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Identifying Hotspots of Liard River Crossings by Nahanni Wood Bison

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ABSTRACT

Nahanni wood bison are often observed swimming across the Liard River. We used data from GPS-collared animals to identify where and when they crossed the Liard River. We documented 315 crossings by 11 individual bison (ten females and one male). Crossings were almost exclusively during the ice-free period and were most frequent during July. There was a range of three to 78 crossings by each individual over the lifetime of its collar (169-995 days). Crossings were more frequent in areas of the river where there were permanent islands. Most of the hotspots we identified, with comparatively high crossing densities, were in the southern part of the study area. We found no crossings for a *ca.* 130 km section of river. River crossing is not without risk of drowning and with vessel traffic those risks could increase.

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INTRODUCTION

The Nahanni wood bison population inhabits an area of approximately 10,000 km^2 in the southwestern Northwest Territories (NWT), south eastern Yukon Territory (YT), and northeastern British Columbia (BC). At last count the population was estimated at 544 (≥1 years-old; Armstrong unpublished). The Liard River and its tributaries bisect the range. Swimming seems to be an inherent part of the ecology of this population. Bison are commonly seen swimming across the Liard River (Larter et al. 2003). Although bison appear to be strong swimmers, they typically swim spread out with their heads just above water which may make them susceptible to drowning (Figure 1.).

Figure 1. Groups of wood bison swimming the Liard River.

As part of a larger study on the Nahanni population (see Larter and Allaire 2007), bison were equipped with GPS radio collars. We wanted to determine if crossings were concentrated in certain places along the Liard River, and when, and how frequently bison crossed the river. This information would be useful information for current and future river vessel traffic. Data presented in this report have been used for a more detailed predictive modeling study of river crossings (Thomas et al. 2022).

METHODS

Between 2007 and 2017 we captured 12 adult wood bison using chemical immobilization following a protocol approved by the Government of the NWT (GNWT) Wildlife Care Committee. Some bison were immobilized by ground-based stalking, others by aerial darting. On all animals we deployed Telonics ARGOS GPS collars; from 2007-2011 with model TGW-3780, and for 2017 with model TGW-4780-3. GPS collars were expected to function for ≥2 years and had variable fix schedules: collars deployed in 2007 and 2009 (n=5) were programmed to collect two fixes/day, collars deployed in 2011 (n=3) to collect four fixes/day, and collars deployed in 2017 (n=4) to collect six fixes/day. Jung and Kuba (2015) report GPS collars on bison in the boreal forest have high fix success and deliver precise location data (<10m). Location data was transcribed and stored in the GNWT Wildlife Management Information System (WMIS).

GPS collar data were screened for errors using a three-step process. First, we calculated fix success rates to check for general collar malfunction and disregarded any data collected after gaps of >10 days between successful fixes (D'Eon et al. 2002). Then, using prior knowledge of wood bison movement rates (Larter and Gates 1994; Jung et al. 2019) we applied an algorithm based on animal movement behaviour to detect and remove outliers (Bjorneraas et al. 2010) implemented with *adehabitatLT* package in R (v. 3.6.3, www.rproject.org). Finally, data were manually removed to remove apparent errors like duplicate fixes.

River crossing events were defined as those with ≥2 fixes on the opposite side of the river, to prevent the identification of false crossings caused by collar location error. We did not record crossing locations if the interval between fixes was >12 hours.

RESULTS

Between 2007 and 2017, GPS collars were deployed on 12 bison. One collar malfunctioned prematurely (#508) and was excluded from the analysis. A total of 315 river crossings were documented from 11 bison (ten females and one male). There was a range of three to 78 crossings by each individual over the lifetime of its collar (Table 1). Two female bison crossed more frequently, accounting for 46% of the crossings. Crossings were almost exclusively during the ice-free period with most crossings occurring in July (Table 2). We identified multiple hotspots with comparatively high crossing densities, most in the southern part of the study area, however for one section of river (*ca.* 130 km) we found no crossings (Figures 2 and 3).

Table 1. The identification number, sex, collar active period, fix schedule, collar life (days), number of river crossings and crossings/100 ice free days for the 12 individual bison collared for this study. [1] Number of river crossings per 100 ice-free days of collar activity (May 5 - October 29).

