NEW GOLD RAINY RIVER MINE
APPENDIX B
WHITE-TAILED DEER TISSUE MONITORING REVIEW

Ecometrix | Environmental INTELLIGENCE

2021 DEER TISSUE REVIEW

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2021 DEER TISSUE REVIEW

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EXECUTIVE SUMMARY

The Rainy River Mine (RRM) is a gold-silver mine located in northwestern Ontario in the District of Rainy River, approximately 65 km northwest of Fort Frances and 420 km west of Thunder Bay. Operations at RRM presently include an open pit and underground mining with ore processed at the Rainy River Mill, located on site. The mine has an anticipated mine life of around 16 years. The RRM began processing ore in September 2017, fifty years after it was first explored in 1967. Provincial and Federal EA approvals were granted in 2015 leading to the RRM site construction.

As part of commitments made during the EA approvals process, New Gold conducted an opportunistic citizen-science based White-tailed deer tissue and organ sampling program from 2016–2021. Briefly, New Gold distributed sampling kits to collect deer tissue and liver samples from hunters on a voluntary basis. Deer tissue and organ samples were sent to accredited laboratories and analyzed for major ions (e.g., calcium), trace metals, and cyanide.

Conclusions

Multiple lines of evidence suggest that, in general, tissue concentrations collected from deer near RRM (median 16 km) are currently low and that 2016–2018 baseline data are similar to the first year of impact data collected in 2021. This is supported by the following key results:

- Deer tissue concentrations did not correlate with distance from mine in 2016–2018 baseline or 2021 impact time periods for any constituent based on Spearman rank correlations, similar to findings in Wood (2018).
- Deer tissue concentrations in the 2016–2018 baseline and 2021 impact time periods (50th and 95th percentiles) were generally below constituent-specific screening values calculated for the highest consumption rate of 30 meals/month.
- Multivariate analysis including an analysis of similarity (ANOSIM) suggested that deer tissue concentrations are generally similar between 2016–2018 baseline and 2021 impact time periods.
- Some individual constituents significantly increased with effect sizes greater than 25% relative to baseline medians (5/31 = 16% of constituents). These were boron, cesium, cyanide, selenium, and tin and ranged from 27–380% increases. Nevertheless, all these constituents were below the conservative screening values for consuming 30 meals/month.

Recommendations

The below are suggestions to modify or improve the program:

- Meet holding time requirements for deer tissue analysis to ensure robust results.

- Consider collecting ageing structures (e.g., jaw) to determine whether there are positive relationships between deer tissue concentration and age.

- As more data become available, continue analyses undertaken in the current report but consider building more sophisticated models that explicitly address year-to-year variation and spatial variation (e.g., generalized linear mixed effects models that incorporate spatial autocorrelation) including the local conditions near where deer were sampled. This will allow for a better understanding of how variation is partitioned at different scales (e.g., nearby deer are more similar, large differences year-to-year).

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1.0 Introduction

1.1 Background Information

The Rainy River Mine (RRM) is a gold-silver mine located in northwestern Ontario in the District of Rainy River, approximately 65 km northwest of Fort Frances and 420 km west of Thunder Bay (**Figure 1-1**). Operations at RRM presently include an open pit and underground mining with ore processed at the Rainy River Mill, located on site. The mine has an anticipated mine life of around 16 years (AMEC, 2014). The RRM began processing ore in September 2017, fifty years after it was first explored in 1967. In 2005, the project was acquired by Rainy River Resources Ltd. with initial baseline studies conducted in 2008. In 2013, the RRM was acquired by New Gold. An Environmental Assessment (EA) report, which included baseline conditions, was submitted in 2014 (AMEC, 2014). Provincial and Federal EA approvals were granted in 2015 leading to the RRM site construction.

As part of commitments made during the EA approvals process, New Gold conducted an opportunistic citizen-science based White-tailed deer tissue and organ sampling program from 2016–2021. Briefly, New Gold distributed sampling kits to collect deer tissue and liver samples from hunters on a voluntary basis. Deer tissue and organ samples were sent to accredited laboratories; liver samples were analyzed for major ions (e.g., Ca) and trace metals whereas muscle tissue was analyzed for cyanide.

A report completed by Wood using 2016 and 2017 data found no correlations of deer tissue concentrations with proximity to RRM (Wood, 2018). They found their 2017 impact concentrations of arsenic, bismuth, cesium, copper, lithium, mercury, nickel, rubidium, selenium, strontium, and cyanide were significantly lower compared with their 2016 baseline concentrations. Only sodium 2017 impact concentrations were significantly higher than the 2016 baseline concentrations. More sampling years with more deer tissue samples were expected to reveal any patterns in deer tissue concentrations related to mining operations exist.

Since the previous report, more data were collected in 2018 and 2021. In the current report, baseline years were 2016, 2017, and 2018 whereas the impact year was 2021. The 2016–2018 baseline period was established following consultations with New Gold and Ontario Ministry of Natural Resources and Forestry staff (per New Gold communication to Ecometrix).

1.2 Objectives of the Current Report

The objectives of this report were the following:

- Review previous deer tissue monitoring reports to possibly identify a subset of parameters for further analysis, including mercury and cyanide.
- Compile and confirm the 2016, 2017, 2018, and 2021 field sheet and deer tissue concentration data.

- Re-examine the relationship of deer tissue constituent concentrations with proximity to RRM in both 2016–2018 baseline and 2021 impact periods.
- Generate univariate summary statistics for deer tissue constituents (e.g., median and 95th percentile) to compare against available consumption guidelines in both 2016–2018 baseline and 2021 impact periods.
- Use multivariate techniques to investigate relationships between constituents and determine whether the clustering of deer tissue concentrations differed between 2016–2018 baseline and 2021 impact periods.
- Use pairwise comparisons to examine constituent differences between 2016–2018 and 2021 impact periods.

Through completion of this assessment, recommendation for further study or monitoring was possible and provided herein.

