Online Appendix

A Additional Results

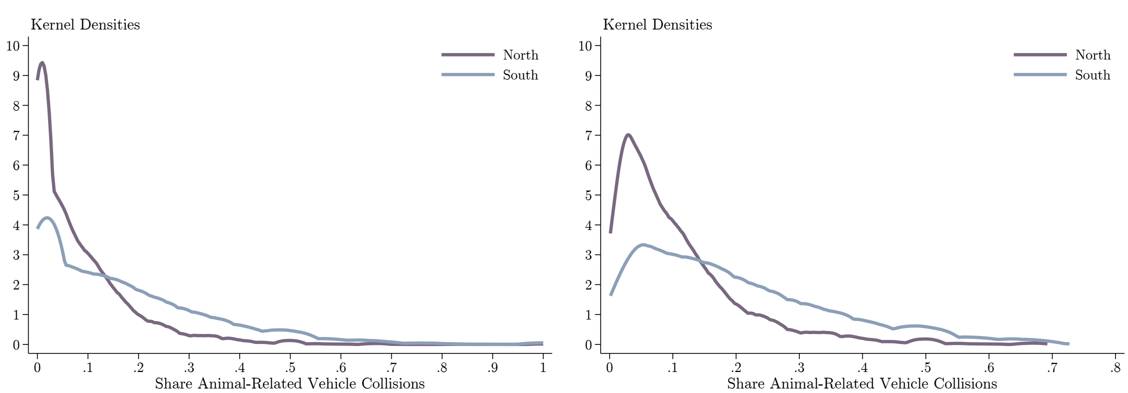
A.1 Summary Statistics for Vehicle Collisions in Quebec

In the main text, we focus on the difference in the share of animal-related vehicle collisions, on average, between municipalities north and south of the Saint Lawrence River. Here we expand on that analysis by describing the distribution of AVCs, how stable it is over time, and whether we observe it solely in animal-related causes.

In Figure A1, we plot the kernel densities for the share of animal-related vehicle collisions, for municipalities that are within 50 km of the river (similar to the sample we use in the main analysis). We report the kernel densities separately for north and south, and we observe that there is a much higher density in the north for low shares of animal-related vehicle collisions than in the south (Panel a). This difference in the distributions is even starker when we truncate the values of the sample at the 1st and 99th percentile values (Panel b).

Figure A1: Distribution of the Share of Animal-Related Collisions

(a) All Municipalities (b) Truncated



Notes: Plotting kernel densities for the share of animal-related vehicle collisions for municipalities that are within 50 km of the Saint Lawrence River. Panel (a) reports the data for all municipalities within that range, while in (b) we truncate at the 1st and 99th percentiles.

In Figure A2, we report the evolution over time of the shares of animal-related vehicle collisions, the share of property damages only (PDO) collisions, and collisions that had at least one injury (each share is calculated separately and categories may overlap).[7] We report the mean shares, by year, for all municipalities either north or south of the river, in either the full sample or the sample of municipalities within 50 km of the river. The first stylized fact that emerges from the top row of the figure is that the share of animal-related vehicle collisions is higher in the south relative to the north, and it has been persistently higher over the span of 2000 to 2019. The second stylized fact is that we *fail* to observe any differences in the share of PDO collisions, or collisions that had at least one injury. With respect to those shares, municipalities north and south of the river exhibit nearly identical shares, on average, over time.

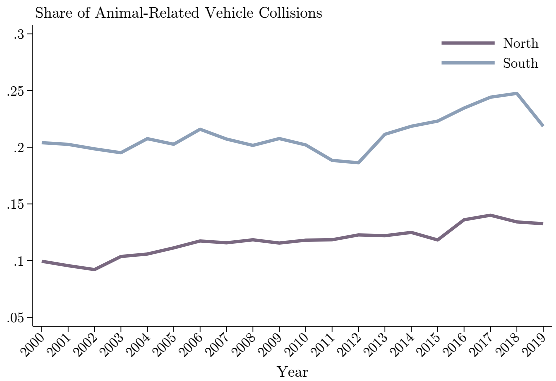
In addition to summarizing the share of collisions, we also describe how the different collision rates, per 1,000 people, change over time, between the municipalities north and south of the river. In Figure A3, we plot (in the first row) the population-weighted all-cause collision rate per 1,000 people. While we see an overall declining trend, especially after 2009, the all-cause collision rate is persistently very similar between the south and the north. When we decompose the all-cause collision rate to animal-related and non-animal-related collision rates (middle and bottom rows, respectively), the key stylized fact that emerges is that within the 50k km estimation bandwidth, there is a striking difference strictly in the animal-related collision rate. In the full sample, there appears to be a reversal between the two rates: animal-related collisions are higher in the south, while non-animal-related collisions are lower in the south. In the restricted sample (within 50 km from the river), we only observe a higher animal-related collision rate in the south relative to the north, while the non-animal-related collision rate essentially overlaps between the south and the north.

[7] Share or animal-related vehicle collisions are the number of animal-related relative to all vehicle collisions; PDO collisions are all PDO collisions, animal-related or not, relative to all collisions; and collisions with at least one injury are also measured, animal-related or not, relative to all collisions.