	Sex	Collar Active Period	Fix Schedule	Collar Life (Days)	No. of Crossings	Crossings/ 100 Ice-Free Days[1]
500	Female	July 2007 – July 2008	12 hours	363	6	3.3
506	Female	July 2007 – June 2008	12 hours	331	19	10.4
508	Female	November 2008 – June 2009	12 hours	208	0	0.0
511	Female	January 2009 – April 2010	12 hours	450	3	1.6
514	Female	January 2009 – March 2010	12 hours	444	20	10.9
515	Female	February 2011 – December 2012	6 hours	686	13	3.5
516	Female	February 2011 – October 2013	6 hours	995	43	7.8
520	Female	February 2011 – April 2013	6 hours	801	45	12.2
522	Female	February 2017 – September 2018	4 hours	575	67	21.1
524	Female	February 2017 – September 2019	4 hours	956	78	15.1
526	Female	February 2017 – August 2018	4 hours	552	18	5.9
527	Male	February 2017 – August 2017	4 hours	169	3	2.9
			Total:	**6,530**	**315**	

Table 2. The number of river crossings made by GPS collared bison in different months.

January	February	March	April	May	June	July	August	September	October	November	December
0	0	1	8	31	62	86	53	31	39	4	0

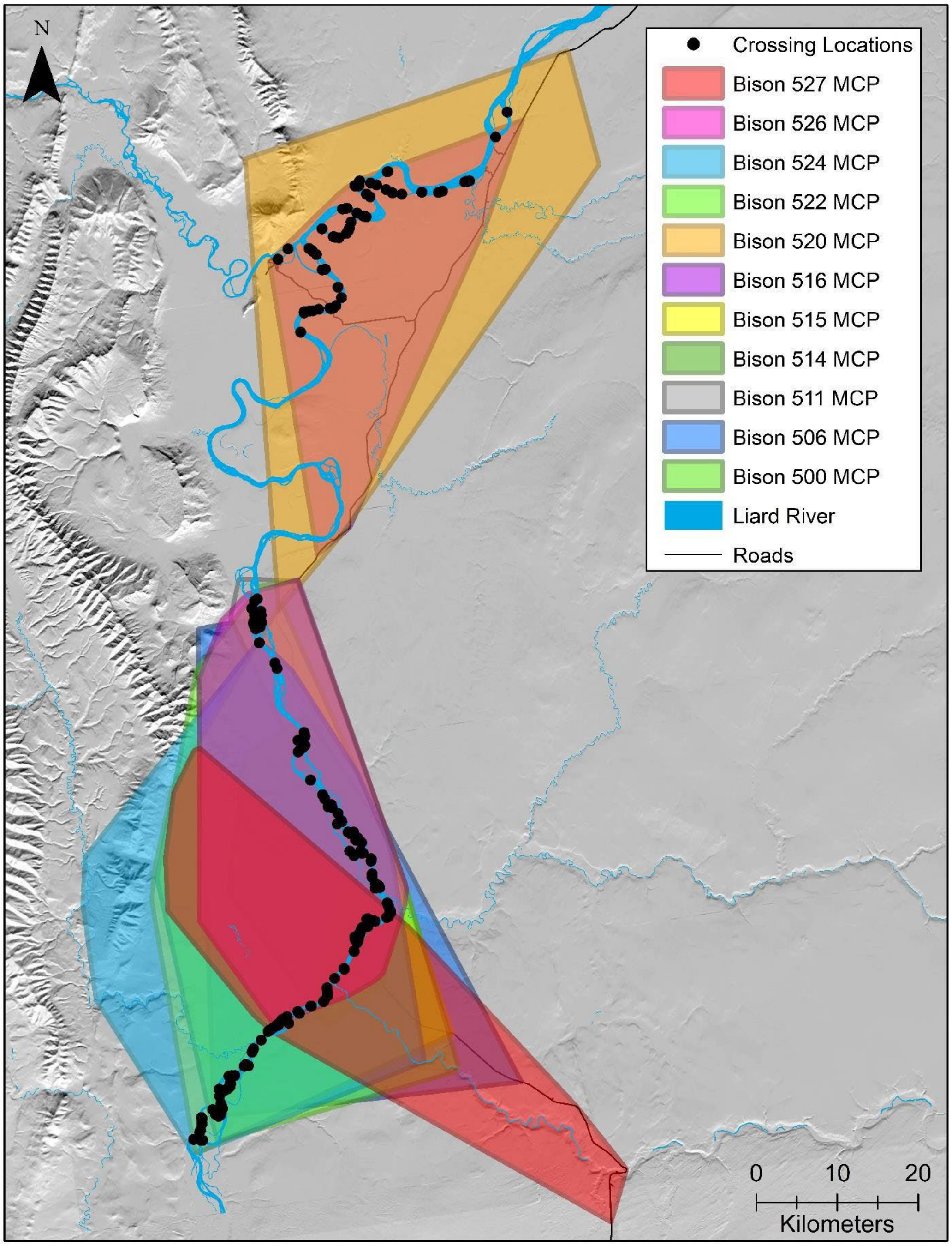

Figure 2. Locations where 11 GPS-collared bison crossed the Liard River. The 95% minimum convex polygons for each bison is provided.

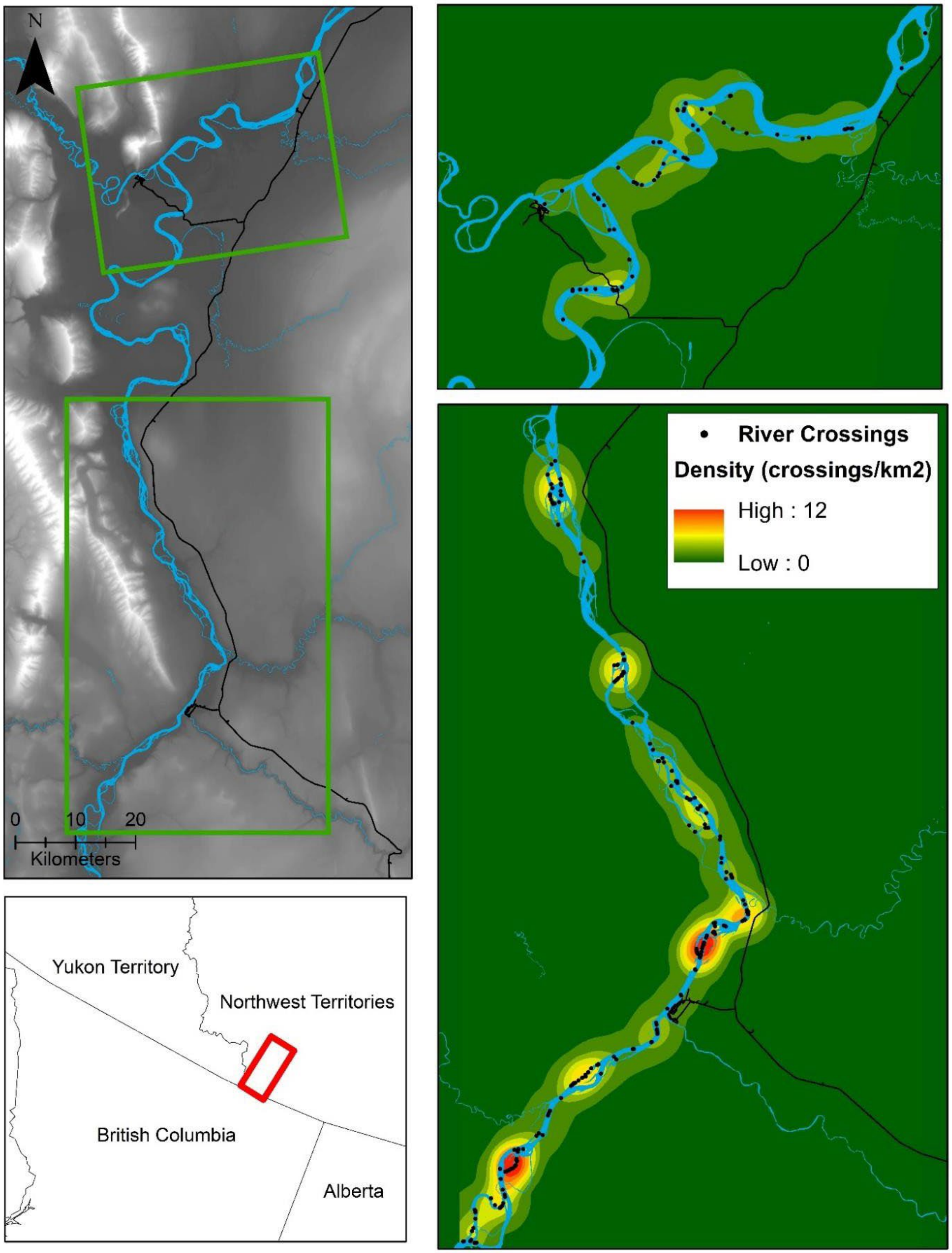

Figure 3. The density of river crossings in the northern and southern portions of the Liard River based upon movements of two and nine bison, respectively over the course of the study.

