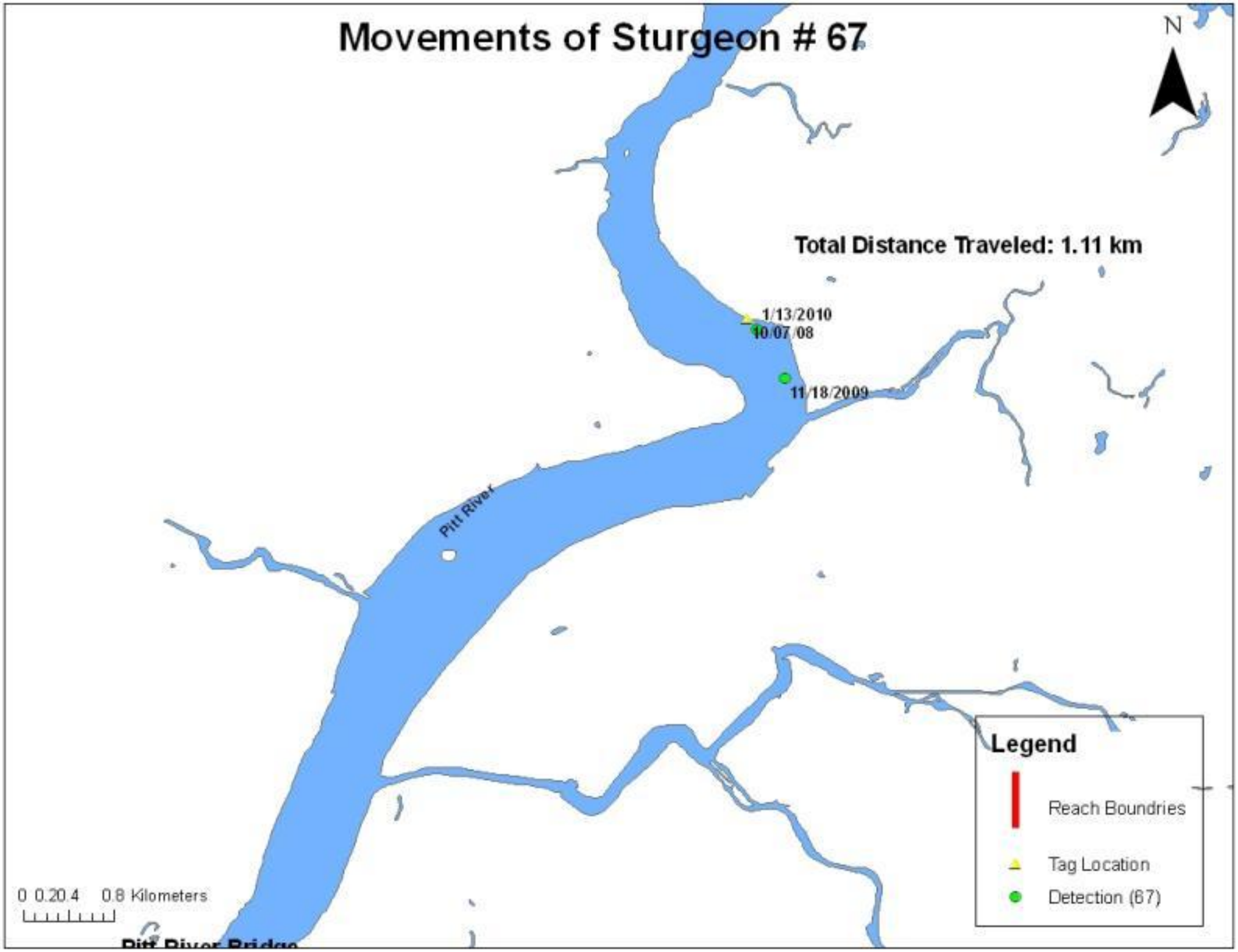

Movements of Sturgeon # 75
N
Pitt River
Total Distance Traveled: 1.51 km
1/13/2010
11/18/2009
06/01/09
Pitt River Bridge
0 0.15 0.3 0.6 Kilometers
Legend
Reach Boundries
Detection (75)
Tag Location (75)

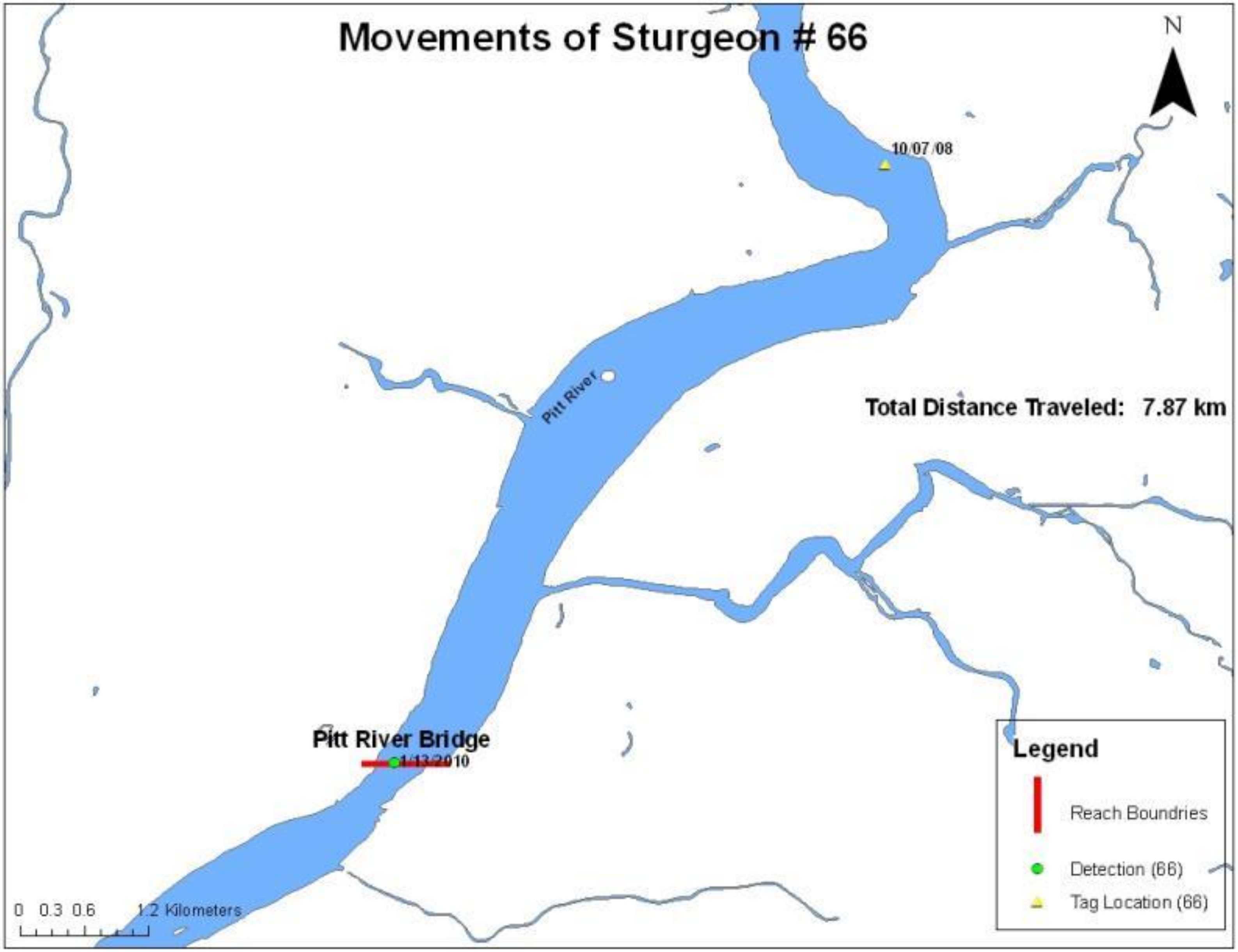


Movements of Sturgeon # 71
N
Total Distance Traveled: 1.13 km
1/13/2010
06/01/09
Pitt River
Pitt River Bridge
Legend
Reach Boundries
Detection (71)
Tag Location (71)
0
1
2
4 Kilometers

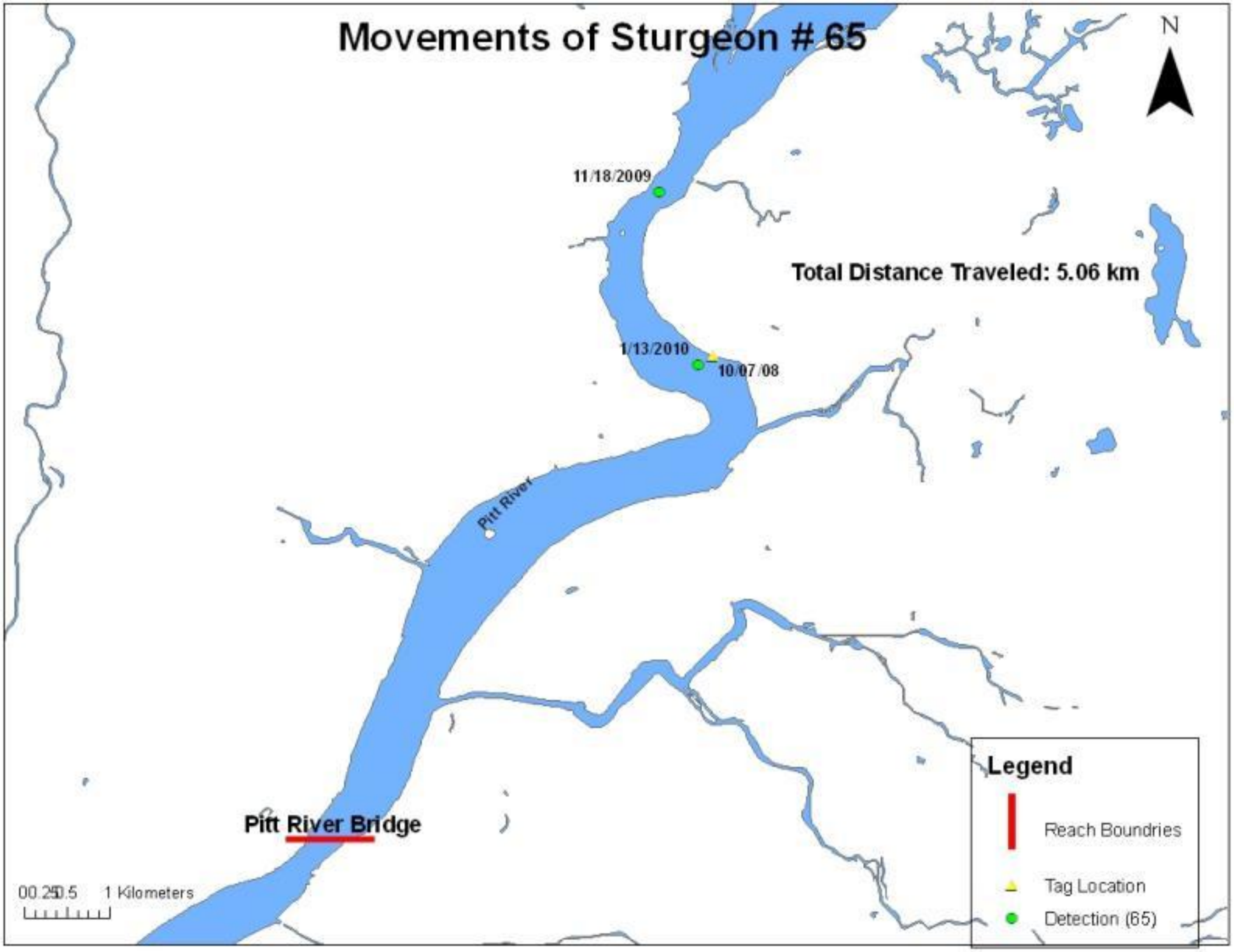


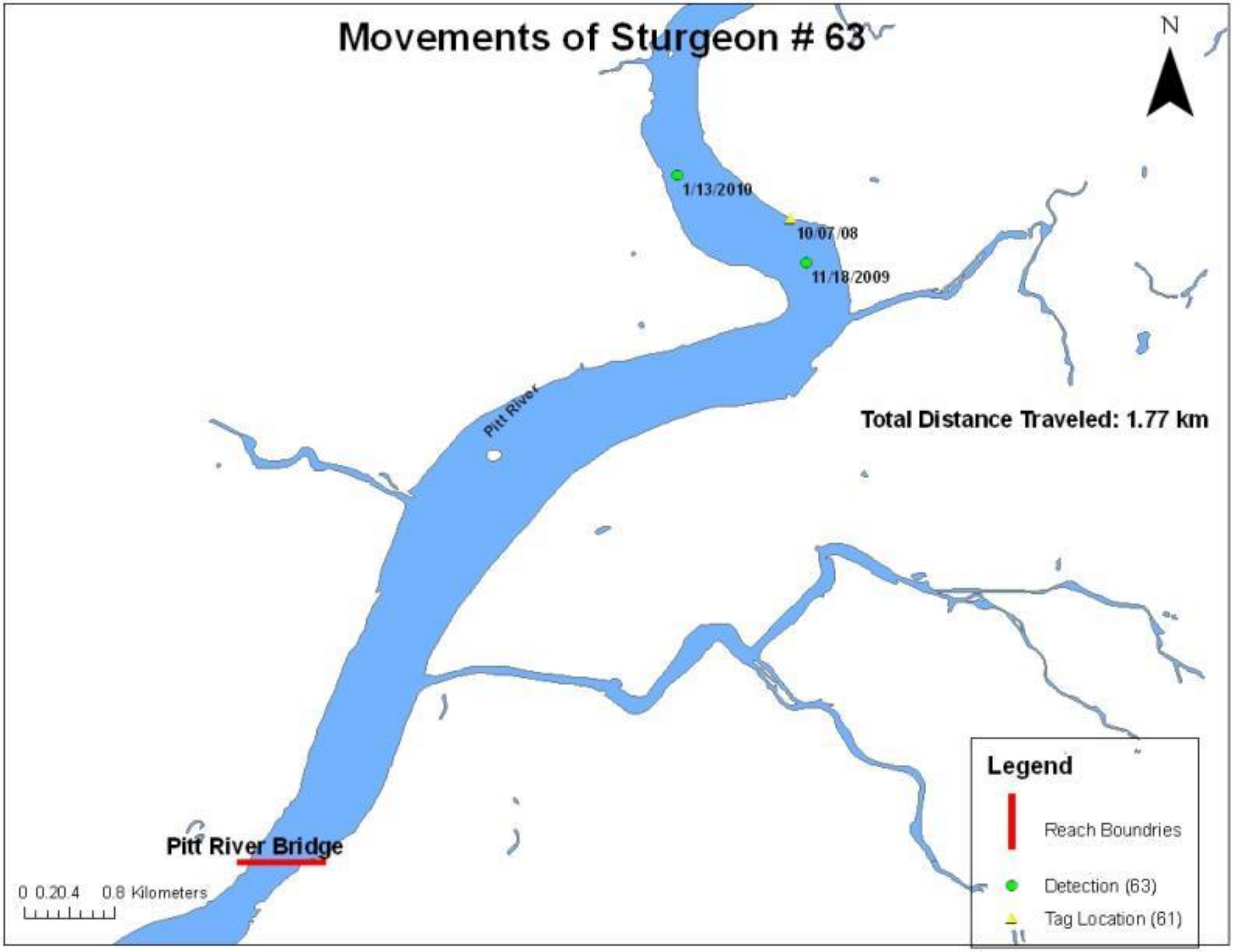
Movements of Sturgeon # 70
N
Total Distance Traveled: 0.91 km
1/13/2010
06/01/09
11/18/2009
Pitt River
Pitt River Bridge
00.250.5 1 Kilometers
Legend
Reach Boundries
Detection (70)
Tag Location (70)


Movements of Sturgeon # 67
N
Total Distance Traveled: 1.11 km
1/13/2010
10/07/08
11/18/2009
Pitt River
Legend
Reach Boundries
Tag Location
Detection (67)
0 0.20.4 0.8 Kilometers
Pitt River Bridge