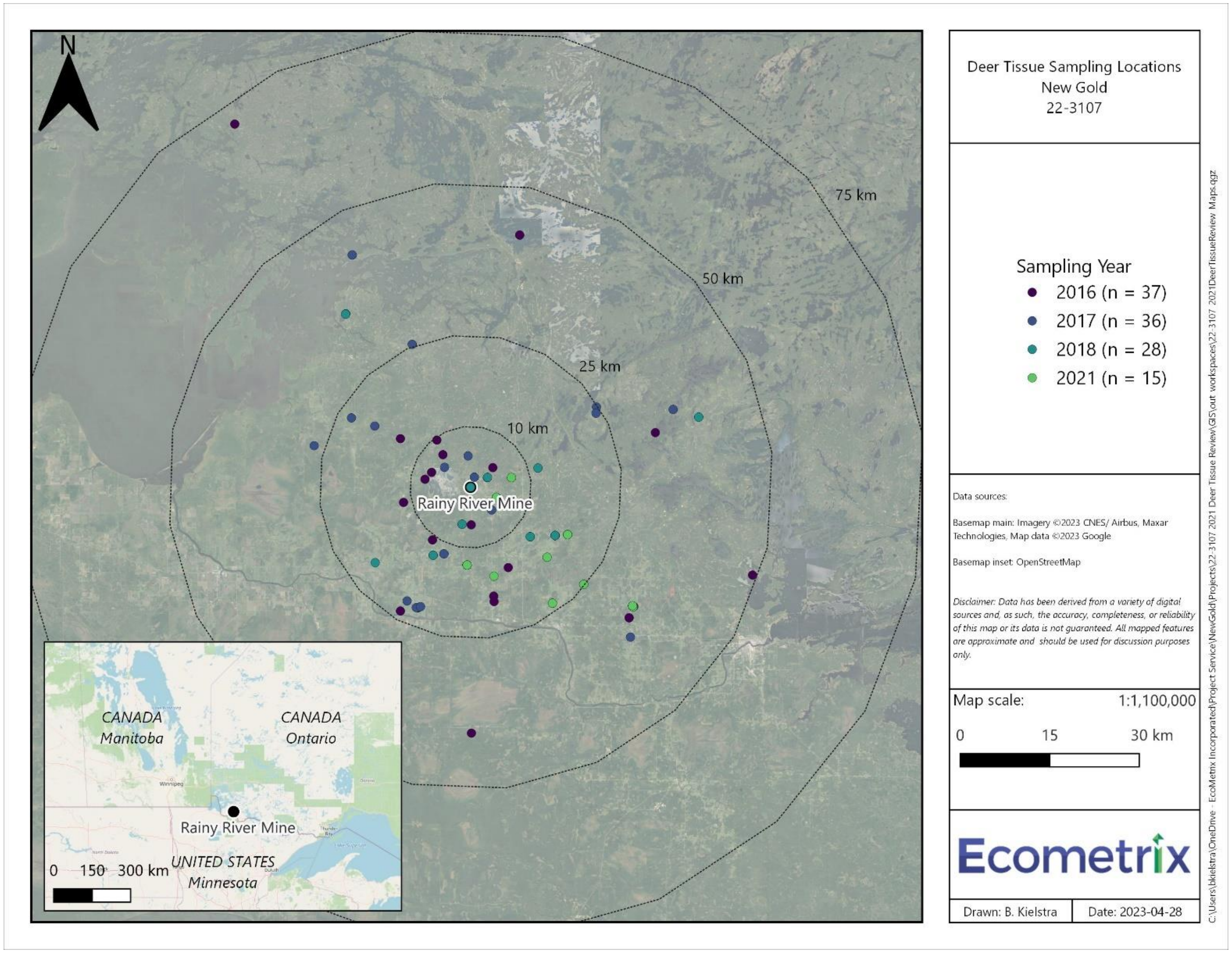

Figure 1-1 Deer tissue sampling locations for years 2016–2021. One sample taken in Thunder Bay (>300 km) was excluded from the figure.

2.0 Data Analysis and Results

2.1 Data compilation and sampling characteristics

New Gold provided data in various forms including laboratory spreadsheets, laboratory reports, a digitized field sheet database, and scanned field sheets. Information was gathered into a single spreadsheet. The combined dataset consisted of 117 deer tissue analyses representing deer sampled in years 2016, 2017, 2018, and 2021. Data columns were scrutinized and corrected for consistency (e.g., conversion of Latitude and Longitude to UTM coordinates).

All deer tissue was submitted to ALS Global laboratories for homogenization and chemical analysis. In one case, deer 2016_D006 had duplicate tissue samples sent to the University of Guelph Agriculture and Food Laboratory and ALS Global laboratory. In this case, concentrations were averaged.

In 2021, 10 of 15 samples were received by ALS past the recommended holding time of 365 days. The minimum and maximum holding times for those samples were 368 and 387, respectively.

Most deer were sampled during November, were male, were adult, and were killed by firearm mostly coincident with the deer hunting season and regulations (**Table 2-1**; OMNRF, 2023). However, deer tissue sampling timing and conditions could vary considerably based on comments in field sheets. Nevertheless, this variability is likely representative of the conditions deer tissue would be under when harvesting for consumption. The general deer sampling locations by year are in **Figure 1-1**.

Table 2-1 Deer sampling characteristics for years 2016–2021

Grouping	Parameter	2016	2017	2018	2021
Sampling Month	Minimum	Oct	Jun	Oct	Nov
	Median	Nov	Nov	Nov	Nov
	Maximum	Dec	Dec	Dec	Dec
Sex	Female	13	8	8	4
	Male	24	27	18	11
	Unknown	0	1	2	0
Age	Adult	28	25	22	8
	Fawn	2	3	1	1
	Yearling	6	5	3	5
	Unknown	1	3	2	1
Type of Harvest	Crossbow	2	0	0	0
	Firearm	34	24	20	11
	Vehicle	2	3	1	2
	Bow	0	4	2	2
	Unknown	0	5	5	0

2.2 Deer tissue concentration data handling

Deer tissue concentrations <DL (less than the detection limit) values were conservatively substituted for with the DL (detection limit) (e.g., DL = 0.002 mg/kg therefore <DL = 0.002 mg/kg). This approach is a generally accepted and conservative practice in risk assessment. By design this approach also results in summary statistics (e.g., mean, median, percentiles) and therefore data trends that are likely overestimates of their respective values when <DL data are present. As a result, it is more appropriate herein to evaluate medians, percentiles, and their differences using censored/substituted data (Helsel, 2012).

Deer tissue concentrations were evaluated for outliers across the entire substituted dataset. A datapoint was considered an outlier if its z-score (*(value – mean) / standard deviation*) was >3 and/or its value exceeded 1.5 times the interquartile range (*IQR; IQR = 75th percentile value – 25th percentile value*). Despite outliers being identified in the dataset, univariate summary statistics were conducted on the entire dataset.

Constituents with a substantial proportion of <DL (90%) were excluded from further statistical analysis; these were beryllium (100% <DL), bismuth (91% <DL), tellurium (100% <DL), and zirconium (98% <DL). Thirty-one constituents remained as a mixture of major ions (e.g., calcium), trace metals, and cyanide. Summary statistics were calculated using *dplyr* 2.3.2 and base functions in *R* 4.2.3 (R Core Team, 2023; Wickham et al., 2023).

Univariate summary statistics were completed, and boxplots were generated aggregated by year and by 2016–2018 baseline and 2021 impact periods (**Section A.1**). Comparisons of these summary statistics to constituent-specific consumption screening values are undertaken in **Section 2.3.2**.

Conclusions regarding comparisons of 2016–2018 baseline and 2021 impact periods should consider the relatively small impact sample size and that 10 of 15 samples exceeded laboratory holding times of 365 days.

2.3 Deer tissue concentrations in 2016–2018 baseline and 2021 impact

The following section outlines work completed and results of the investigation of deer tissue concentrations in the 2016–2018 baseline and 2021 impact periods. The key results are as follows:

- Deer tissue concentrations did not correlate with distance from mine in 2016–2018 baseline or 2021 impact periods for any constituent based on Spearman rank correlations, similar to findings in Wood (2018).
- Deer tissue concentrations in the 2016–2018 baseline and 2021 impact periods (50^{th} and 95^{th} percentiles) were generally below constituent-specific screening values calculated for the highest consumption rate of 30 meals/month.
- Multivariate analysis suggested that deer tissue concentrations are generally similar between 2016–2018 baseline and 2021 impact periods.
- Some constituents significantly increased with effect sizes greater than 25% relative to baseline medians (5/31 = 16% of constituents). These were boron, cesium, cyanide, selenium, and tin and ranged from 27–380% increases. Nevertheless, all these constituents were below the conservative screening values for consuming 30 meals/month.

Further details are outlined in **Sections 2.3.1–2.3.4** below.

2.3.1 Deer tissue concentrations and proximity to RRM

Deer were sampled at a median distance of 16 km from RRM; the 25^{th} percentile was 13 km, the 75^{th} percentile was 22 km, and the maximum was 346 km in Thunder Bay. Deer sampling locations are approximate.

Relationships of deer tissue concentrations with proximity to RRM were examined using Spearman rank correlations for 2016–2018 baseline and 2021 impact periods. This nonparametric correlation test does not assume an explicit linear relationship (i.e., the relationship may be exponential) or that the data come from a normal distribution. Spearman's rho (ρ) values range between -1 and 1 where values closer to -1 or 1 indicate strong negative or positive correlations, respectively. Generally, absolute values of ρ <0.20 indicate very weak correlations whereas successively>0.20 indicate stronger relationships.

Results indicated no significant correlations of deer tissue concentrations with distance from mine in the 2016–2018 baseline or 2021 impact periods (all $p > 0.05$; **Table A-3**). This was similar to the Wood (2018) finding.

2.3.2 Deer tissue concentrations against consumption-specific screening values

Deer tissue concentrations were compared against screening values that consider consumption (i.e., meals/month) in the 2016–2018 baseline and 2021 impact periods. The 50th and 95th percentile were used as they represent median and high concentrations and that the maximum value could have been an outlier.

The screening values were developed by Ecometrix based on constituent-specific toxicity reference values at various ingestion rates. The toxicity reference values were from, in order of preference, Health Canada (Health Canada, 2021), Ontario Ministry of Conservation and Parks (MECP, 2022), the United States Environmental Protection Agency Integrated Risk Information System (US EPA 2023), and the United States Agency for Toxic Substances and Disease Registry (US ATSDR, 2023).

Screening values for constituents were derived using a conservative (95th percentile) ingestion rate of 61.55 grams per day (Chan et al., 2014 Table 9a) and a standard body weight of 70 kg (154 lb). Screening values were calculated for consumption rates of 30, 4, 2, and 1 meals per month. A review of ingestion rates per unit body weight suggested a relatively constant ratio between ingestion rates for wild game and body weight for toddlers (7 months to 4 years old), children (5–11 years old), teens (12–19 years old) and adults (>20 years old) for Canadian Indigenous populations (Richardson, 1997 as found in Health Canada, 2012). Because of this relatively constant proportional relationship, it is reasonable to assume that the screening values can be applied to individuals with different body weights. The following equation was used:

$$Screening\ value_{ij}(mg/kg_{fw}) = \frac{TDI_i\left(\frac{mg}{kg_{fw}}/day\right)\times 70\ (kg)}{I_j(\frac{kg_{fw}}{day})}, \qquad \textbf{Equation 1}$$

where TDI is the Tolerable Daily Intake (or, Risk Specific Dose) for constituent i at ingestion rate j and *fw* indicates fresh weight or wet weight.