Figure A2: Comparing Collision Shares Over Time

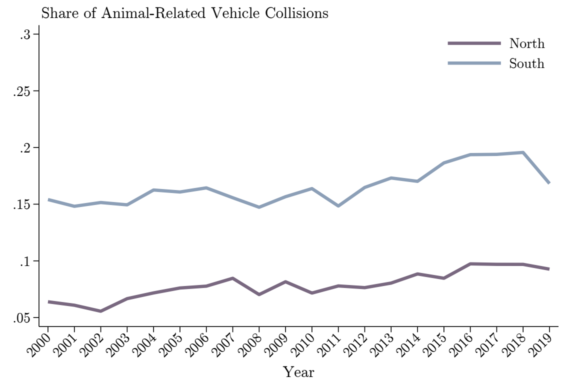
All Municipalities

(a) Animal-Related

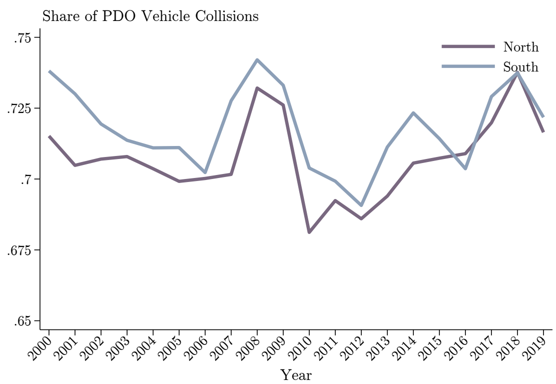


Within 50 km of the River

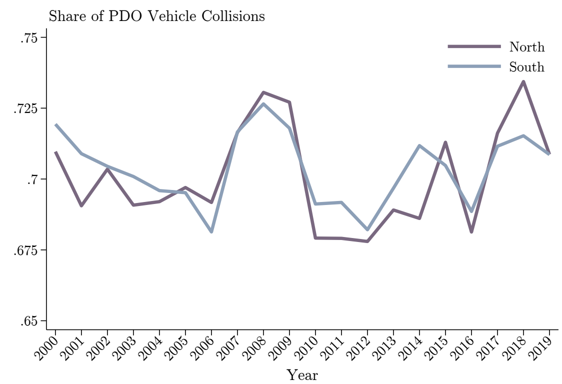
(b) Animal-Related



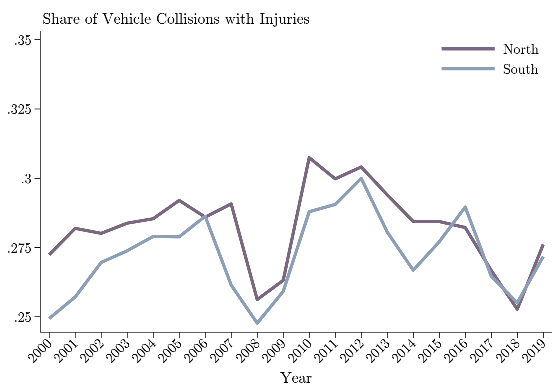
(c) PDO Collisions



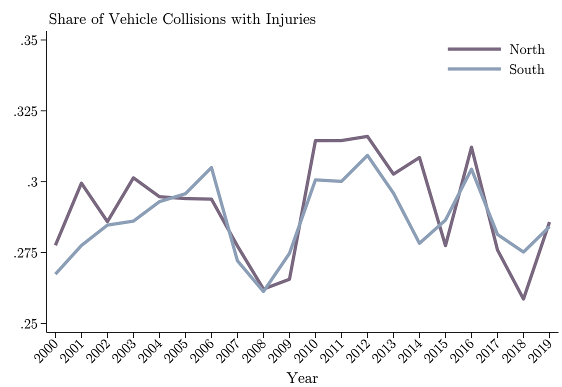
(d) PDO Collisons



(e) Collisions with Injuries



(f) Collisions with Injuries

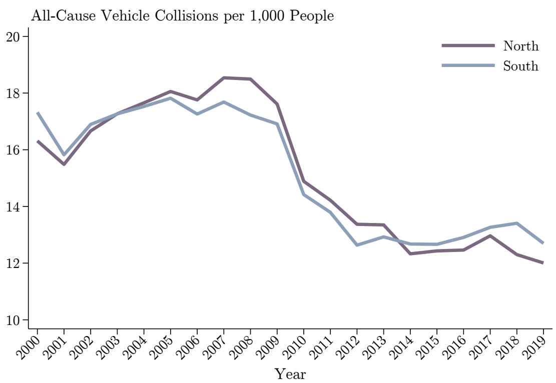


Notes: Mean shares of animal-related, property damages only (PDO), or vehicle collisions that had at least one injured person reported, relative to all-cause collisions, north or south of the Saint Lawrence River. The left column of figures includes all the municipalities in Quebec (n = 1,232), and the right column restricts the municipalities to 50 km from the river (n = 689).

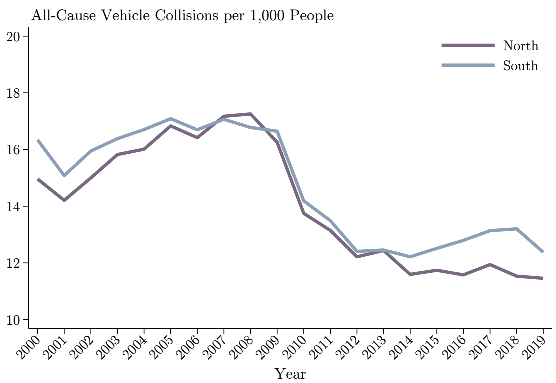
Figure A3: Vehicle Collision Rates Over Time

All Municipalities | *Within 50 km of the River*

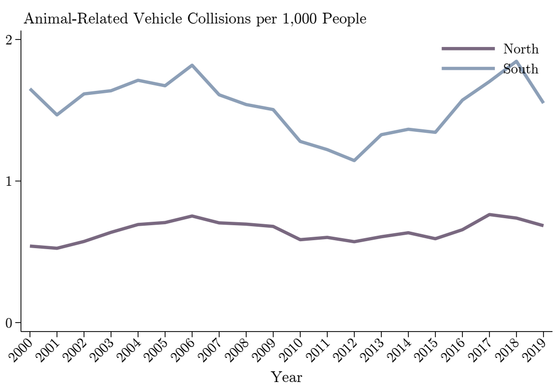
(a) All-Cause



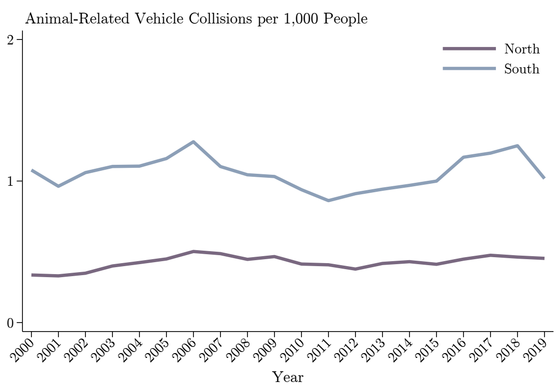
(b) All-Cause



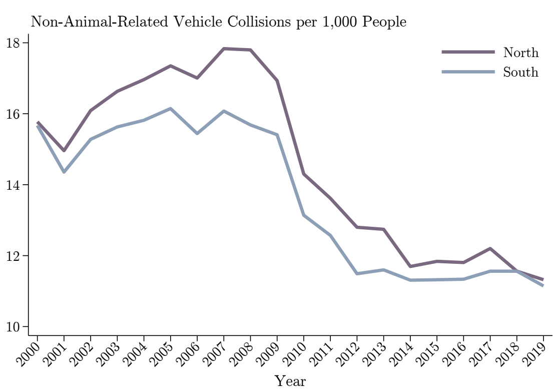
(c) Animal-Related



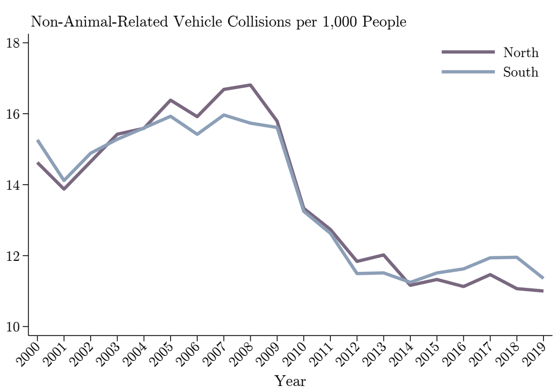
(d) Animal-Related



(e) Non-Animal-Related



(f) Non-Animal-Related



Notes: Population-weighted mean vehicle collision rates, per 1,000 people, north or south of the Saint Lawrence River. The left column of figures includes all the municipalities in Quebec (n = 1,232), and the right column restricts the municipalities to 50 km from the river (n = 689).