DISCUSSION

Despite our limited number of collared bison and the limitations in collar lifespan, we show that bison regularly crossed the Liard River, particularly during summer months, and more frequently in areas with permanent river islands. That most crossings occurred in the month of July is not surprising. River surveys, conducted annually over three to four days in July, have observed at least one group of bison crossing the river for 17 consecutive years (Larter 2018).

There was considerable variation in the number of crossings/100 ice free days by collared bison, from 1.6-21.1. A female in the north of the study area made the most crossings/100 ice free days, while the fewest crossings were made by a female in the south of the study area. The lone collared male had relatively few crossings. More collared male bison are required to explore differences in crossing rate by males and females.

Although only two females were collared in the north of the study area, they accounted for 112 crossings in total, and provide some information on more frequently used crossing areas. More collared bison in the north of the study area would provide more confidence in crossing hotspots. The data from nine individuals in the south of the study area has its limitations; however they demonstrate regular crossings during the ice-free period and provide the first information on river crossing hotspots.

We found no river crossings for a 130 km stretch of the Liard River, running north from Flett Rapids to Nelta. Few home ranges of collared bison overlapped with this area, resulted in low sampling intensity. This area has fewer permanent islands in the river and also has some substantially higher river banks than elsewhere. However, additional movement data of collared animals in this part of the study area is necessary in order to determine whether crossings occur less frequently in this stretch of the river versus elsewhere.

Swimming is energetically costly for large terrestrial mammals (Fish 1993). Collared individuals in this study made 315 river crossings, which entailed substantial energetic cost and risk. Bison may take >30 minutes to cross the Liard River, and some are reported annually to drown while doing so (Larter et al. 2003). Bison could also drown as a result of direct collisions with vessels, or indirectly as a consequence of being swamped by their wake (Carbyn et al. 1993). Additionally, vessel-related disturbance may cause bison to alter their crossing trajectory or increase swimming time, escalating the risk of drowning or hypothermia, particularly for calves (Larter et al. 2003). Given river crossing appears to be a fundamental aspect of the ecology of the Nahanni bison population (Larter and Allaire 2007), should vessel traffic on the Liard river begin to increase then mitigation measures at bison crossing hotspots are likely required.

ACKNOWLEDGEMENTS

We appreciate the continued support of Nahanni Butte Dene Band and Acho Dene Koe Band for the Nahanni wood bison monitoring program. Bonnie Fournier and the late Danny Allaire are acknowledged for their assistance in managing the location data.