Comparing Q50 and Q95 (the 50th and 95th percentile, respectively) deer tissue concentrations in both 2016–2018 baseline and 2021 impact periods against screening values indicated that all constituents except arsenic and cadmium were below the 30 meals/month screening criteria across both periods.

For arsenic, the 2021 impact period Q95 (0.1193 mg/kg) was greater than the 30 meals/month screening criterion of 0.06 mg/kg. The 2016–2018 baseline concentrations were below this screening value. The Q50 for the 2021 impact period was 0.0048 mg/kg and nearly two orders of magnitude smaller than the Q95. Two of 15 deer (13%) were greater than this criterion that were sampled approximately 17 km from RRM (2021_D008 and 2021_D010). These two samples were among those 10 of 15 samples that exceeded holding time of 365 days. These two samples were flagged as outliers for arsenic based on z-scores > 3 and >1.5 x IQR. They were also flagged as outliers for boron, selenium, calcium (2021_D010 only), and strontium (2021_D010 only) but did not exceed their respective screening values for those four constituents. If the two were removed, the Q95 in the 2021 impact period would be 0.01 mg/kg and below the screening value of 0.06 mg/kg.

For cadmium, the 2016–2018 baseline Q95 (1.52 mg/kg) and 2021 impact Q95 (1.43 mg/kg) were greater than the 30 meals/month screening value of 0.91 mg/kg. The 2016–2018 baseline Q50 (0.297 mg/kg) and 2021 impact period Q50 (0.426 mg/kg) were below this screening value. For the 2016–2018 baseline period, 12 of 101 (12%) samples were greater than this screening value. The 12 deer were a median 16 km (4–195 km; minimum and 95th percentile) from RRM. One of the 12 deer was sampled in Thunder Bay at nearly 350 km away. Six of these 12 samples, including the deer sampled in Thunder Bay, were flagged as outliers. If removed, the Q95 for the 2016–2018 baseline period would be 0.92 mg/kg and just above the screening value of 0.91 mg/kg for 30 meals/month. For the 2021 impact period, 2 of 15 (13%) samples were greater than this screening value (2021_D006 and 2021_D015) and were sampled at 18 km and 24 km from RRM, respectively. The two samples were among those 10 of 15 samples exceeding holding times of 365 days. One sample was flagged as an outlier (2021_D015). If removed, the Q95 for the 2021 impact period would be 0.87 mg/kg and below the screening value of 0.91 mg/kg.

In summary, the deer tissue concentrations are generally below screening values at the 30 meals/month level. For those samples greater than the 30 meals/month screening values, they were below the next ingestion rate concentrations at the 4 meals/month level. For arsenic, some samples were considered outliers in the dataset and not representative of arsenic concentrations in deer tissue in the dataset as a whole. If removed from analysis, the Q95 would be below the 30 meal/month screening value. For cadmium, the baseline and impact concentrations were similar at Q95 and greater than the screening value when outliers were included. With outliers excluded, the baseline and impact concentrations were similar at Q95 and near the screening value.

Table 2-2 Deer tissue constituent screening values for different ingestion rates and associated Q50 and Q95 summary statistics for 2016–2018 baseline and 2021 impact periods. Bold numbers indicate concentrations greater than screening values. The indicator "--" indicates no applicable value or no reference toxicity value found.

Constituent	Screening values for different meals/month (mg/kg)				Q50 and Q95 for impact and baseline (mg/kg)				>Screening level
	30 meals	4 meals	2 meals	1 meal	Baseline Q50	Impact Q50	Baseline Q95	Impact Q95	
Aluminum (Al)	1137.29	8529.65	17059.30	34118.60	0.4	0.4	3.28	0.415	--
Antimony (Sb)	0.45	3.41	6.82	13.65	0.002	0.002	0.0054	0.00379	--
Arsenic (As)	0.06	0.47	0.95	1.90	0.0063	0.0048	0.0197	**0.1193**	30 meals
Barium (Ba)	227.46	1705.93	3411.86	6823.72	0.036	0.035	0.089	0.0711	--
Beryllium (Be)	2.27	17.06	34.12	68.24	0.002	0.002	0.002	0.002	--
Bismuth (Bi)	--	--	--	--	0.002	0.002	0.0028	0.002	--
Boron (B)	363.93	2729.49	5458.98	10917.95	0.22	0.28	0.38	0.463	--
Cadmium (Cd)	0.91	6.82	13.65	27.29	0.297	0.426	**1.52**	**1.4299**	30 meals
Calcium (Ca)	--	--	--	--	48.1	51.4	70.4	98.63	--
Cesium (Cs)	--	--	--	--	0.0212	0.0312	0.0993	0.07057	--
Chromium (Cr)	2.50	18.77	37.53	75.06	0.019	0.01	0.27	0.027	--
Cobalt (Co)	1.14	8.53	17.06	34.12	0.0515	0.0477	0.0878	0.06615	--
Copper (Cu)	484.48	3633.63	7267.26	14534.52	62.9	107	143	134.4	--
Cyanide	2.27	17.06	34.12	68.24	0.1	0.48	0.314	0.708	--
Iron (Fe)	3411.86	25588.95	51177.90	102355.81	140	161	753	635.6	--
Lead (Pb)	0.57	4.26	8.53	17.06	0.0069	0.006	0.113	0.03111	--
Lithium (Li)	--	--	--	--	0.17	0.23	0.59	0.506	--
Magnesium (Mg)	5686.43	42648.25	85296.51	170593.01	167	176	200	196.6	--
Manganese (Mn)	28.43	213.24	426.48	852.97	2.61	2.84	4.14	4.18	--
Mercury (Hg) - G	0.23	1.71	3.41	6.82	0.0041	0.0083	0.0151	0.0131	--
Mercury (Hg) - S	0.53	4.01	8.02	16.04	0.0041	0.0083	0.0151	0.0131	--
Molybdenum (Mo)	34.12	255.89	511.78	1023.56	0.357	0.334	0.824	0.8379	--
Nickel (Ni)	13.65	102.36	204.71	409.42	0.04	0.04	0.088	0.04	--

Constituent	Screening values for different meals/month (mg/kg)				Q50 and Q95 for impact and baseline (mg/kg)				>Screening level
	30 meals	4 meals	2 meals	1 meal	Baseline Q50	Impact Q50	Baseline Q95	Impact Q95	
Phosphorus (P)	262450.79	1968380.93	3936761.86	7873523.71	3590	3730	4150	4182	--
Potassium (K)	--	--	--	--	2900	3040	3600	4044	--
Rubidium (Rb)	--	--	--	--	15.8	18.5	33.2	29.5	--
Selenium (Se)	6.26	46.91	93.83	187.65	0.609	1.4	1.63	2.707	--
Sodium (Na)	--	--	--	--	807	748	1220	1033.2	--
Strontium (Sr)	682.37	5117.79	10235.58	20471.16	0.033	0.028	0.089	0.2076	--
Tellurium (Te)	--	--	--	--	0.004	0.004	0.004	0.004	--
Thallium (Tl)	0.02	0.12	0.23	0.46	0.00042	0.00061	0.00174	0.001035	--
Tin (Sn)	341.19	2558.90	5117.79	10235.58	0.02	0.046	0.071	0.0999	--
Uranium (U)	0.68	5.12	10.24	20.47	0.0004	0.0004	0.00058	0.002071	--
Vanadium (V)	29.57	221.77	443.54	887.08	0.02	0.02	0.095	0.02	--
Zinc (Zn)	545.90	4094.23	8188.46	16376.93	32.6	35.9	49.7	52.46	--
Zirconium (Zr)	--	--	--	--	0.04	0.04	0.04	0.04	--

2.3.3 Deer tissue concentration constituent relationships and sample clustering using multivariate techniques

Deer tissue constituents were plotted in multivariate space as a generalized representation of constituent relationships and how samples clustered together with these constituents. Principal components analysis (PCA) allows for investigation of patterns that might not be found by analyzing each variable separately (Quinn & Keough, 2002). PCA requires a complete *sample* x *variable* matrix; this was achieved by excluding eight datapoints (one in 2016, seven in 2017, and one in 2018) based on missing cyanide data. Because of the many <DL datapoints, the matrix used in the PCA was one of ranked u-scores as suggested by Helsel (2012). For each constituent, the ranked u-score was calculated by comparing each observation, *i*, to each other observation, *k*, for a given variable (**Equation 2**) where 'sign' indicates a positive difference is given a value of +1, a negative difference is assigned a value of -1, and no difference is assigned a value of 0. The values are summed to give the u-score,

$$u_i = \sum_{i \neq k} sign(x_i - x_k), \quad \textbf{Equation 2}$$

Ranked u-scores were generated using *NADA*2 1.1.3 and the PCA was conducted using *vegan* 2.6–4 in *R* (Helsel, 2012; B. Kielstra, 2014; B. W. Kielstra et al., 2017; Oksanen et al., 2022).