A.2 Jackknife Estimation Results

We run the estimation in Equation (1) while leaving one municipality out of the sample each time. In Figure A4, we report the distributions of the coefficients for the cases where we set the bandwidth at 50 km, allow the bandwidth to be chosen optimally, or use the optimal bandwidth when using the donut sample (i.e., that leaves out the municipalities whose centroid is less than 5 km away from the river). Overall, all the coefficients are narrowly distributed, have the same sign, and are of similar qualitative magnitude.

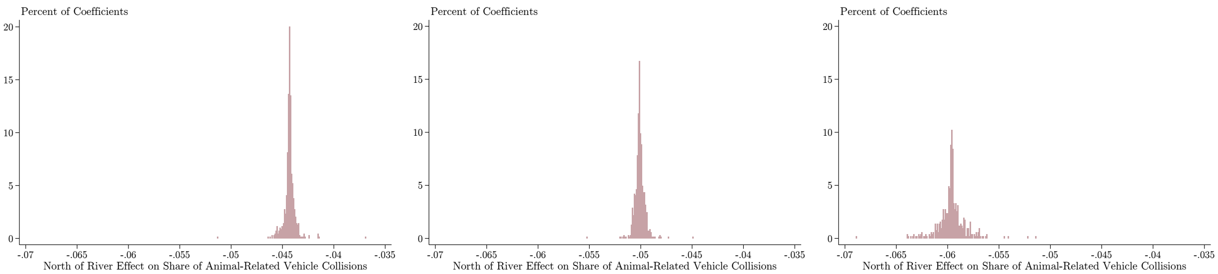
We make two adjustments to the jackknife procedure to avoid artificially inflating the jackknife results. One concern is that because in most cases, the optimally chosen bandwidth is below 50 km, any municipality we exclude that is more than 50 km away from the river would not change the estimation result—as that municipality would not get chosen by either the fixed 50 km bandwidth rule, or the optimal bandwidth procedure. The adjustment we make in this case is to skip the estimation if the chosen leave-one-out municipality is more than 50 km away from the river. We do this instead of restricting the sample to municipalities that are within 50 km as the optimal bandwidth procedure relies on variation from municipalities in the full sample. The other concern is that when excluding any municipalities that are less than 5 km from the river (the donut sample), any chosen leave-one-out municipality within that range will not change the estimation results. Similarly in this case, the adjustment we make is to skip the estimation if the chosen leave-one-out municipality is within 5 km to the river.

A.3 Examining Environmental & Demographic Variables Around the Saint Lawrence River

In the main text, we describe the collection of different observable characteristics (Section 3), how we standardize each of the 15 variables, and include them as controls in the estimation (Table 1), or plot how they change flexibly around the border of the river (Figure 3). Here we report detailed regression results for each of the 15 variables, which estimate whether

Figure A4: Jackknife Estimation Results

(a) BW=50 (b) Op. BW (c) Op. BW & 5 km Donut



Notes: Distribution of the RDD-jackknife estimation. See text for more details.

they change sharply at the river boundary, or whether they change the estimation results when included as a control variable.

In Table A1, we report a different variable in each column. We repeat the analysis in three variations. First, we use the full sample and allow the bandwidths (for estimation and bias correction) to be selected optimally (Panel A). Next, we set a fixed bandwidth of 50 km, for both estimation and bias correction (Panel B). Finally, we set the same fixed 50 km bandwidth, but also impose a Donut-RDD (D-RDD) approach where we exclude the municipalities that have a centroid distance below 5 km to the river (Panel C).

We fail to detect meaningful differences for most of the coefficients with exceptions in the cases of four variables: mean temperature (column 4), mean household size (column 9), median age (column 14), and population density (column 15). In all four cases, the optimally chosen bandwidth is below 10 km. When we set a fixed 50 km bandwidth (Panel B), the magnitude of all four differences becomes smaller. In the case of mean temperature, there is no longer a meaningful difference. However, the remaining three demographic variables still exhibit a potentially concerning magnitude with respect to the mean difference north versus south of the river. Those three differences shrink by about 75% when we exclude the municipalities closest to the river in the D-RDD sample (Panel C). In short, while three out of 15 variables exhibit potential differences once we allow for a sufficiently wide bandwidth, those differences get attenuated if we exclude the locations closest to the river. This analysis motivates why we report the D-RDD results in the main text. In Table 1, the results between the non-donut (columns 1 to 5) and the donut samples (columns 6 and 7) are nearly identical in terms of magnitude and precision.

In the main text, we include all 15 variables as controls (Table 1, columns 7, 9, and 10). Here we include each variable separately as a control to focus on which municipality characteristic has a larger influence on the estimated discontinuity. We repeat the process we detailed above for Table A1, only we set each characteristic as a control variable instead of the outcome variable. In Table A2, we report the results for the RDD estimation for the share of animal-related vehicle collisions. Across all panels and columns, the coefficients are always negative, and often within the range of a four to six percent drop in the share of animal-related vehicle collisions north relative to south of the river.

A.4 Displacing the True Saint Lawrence River Border

We perform a falsification test by displacing the river border south or north by varying distances (Ebenstein et al. 2017). In each iteration, we either move the river border north, or south, by the same distance. When displacing the river to the south, we effectively are switching some of the municipalities that are truly south of the river to be considered as north of the displaced river. In other words, we are moving control units (no wolf presence) into the treatment group (wolf presence). If we displace the river to the north, we are shifting municipalities that were north of the river (treatment) to be south of the displaced river (control). Displacement in either direction makes the mean share of AVCs more similar across the treatment and control units, and as a result, attenuates the results.