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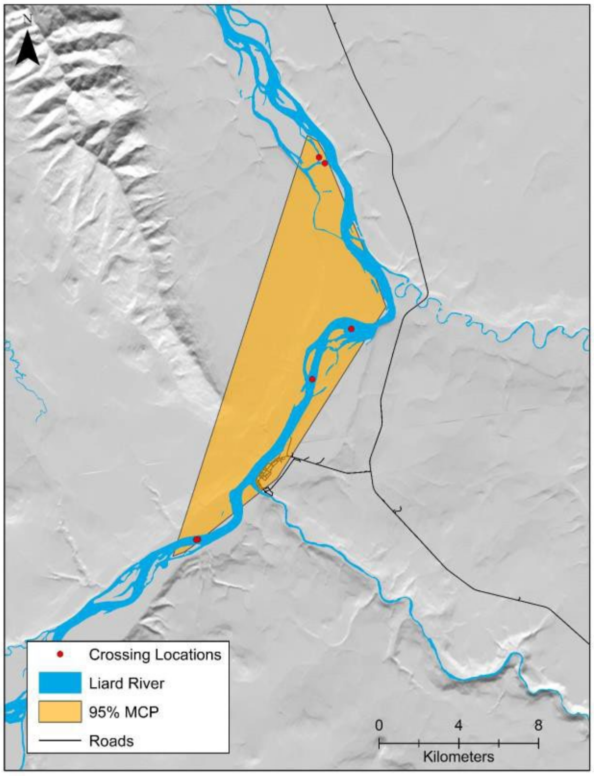
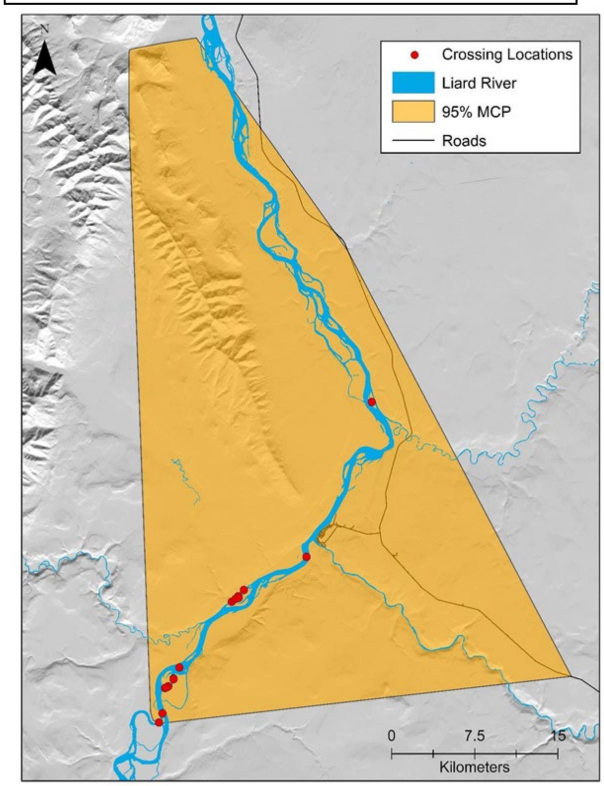
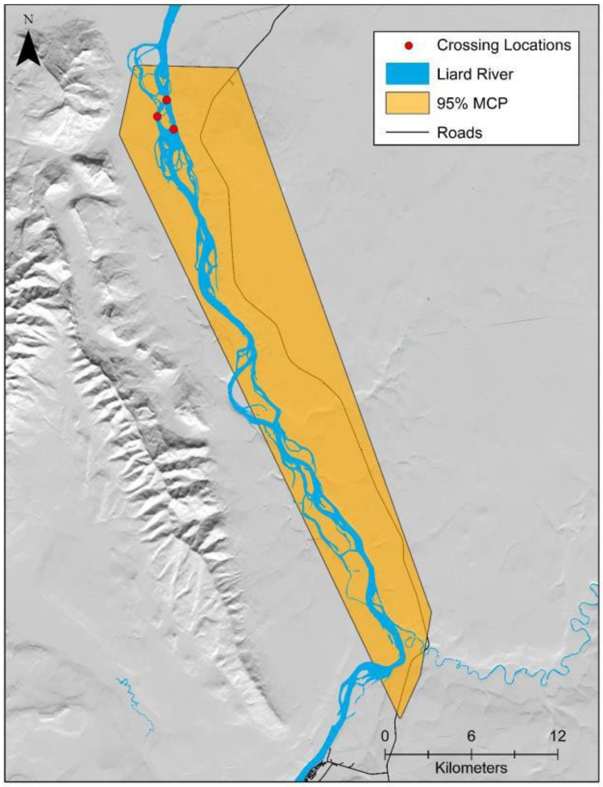
APPENDIX A. THE HOME RANGE (95% MINIMUM CONVEX POLYGON) NUMBER OF RIVER CROSSINGS AND LOCATION OF RIVER CROSSINGS MADE BY EACH OF 11 COLLARED BISON.