To examine whether deer tissue sample clustering varied in multivariate space between 2016–2018 baseline and 2021 impact periods (similar to PCA), Analysis of Similarity (ANOSIM) was used. ANOSIM uses a matrix of ranked data to determine if the similarities *between* groups is greater than the similarity *within* groups. Here, the purpose of an ANOSIM is to examine if the difference *between* the periods (baseline vs. impact) are greater than differences *within* a period. The ANOSIM provides an R statistic for interpretation along with a p-value. If R = 1, then all replicates within a period are more like each other than they are to any replicates from different periods (i.e., no overlap in multivariate space). If the R value approaches 0, the similarities between and within periods are the same (i.e., complete overlap in multivariate space). The ANOSIM was run on the scaled rank u-score data using the Euclidean dissimilarity (analogous to the PCA above) using 999 random permutations in *vegan* in *R*.

Results of examining the PCA and the correlations (i.e., loadings) of the original constituents on principal components (PCs) suggest there are no strong underlying chemical gradients in the dataset and that there are no strong sets of constituents driving variation in the PCs (**Figure 2-1**). In sequential order, PCs explain successively less variation in the original data – PC1 and PC2 explained a small proportion of the total variation at 18% and 10%, respectively. Examining the loadings of the top ten constituents per axis reveals similar-strength correlation values and therefore no strong set of constituents driving variation in these PC axes (**Table 2-3**).

Results of the ANOSIM indicate high overlap in multivariate space between periods. The p-value was 0.07 (i.e., not significantly different at $p = 0.05$) and the R-value was 0.10.

In summary, the PCA and ANOSIM suggest that deer tissue concentrations are generally similar between 2016–2018 baseline and 2021 impact periods.

Table 2-3 Loadings (i.e., correlations) of ranked u-score chemical constituents with derived principal components (PCs).

PC1 (18% of overall variation)		PC2 (10% of overall variation)	
Constituent	**Loading**	**Constituent**	**Loading**
Mercury (Hg)	0.33	Rubidium (Rb)	0.34
Cobalt (Co)	0.28	Sodium (Na)	-0.34
Phosphorus (P)	0.27	Chromium (Cr)	-0.29
Cadmium (Cd)	0.25	Vanadium (V)	-0.29
Manganese (Mn)	0.25	Potassium (K)	0.28
Molybdenum (Mo)	0.24	Selenium (Se)	0.27
Zinc (Zn)	0.23	Cesium (Cs)	0.24
Calcium (Ca)	0.22	Thallium (Tl)	0.21
Arsenic (As)	0.22	Aluminum (Al)	-0.20
Copper (Cu)	0.22	Strontium (Sr)	-0.20

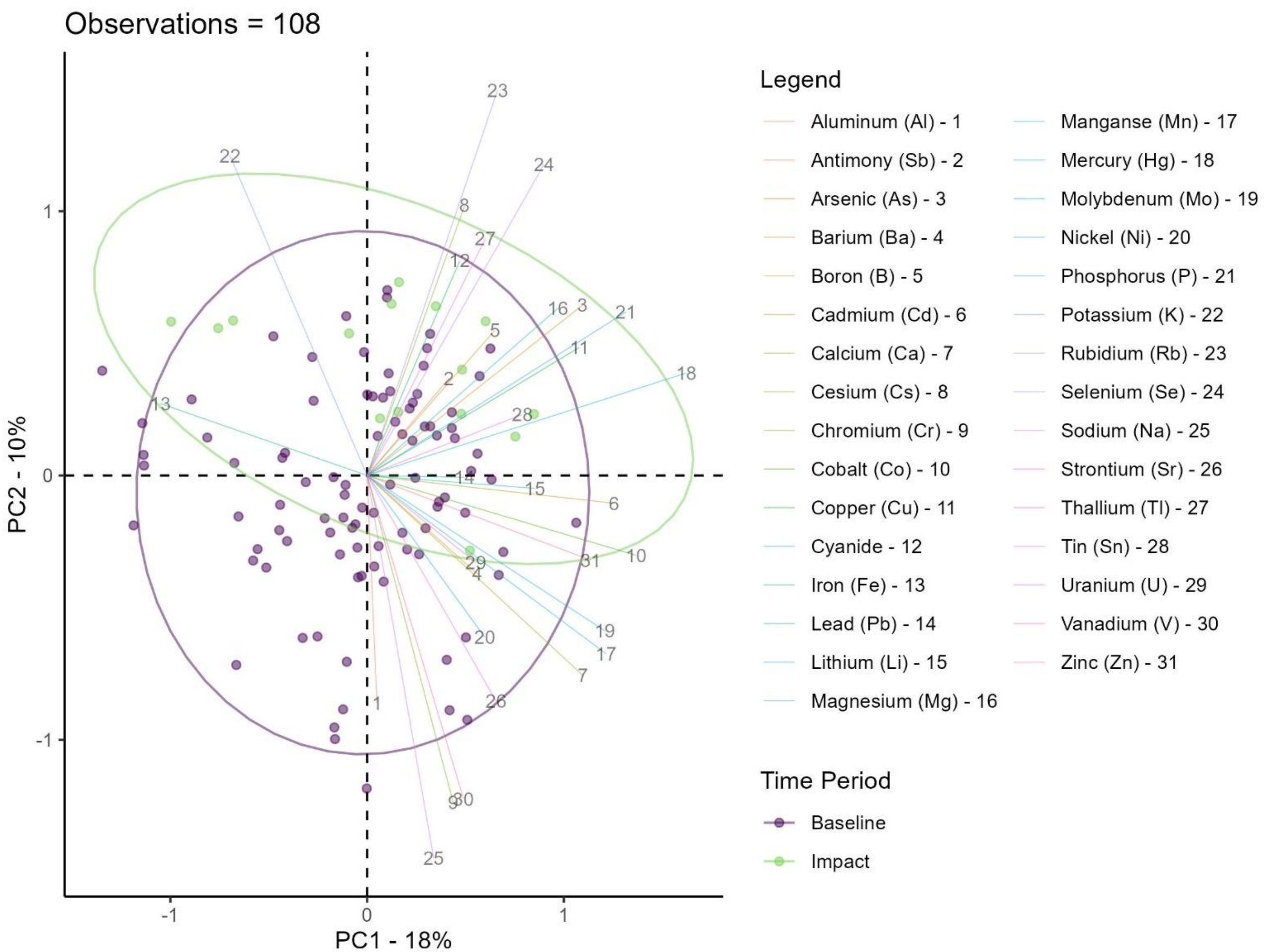

Figure 2-1 Results of principal components analysis (PCA) for deer tissue constituents. Scores for constituents (lines with numbers at endpoint) and individual deer (points) are plotted using scaling = 3 which compromises plotting both independently; the result is that generally points and lines closer to one another are more similar/correlated. Confidence ellipse added from *ggplot2* stat_ellipse() as the 95% confidence ellipse assuming a multivariate normal distribution.

2.3.4 Deer tissue concentration differences between 2016–2018 baseline and 2021 impact periods for individual constituents

Comparisons of constituent concentrations in 2016–2018 baseline and 2021 impact periods were also made irrespective of screening values. Recognizing imbalance and relatively small sample size in some cases, a conservative permutation nonparametric Kruskal-Wallis analogue was used for the comparisons (Approximate Kruskal-Wallis Test, *kruskal_test* function from *coin* 1.4-2 in *R*; Hothorn et al., 2006). The Kruskal-Wallis test compares distribution differences in ranked values between groups; a $p<0.1$ indicates at least one group, a period in this case, is different. Along with the results of the Kruskal-Wallis test, the magnitude of difference between 2016–2018 baseline and 2021 impact periods were calculated as:

$$\textit{Magnitude of Difference}_i\ (\%) = (\textit{Impact} - \textit{Baseline})/(\textit{Baseline}) \times 100, \qquad \textbf{Equation 3}$$

where *Impact* is the Q50 for the 2021 impact period and *Baseline* is the Q50 for the 2016–2018 period for constituent *i*.