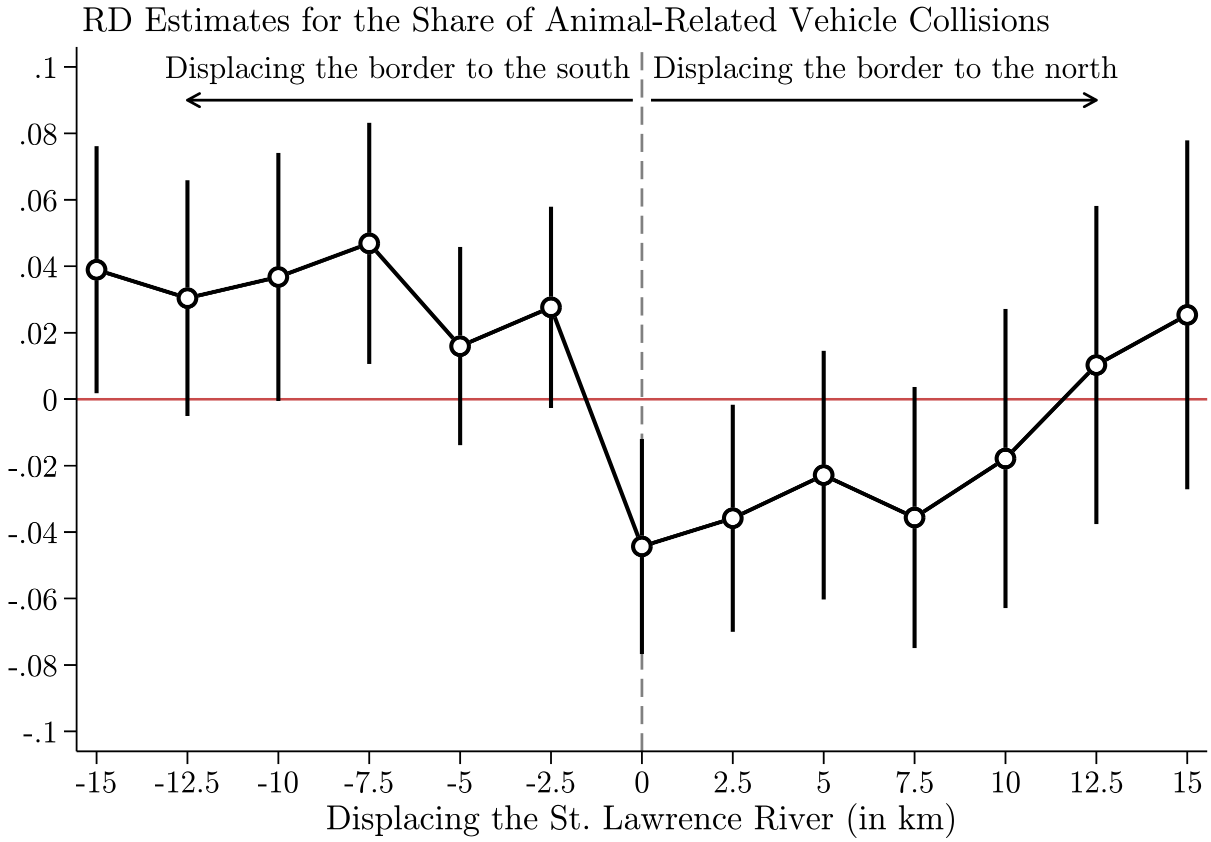
In Figure A5, we report that we only observe the discontinuous difference in the share of AVCs between north and south of the Saint Lawrence River when using the correct border. When we displace the river, the results attenuate, and as we continue to displace the river, the coefficient flips signs. This exercise helps to verify that the main coefficient we report for the discontinuous change in the share of AVCs is not a spurious effect that is estimated at arbitrary divisions of north and south.

The coefficient changes more sharply when we displace the river to the south than to the north (left relative to the right of the dashed line). Displacing the river south means that the right-hand local regression, estimated with a 50 km bandwidth, straddles the *true* river and therefore mixes high- and low-AVC observations. As a result, this contamination biases the fitted intercept downward and can reverse the sign even when the south-side slope is negative. This is because the share of AVCs is higher south of the river, and increases further away from the river, as can be seen in Figure 2, making it such that the difference at the displaced boundary is positive. Changes in the share of AVCs north of the river are more subtle, such that the estimated discontinuity at the displaced river shrinks and gets closer to zero with larger displacements.

A.5 Examining the Precision of the Results Using Alternative Clustering Schemes

In the main text, we cluster the standard errors at the unit of observation—the municipality. Here, we evaluate how the precision of the north dummy coefficient changes when we cluster at two alternative levels. The first change we make is clustering at a higher administrative region that nests the municipality: the regional county municipality. The 688 municipalities that are within 50 km are nested by 79 regional county municipalities. The second clustering alternative we evaluate is to cluster at the admin region by hunting zone level. Hunting zones allow us to capture geographical and environmental differences instead of only relying on administrative boundaries. However, because the number of hunting zones that are within 50 km of the river is low, we split a hunting zone if it extends over more than one administrative region. This provide a more granular level of clustering than using the hunting zones alone, but is still a coarse and very conservative level of clustering. For comparison, the 688 municipalities that are within 50 km of the river are nested by just 37 admin region by hunting zone areas.

Figure A5: Displacing the Saint Lawrence River



Notes: We displace the river in increments of 2.5 km either north or south of its true location. This shift municipalities that were previously treatment to be control units, and vice versa. For each such displacement, we estimate the specification in Equation (1) using a fixed bandwidth of 50 km. At zero displacement, we observe the coefficient we report in Table 1, Panel A, column 1. As we displace the river, the result attenuates, verifying that we only observe it at the true river boundary.

The alternative clustering levels help to assess whether clustering at the municipality level overestimates the precision of the coefficient for the north dummy because of the spatial correlation of the error term. In Table A3, we report the three different levels: the baseline one and the two alternatives. Precision remains largely unaffected by the changes to the level of clustering. This holds whether we set the bandwidth manually at 50 km (columns 1, 2, and 3), truncate the sample (columns 2, 5, and 7), exclude the municipalities that are close to the river (columns 3, 6, and 7), or use the optimally chosen bandwidth (columns 4, 6, and 7). In cases where we meaningfully see a decline in the precision of the coefficient, we can still reject the null hypothesis of no discontinuous change at the river border at the 10 percent significance level (columns 5 and 7), whereas the estimate becomes less precise than that in the case of the donut sample when we do not truncate the sample (columns 3 and 6).

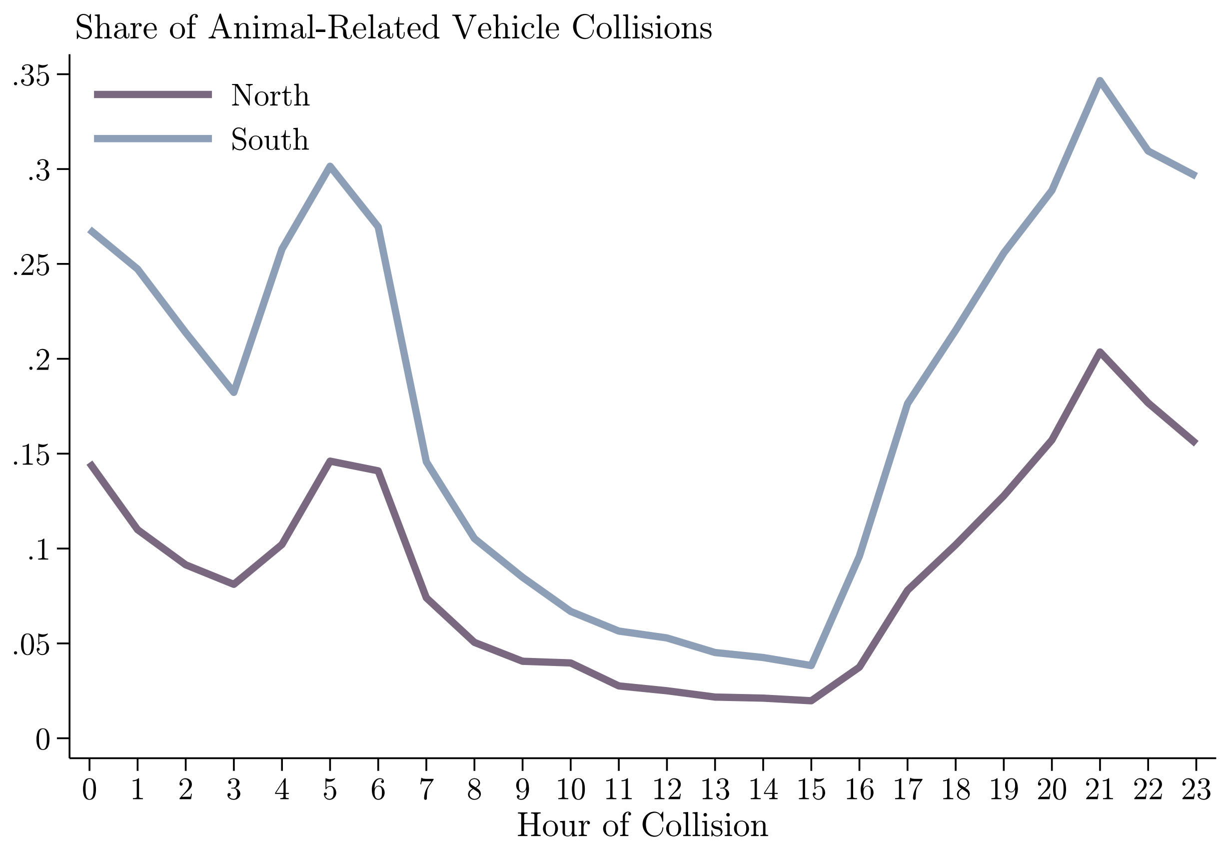
A.6 Examining Heterogeneity With Respect to Time of Day of Collisions