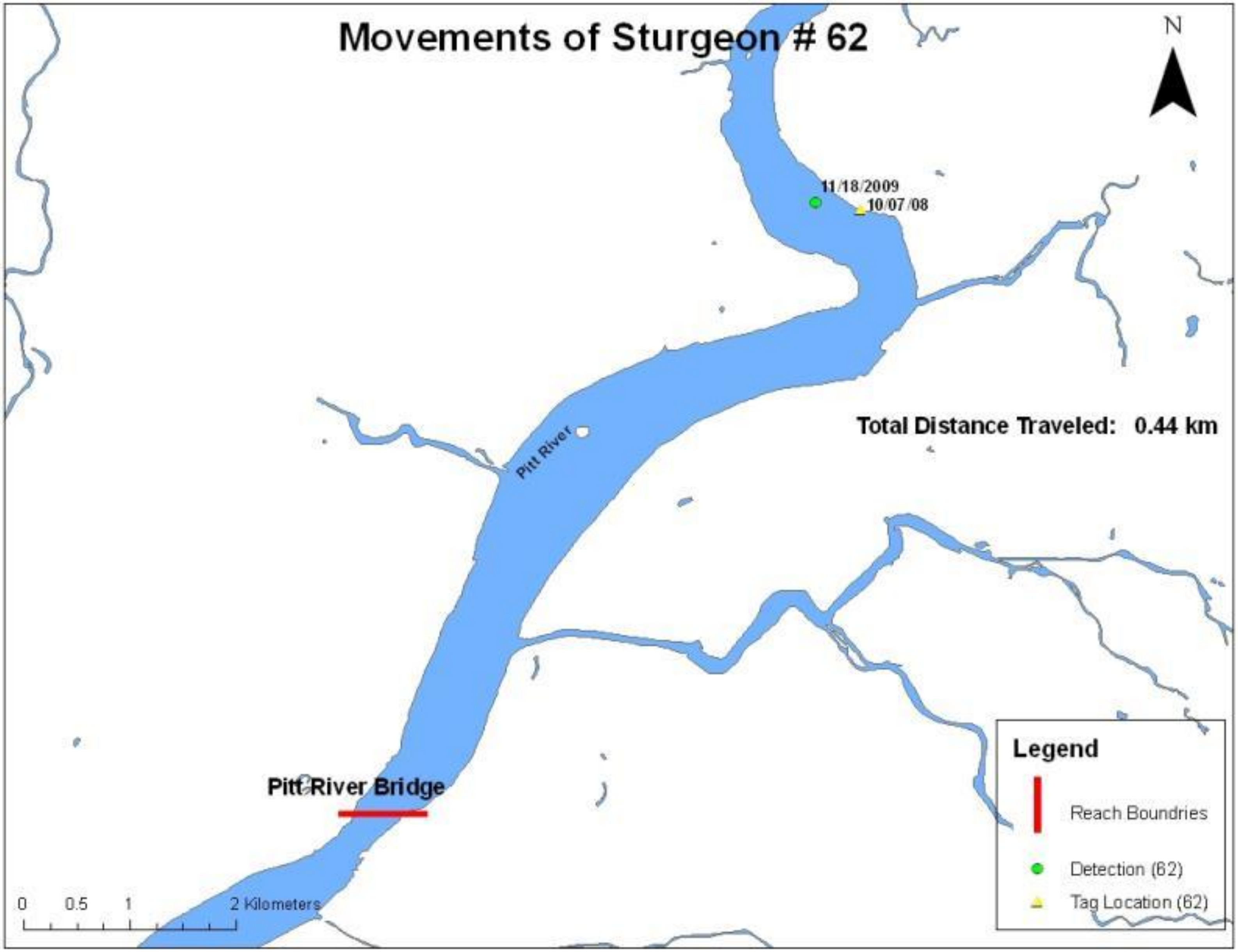


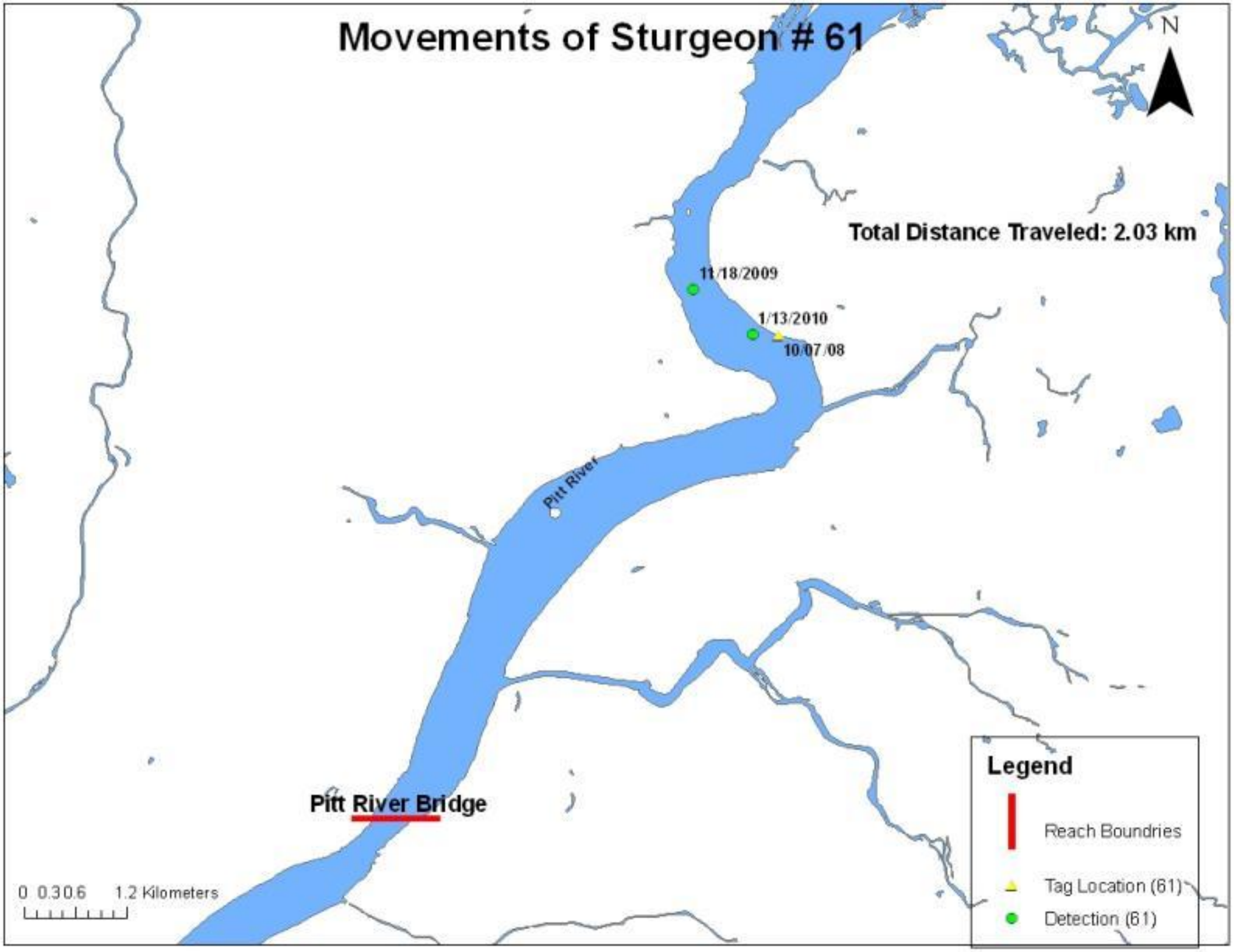
Movements of Sturgeon # 66
N
10/07/08
Pitt River
Total Distance Traveled: 7.87 km
Pitt River Bridge
1/13/2010
Legend
Reach Boundries
Detection (66)
Tag Location (66)
0 0.3 0.6 1.2 Kilometers

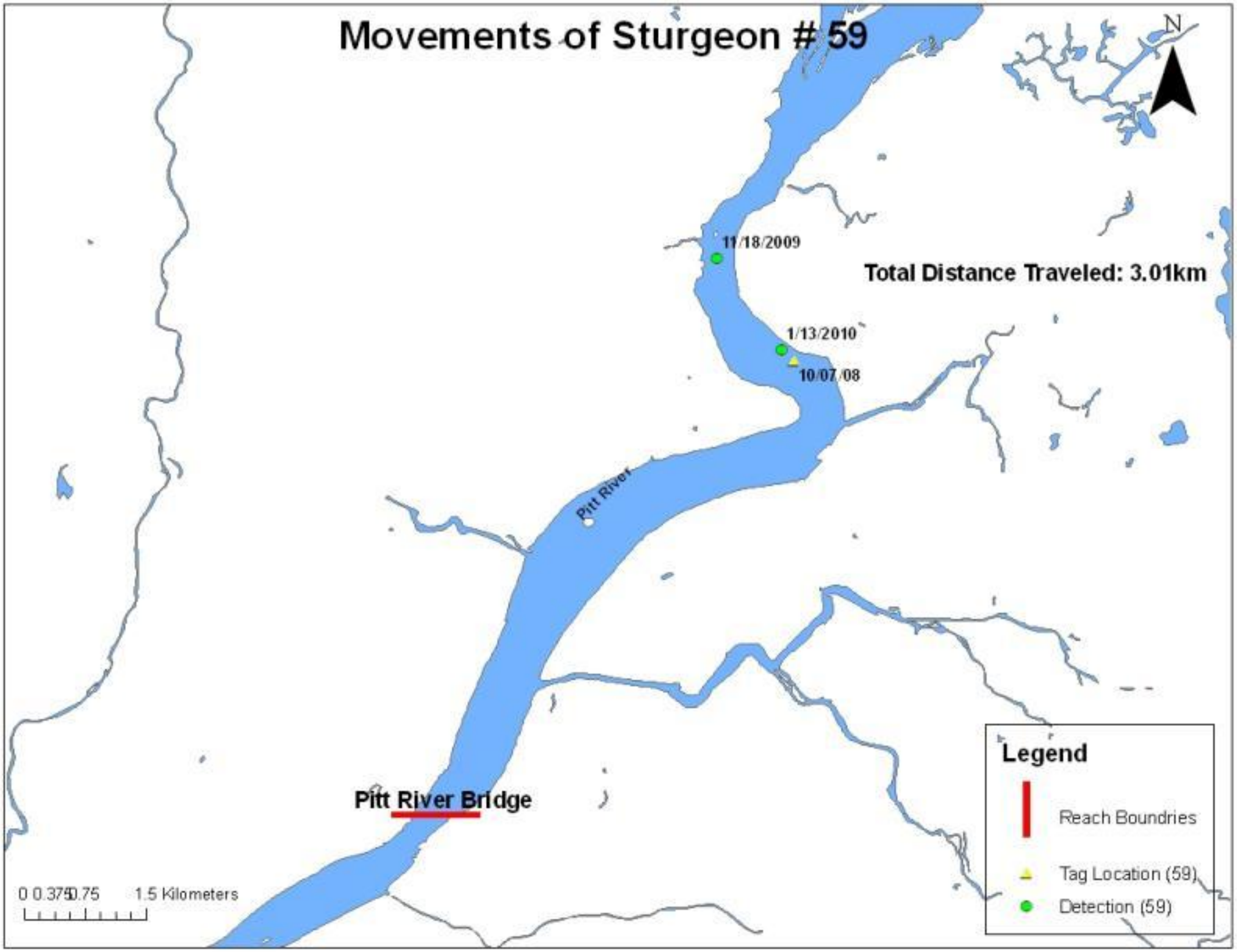

Movements of Sturgeon # 65
N
11/18/2009
Total Distance Traveled: 5.06 km
1/13/2010
10/07/08
Pitt River
Pitt River Bridge
00.250.5 1 Kilometers
Legend
Reach Boundries
Tag Location
Detection (65)



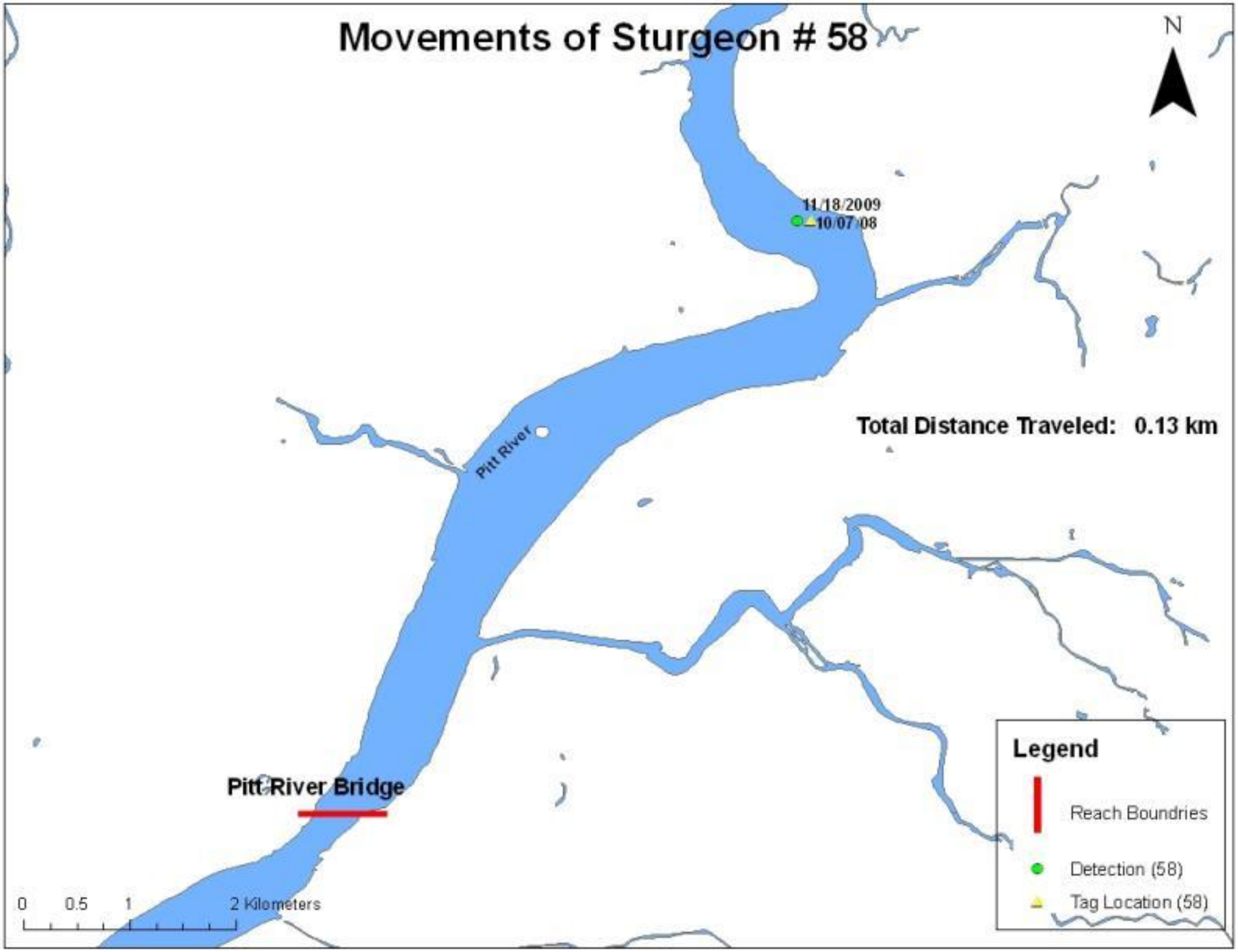
Movements of Sturgeon # 63
N
1/13/2010
10/07/08
11/18/2009
Pitt River
Total Distance Traveled: 1.77 km
Pitt River Bridge
0 0.20.4 0.8 Kilometers
Legend
Reach Boundries
Detection (63)
Tag Location (61)

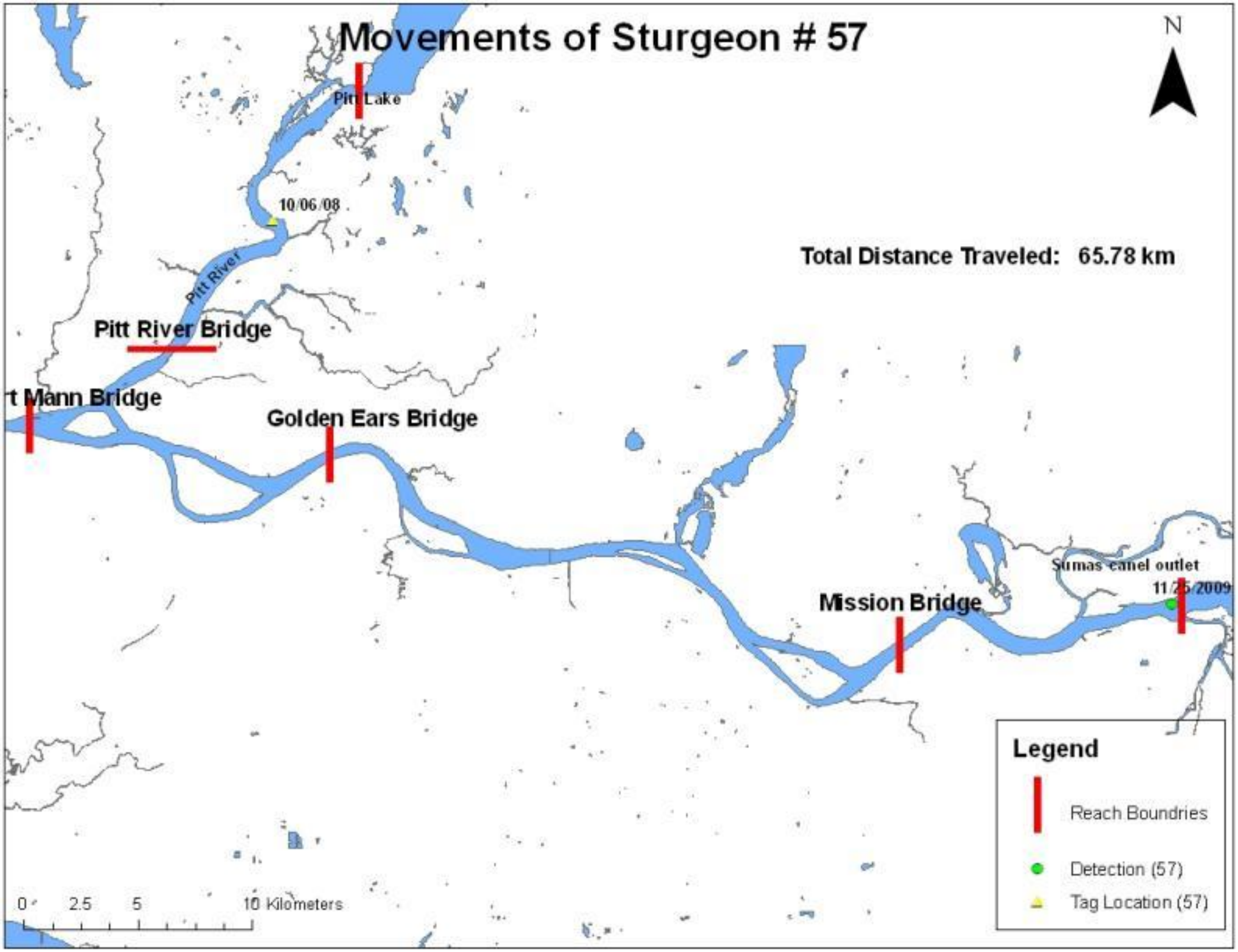

Movements of Sturgeon # 62
N
11/18/2009
10/07/08
Pitt River
Total Distance Traveled: 0.44 km
Pitt River Bridge
0 0.5 1 2 Kilometers
Legend
Reach Boundries
Detection (62)
Tag Location (62)


Movements of Sturgeon # 61
N
Total Distance Traveled: 2.03 km
11/18/2009
1/13/2010
10/07/08
Pitt River
Pitt River Bridge
0 0.3 0.6 1.2 Kilometers
Legend
Reach Boundries
Tag Location (61)
Detection (61)