Results suggested several constituents (11/31 = 35%) significantly increased from baseline (**Table 2-4** and **Figures 2-2 to 2-5**). Those impact Q50 values greater than a common effect size of 25% relative to baseline medians are highlighted here (5/31 = 16%; ECCC, 2014). Those >25% of baseline medians were boron (27%), cesium (47%), cyanide (380%), selenium (129%), and tin (130%). Nevertheless, all these constituents were still below the screening values for 30 meals/month. Chromium significantly decreased from baseline (47%). As stated earlier, these increases should be interpreted with caution because of relatively small sample sizes compared to baseline and that 10 of 15 2021 impact period samples exceeded hold time requirements. More data collected in subsequent years may confirm or refute these trends.

In summary, some constituents significantly increased with an effect size greater than 25% relative to baseline medians (5/31 parameters). These were boron, cesium, cyanide, selenium, and tin and ranged from 27–380% increases. Nevertheless, all these constituents were below the conservative screening values for consuming 30 meals/month.

Table 2-4 Results of comparing deer tissue constituent concentrations in 2016–2018 baseline and 2021 impact time periods. The Kruskal-Wallis p-value is presented along with baseline and impact Q50 values for calculating magnitude of difference. Magnitude of difference only calculated for significant differences at 0.10 level (bolded constituents). Note that although significant differences may have been detected, magnitude of difference calculations use medians that may still be identical between time periods resulting in 0.00% (e.g., aluminum and vanadium). Screening values at 30 meals/month level provided as reference.

Constituent	K-W p-value	Baseline vs. impact difference?	Baseline Q50	Impact Q50	Magnitude of difference (%)	Screening value (30 meals/month)
Aluminum (Al)	**0.003**	**Yes**	**0.4**	**0.4**	**0.00**	1137.29
Antimony (Sb)	0.851	No	0.002	0.002	--	0.45
Arsenic (As)	0.787	No	0.0063	0.0048	--	0.06
Barium (Ba)	0.994	No	0.036	0.035	--	227.46
Boron (B)	**0.006**	**Yes**	**0.22**	**0.28**	**27.27**	363.93
Cadmium (Cd)	0.452	No	0.297	0.426	--	0.91
Calcium (Ca)	0.263	No	48.1	51.4	--	--
Cesium (Cs)	**0.081**	**Yes**	**0.0212**	**0.0312**	**47.17**	--
Chromium (Cr)	**<0.001**	**Yes**	**0.019**	**0.01**	**-47.37**	2.50
Cobalt (Co)	0.226	No	0.0515	0.0477	--	1.14
Copper (Cu)	0.149	No	62.9	107	--	484.48
Cyanide	**<0.001**	**Yes**	**0.1**	**0.48**	**380.00**	2.27
Iron (Fe)	0.245	No	140	161	--	3411.86
Lead (Pb)	0.333	No	0.0069	0.006	--	0.57
Lithium (Li)	0.669	No	0.17	0.23	--	--
Magnesium (Mg)	**0.096**	**Yes**	**167**	**176**	**5.39**	5686.43
Manganese (Mn)	0.733	No	2.61	2.84	--	28.43
Mercury (Hg)	0.210	No	0.0041	0.0083	--	0.53
Molybdenum (Mo)	0.844	No	0.357	0.334	--	34.12
Nickel (Ni)	**0.122**	**No**	**0.04**	**0.04**	**--**	13.65
Phosphorus (P)	0.401	No	3590	3730	--	262450.79
Potassium (K)	**0.046**	**Yes**	**2900**	**3040**	**4.83**	--

Constituent	K-W p-value	Baseline vs. impact difference?	Baseline Q50	Impact Q50	Magnitude of difference (%)	Screening value (30 meals/month)
Rubidium (Rb)	0.401	No	15.8	18.5	--	--
Selenium (Se)	**0.001**	**Yes**	**0.609**	**1.4**	**129.89**	6.26
Sodium (Na)	0.348	No	807	748	--	--
Strontium (Sr)	0.914	No	0.033	0.028	--	682.37
Thallium (Tl)	0.267	No	0.00042	0.00061	--	0.02
Tin (Sn)	**0.001**	**Yes**	**0.02**	**0.046**	**130.00**	341.19
Uranium (U)	0.070	No	0.0004	0.0004	--	0.68
Vanadium (V)	**0.007**	**Yes**	**0.02**	**0.02**	**0.00**	29.57
Zinc (Zn)	0.282	No	32.6	35.9	--	545.90

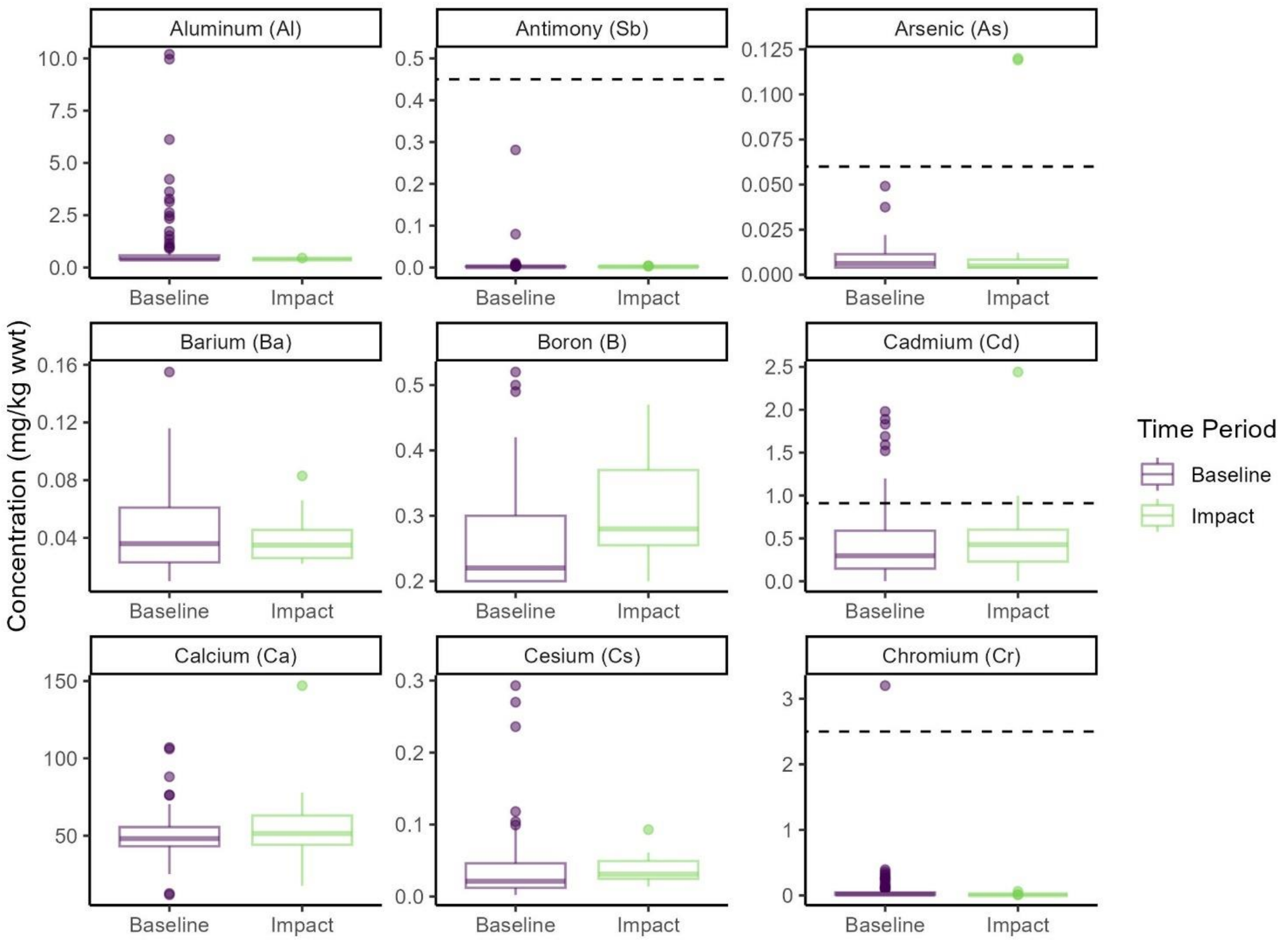

Figure 2-2 Boxplots separated by 2016–2018 baseline and 2021 impact periods for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR. Dotted lines show select 30 meal/month screening values when that value was within the data or +50% of the maximum value for the constituent.