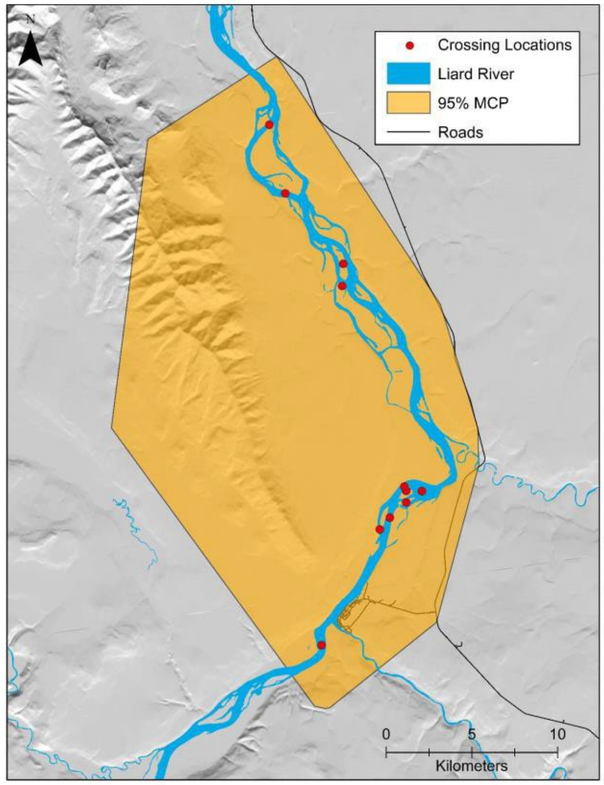


#500 Female, July 2007 – July 2008, 363 days, six crossings

#506 Female, July 2007 – June 2008, 331 days, 19 crossings

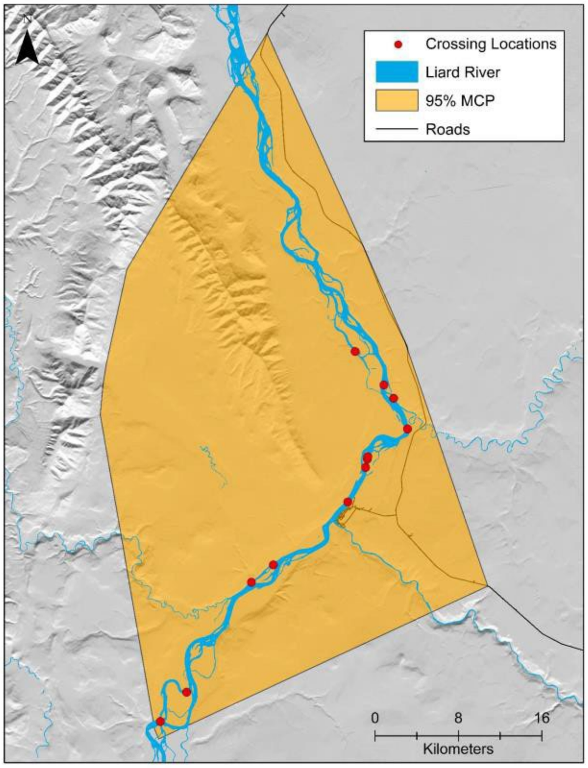




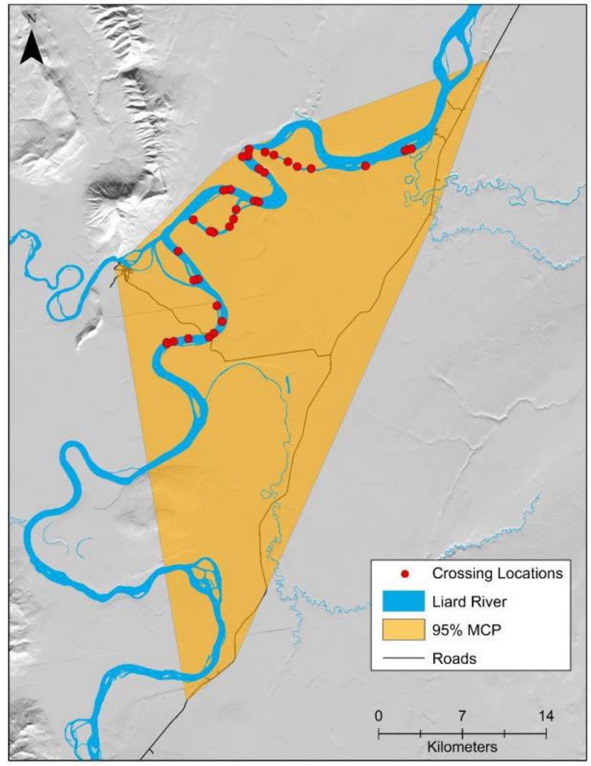


#511 Female, January 2009 – April 2010, 450 days, three crossings