In the main text, we pool all vehicle collisions throughout all years, months, and hours of the day. Here we examine if there is meaningful heterogeneity, north versus south of the river, in when vehicle collisions happen relative to the time in the day. To do so, we re-aggregate our data in four-hour intervals. First, we estimate whether the share of all-cause collisions (collisions in a four-hour interval relative to all collisions) changes at the river border. This allow us to examine if there is suggestive evidence that drivers might be shifting the time they are on the road. For example, if drivers are adapting by driving less when it is dark, we would expect to see a lower share of total vehicle collisions. Second, we re-estimate our main outcome, the share of animal-related collisions (animal-related collisions relative to all-cause collisions in the same four-hour interval). This allows us to examine whether the presence of wolves north of the river lowers AVCs more so during some parts of the day than others. For example, if AVCs are more likely to happen when it is dark, we would expect to see a larger reduction north of the river in AVCs that happen in the evenings, nights, and early mornings.

Our analysis reveals meaningful heterogeneity in the reduction of AVCs, but not in the overall share of all-cause collisions. We summarize the results of these regressions in Table A4. In Panel A, we see small and noisy coefficients. We interpret this as a lack of strong evidence that drivers south of the river have adapted to the absence of wolves by driving at different times of the day. It is very likely that the decisions regarding when to drive are based on other, more pressing, schedule considerations. It is still possible that drivers south of the river are adapting by driving more slowly in certain hours, but we do not observe that in our data.

In Panel B, we find that the share of AVCs is lower north of the river throughout the different hourly bins, however, the effect is suggestively larger from midnight to morning, and from the late afternoon to the evening. While each coefficient is precisely estimated, our coefficients are not sufficiently precise to allow us to reject that they are equal. The findings in Panel B align with the more descriptive summary in Figure A6 of when and where the share of AVCs is higher.

Figure A6: Distribution of AVCs During the Day by Hour of Accident



Notes: We plot the mean share of animal-related vehicle collisions throughout the time of day, by the hour of the accident. We use the sample of municipalities that are within 50 km of the river.

A.7 Examining Differences in Vehicle Type & Weight

In addition to testing whether drivers potentially adapt by driving at different hours, we also test whether drivers choose different vehicle classes, north versus south of the river. We use data on the registered vehicles (Société de l'assurance automobile du Québec 2022), as of 2022, and calculate for each municipality the share of vehicles that are: (i) cars or light trucks, (ii) trucks or tractors, (iii) snowmobiles, (iv) special equipment vehicles, (v) or all terrain vehicles. These five categories account for 98.5 percent of the seven million vehicles in the data.

In Table A5, we report the estimation results for the RDD when using a bandwidth of 50 km around the river. The two categories for which we find a meaningful and precisely estimated difference are cars or light trucks, and special equipment vehicles. The share of cars or light trucks is 5.8 pp higher north of the river, relative to the south. At the same time, special equipment vehicles are 5.6 pp lower north of the river. Cars or light trucks are by far the most common category, accounting for 64 percent of all vehicles in the 50 km around the river, while special equipment vehicles are only 11 percent. We also estimate a negative coefficient for all-terrain vehicles, but it is imprecisely estimated.

Vehicles north of the river are lighter, on average, by 100 kg (column 6, imprecisely estimated), or by 6.1 percent (column 7, precisely estimated). This suggests that drivers north of the river are less concerned about the weight of their vehicle and the potential for collision, as previous research has documented that drivers attribute higher safety to heavier vehicles (Anderson and Auffhammer 2014). We interpret these results on vehicle types and weight as suggestive evidence that drivers have adapted to the absence of wolves south of the river by driving cars in larger categories, as well as driving heavier vehicles.

A.8 Wildlife Hunting Certificates Around the Saint Lawrence River

In the main text, we plot the distribution of the mean number of hunter's certificates per 100,000 people across municipalities north and south of the river (Figure 4a). Here, we report RDD estimation results using that variable as the outcome, as well as using it as a control when the share of AVCs is the outcome. We report the estimation results in Table A6. We do not find precisely estimated differences at the river border in the mean number of hunters' certificates per 100,000 people (columns 1 to 4). More importantly, when we include hunters' certificates as a control in the analysis of the share of animal collisions, we continue to recover meaningful and precisely estimated negative effects for the discontinuity coefficient (columns 5 to 9). To summarize, we fail to find that wildlife management, through the channel of wildlife hunters' certificates, effectively explains the difference in the share of animal collisions between municipalities north and south of the Saint Lawrence River.

A.9 Wildlife Harvest Densities Around the Saint Lawrence River

In the main text, we plot the kernel densities of comparing the hunting harvests between north and south of the river (Figure 4b). Here, we report how including the data on harvests affects the estimation results. To do so, we first match each municipality to a hunting zone based on the location of the municipality centroid. We assign to each municipality the hunting data of its linked hunting zone for the years 2000 to 2019 (so it matches the span of the vehicle collision data). Then, we collapse the data into a cross-sectional of means for the vehicle collision data, harvest densities, hunting certificates, and the 15 environmental, demographic, and infrastructure variables. In Table A7, we report results for the baseline sample (column 1), and how including additional controls affects the magnitude and precision of the estimates. If we include the mean number of all animals hunted per square kilometer or only the ungulate species, we find no difference in the estimated discontinuity in the share of AVCs (columns 2 and 3). Adding more controls in the form of the hunting certificates data, or the additional covariates, results in a precisely estimated drop in the share of AVCs of 0.06 or 0.03 percentage points (columns 4 and 5). Controlling for the harvest densities, the hunting certificates, the additional covariates, and setting the bandwidth to be 25 km instead of 50 km, results in a precisely estimated drop in the share of AVCs of 0.04 percentage points (column 6). If we allow the bandwidth to be chosen optimally, the decline in the share of AVCs north relative to just south of the river is precisely estimated to be 0.05 percentage points (column 7).