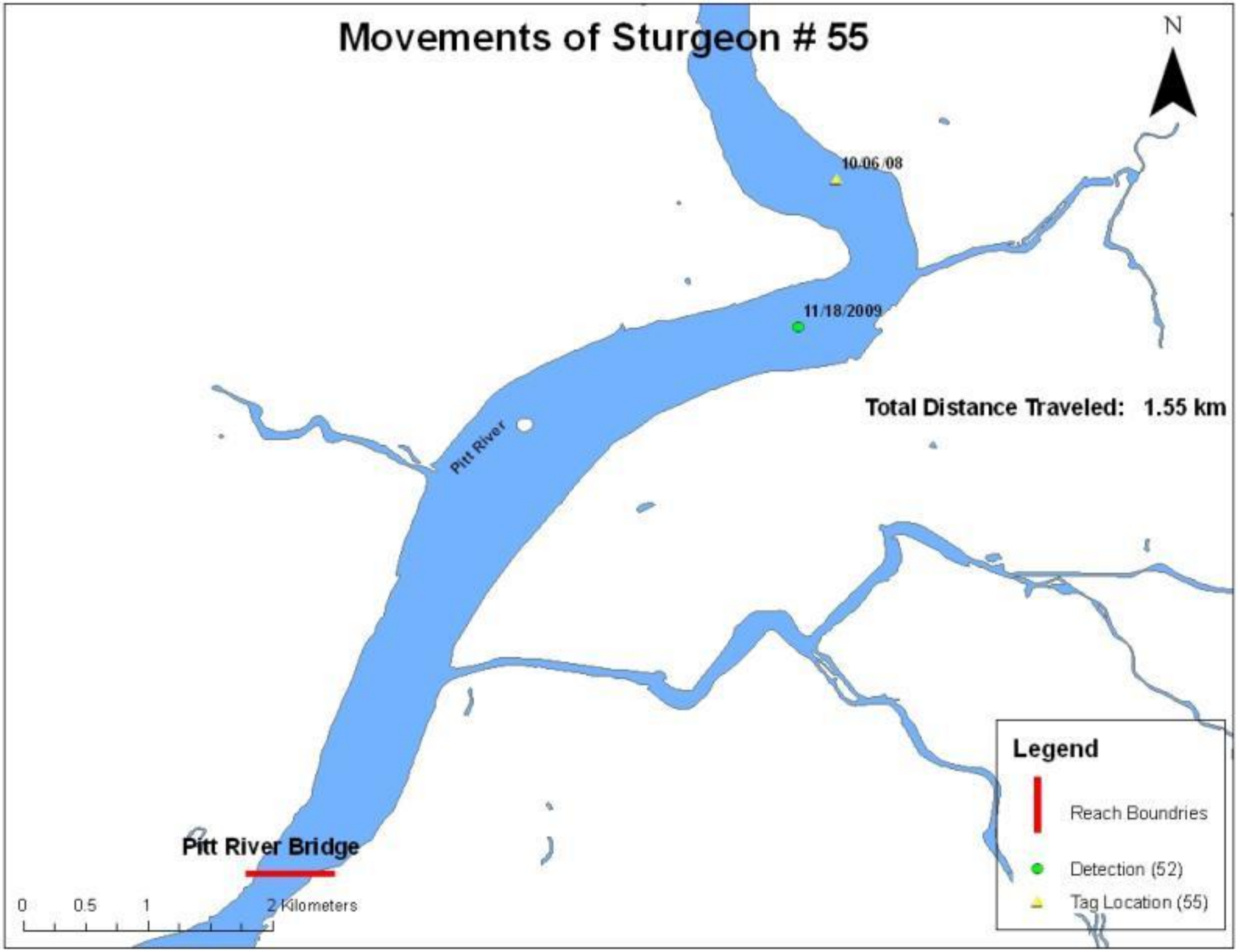


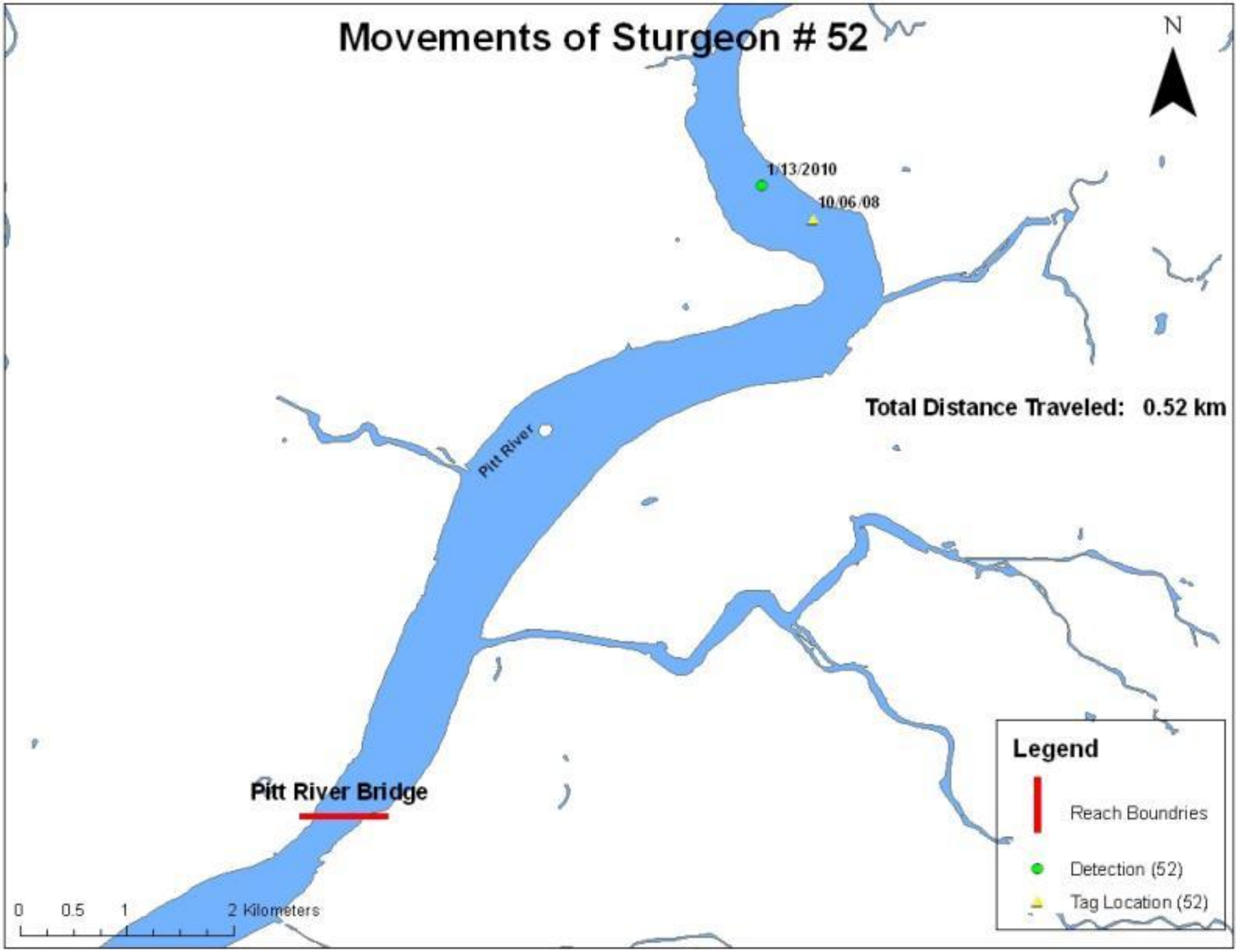
Movements of Sturgeon # 59
N
11/18/2009
Total Distance Traveled: 3.01km
1/13/2010
10/07/08
Pitt River
Pitt River Bridge
0 0.375 0.75 1.5 Kilometers
Legend
Reach Boundries
Tag Location (59)
Detection (59)

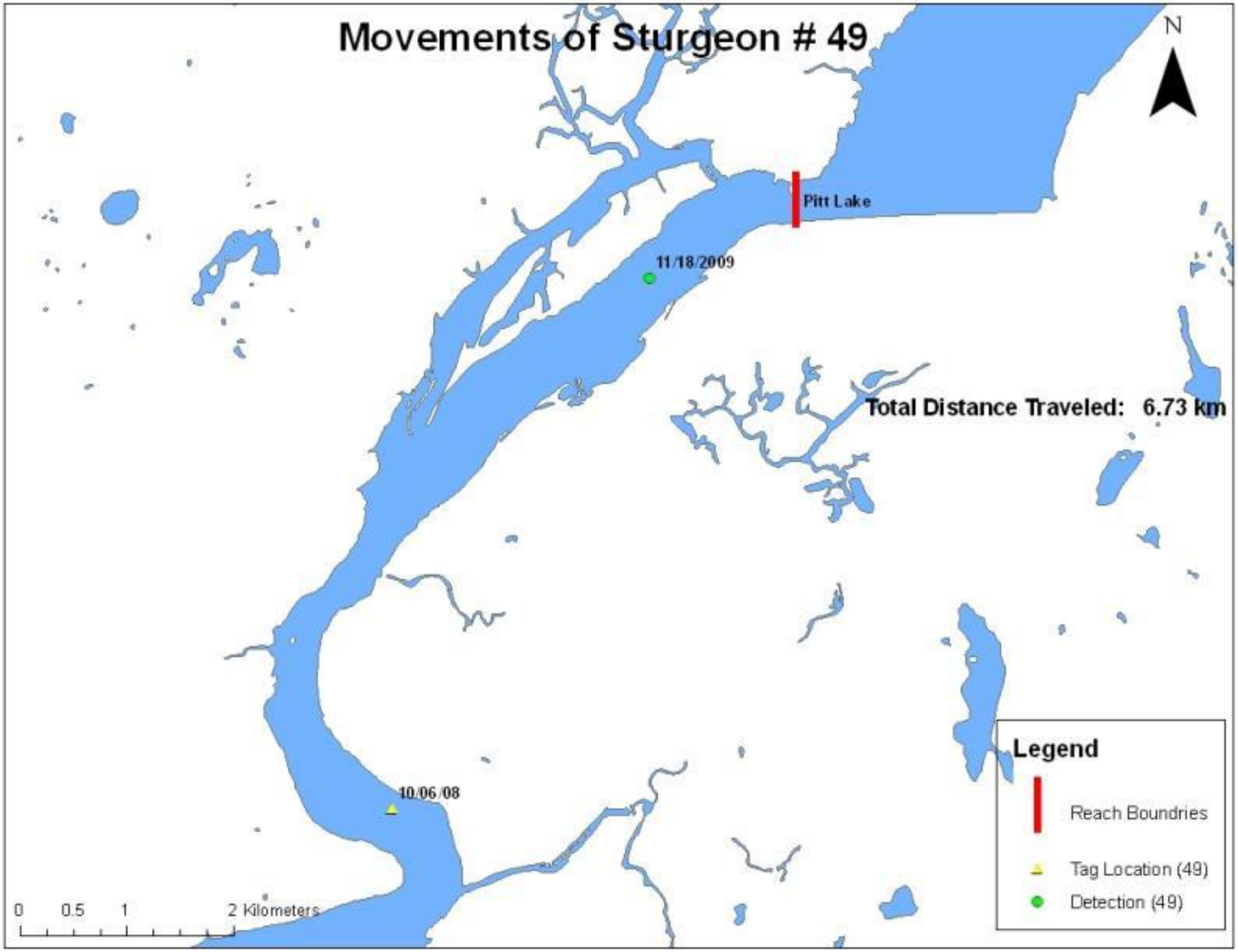

Movements of Sturgeon # 58
N
11/18/2009
10/07/08
Total Distance Traveled: 0.13 km
Pitt River
Pitt River Bridge
0 0.5 1 2 Kilometers
Legend
Reach Boundries
Detection (58)
Tag Location (58)

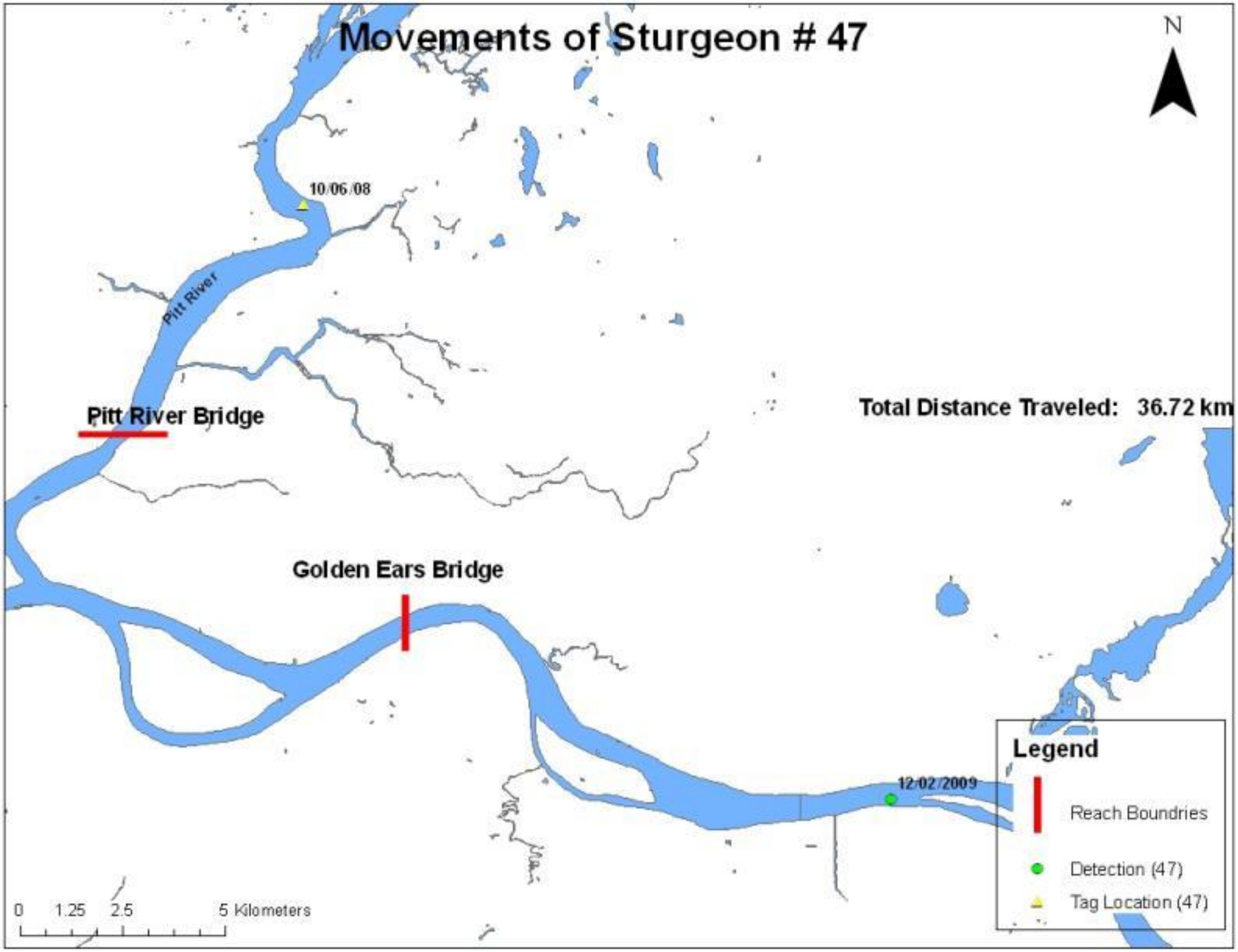


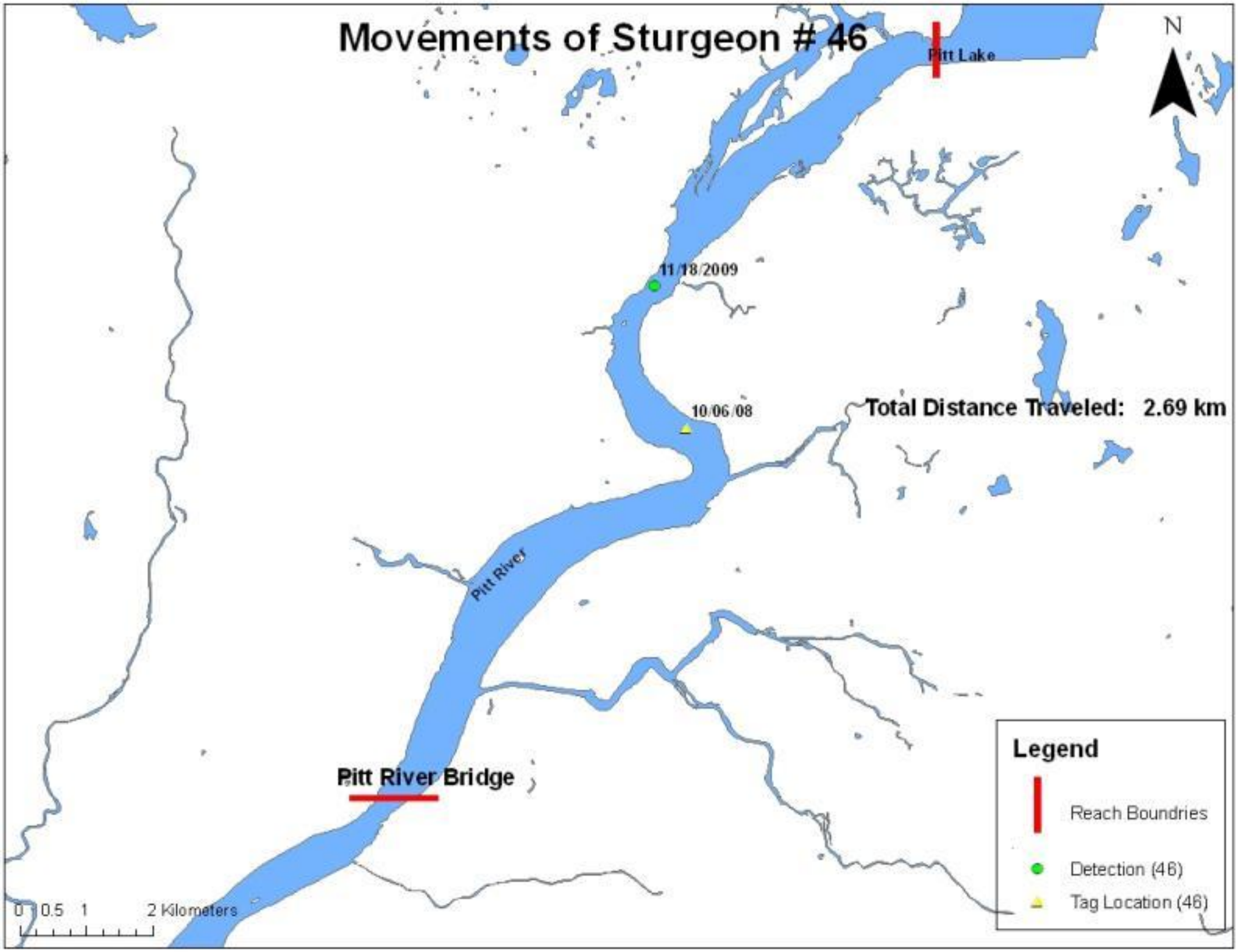
Movements of Sturgeon # 57
N
Pitt Lake
10/06/08
Pitt River
Total Distance Traveled: 65.78 km
Pitt River Bridge
t Mann Bridge
Golden Ears Bridge
Sumas canel outlet
11/25/2009
Mission Bridge
Legend
Reach Boundries
Detection (57)
Tag Location (57)
0
2.5
5
10 Kilometers


Movements of Sturgeon # 55
N
10/06/08
11/18/2009
Pitt River
Total Distance Traveled: 1.55 km
Pitt River Bridge
0
0.5
1
2 Kilometers
Legend
Reach Boundries
Detection (52)
Tag Location (55)

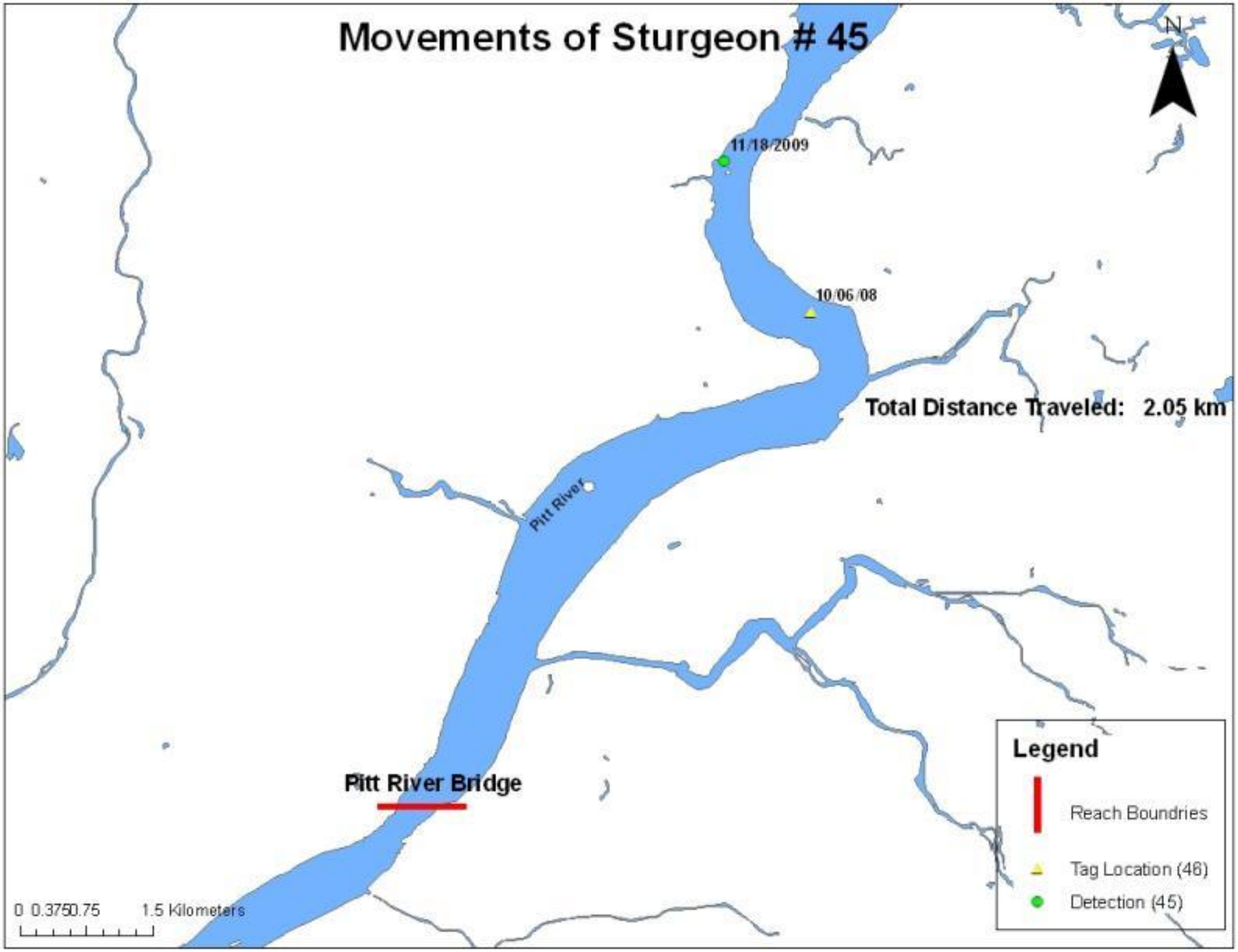

Movements of Sturgeon # 52
N
1/13/2010
10/06/08
Total Distance Traveled: 0.52 km
Pitt River
Pitt River Bridge
0 0.5 1 2 Kilometers
Legend
Reach Boundries
Detection (52)
Tag Location (52)