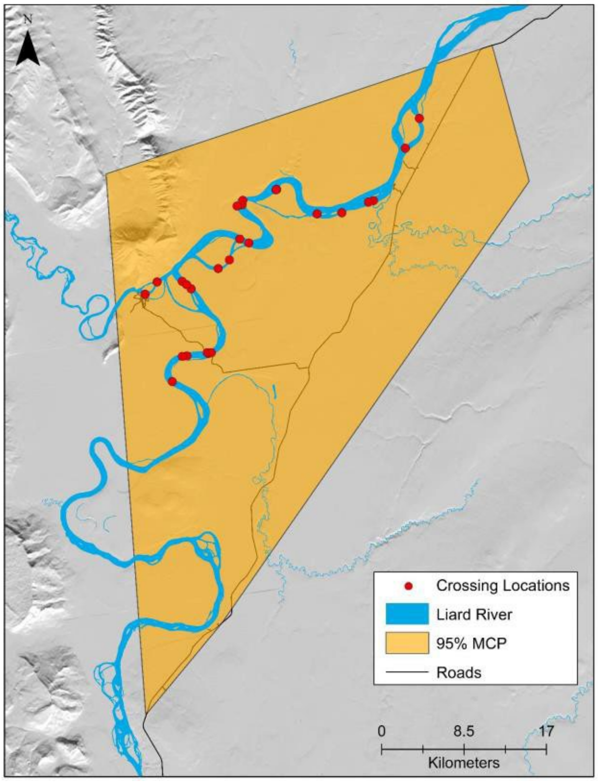
#514 Female, January 2009 – March 2010, 444 days, 20 crossings

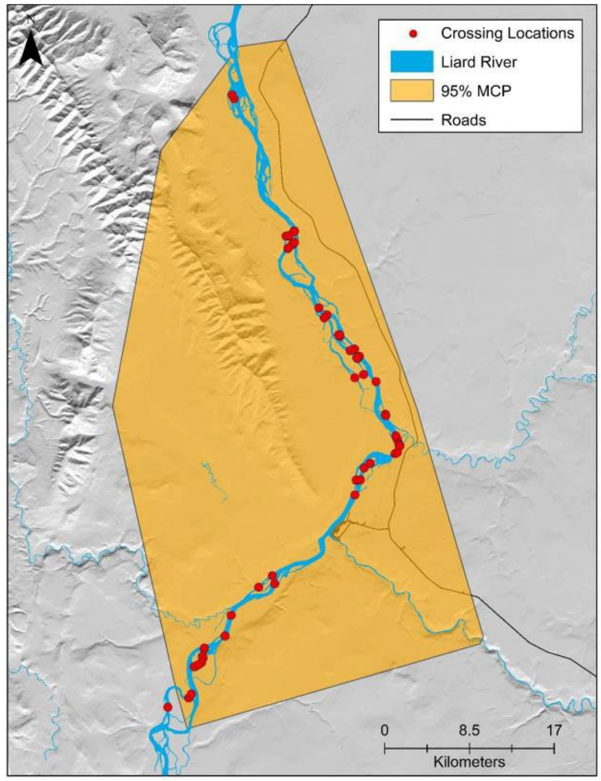


#515 Female, February 2011 – December 2012, 686 days, 13 crossings



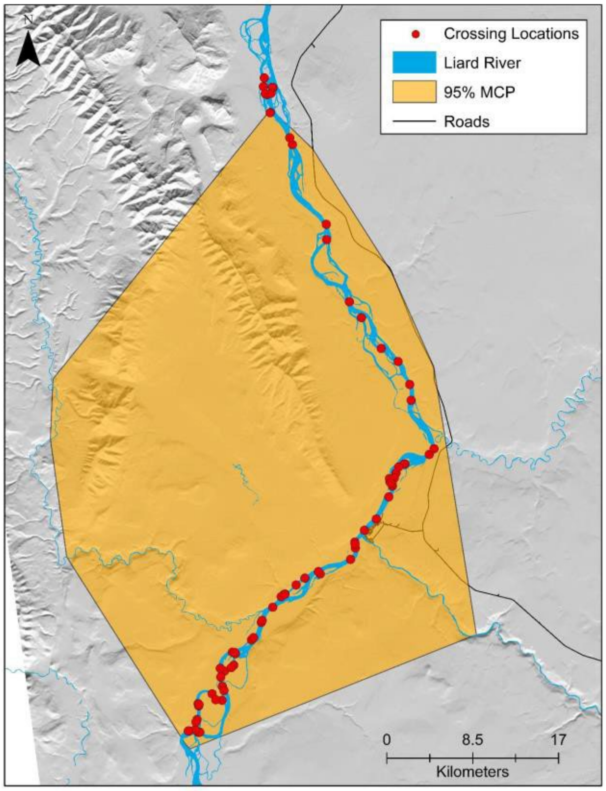
#516 Female, February 2011 – October 2013, 995 days, 43 crossings