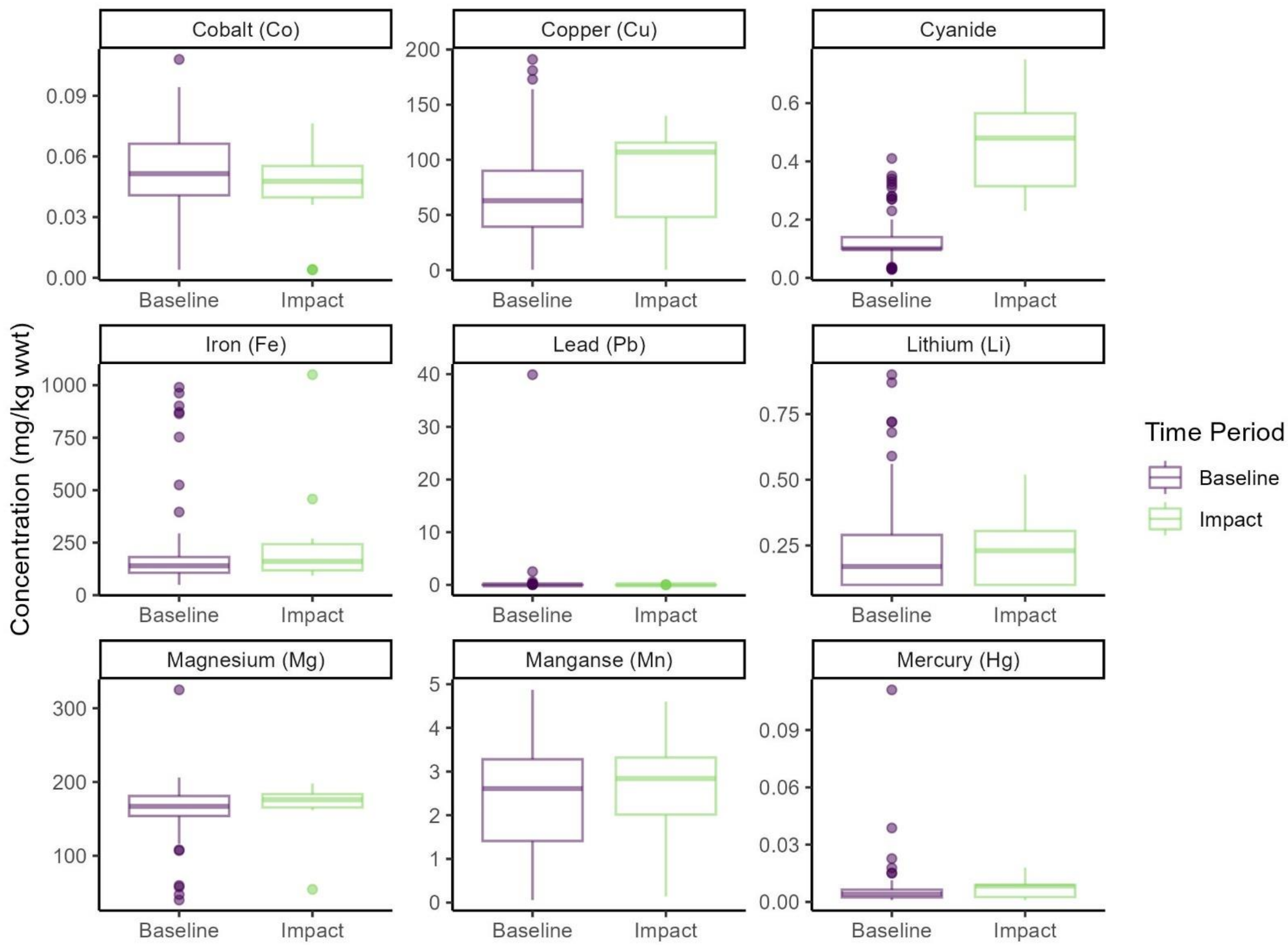

Figure 2-3 Boxplots separated by 2016–2018 baseline and 2021 impact periods for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

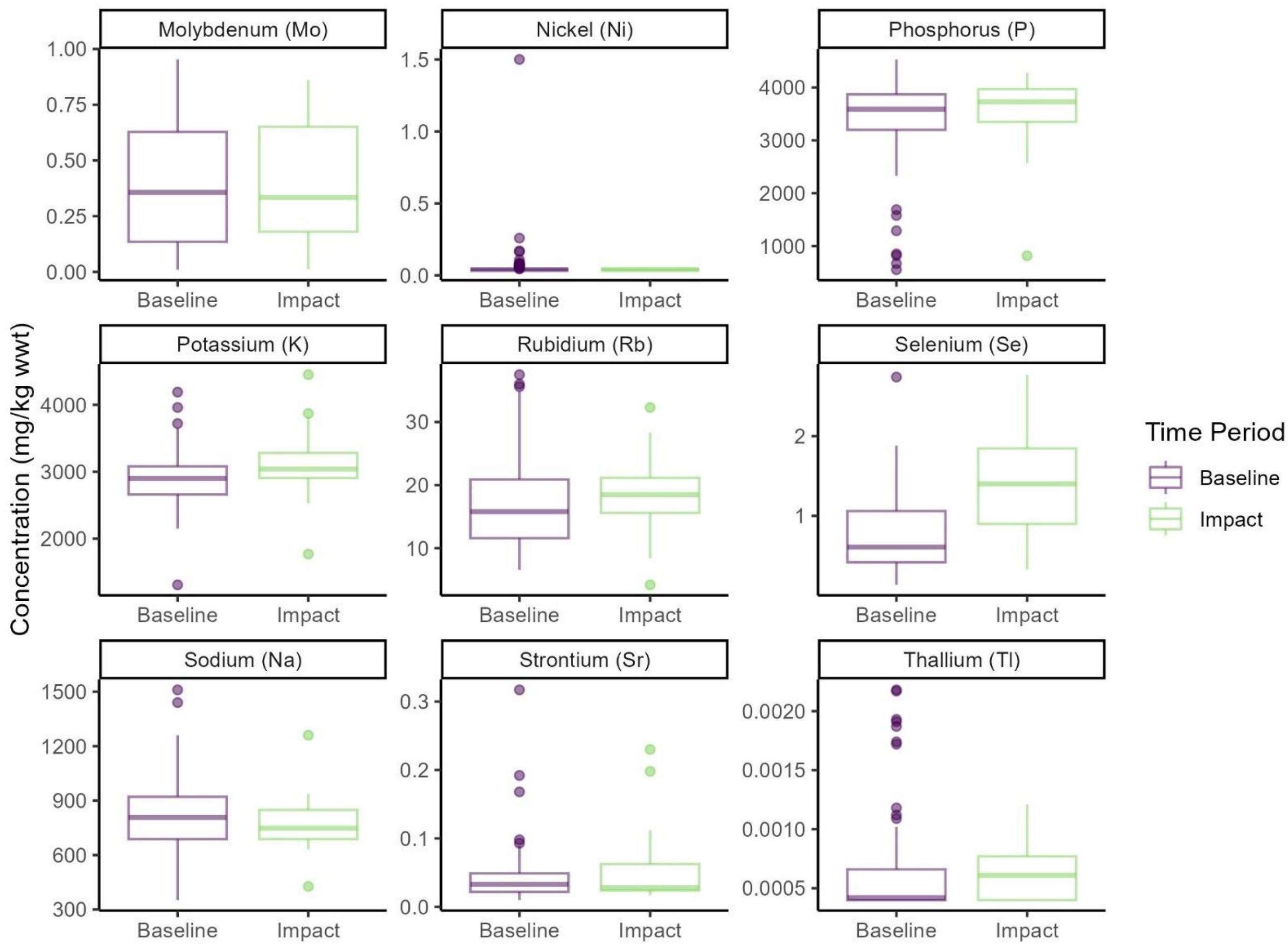

Figure 2-4 Boxplots separated by 2016–2018 baseline and 2021 impact periods for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