A.10 Details on the Monetized Damage Calculation

In the main text, we report that we estimate monetized prevented damages from the presence of wolves north of the river at 41.7 million 2024 CAD. Here we describe this calculation in more detail. First, to arrive at the number of 7.2 averted collision per municipality, we use the following conversion that relies comparing of the share of animal-related collisions without wolves versus with wolves (corresponding to β_1 in Equation 1): $\frac{A+X}{T+X} - \frac{A}{T} = 0.05$. Where we denote the number of animal collisions with wolves present as A, the number of total collisions with wolves present as T, and the additional collisions that *would have happened* if wolves were absent as X. Solving for X results in: $X = \frac{0.05T^2}{(0.95T-A)}$.

The most detailed, complete, and recent account of monetized estimates for vehicle collisions for the setting of Quebec, Canada comes from Transports Canada – Direction générale de l'analyse économique (2007). We use the following central estimates from the report (calculated for the year 2000) of 4,787,000 CAD for a crash with a fatality; 29,000 CAD for a crash with injuries only; and 6,500 CAD for a crash with PDO. We then use the estimates for the averted collisions (1,836 annually), and the share of collisions with injuries only or PDO, for the municipalities that are 50 km north of the river and arrive at the following value:

$$\begin{aligned}&0.903 \times 1,836 \times 6,500\$+\\&0.096 \times 1,836 \times 29,000\$+\\&(1-0.903-0.096) \times 1,836 \times 4,787,000\$\\&=24,676,758\$\end{aligned}$$

We then convert the values from 2000 CAD to 41,720,997 2024 CAD.[8] We use the exchange rate of December 2024 to convert those into 29,033,641 2024 USD.[9] Similarly, if we focus on the averted damages that exclude the small fraction of crashes with fatalities, we obtain values of 15,887,826 2000 CAD, 26,861,549.08 2024 CAD, and 18,692,952 2024 USD.

To put this magnitude in context, we also show how it compares to expenditures on road infrastructure. While municipality level data on road budgets in Quebec are not available, we do know that, in the budget period of 2005 to 2006, Quebec spent 1.94 billion 2024 CAD on road infrastructure for the entire province.[10] If we take into account that, on average, Quebec's population north of the river within 50 km reflects 39.6 percent of the total population in the province, and public expenditure is proportional to the population share, then our full account of annual averted damages amounts to 5.4 percent of annual realized road infrastructure expenditures.

We also compare averted damages to planned expenditures. This is important because the provincial government of Quebec is planning an ambitious public infrastructure program, of which 31.3 billion 2024 CAD are allocated to road improvements over the 2022 to 2032 period.[11] Making the same population share adjustment as above, our estimated averted

[8] We use the Bank of Canada inflation calculator: https://www.bankofcanada.ca/rates/related/inflation-calculator/. Accessed: September 25, 2025.

[9] Specifically, we use the exchange rate of December 23, 2024: 1 CAD = 0.6959 USD. Obtained from https://www.exchange-rates.org/exchange-rate-history/cad-usd-2024-12-23. Accessed September 25, 2025.

[10] See page 25 of: www.budget.finances.gouv.qc.ca. Accessed September 25, 2025.

[11] For more details, see https://www.caaquebec.com/en/news/news/article/a-look-at-the-2022-2023-provincial-budget-a-half-baked-budget-for-motorists. Accessed September 25, 2025.

damages reflect 3.7 percent of the annual projected road infrastructure expenditures.

To place this number in a broader context for North America, we extrapolate the back-of-the-envelope calculation to all of Canada and all of the United States. To do so, we use the total number of vehicle collisions, obtained from Pitel and Solomon (2013), and the total number of AVCs by severity in Canada in 2003, obtained from Canada Transport (2020). We apply the same approach to recover the increase in AVCs, assuming that the same effect persists throughout the country. For the United States, we use the estimated number of all vehicle collisions, obtained from Weiss et al. (2011), and the number of estimated AVCs for 2008, obtained from Huijser et al. (2008). To monetize the costs in a comparable manner in both settings, we use the severity-weighted value for the monetized cost of a vehicle collision in the United States of $9,078 (2024 USD), using the damage estimates in Huijser et al. (2008). For Canada, we calculate a similar severity-weighted value of $9,634 (2024 USD) using the monetized costs per severity category, and the proportion of accidents in each category.[12] We convert the number of averted AVCs in the United States and Canada, 564,274 and 128,682, to $5.12 and $1.24 billion in total or $15.1 and $30 in per capita terms, respectively. In total, our extended back-of-the-envelope calculation suggests that the presence of wolves in North America has the potential to reduce damages from AVC by $6.36 billion per year or a population-weighted $16.7 per person per year. This assumes that the effect of wolf presence is homogeneous regardless of wolf density, prey composition and density, road density, and other management and defensive expenditure actions.

[12] This calculation implies two important and non-trivial assumptions: (i) that Canada and the United States have the same distribution of deer, elk, and moose crashes as a percent of AVCs; and (ii) that they also have the same distribution of injury types. In other words, the difference in values arises only from the differences in the estimates of the monetized costs.

Table A1.
Estimation Results for Standardized Covariates

Panel A. Results Using Optimally Chosen Bandwidths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
N. D.	-0.12	-0.10	0.01	-0.68	0.08	0.03	-0.19	-0.09	1.77	0.21	-0.03	-0.36	0.08	-1.10	1.02
	(0.09)	(0.17)	(0.23)	(0.36)	(0.21)	(0.25)	(0.37)	(0.22)	(0.50)	(0.30)	(0.35)	(0.32)	(0.28)	(0.36)	(0.42)
$\overline{Y}$	-0.44	-0.20	-0.23	-0.01	-0.22	0.15	0.05	-0.03	0.04	0.13	-0.09	0.17	-0.35	0.09	0.16
BW	47.4	32.2	9.3	8.5	11.4	41.1	42.6	51.3	9.3	17.3	17.0	12.7	12.4	11.1	16.0

Panel B. Results Using a Fixed Bandwidth of 50 km

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
N. D.	0.00	-0.11	-0.03	-0.16	-0.01	0.01	-0.34	-0.12	1.09	0.39	-0.08	-0.09	0.11	-0.84	0.95
	(0.09)	(0.17)	(0.15)	(0.20)	(0.15)	(0.28)	(0.48)	(0.31)	(0.25)	(0.22)	(0.25)	(0.21)	(0.18)	(0.22)	(0.30)
$\overline{Y}$	-0.41	-0.11	0.00	-0.00	0.00	0.11	0.04	-0.03	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00