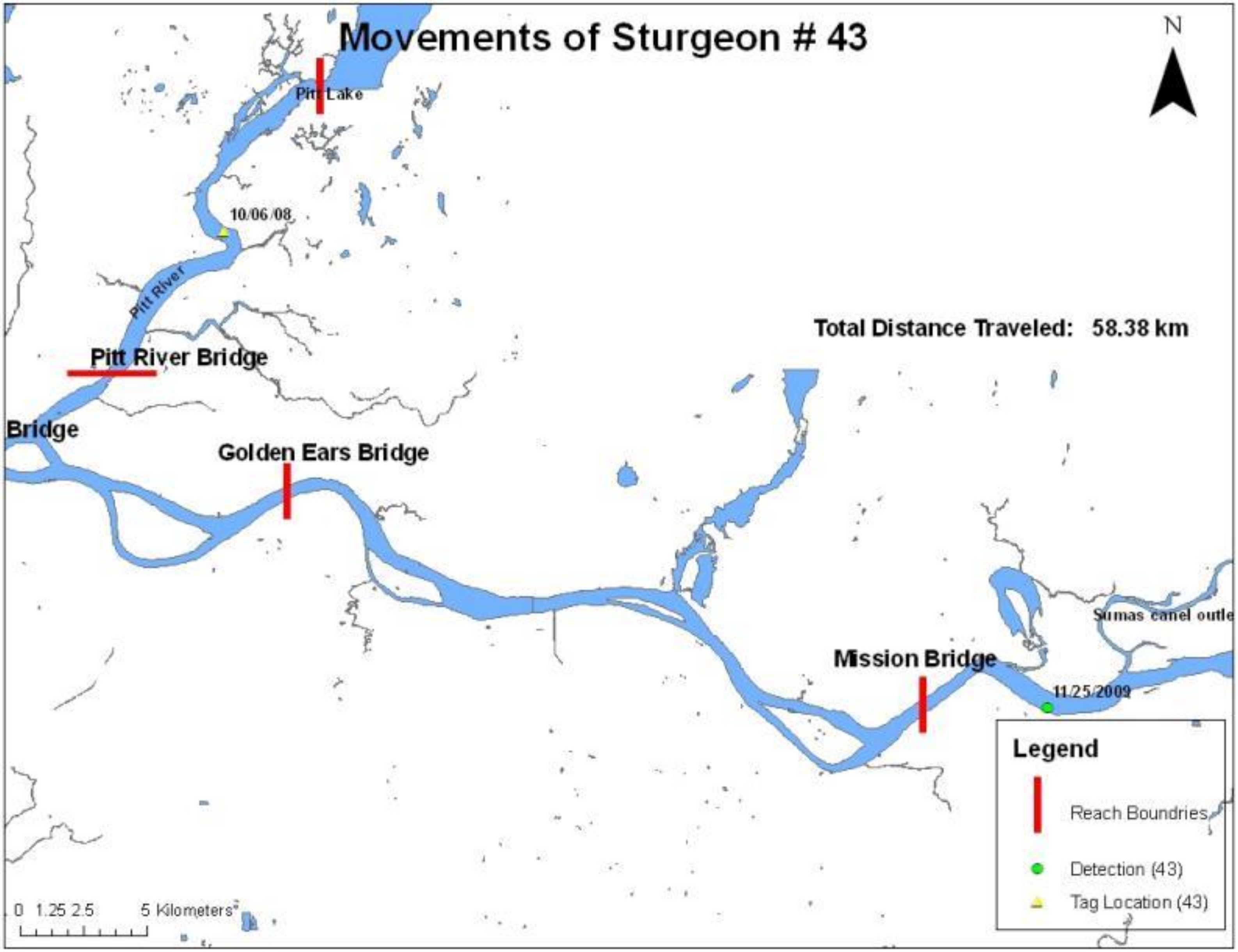

Movements of Sturgeon # 49
N
Pitt Lake
11/18/2009
Total Distance Traveled: 6.73 km
10/06/08
Legend
Reach Boundries
Tag Location (49)
Detection (49)
0 0.5 1 2 Kilometers

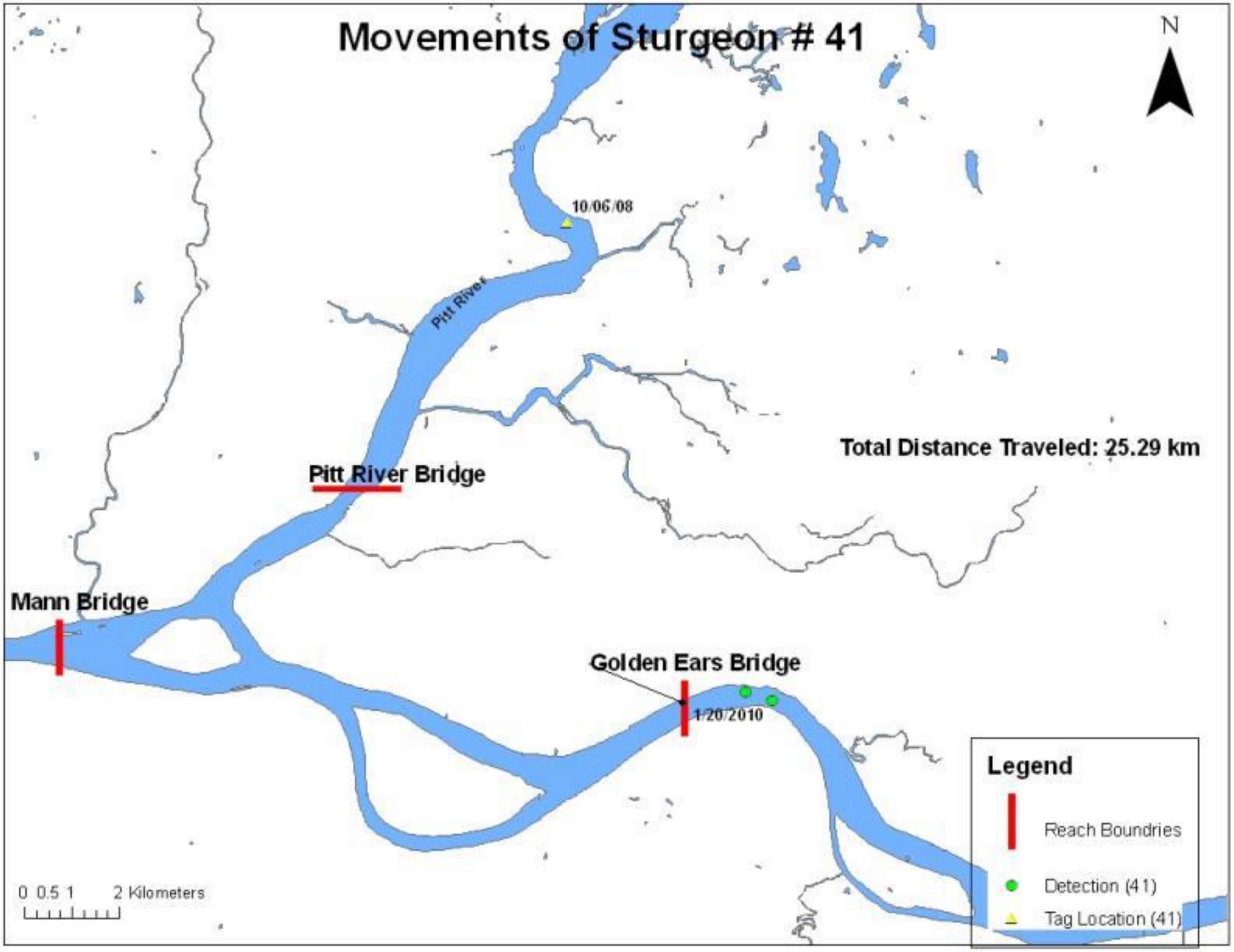

Movements of Sturgeon # 47
N
10/06/08
Pitt River
Pitt River Bridge
Total Distance Traveled: 36.72 km
Golden Ears Bridge
12/02/2009
Legend
Reach Boundries
Detection (47)
Tag Location (47)
0 1.25 2.5 5 Kilometers

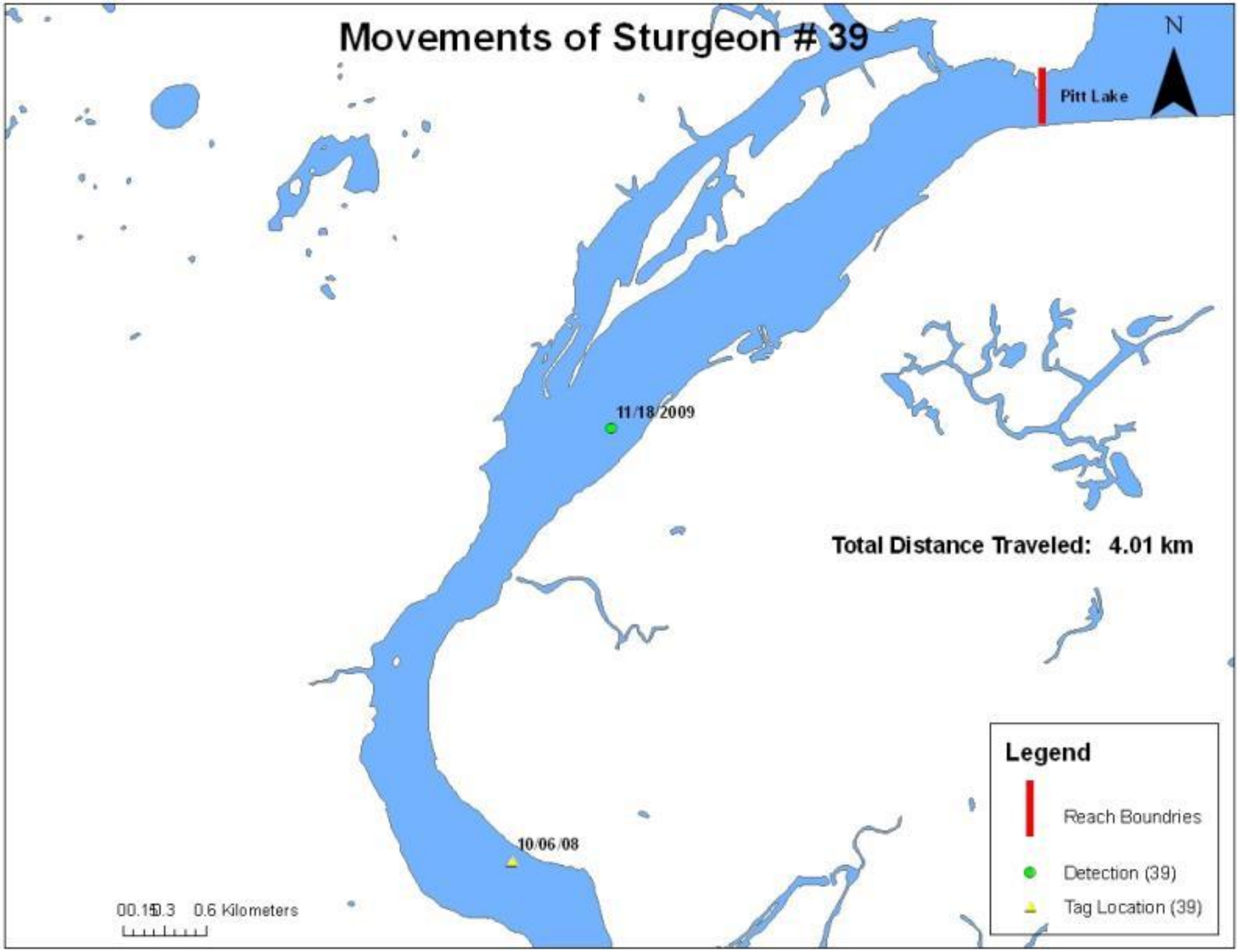


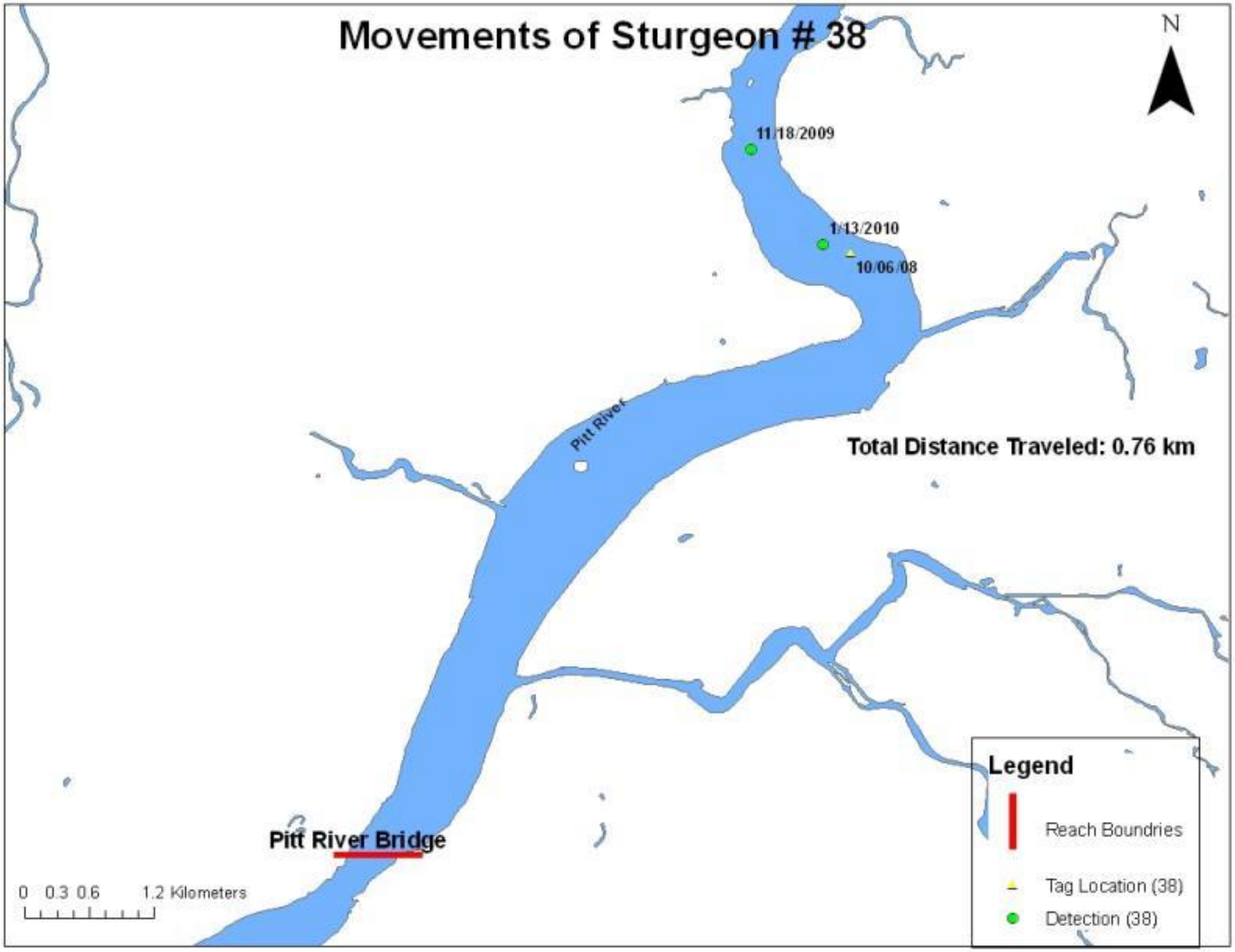
Movements of Sturgeon # 46
Pitt Lake
N
11/18/2009
10/06/08
Total Distance Traveled: 2.69 km
Pitt River
Pitt River Bridge
0 0.5 1 2 Kilometers
Legend
Reach Boundries
Detection (46)
Tag Location (46)


Movements of Sturgeon # 45
N
11/18/2009
10/06/08
Total Distance Traveled: 2.05 km
Pitt River
Pitt River Bridge
Legend
Reach Boundries
Tag Location (46)
Detection (45)
0 0.3750.75 1.5 Kilometers

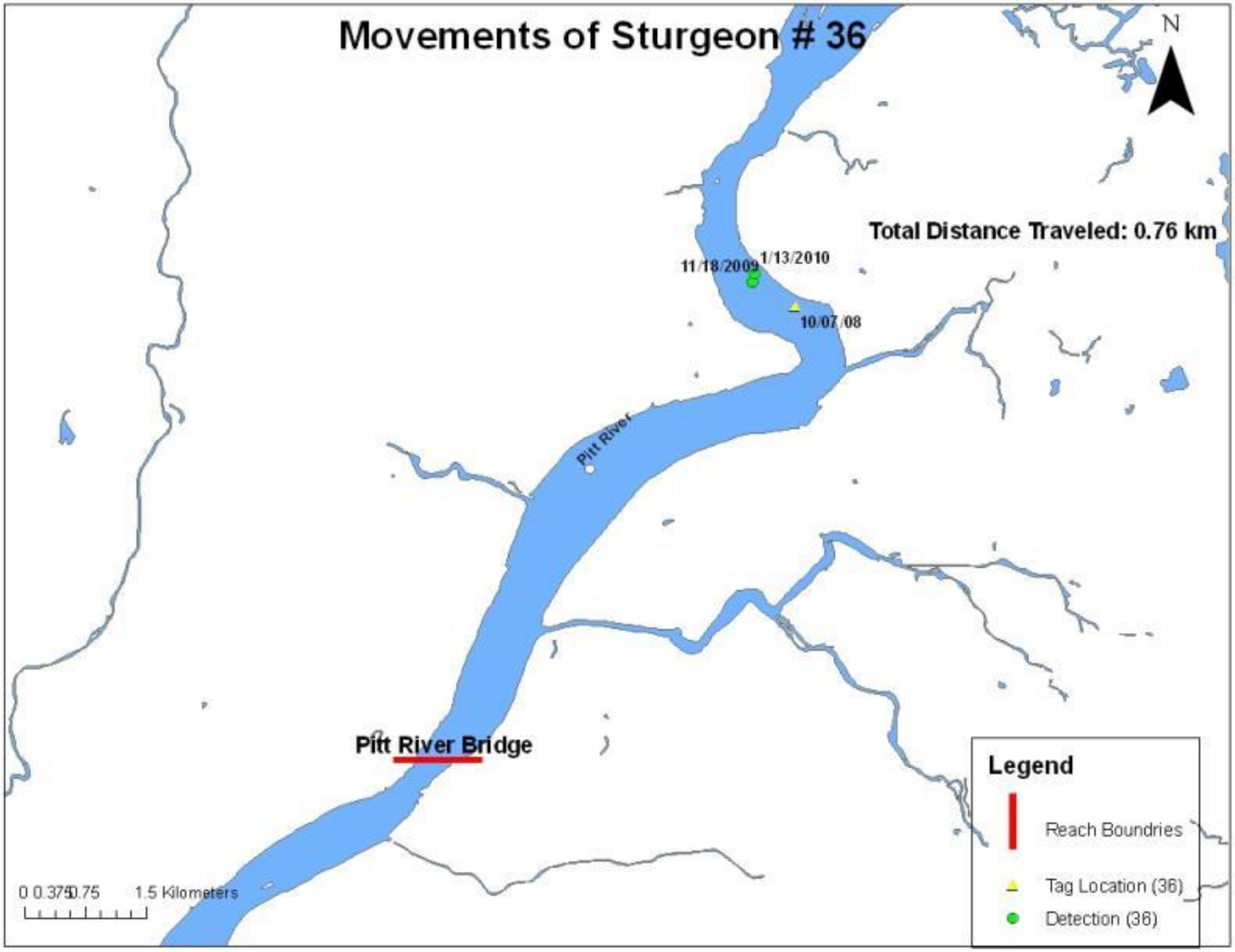

Movements of Sturgeon # 43
N
Pitt Lake
10/06/08
Pitt River
Pitt River Bridge
Bridge
Golden Ears Bridge
Total Distance Traveled: 58.38 km
Sumas canel outle
Mission Bridge
11/25/2009
Legend
Reach Boundries
Detection (43)
Tag Location (43)
0 1.25 2.5 5 Kilometers