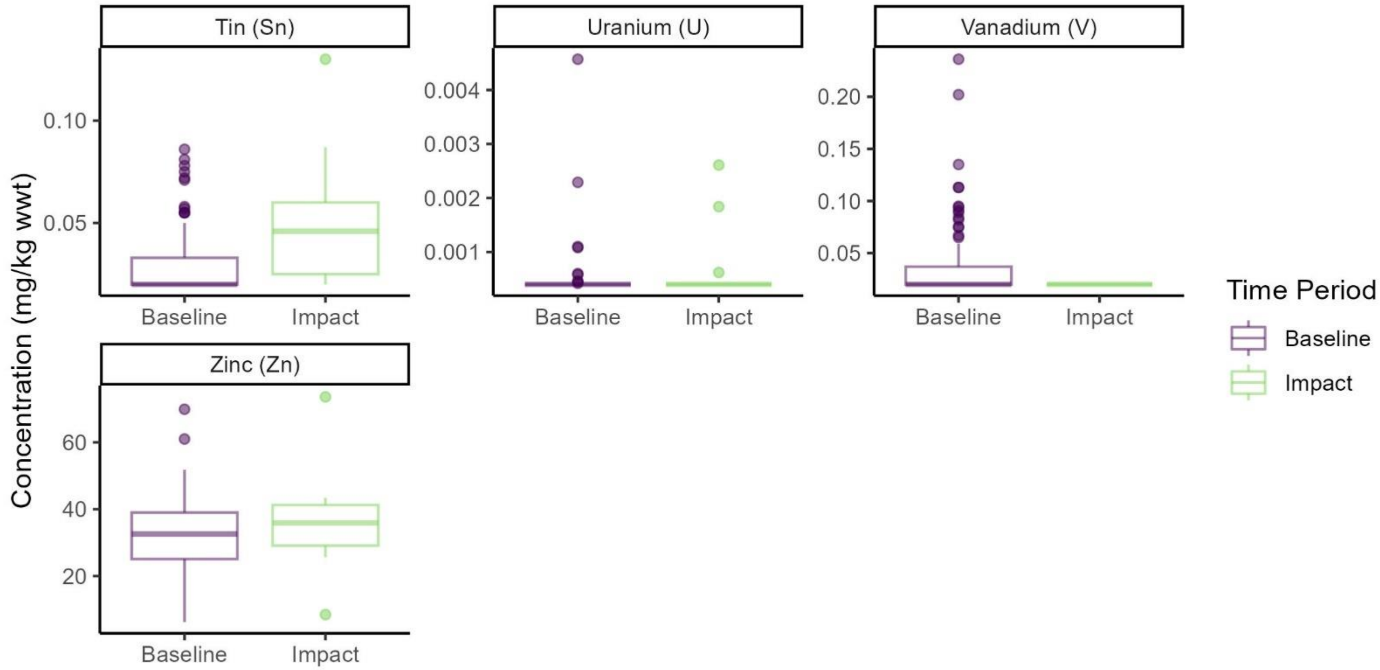

Figure 2-5 Boxplots separated by 2016–2018 baseline and 2021 impact periods for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR

3.0 Conclusions and Recommendations

3.1 Conclusions

Multiple lines of evidence suggest that, in general, tissue concentrations collected from deer near RRM (median 16 km) are currently low and that 2016–2018 baseline data are similar to the first year of impact data collected in 2021. This is supported by the following key results:

- Deer tissue concentrations did not correlate with distance from mine in 2016–2018 baseline or 2021 impact time periods for any constituent based on Spearman rank correlations, similar to findings in Wood (2018).
- Deer tissue concentrations in the 2016–2018 baseline and 2021 impact time periods (50th and 95th percentiles) were generally below constituent-specific screening values calculated for the highest consumption rate of 30 meals/month.
- Multivariate analysis including an analysis of similarity (ANOSIM) suggested that deer tissue concentrations are generally similar between 2016–2018 baseline and 2021 impact time periods.
- Some individual constituents significantly increased with effect sizes greater than 25% relative to baseline medians (5/31 = 16% of constituents). These were boron, cesium, cyanide, selenium, and tin and ranged from 27–380% increases. Nevertheless, all these constituents were below the conservative screening values for consuming 30 meals/month.

3.2 Recommendations

The below are suggestions to modify or improve the program:

- Meet holding time requirements for deer tissue analysis to ensure robust results.
- Consider collecting ageing structures (e.g., jaw) to determine whether there are positive relationships between deer tissue concentration and age.
- As more data become available, continue analyses undertaken in the current report but consider building more sophisticated models that explicitly address year-to-year variation and spatial variation (e.g., generalized linear mixed effects models that incorporate spatial autocorrelation) including the local conditions near where deer were sampled. This will allow for a better understanding of how variation is partitioned at different scales (e.g., nearby deer are more similar, large differences year-to-year).

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Appendix A

A.1 Univariate summary statistics for deer tissue chemical constituents

Table A-1 Annual summary statistics for deer tissue chemical constituents.

Note: n is number of samples; n<DL and %<DL are number and percentage of samples less than detection limit (DL), respectively; SD is standard deviation, CV is coefficient of variation, Min is minimum, Max is maximum, and Q represent percentiles (e.g., Q25 = 25th percentile).

Constituent	Year	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Aluminum (Al)	2016	37	18	49	1.1995	2.3557	1.964	0.4	0.4	0.41	0.58	6.888	10.2
Aluminum (Al)	2017	36	22	61	0.7689	0.9185	1.1946	0.4	0.4	0.4	0.5325	2.88	4.22
Aluminum (Al)	2018	28	16	57	0.8075	0.816	1.0105	0.4	0.4	0.4	0.74	2.902	3.28
Aluminum (Al)	2021	15	14	93	0.4033	0.0129	0.032	0.4	0.4	0.4	0.4	0.415	0.45
Antimony (Sb)	2016	37	27	73	0.0121	0.0472	3.8941	0.002	0.002	0.002	0.0022	0.0203	0.281
Antimony (Sb)	2017	36	32	89	0.0022	0.0007	0.3273	0.002	0.002	0.002	0.002	0.003	0.0061
Antimony (Sb)	2018	28	13	46	0.0028	0.0018	0.6516	0.002	0.002	0.002	0.0026	0.0059	0.0106
Antimony (Sb)	2021	15	11	73	0.0023	0.0007	0.2959	0.002	0.002	0.002	0.002	0.0038	0.004
Arsenic (As)	2016	37	5	14	0.0123	0.0092	0.7485	0.004	0.0067	0.009	0.0176	0.0239	0.0491
Arsenic (As)	2017	36	26	72	0.0054	0.0039	0.7193	0.004	0.004	0.004	0.004	0.0129	0.022
Arsenic (As)	2018	28	6	21	0.0083	0.0044	0.5356	0.004	0.0045	0.0069	0.011	0.0166	0.0197
Arsenic (As)	2021	15	5	33	0.0209	0.0401	1.9194	0.004	0.004	0.0048	0.0084	0.1193	0.12
Barium (Ba)	2016	37	0	0	0.0449	0.0319	0.7106	0.012	0.022	0.034	0.057	0.106	0.155
Barium (Ba)	2017	36	0	0	0.0437	0.0216	0.4941	0.016	0.0258	0.042	0.056	0.079	0.105
Barium (Ba)	2018	28	1	4	0.0412	0.0255	0.6193	0.01	0.0225	0.034	0.061	0.0834	0.116
Barium (Ba)	2021	15	0	0	0.0393	0.0173	0.4406	0.022	0.026	0.035	0.0455	0.0711	0.083
Beryllium (Be)	2016	37	37	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Beryllium (Be)	2017	36	36	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Beryllium (Be)	2018	28	28	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Beryllium (Be)	2021	15	15	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Bismuth (Bi)	2016	37	27	73	0.0025	0.0011	0.4591	0.002	0.002	0.002	0.0022	0.0051	0.0067
Bismuth (Bi)	2017	36	36	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Bismuth (Bi)	2018	28	28	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Bismuth (Bi)	2021	15	15	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Boron (B)	2016	37	13	35	0.2673	0.0898	0.336	0.2	0.2	0.24	0.29	0.492	0.52
Boron (B)	2017	36	17	47	0.2364	0.0454	0.1922	0.2	0.2	0.215	0.2725	0.31	0.35