Panel C. Results Using a Fixed Bandwidth of 50 km & 5 km Donut

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
N. D.	0.00	-0.17	0.36	-0.46	0.15	-0.07	0.39	0.04	-0.04	0.62	-0.32	-0.09	0.33	-0.21	0.21
	(0.32)	(0.50)	(0.35)	(0.38)	(0.46)	(0.32)	(0.24)	(0.17)	(0.43)	(0.42)	(0.46)	(0.40)	(0.36)	(0.40)	(0.19)
$\overline{Y}$	-0.41	-0.11	0.00	-0.00	0.00	0.11	0.04	-0.03	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00

Notes: Estimation results using the specification in Equation (1). We report the robust coefficient following Calonico et al. (2014). Each outcome is a z-score of a different observable characteristic, or the mean of all the z-scores. We calculate the z-scores using the full sample, and report the mean of each outcome to help convey how different, if at all, the sample contained in the chosen bandwidth is from the full sample (the closer the mean is to zero, the smaller the difference is). In each column, we report the following: mean elevation (1); mean slope (2); share of forest land cover (3); mean temperature (4); mean precipitation (5); road density, length over area (6); mean traffic per road density (7); fiscal revenue per capita (8); mean household size (9); natural log of median income (10); share married (11); share with any university degree (12); sex-ratio (13); median age (14); and population density (15).

Table A2.
Estimation Results for Share of Animal-Related Collisions With Standardized Covariates

Panel A. Results Using Optimally Chosen Bandwidths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
N. D.	-0.04	-0.04	-0.05	-0.07	-0.07	-0.04	-0.04	-0.04	-0.05	-0.06	-0.07	-0.07	-0.07	-0.05	-0.03
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
BW	39.8	40.5	13.4	11.1	11.5	35.9	37.5	40.7	12.2	12.0	10.8	11.3	10.5	12.8	14.1

Panel B. Results Using a Fixed Bandwidth of 50 km

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
N. D.	-0.04	-0.04	-0.05	-0.06	-0.06	-0.04	-0.05	-0.04	-0.04	-0.05	-0.05	-0.05	-0.06	-0.04	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)

Panel C. Results Using a Fixed Bandwidth of 50 km & 5 km Donut

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
N. D.	-0.04	-0.04	-0.07	-0.06	-0.06	-0.04	-0.03	-0.04	-0.05	-0.04	-0.05	-0.05	-0.06	-0.04	-0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)

Notes: Estimation results using the specification in Equation (1). We report the robust coefficient following Calonico et al. (2014). Each column is a regression of the same outcome, the share of animal-related collisions, while controlling for a different a z-score of a different observable characteristic. We calculate the z-scores using the full sample, In each column, we control for the following: mean elevation (1); mean slope (2); share of forest land cover (3); mean temperature (4); mean precipitation (5); road density, length over area (6); mean traffic per road density (7); fiscal revenue per capita (8); mean household size (9); natural log of median income (10); share married (11); share with any university degree (12); sex-ratio (13); median age (14); and population density (15).

Table A3.
Clustering Standard Errors at Different Administrative Levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N. Dummy	-0.04	-0.04	-0.06	-0.05	-0.04	-0.06	-0.05
Clustering Level:							
Municipality	(0.02)	(0.01)	(0.03)	(0.01)	(0.01)	(0.03)	(0.02)
Regional County Municipality	(0.02)	(0.02)	(0.05)	(0.02)	(0.02)	(0.04)	(0.03)
Admin Region-Hunting Zone	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.04)	(0.03)
Truncated		X			X		X
Donut			X			X	X
Op. BW				X	X	X	X
$\overline{Y}$	0.13	0.13	0.13	0.12	0.11	0.11	0.11
BW	50.0	50.0	50.0	37.4	29.4	26.4	31.2
$\text{Clusters}_{\text{M}}$ South	433	400	339	364	296	187	213
$\text{Clusters}_{\text{M}}$ North	255	253	170	228	208	119	126
$\text{Clusters}_{\text{RCM}}$ South	46	46	40	47	41	41	46
$\text{Clusters}_{\text{RCM}}$ North	33	33	30	33	30	30	32
$\text{Clusters}_{\text{ARHZ}}$ South	17	17	13	15	14	10	10
$\text{Clusters}_{\text{ARHZ}}$ North	20	20	17	18	18	15	15

Notes: Same as in Table 1, but we report how alternative clustering, at higher administrative levels, affects the precision of the coefficient. For comparison, we report the standard errors when clustering at the municipality (M) level, as we do in the main text. In addition, we cluster at a higher level of administrative boundary, the regional county municipality (RCM), or we cluster at the admin region by hunting zone (ARHZ) level.

Table A4.
Estimation Results for Hourly-Binned Collisions

	00:00-03:59	04:00-07:59	08:00-11:59	12:00-15:59	16:00-19:59	20:00-23:59
Panel A. Share of All-Cause Collisions in Hourly Bin						
	(1)	(2)	(3)	(4)	(5)	(6)
N. Dummy	0.002	0.000	-0.009	-0.009	0.012	0.004
	(0.007)	(0.011)	(0.012)	(0.012)	(0.010)	(0.009)
$\overline{Y}$						
N South	433	433	433	433	433	433
N North	255	255	255	255	255	255
Panel B. Share of Animal-Related Collisions in Hourly Bin						
	(1)	(2)	(3)	(4)	(5)	(6)
N. Dummy	-0.056	-0.086	-0.035	-0.019	-0.051	-0.081
	(0.024)	(0.026)	(0.009)	(0.007)	(0.018)	(0.027)
$\overline{Y}$						
N South	422	423	424	426	427	423
N North	251	252	253	252	254	253

Notes: Estimation results using the specification in Equation (1). We report the robust coefficient following Calonico et al. (2014). We use a 50 km bandwidth for all regressions. In Panel A, we report results for the outcome of the share of the mean all-cause collisions in the four-hour interval bin, relative to the mean total number of collisions in the municipality. In other words, the numerator is the mean number of all-cause collisions in the four-hour interval, and the denominator is the mean of the total number of all-cause collisions in the municipality. In Panel B, we report the results for the outcome of the mean number of animal-related collisions in the four-hour interval bin, relative to the mean number of all collisions in the municipality. In other words, the numerator is the mean number of animal-related collisions in the four-hour interval, and the denominator is the mean number of all-cause collisions in the same four-hour interval bin. Standard errors are clustered at the municipality level.

Table A5.
Estimation Results for Vehicle Types & Weight

	Share of Vehicle Type					Vehicle Weight	
	Car or Light Truck	Truck or Tractor	Snowmobile	Special Equipment	All Terrain	Levels (kg)	Logged
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N. Dummy	0.058	0.003	0.012	-0.056	-0.015	-99.049	-0.061
	(0.022)	(0.005)	(0.009)	(0.009)	(0.010)	(69.164)	(0.030)
$\overline{Y}$	.64	.026	.066	.11	.13	1,932	7.5
N South	395	395	395	395	395	395	395
N North	231	231	231	231	231	231	231

Notes: Estimation results using the specification in Equation (1). We report the robust coefficient following Calonico et al. (2014). We use a 50 km bandwidth for all regressions. We report results for the outcome of the share of vehicle types, columns 1-5, and mean vehicle weight, in levels or in log points, columns 6 and 7. Standard errors are clustered at the municipality level.