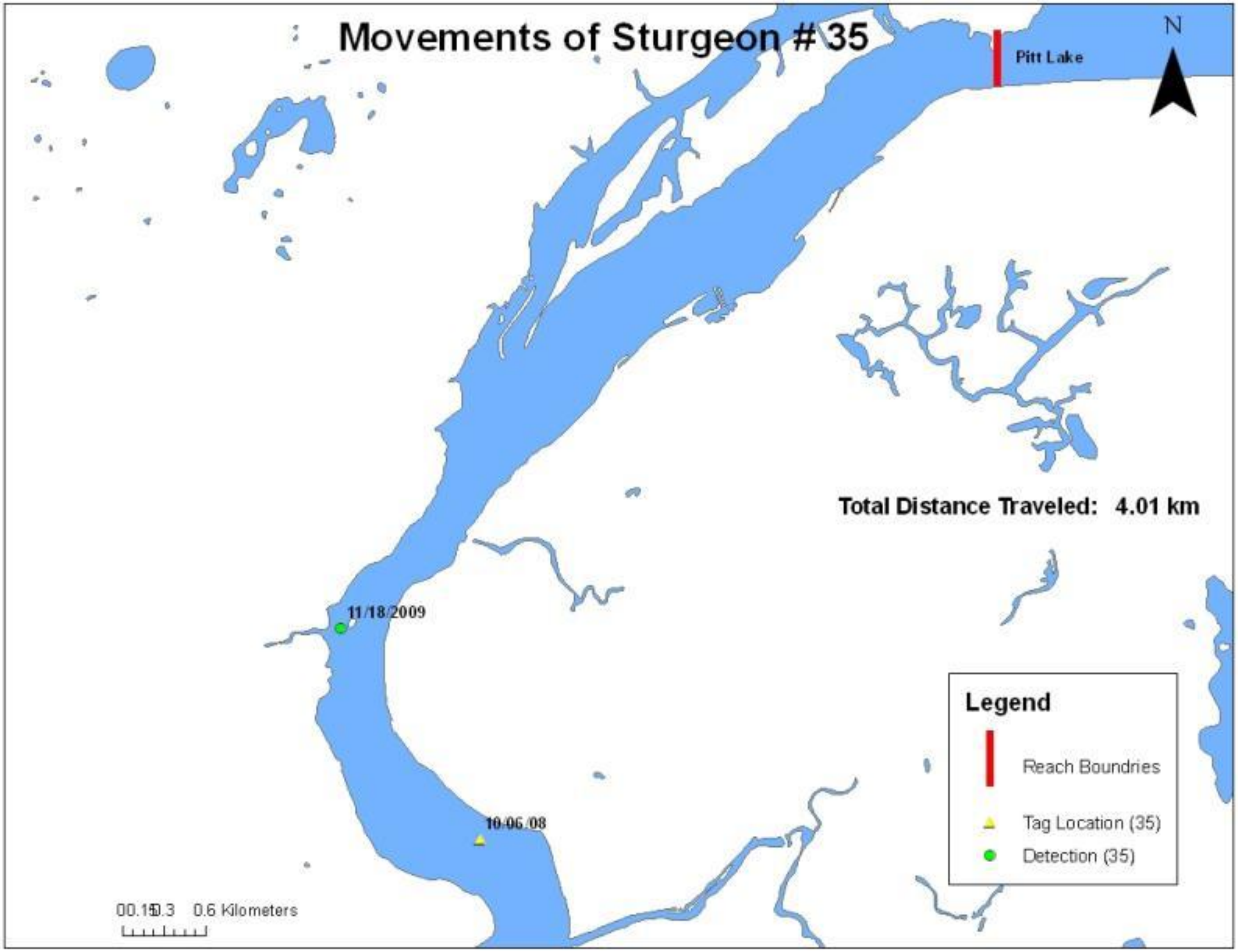

Movements of Sturgeon # 41
N
10/06/08
Pitt River
Total Distance Traveled: 25.29 km
Pitt River Bridge
Mann Bridge
Golden Ears Bridge
1/20/2010
Legend
Reach Boundries
Detection (41)
Tag Location (41)
0 0.5 1 2 Kilometers

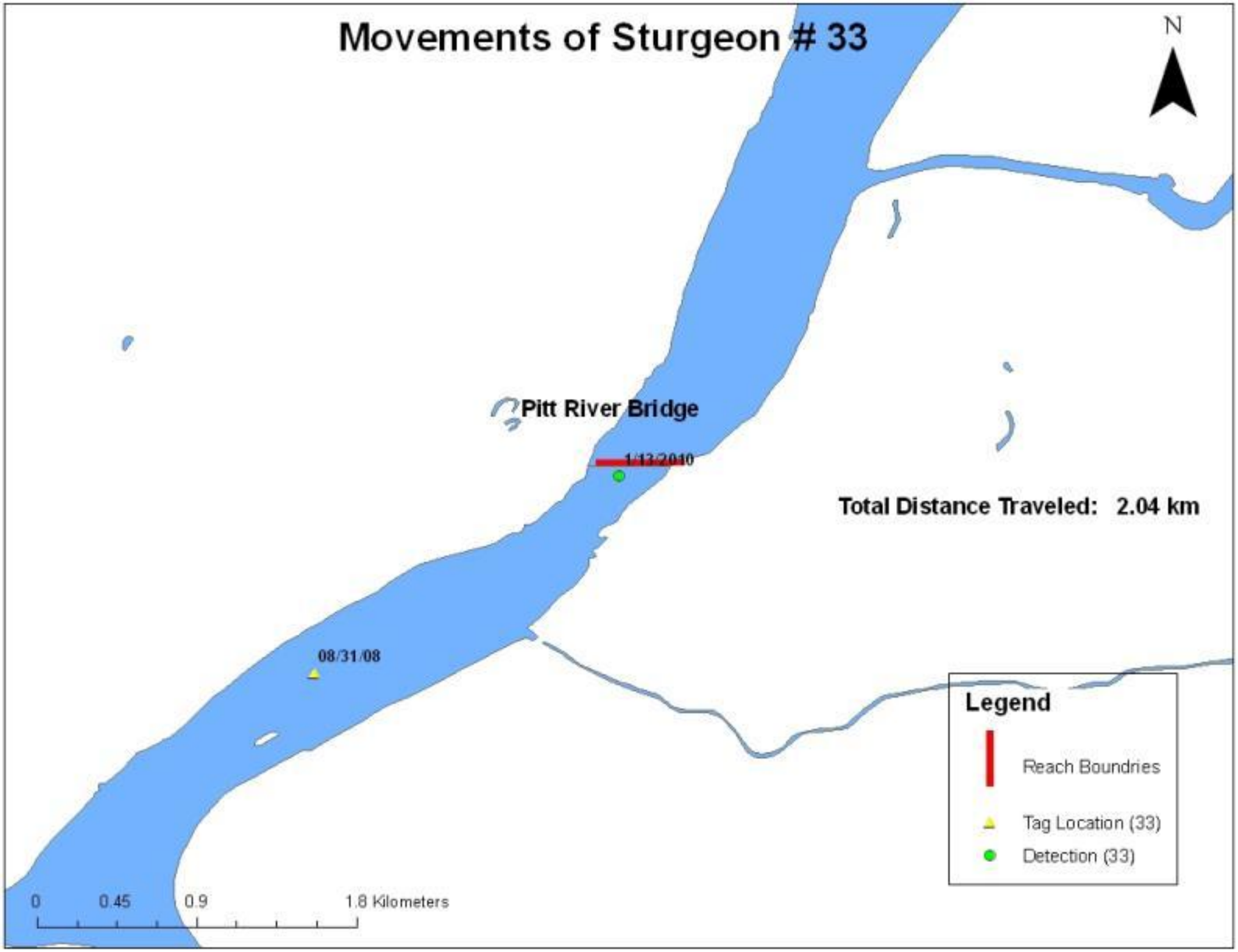

Movements of Sturgeon # 39
N
Pitt Lake
11/18/2009
Total Distance Traveled: 4.01 km
10/06/08
00.150.3 0.6 Kilometers
Legend
Reach Boundries
Detection (39)
Tag Location (39)

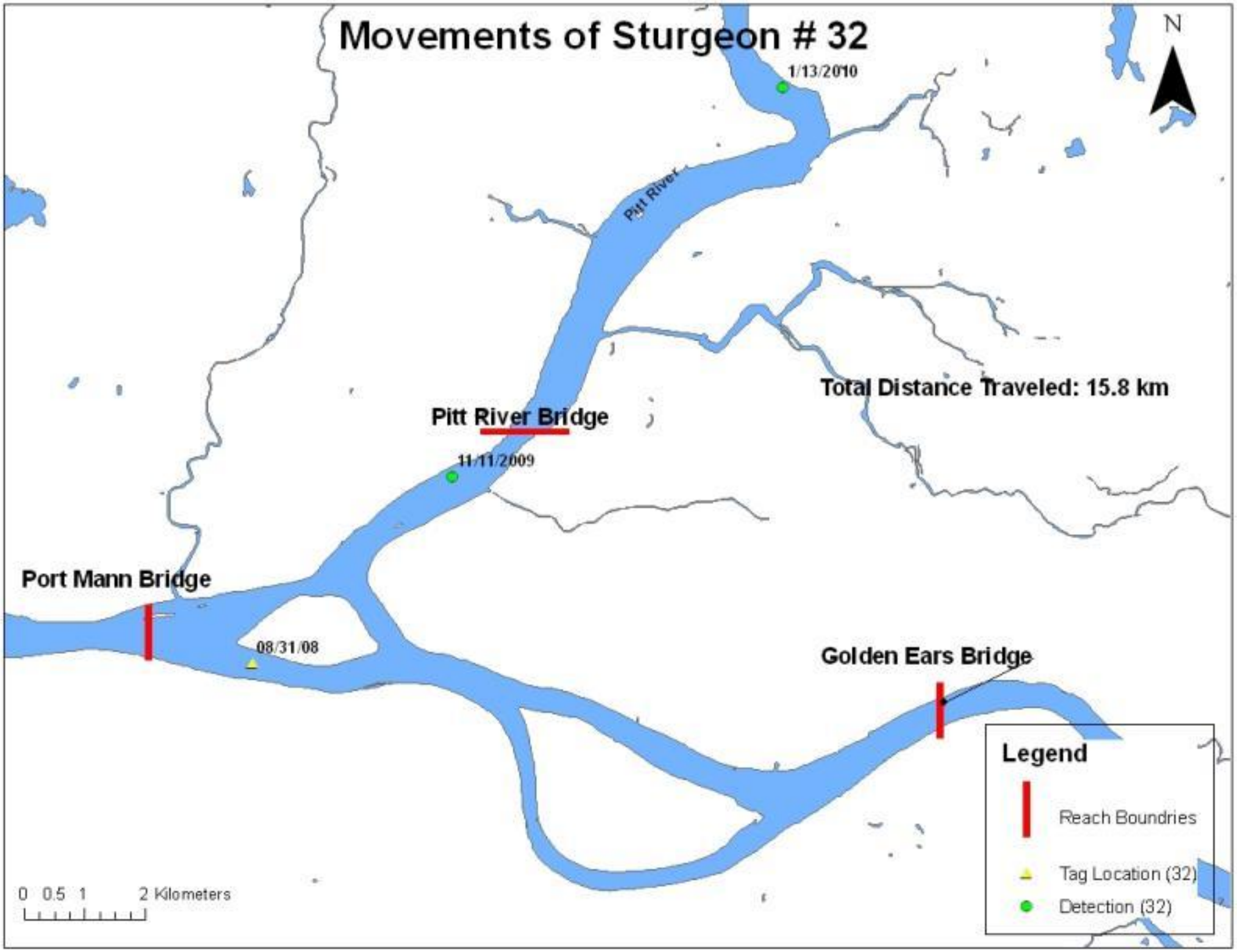


Movements of Sturgeon # 38
N
11/18/2009
1/13/2010
10/06/08
Pitt River
Total Distance Traveled: 0.76 km
Pitt River Bridge
0 0.3 0.6 1.2 Kilometers
Legend
Reach Boundries
Tag Location (38)
Detection (38)

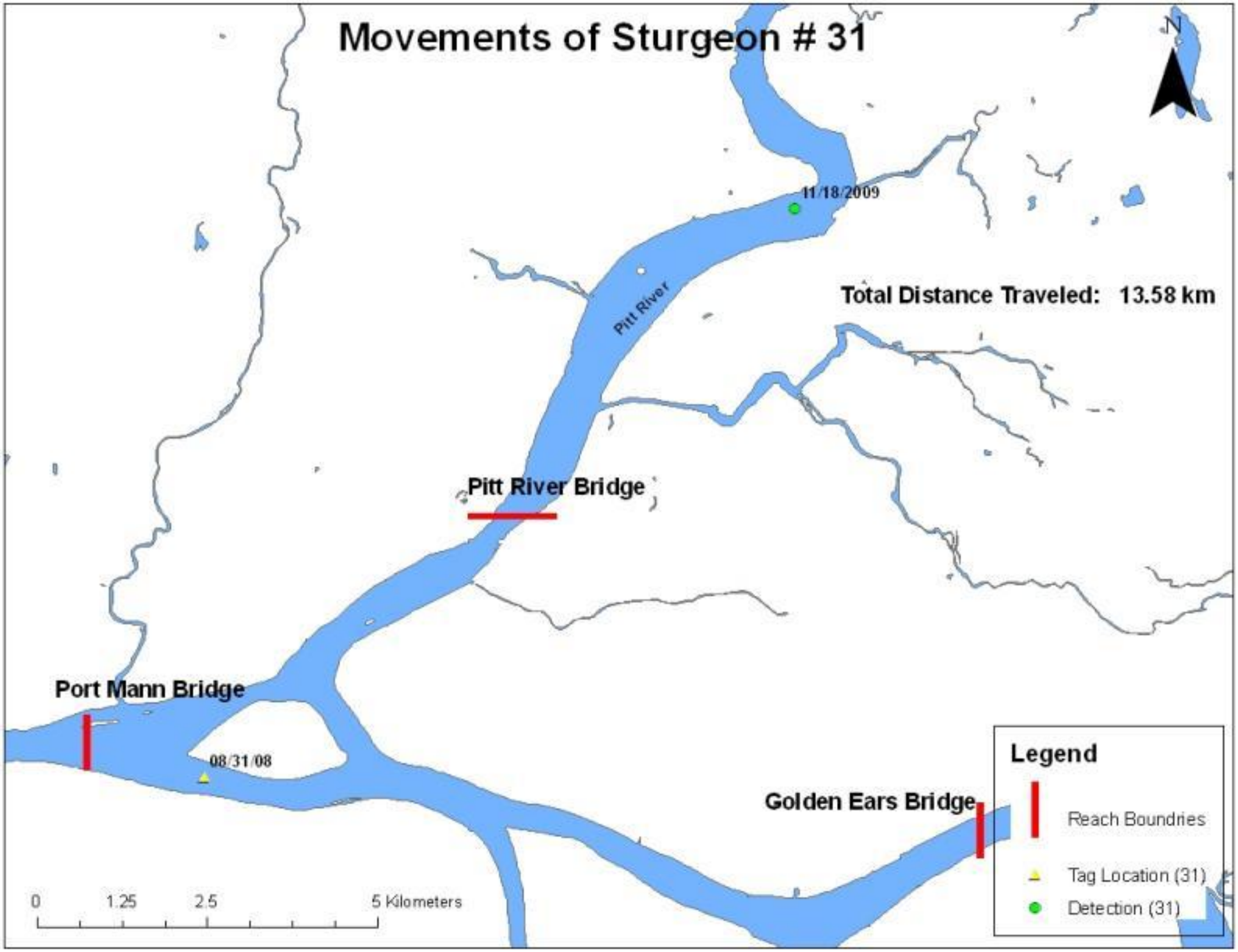

Movements of Sturgeon # 36
N
Total Distance Traveled: 0.76 km
11/18/2009
1/13/2010
10/07/08
Pitt River
Pitt River Bridge
0 0.375 0.75 1.5 Kilometers
Legend
Reach Boundries
Tag Location (36)
Detection (36)


Movements of Sturgeon # 35
N
Pitt Lake
Total Distance Traveled: 4.01 km
11/18/2009
10/06/08
Legend
Reach Boundries
Tag Location (35)
Detection (35)
0 0.15 0.3 0.6 Kilometers

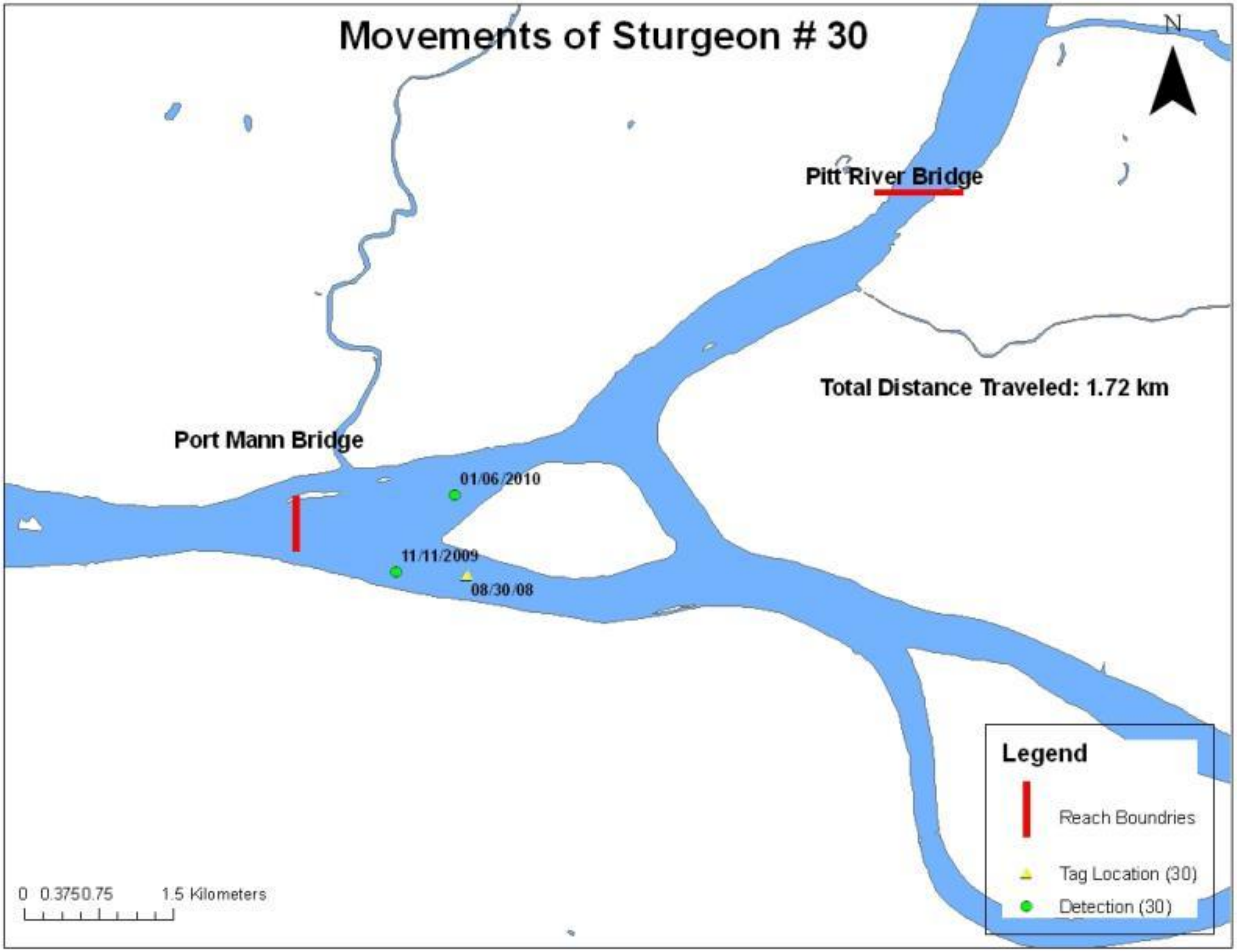

Movements of Sturgeon # 33
N
Pitt River Bridge
1/13/2010
Total Distance Traveled: 2.04 km
08/31/08
Legend
Reach Boundries
Tag Location (33)
Detection (33)
0 0.45 0.9 1.8 Kilometers