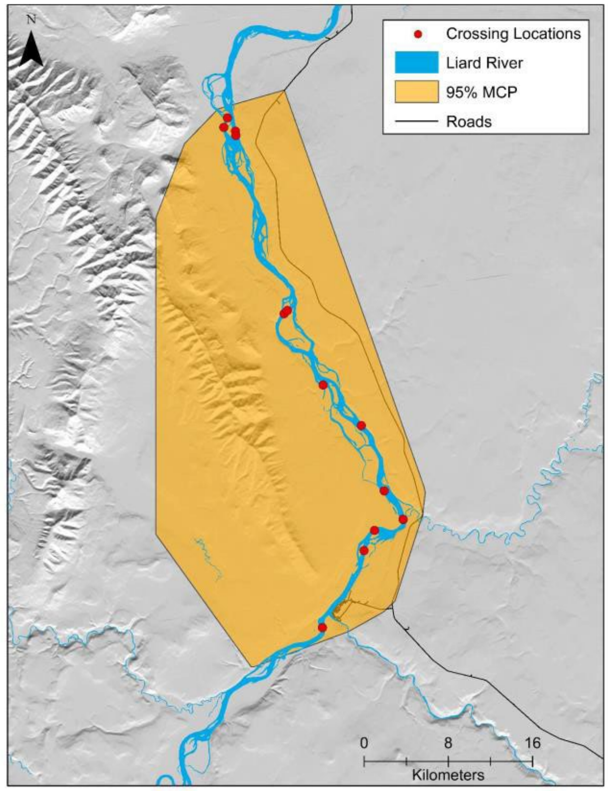




#520 Female, February 2011 – April 2013, 801 days, 45 crossings

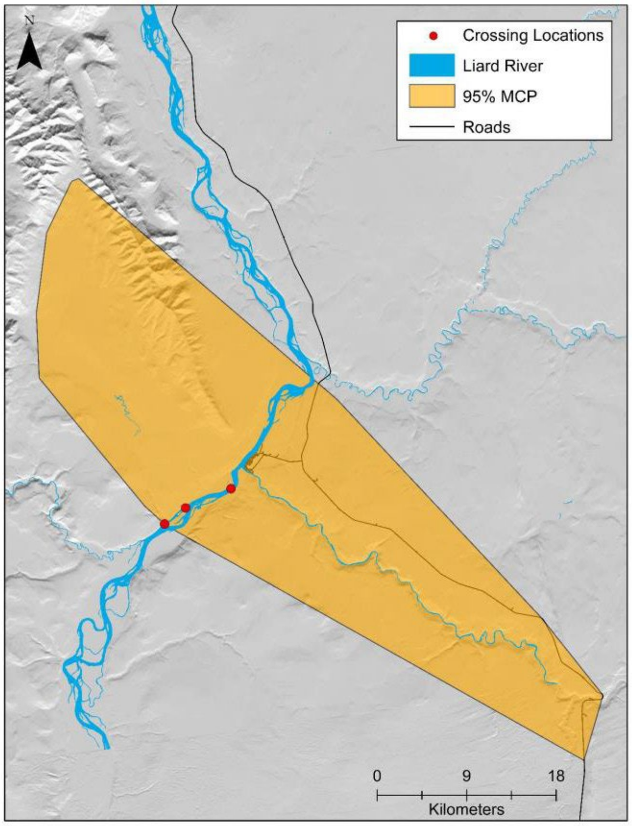
#522 Female, February 2017 – September 2018, 575 days, 67 crossings





#524 Female, February 2017 – September 2019, 956days, 78 crossings

#526 Female, February 2017 – August 2018, 552 days,18 crossings



#527 Male, February 2017 – August 2017, 169 days, three crossings