Table A6.
Estimation Results for Hunting Certificates as the Outcome and as a Control Variable

	Hunting Certificates				Share of Animal Collisions				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
N. Dummy	66.44	11.85	42.44	14.91	-0.06	-0.07	-0.03	-0.08	-0.05
	(71.25)	(39.07)	(48.18)	(17.65)	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)
Covs.		X		X			X		X
Pop. W.			X	X					
Hunting Certificates					X	X	X	X	X
Op. BW								X	X
$\overline{Y}$	474.62	474.62	474.62	474.62	0.13	0.11	0.13	0.09	0.10
BW	50.0	50.0	50.0	50.0	50.0	25.0	50.0	11.6	13.2
N South	390	368	390	368	390	253	368	154	152
N North	231	218	231	218	231	176	218	121	116

Notes: Estimation results using the specification in Equation (1). We report the robust coefficient following Calonico et al. (2014). Optimal bandwidths use the MSERD procedure with trinangular kernel. In columns 1 to 4, we report results when the outcome is the mean number of hunting certificates per 100,000 people. In columns 5 to 9, we report results for the share of animal collisions when controlling for the mean number of hunting certificates per 100,000 people. When including covariates, we include all 15 environmental, demographic, and municipality infrastructure variables. Population weights use the 2011 census data. Standard errors are clustered at the municipality level.

Table A7.
Estimation Results for Share of AVCs When Controlloing for
Hunting Certificates & Densities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
N. Dummy	-0.04	-0.04	-0.04	-0.06	-0.03	-0.04	-0.05
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Harvest Densities (All Species)		X		X	X	X	X
Hunting Densities (Ungulate Species)			X				
Hunting Certificates				X	X	X	X
Covariates					X	X	X
Op. BW							X
BW	50.00	50.00	50.00	50.00	50.00	25.00	13.56
N South	433	433	433	391	369	238	158
N North	255	255	255	234	221	168	119

Notes: Estimation results using the specification in Equation (1). We report the robust coefficient following Calonico et al. (2014). Optimal bandwidths use the MSERD procedure with trinangular kernel. When including covariates, we include all 15 environmental, demographic, and municipality infrastructure variables. Standard errors are clustered at the municipality level.

B Data Sources

B.1 Collisions Data

Collisions data are gathered by the Société de l'Assurance Automobile du Québec (SAAQ). We use the universe of vehicle collisions at the crash record level, 2000-19. It comprises all crashes *involving at least one authorized vehicle* that led to either physical injury or at least CAD 2,000 in property damage.[13] We classify accident codes 15, 35, 36, or 37 as animal-related vehicle collisions.

B.2 Data Sources for Observables

Population at the municipalité level in Québec are obtained from the Government of Québec's Ministère des Affaires municipales et de l'Habitation.[14] Census data is also obtained from the government of Canada, via R package 'cancensus' (von Bergmann et al. 2021); it provides further detail on gender, age, household makeup (size, share married), income, education.

Administrative boundaries at a 1/1,000,000 scale are obtained from the Base de données géographiques et administratives (spatial and administrative database), from the Ministère de l'Énergie et des Ressources naturelles of Québec.[15]

Elevation and slope are obtained and processed through the Google Earth Engine, from a digital elevation model (DEM) produced by NASA / USGS / JPL-Caltech (USGS/SRTMGL1_003, a global DEM at a ground resolution of resolution of 1 arc-second, i.e., about 30 m at the Equator, 20 m at 50° latitude (Farr et al. 2007; NASA 2015)).

Temperature and precipitation are obtained and processed through the Google Earth

[13] This threshold has been stable since March 18, 2010, see donneesquebec.ca/recherche/dataset/rapports-d-accident. Accessed: May 30, 2025.

[14] https://donneesouvertes.affmunqc.net/, see https://www.donneesquebec.ca/recherche/dataset/repertoire-des-municipalites-du-quebec/ for more information.

[15] https://www.donneesquebec.ca/recherche/dataset/base-de-donnees-geographiques-et-administratives/

Engine from the ERA5 reanalysis data (Muñoz Sabater 2019).[16] Specifically total precipitation [m] and mean temperatures [K|°C] at the monthly level 2000-2019 are aggregated in space (ERA5 pixel size: 11132 m) and over time (averaged).

Forest cover is calculated by summing the forest pixels in each municipality (then converted into square kilometers) in the NALCMS Land Cover layer (Commission for Environmental Cooperation 2024) via Google Earth Engine,[17] and then dividing by municipality area.

Road and traffic densities ("débit de circulation") is taken from Quebec's Ministère des Transports et de la Mobilité Durable (2017).[18]

Fiscal revenue base ("richesse foncière uniformisée," RFU) by sector for the year 2021 is obtained from the Ministère des Affaires municipales et de l'Habitation of Québec (Ministère des Affaires Municipales et de l'Habitation 2017). It enables us to measure and compare the ability of municipalities to generate tax revenue (or assimilated); we focus on the total RFU, and RFU disaggregated at the sectoral level for agriculture, industry, and housing.[19]

B.3 Data Sources for Prey Density and Hunter's Certificates

Hunting and trapping statistics 1971-2024 are obtained from Ministère de l'Environnement (2025a) at the hunting zone and year level for big game (deer, elk, moose), wild turkey and black bear.

Game management zones (as defined by the *Règlement sur les zones de pêche et de chasse* (C-61.1, r. 34) and in the *Règlement sur la chasse* (C-61.1, r. 12)) are used to spatialize the statistics, and, importantly, assign them to one side of the river or the other, and determine whether they lie within 50 km of the river. The shapefiles were

[16] ERA5-Land Monthly Aggregated - ECMWF Climate Reanalysis, https://developers.google.com/earth-engine/datasets/catalog/ECMWF_ERA5_LAND_MONTHLY_AGGR.

[17] Land Cover of North America at 30 meters, 2020, https://developers.google.com/earth-engine/datasets/catalog/USGS_NLCD_RELEASES_2020_REL_NALCMS.

[18] https://www.donneesquebec.ca/recherche/dataset/debit-de-circulation.

[19] Data set: https://donneesouvertes.affmunqc.net/rf/rfu-2021.csv, and metadata: https://www.donneesquebec.ca/recherche/dataset/richesse-fonciere-uniformisee/resource/81028389-ce08-47ed-907e-a95c81dae23f.

obtained by direct request to the Ministry of the Environment of Québec. The zones can be visualized at quebec.ca/tourisme-et-loisirs/activites-sportives-et-de-plein-air/chasse-sportive/cartes-zones.

Valid hunter's certificates (details at quebec.ca/tourisme-et-loisirs/activites-sportives-et-de-plein-air/chasse-sportive/permis-certificat/certificat-chasseur) 2000-2019 from Ministère de l'Environnement (2025b) at the municipality of residence and year level are obtained through Quebec's "Act respecting Access to documents held by public bodies and the Protection of personal information" (*Demande d'accès n° 2025-06-050*). We take the average over the period at the municipality level.

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