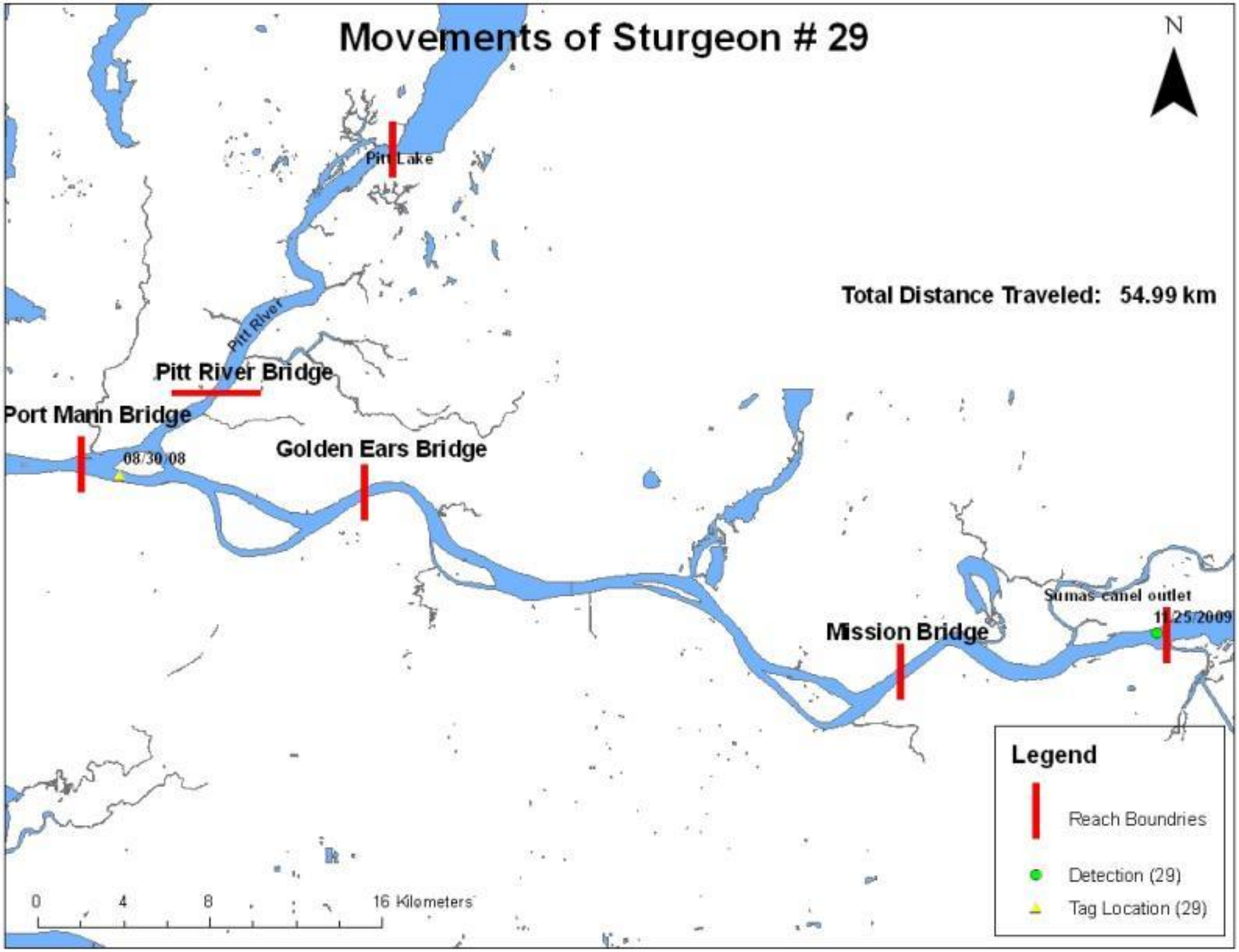
Movements of Sturgeon # 32
N
1/13/2010
Pitt River
Total Distance Traveled: 15.8 km
Pitt River Bridge
11/11/2009
Port Mann Bridge
08/31/08
Golden Ears Bridge
Legend
Reach Boundries
Tag Location (32)
Detection (32)
0 0.5 1 2 Kilometers



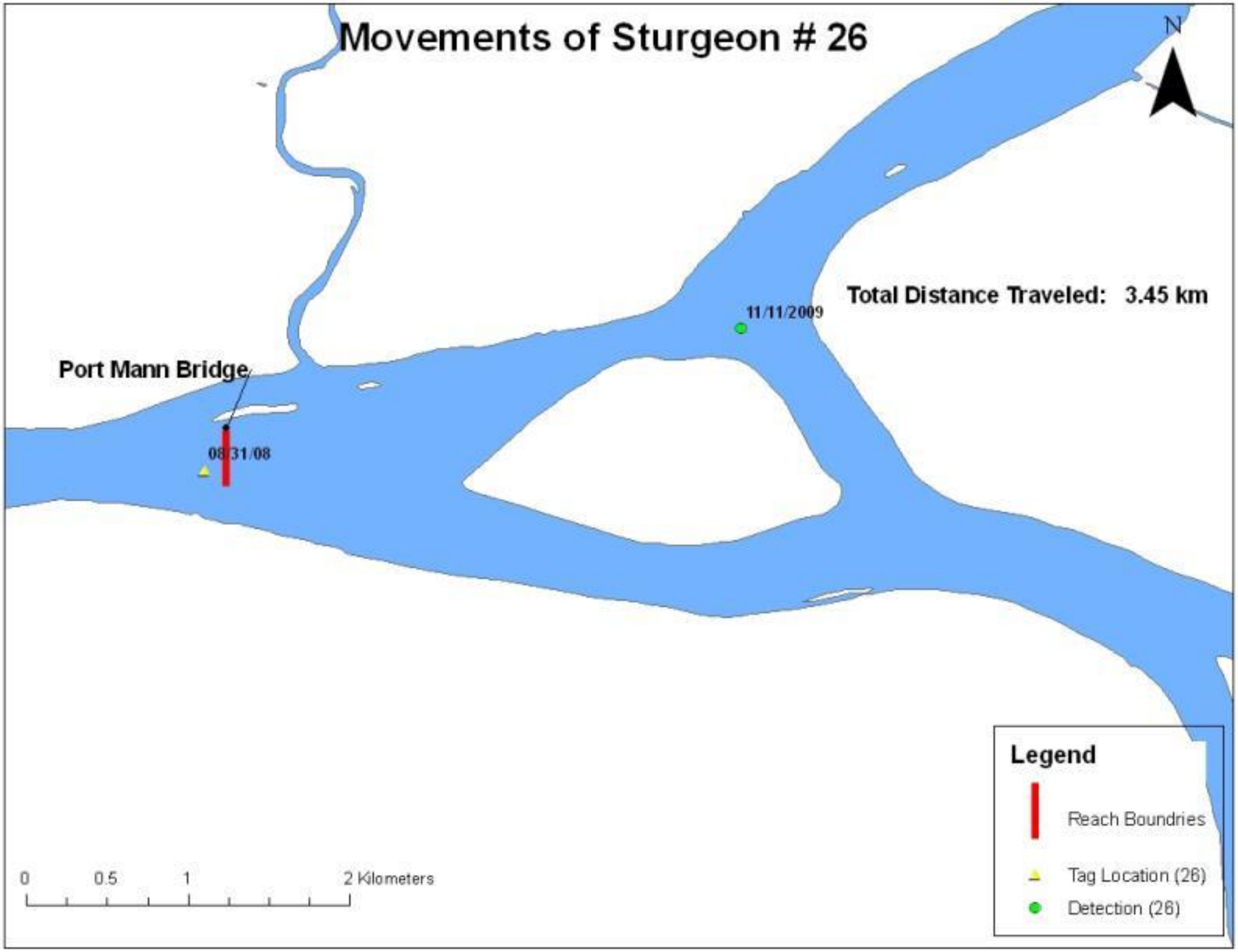
Movements of Sturgeon # 31
N
11/18/2009
Pitt River
Total Distance Traveled: 13.58 km
Pitt River Bridge
Port Mann Bridge
08/31/08
Golden Ears Bridge
Legend
Reach Boundries
Tag Location (31)
Detection (31)
0
1.25
2.5
5 Kilometers

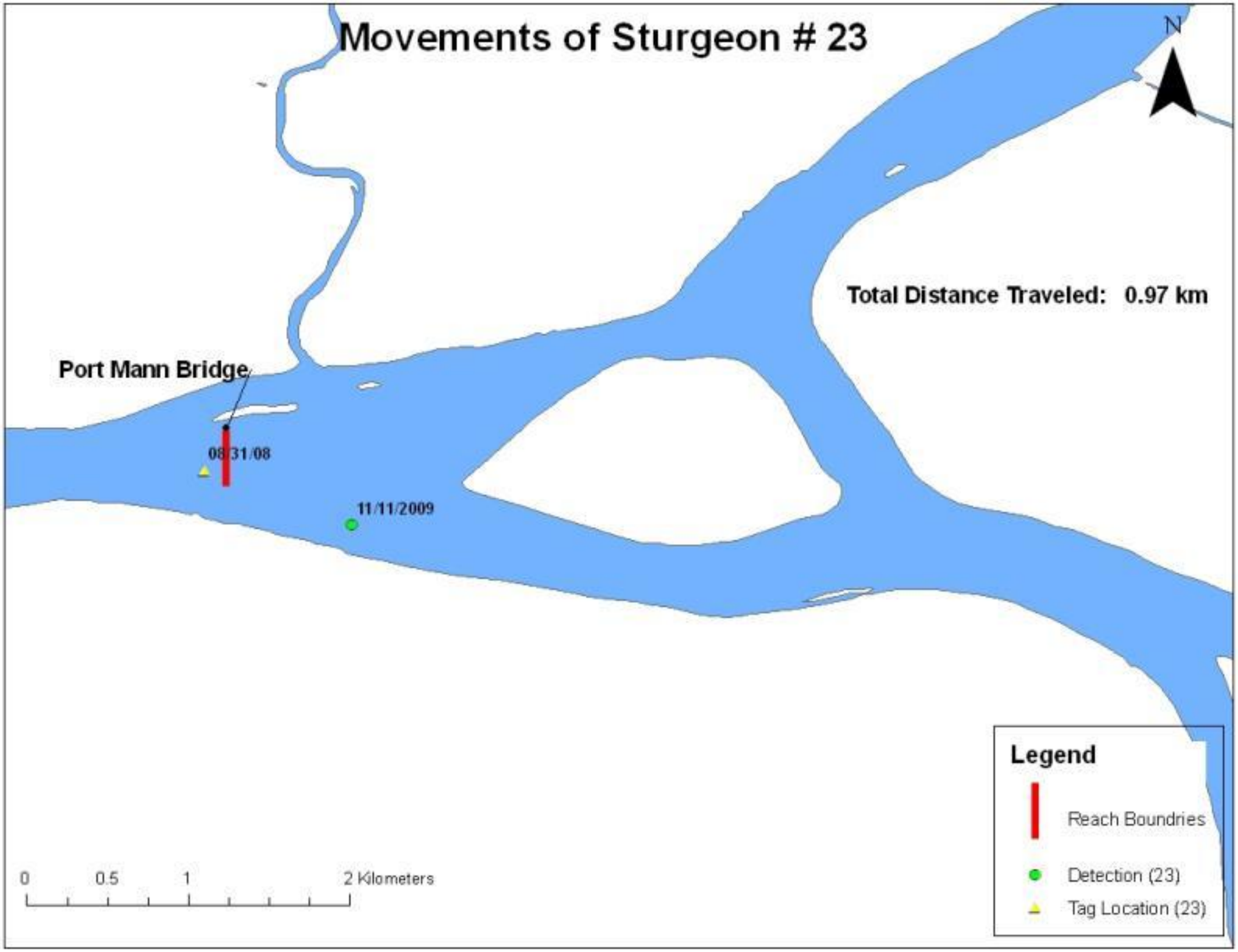


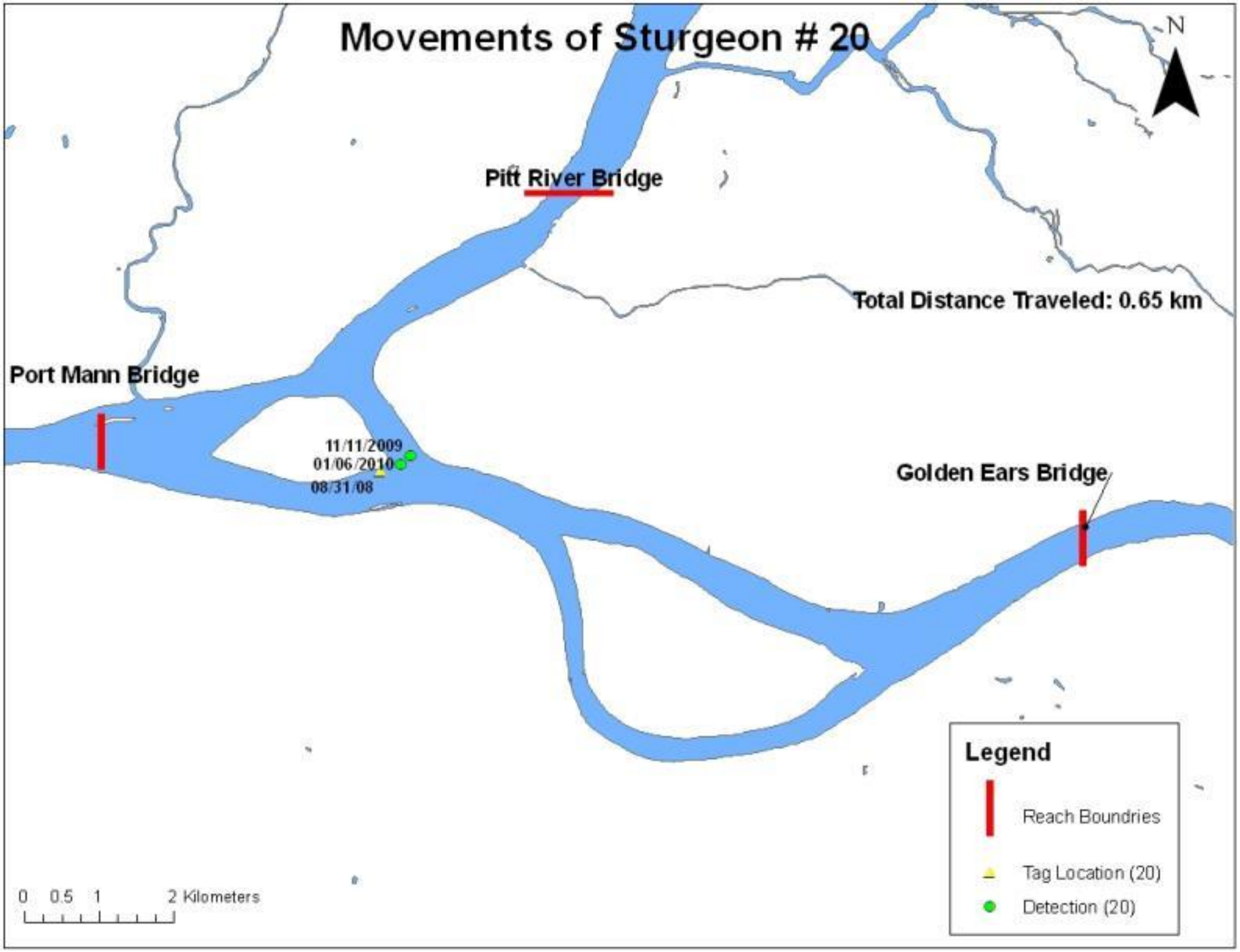
Movements of Sturgeon # 30
N
Pitt River Bridge
Total Distance Traveled: 1.72 km
Port Mann Bridge
01/06/2010
11/11/2009
08/30/08
Legend
Reach Boundries
Tag Location (30)
Detection (30)
0 0.3750.75 1.5 Kilometers



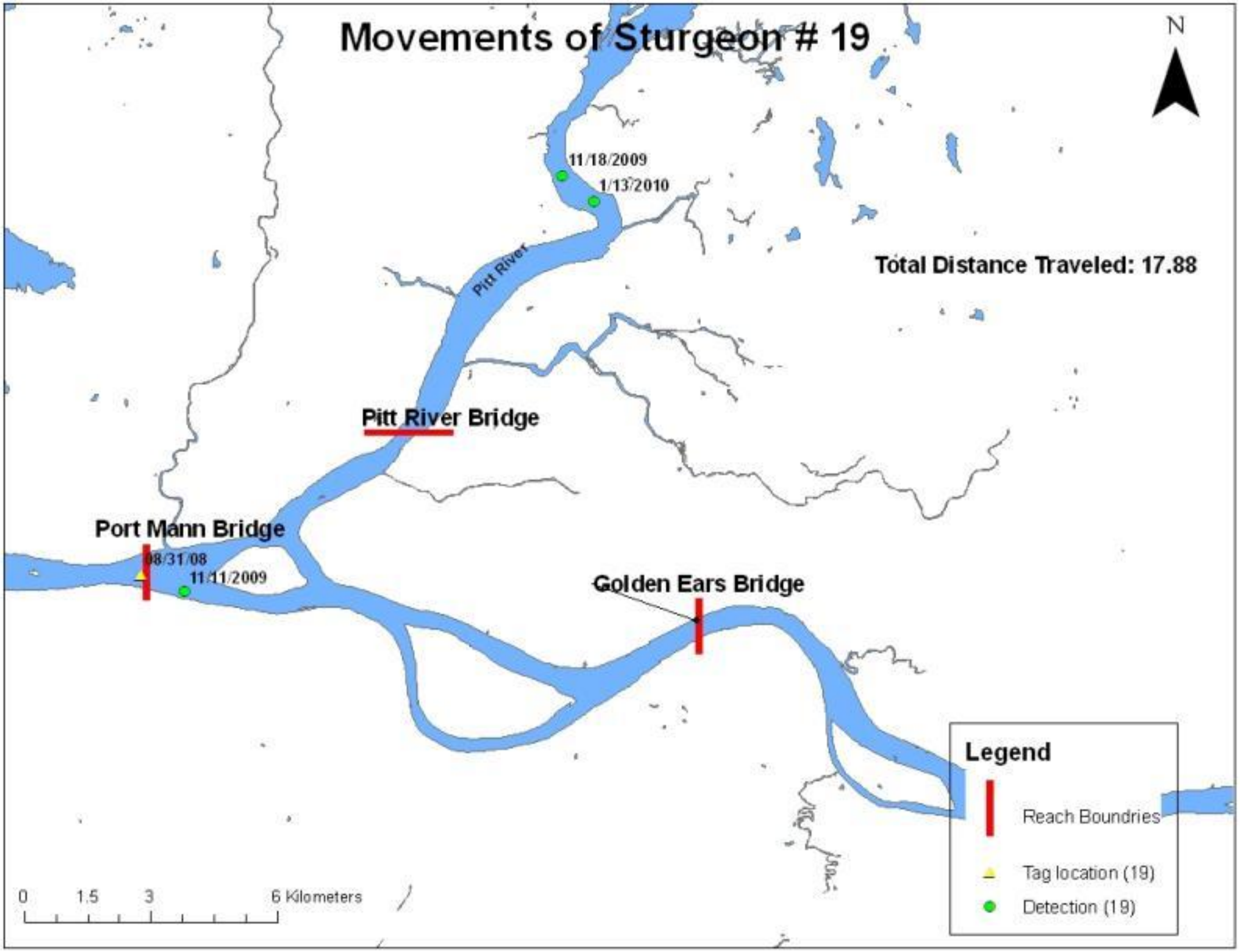
Movements of Sturgeon # 29
N
Pitt Lake
Pitt River
Total Distance Traveled: 54.99 km
Pitt River Bridge
Port Mann Bridge
08/30/08
Golden Ears Bridge
Sumas canel outlet
11/25/2009
Mission Bridge
Legend
Reach Boundries
Detection (29)
Tag Location (29)
0
4
8
16 Kilometers

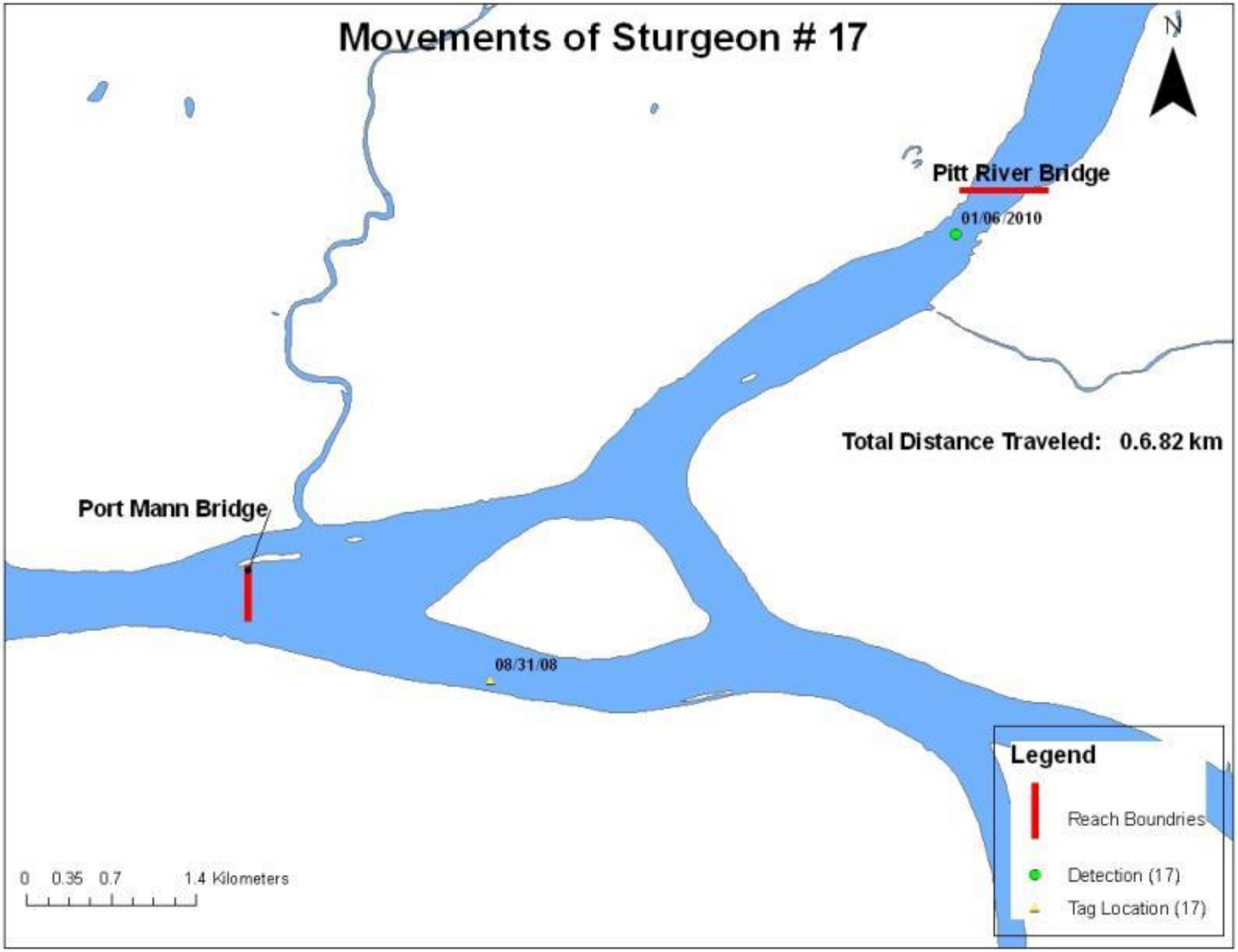

Movements of Sturgeon # 26
N
Total Distance Traveled: 3.45 km
11/11/2009
Port Mann Bridge
08/31/08
Legend
Reach Boundries
Tag Location (26)
Detection (26)
0
0.5
1
2 Kilometers

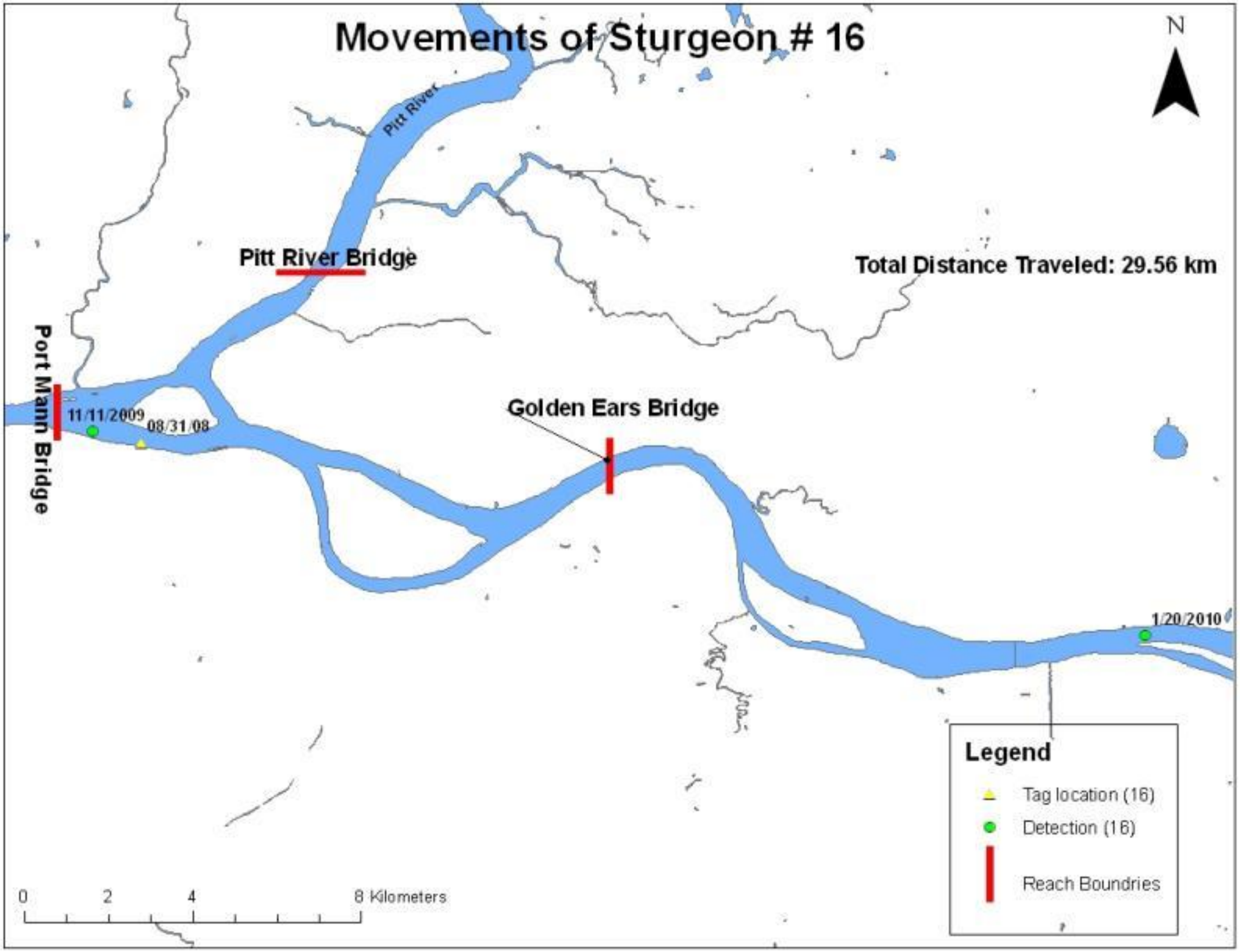

Movements of Sturgeon # 23
N
Total Distance Traveled: 0.97 km
Port Mann Bridge
08/31/08
11/11/2009
Legend
Reach Boundries
Detection (23)
Tag Location (23)
0
0.5
1
2 Kilometers

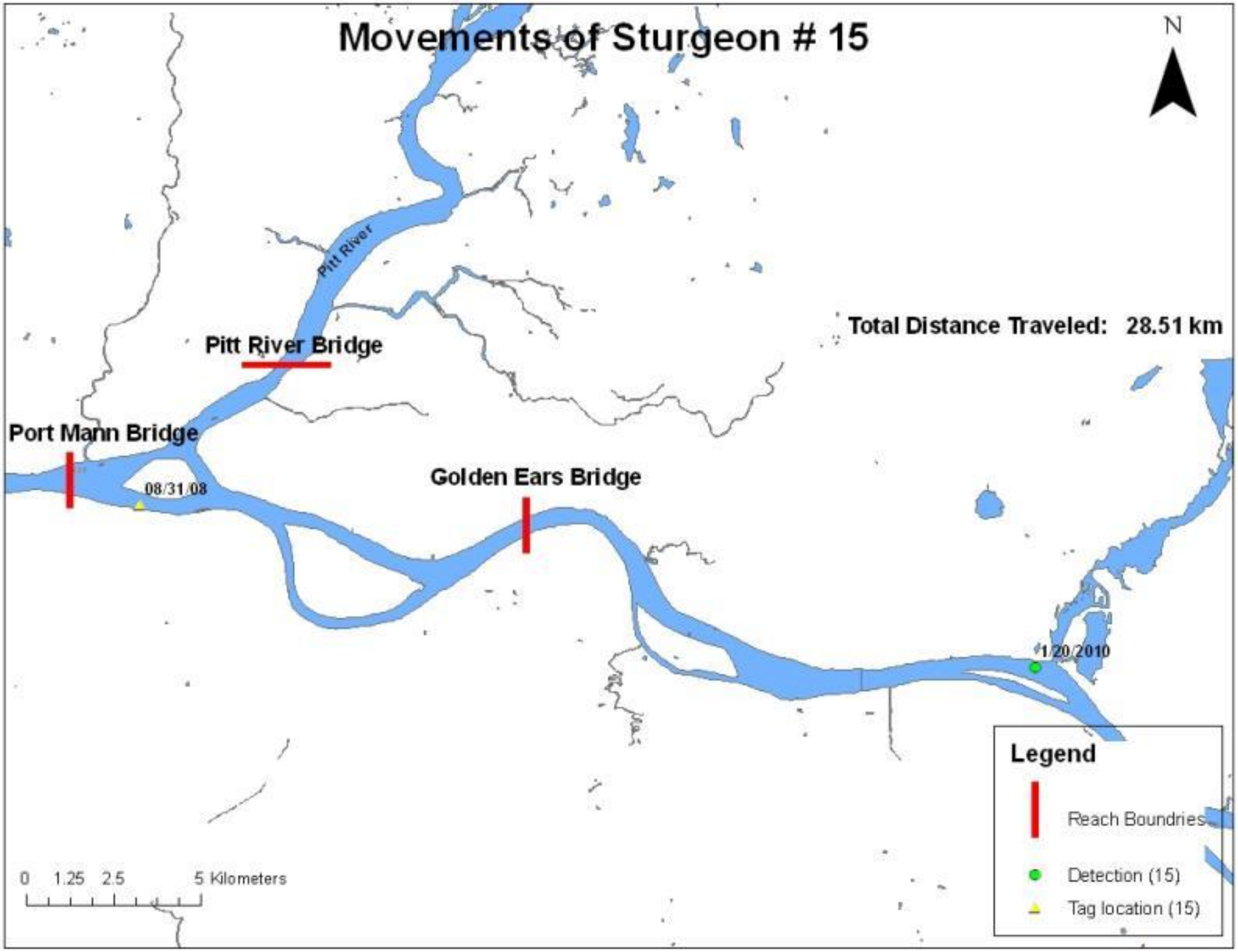


Movements of Sturgeon # 20
N
Pitt River Bridge
Total Distance Traveled: 0.65 km
Port Mann Bridge
11/11/2009
01/06/2010
08/31/08
Golden Ears Bridge
Legend
Reach Boundries
Tag Location (20)
Detection (20)
0 0.5 1 2 Kilometers

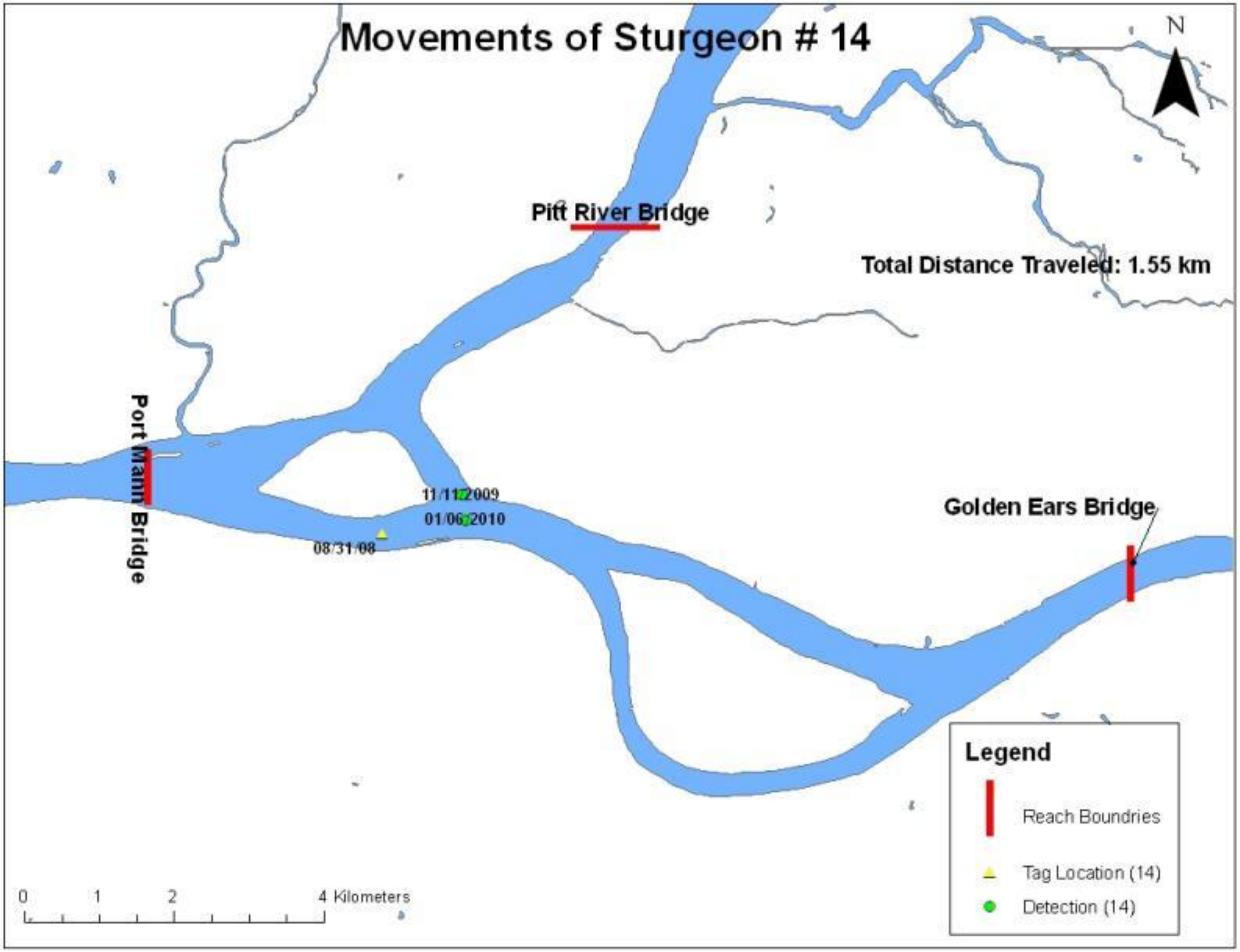

Movements of Sturgeon # 19
N
11/18/2009
1/13/2010
Total Distance Traveled: 17.88
Pitt River
Pitt River Bridge
Port Mann Bridge
08/31/08
11/11/2009
Golden Ears Bridge
Legend
Reach Boundries
Tag location (19)
Detection (19)
0
1.5
3
6 Kilometers

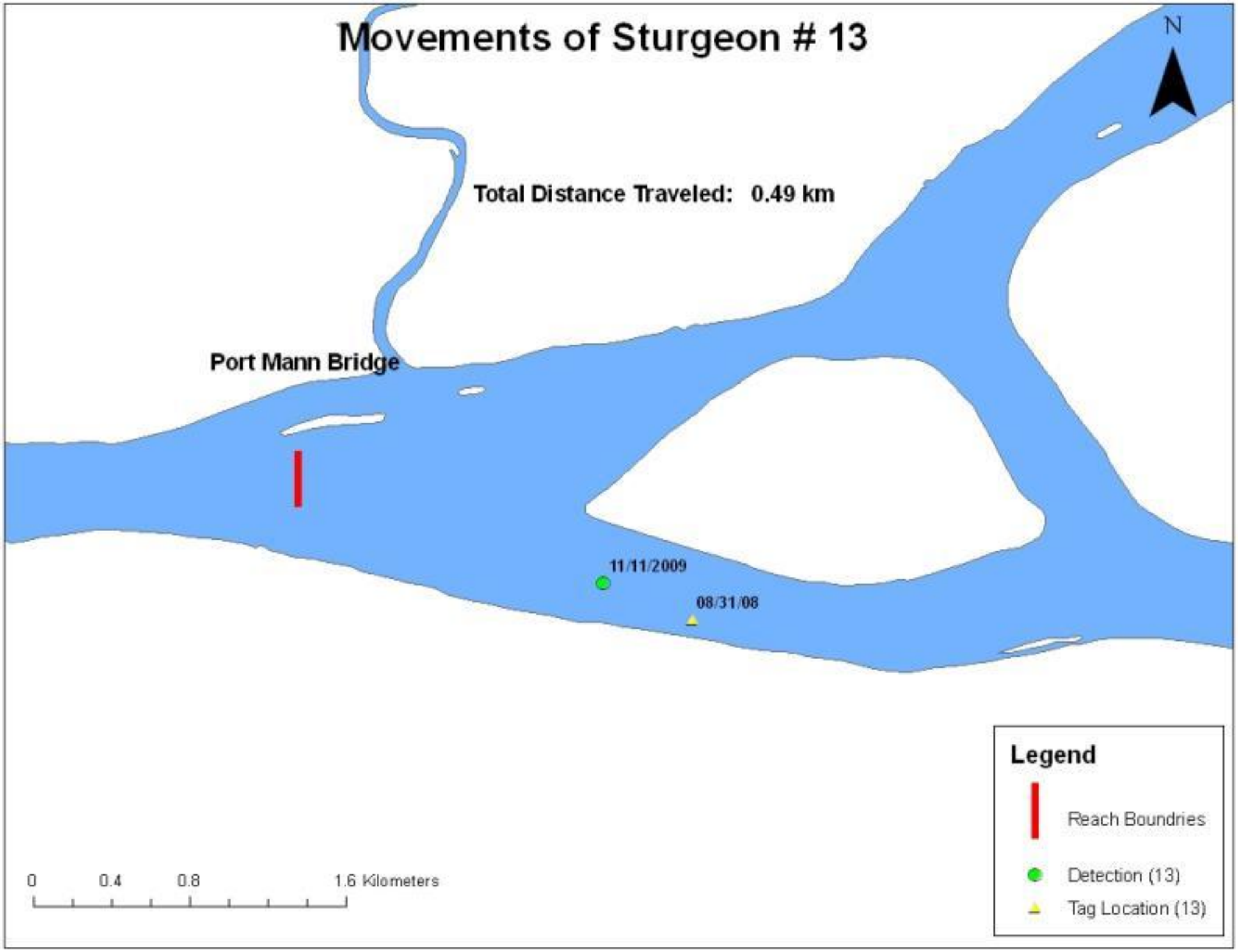

Movements of Sturgeon # 17
N
Pitt River Bridge
01/06/2010
Total Distance Traveled: 0.6.82 km
Port Mann Bridge
08/31/08
Legend
Reach Boundries
Detection (17)
Tag Location (17)
0 0.35 0.7 1.4 Kilometers

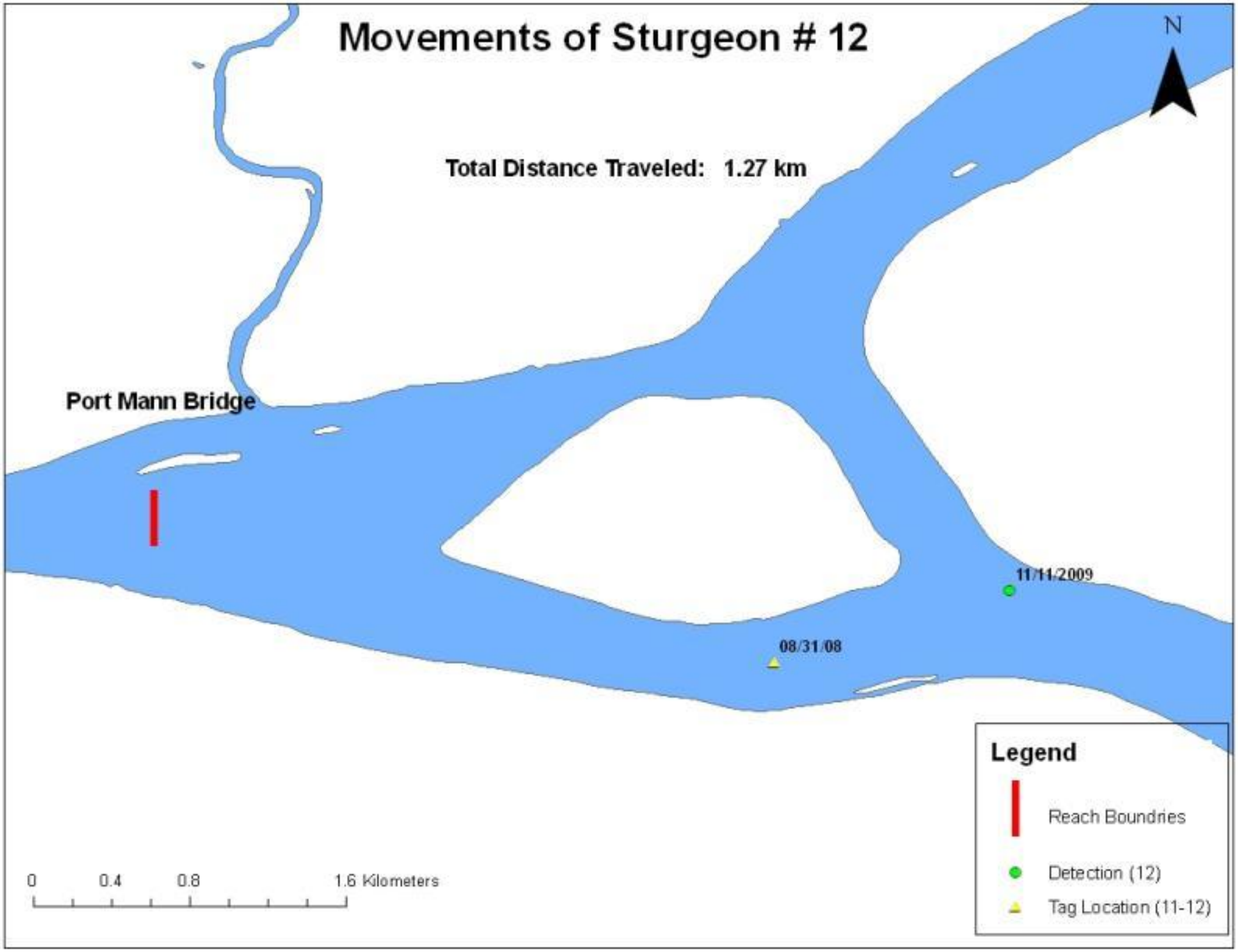

Movements of Sturgeon # 16
N
Pitt River
Pitt River Bridge
Total Distance Traveled: 29.56 km
Port Mann Bridge
11/11/2009
08/31/08
Golden Ears Bridge
1/20/2010
Legend
Tag location (16)
Detection (16)
Reach Boundries
0
2
4
8 Kilometers



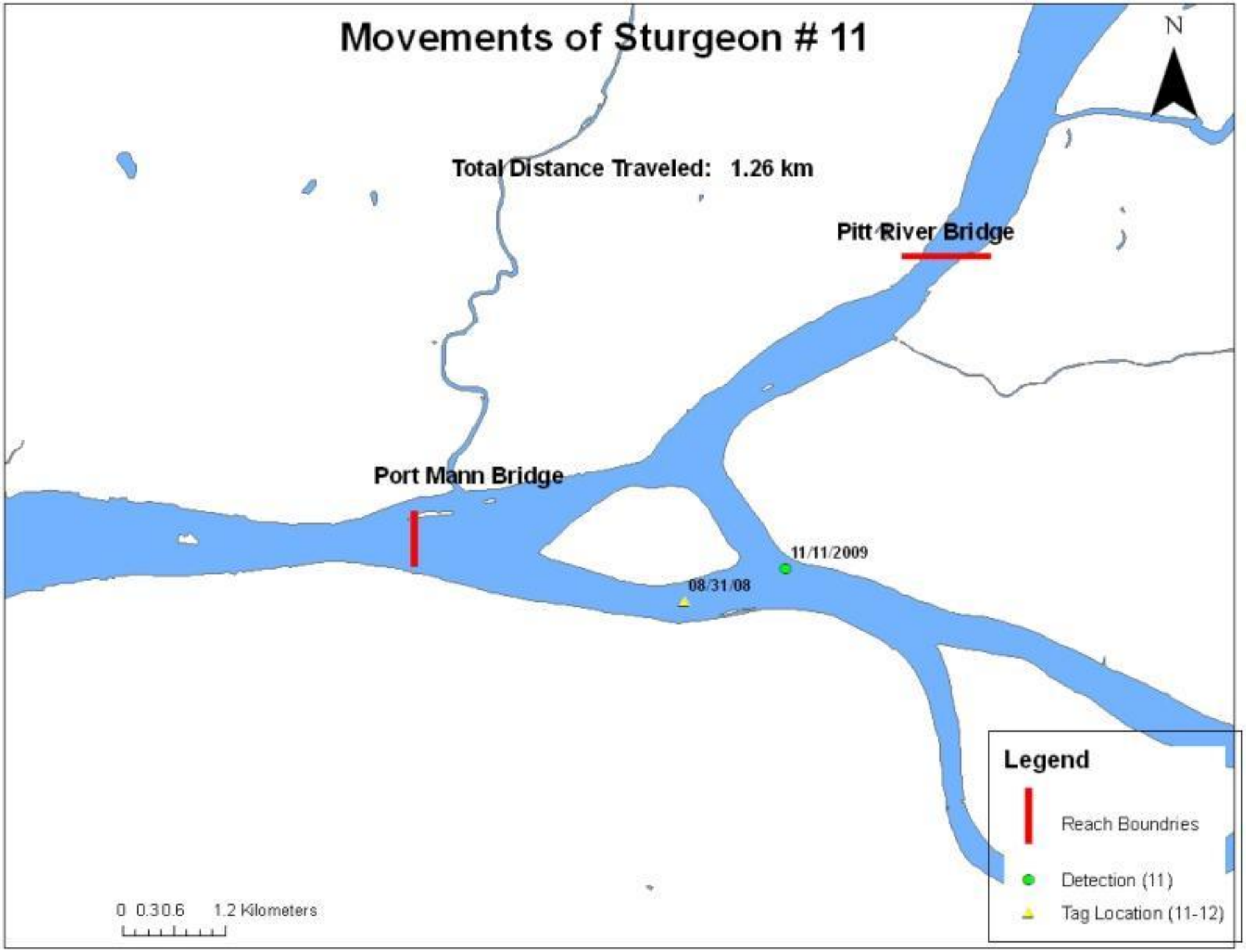
Movements of Sturgeon # 15
N
Pitt River
Total Distance Traveled: 28.51 km
Pitt River Bridge
Port Mann Bridge
08/31/08
Golden Ears Bridge
1/20/2010
Legend
Reach Boundries
Detection (15)
Tag location (15)
0 1.25 2.5 5 Kilometers

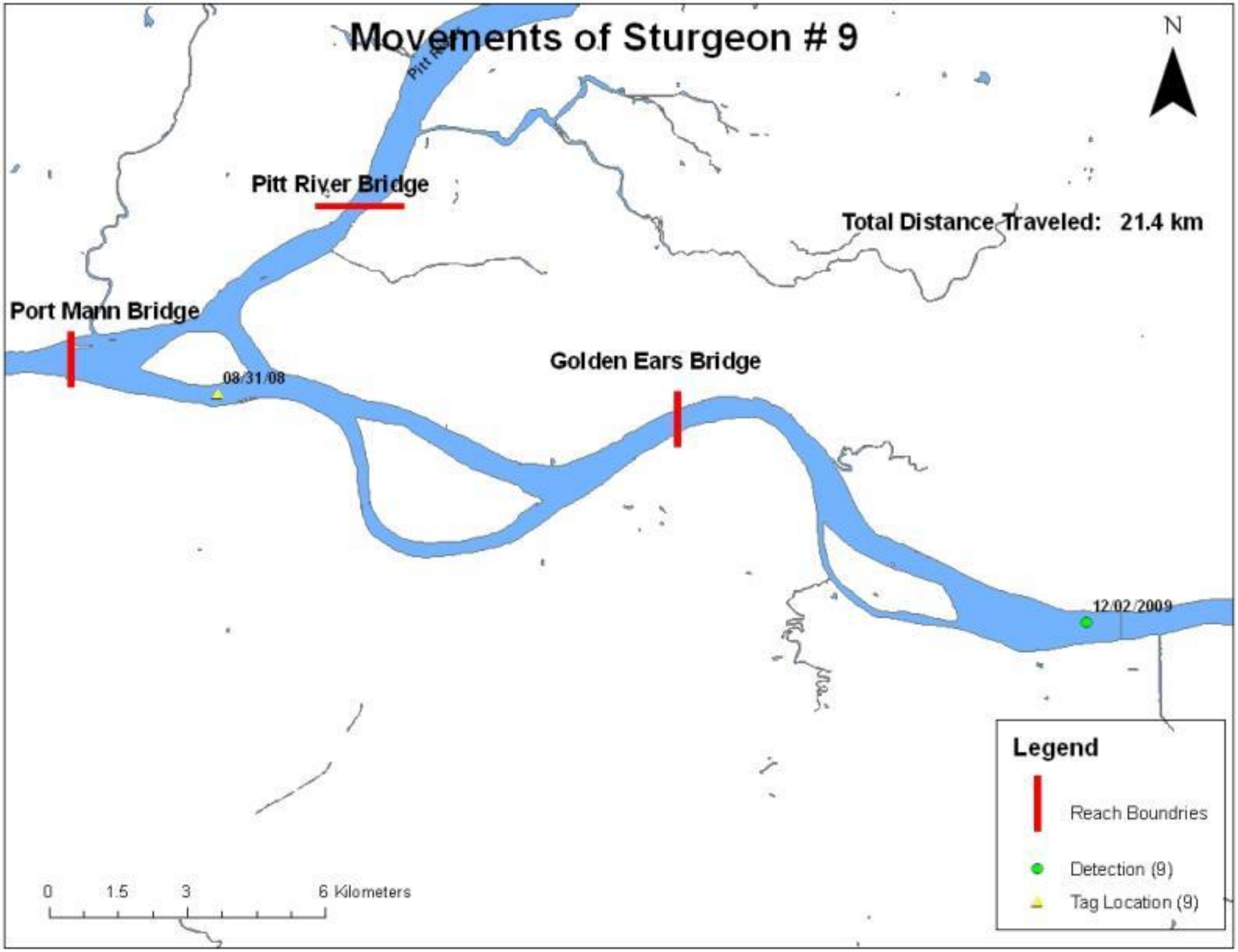

Movements of Sturgeon # 14
N
Pitt River Bridge
Total Distance Traveled: 1.55 km
Port Mann Bridge
11/11/2009
01/06/2010
08/31/08
Golden Ears Bridge
Legend
Reach Boundries
Tag Location (14)
Detection (14)
0
1
2
4 Kilometers

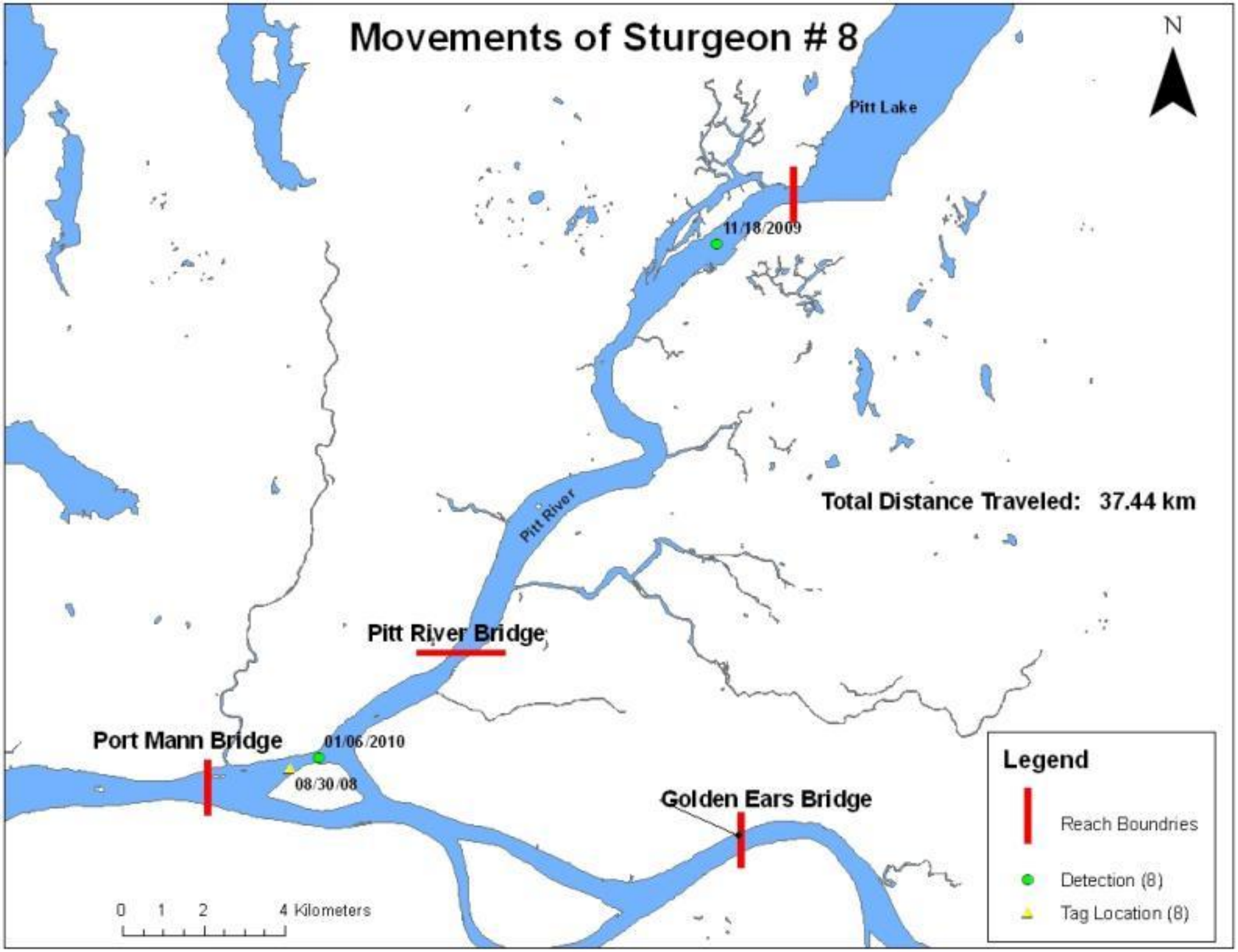

Movements of Sturgeon # 13
N
Total Distance Traveled: 0.49 km
Port Mann Bridge
11/11/2009
08/31/08
Legend
Reach Boundries
Detection (13)
Tag Location (13)
0
0.4
0.8
1.6 Kilometers

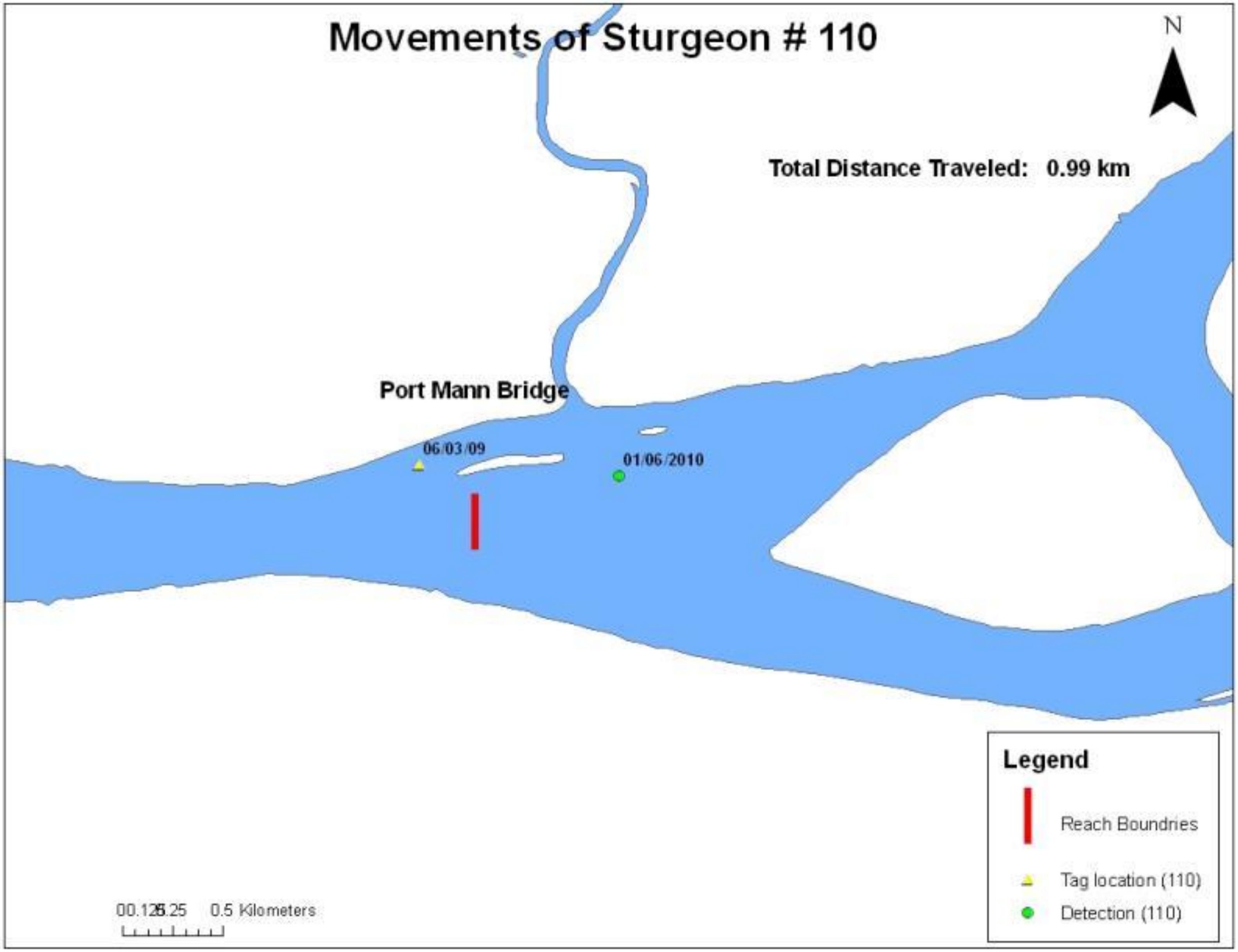


Movements of Sturgeon # 12
N
Total Distance Traveled: 1.27 km
Port Mann Bridge
11/11/2009
08/31/08
Legend
Reach Boundries
Detection (12)
Tag Location (11-12)
0
0.4
0.8
1.6 Kilometers


Movements of Sturgeon # 11
N
Total Distance Traveled: 1.26 km
Pitt River Bridge
Port Mann Bridge
11/11/2009
08/31/08
Legend
Reach Boundries
Detection (11)
Tag Location (11-12)
0 0.3 0.6 1.2 Kilometers


Movements of Sturgeon # 9
N
Pitt River Bridge
Total Distance Traveled: 21.4 km
Port Mann Bridge
Golden Ears Bridge
08/31/08
12/02/2009
Legend
Reach Boundries
Detection (9)
Tag Location (9)
0
1.5
3
6 Kilometers


Movements of Sturgeon # 8
N
Pitt Lake
11/18/2009
Pitt River
Total Distance Traveled: 37.44 km
Pitt River Bridge
Port Mann Bridge
01/06/2010
08/30/08
Golden Ears Bridge
0 1 2 4 Kilometers
Legend
Reach Boundries
Detection (8)
Tag Location (8)


Movements of Sturgeon # 110
N
Total Distance Traveled: 0.99 km
Port Mann Bridge
06/03/09
01/06/2010
Legend
Reach Boundries
Tag location (110)
Detection (110)
00.1250.25 0.5 Kilometers