Constituent	Year	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Boron (B)	2018	28	8	29	0.2618	0.0634	0.2421	0.2	0.2	0.24	0.31	0.373	0.38
Boron (B)	2021	15	1	7	0.3093	0.0846	0.2736	0.2	0.255	0.28	0.37	0.463	0.47
Cadmium (Cd)	2016	37	0	0	0.5402	0.4664	0.8634	0.0094	0.23	0.384	0.719	1.718	1.98
Cadmium (Cd)	2017	36	0	0	0.4209	0.4468	1.0616	0.0011	0.128	0.2815	0.5408	1.2975	1.89
Cadmium (Cd)	2018	28	0	0	0.3075	0.3429	1.1151	0.0023	0.123	0.166	0.3953	0.9768	1.52
Cadmium (Cd)	2021	15	0	0	0.5321	0.5994	1.1265	0.0038	0.229	0.426	0.6015	1.4299	2.44
Calcium (Ca)	2016	37	0	0	50.3635	14.0398	0.2788	29.2	42.6	47.6	54.2	73.94	106
Calcium (Ca)	2017	36	0	0	51.4417	10.9196	0.2123	12.7	46.475	49.55	56.5	68.15	76.4
Calcium (Ca)	2018	28	0	0	47.3821	16.5034	0.3483	11.8	40.275	44.7	55.65	64.66	107
Calcium (Ca)	2021	15	0	0	57.8267	28.9128	0.5	17.6	44.15	51.4	63.05	98.63	147
Cesium (Cs)	2016	37	0	0	0.0484	0.0634	1.3103	0.0044	0.0124	0.026	0.0617	0.1334	0.293
Cesium (Cs)	2017	36	0	0	0.0207	0.0212	1.0258	0.0024	0.0088	0.0144	0.0203	0.0591	0.104
Cesium (Cs)	2018	28	0	0	0.0465	0.0454	0.9764	0.0038	0.0216	0.0324	0.0566	0.1082	0.236
Cesium (Cs)	2021	15	0	0	0.0385	0.021	0.5453	0.0138	0.0248	0.0312	0.0493	0.0706	0.0929
Chromium (Cr)	2016	37	10	27	0.1456	0.523	3.5922	0.01	0.01	0.025	0.097	0.289	3.2
Chromium (Cr)	2017	36	5	14	0.0759	0.1012	1.3346	0.01	0.0138	0.0335	0.071	0.312	0.36
Chromium (Cr)	2018	28	7	25	0.0166	0.0088	0.5293	0.01	0.0108	0.014	0.018	0.0328	0.049
Chromium (Cr)	2021	15	12	80	0.0137	0.0134	0.9792	0.01	0.01	0.01	0.01	0.027	0.062
Cobalt (Co)	2016	37	1	3	0.051	0.0189	0.3708	0.004	0.0426	0.0495	0.0588	0.078	0.108
Cobalt (Co)	2017	36	2	6	0.05	0.0243	0.4859	0.004	0.0408	0.0527	0.0688	0.0789	0.0943
Cobalt (Co)	2018	28	3	11	0.0519	0.0251	0.4833	0.004	0.04	0.0553	0.0676	0.0889	0.0895
Cobalt (Co)	2021	15	3	20	0.0426	0.022	0.5172	0.004	0.0398	0.0477	0.0553	0.0661	0.0763
Copper (Cu)	2016	37	0	0	81.1503	43.7632	0.5393	0.562	48.4	72.1	107	154.6	191
Copper (Cu)	2017	36	0	0	56.2337	37.591	0.6685	0.574	28.25	58	82.225	102.25	173
Copper (Cu)	2018	28	0	0	59.9274	39.4305	0.658	0.389	38.6	54.5	84.375	125.7	164
Copper (Cu)	2021	15	0	0	79.7015	49.8785	0.6258	0.468	48.15	107	115.5	134.4	140
Cyanide	2016	37	6	16	0.1933	0.0875	0.4526	0.1	0.1175	0.18	0.27	0.3425	0.41
Cyanide	2017	36	29	81	0.1003	0.0018	0.0182	0.1	0.1	0.1	0.1	0.1	0.11
Cyanide	2018	28	14	50	0.071	0.0314	0.4419	0.028	0.039	0.1	0.1	0.1	0.1
Cyanide	2021	15	0	0	0.4607	0.1569	0.3405	0.23	0.315	0.48	0.565	0.708	0.75
Iron (Fe)	2016	37	0	0	160.3541	132.3187	0.8252	79.8	111	133	161	247.6	901
Iron (Fe)	2017	36	0	0	193.0722	193.1192	1.0002	49.3	105	141	192.75	514.75	990

Constituent	Year	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Iron (Fe)	2018	28	0	0	228.8071	238.7315	1.0434	70	109.75	155.5	188.25	825.15	962
Iron (Fe)	2021	15	0	0	240.1867	243.3681	1.0132	94	118.5	161	243	635.6	1050
Lead (Pb)	2016	37	7	19	1.17	6.557	5.6043	0.004	0.0042	0.0073	0.028	0.7176	39.9
Lead (Pb)	2017	36	14	39	0.0141	0.0234	1.6542	0.004	0.004	0.0054	0.0118	0.0429	0.131
Lead (Pb)	2018	28	6	21	0.0412	0.1118	2.7155	0.004	0.005	0.0065	0.0324	0.1123	0.592
Lead (Pb)	2021	15	4	27	0.0094	0.0099	1.0545	0.004	0.0046	0.006	0.0066	0.0311	0.0379
Lithium (Li)	2016	37	8	22	0.2677	0.1544	0.5768	0.1	0.14	0.26	0.36	0.534	0.68
Lithium (Li)	2017	36	18	50	0.1878	0.1573	0.8375	0.1	0.1	0.105	0.19	0.545	0.72
Lithium (Li)	2018	28	9	32	0.2479	0.2298	0.9272	0.1	0.1	0.155	0.2525	0.8175	0.9
Lithium (Li)	2021	15	5	33	0.2347	0.1404	0.5983	0.1	0.1	0.23	0.305	0.506	0.52
Magnesium (Mg)	2016	37	0	0	161.1919	24.3917	0.1513	57.6	153	162	175	195.4	202
Magnesium (Mg)	2017	36	0	0	168.675	38.1505	0.2262	47.3	154	171.5	178	199.75	325
Magnesium (Mg)	2018	28	0	0	162.3786	39.5758	0.2437	39.9	154.5	174	184.5	202.6	206
Magnesium (Mg)	2021	15	0	0	169.4267	33.6955	0.1989	54.4	165.5	176	183.5	196.6	198
Manganese (Mn)	2016	37	0	0	2.3231	1.0268	0.442	0.138	1.37	2.55	3.07	3.79	4.14
Manganese (Mn)	2017	36	0	0	2.455	1.2386	0.5045	0.066	1.5775	2.63	3.3475	4.1025	4.35
Manganese (Mn)	2018	28	0	0	2.4432	1.3824	0.5658	0.058	1.2825	2.66	3.285	4.689	4.87
Manganese (Mn)	2021	15	0	0	2.4771	1.371	0.5535	0.139	2.015	2.84	3.32	4.18	4.6
Mercury (Hg)	2016	37	1	3	0.0087	0.0176	2.0264	0.001	0.0033	0.0052	0.0076	0.0151	0.111
Mercury (Hg)	2017	36	4	11	0.0034	0.0026	0.7531	0.001	0.0018	0.0028	0.0039	0.0092	0.0114
Mercury (Hg)	2018	28	1	4	0.0072	0.0078	1.0834	0.001	0.0028	0.0053	0.007	0.021	0.0387
Mercury (Hg)	2021	15	1	7	0.0068	0.0046	0.6724	0.001	0.0026	0.0083	0.0088	0.0131	0.018
Molybdenum (Mo)	2016	37	0	0	0.356	0.259	0.7273	0.0269	0.116	0.331	0.565	0.7848	0.953
Molybdenum (Mo)	2017	36	0	0	0.3881	0.2813	0.7247	0.0104	0.136	0.37	0.6398	0.83	0.866
Molybdenum (Mo)	2018	28	0	0	0.3914	0.2664	0.6805	0.01	0.2052	0.3485	0.6693	0.7502	0.868
Molybdenum (Mo)	2021	15	0	0	0.3926	0.304	0.7744	0.0118	0.1805	0.334	0.651	0.8379	0.861
Nickel (Ni)	2016	37	25	68	0.1	0.241	2.4108	0.04	0.04	0.04	0.066	0.1878	1.5
Nickel (Ni)	2017	36	31	86	0.0428	0.0086	0.1997	0.04	0.04	0.04	0.04	0.0638	0.076
Nickel (Ni)	2018	28	28	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04
Nickel (Ni)	2021	15	15	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04
Phosphorus (P)	2016	37	0	0	3482.243	599.9223	0.1723	853	3320	3620	3780	4150	4430
Phosphorus (P)	2017	36	0	0	3451.417	737.3014	0.2136	671	3252.5	3645	3930	4062.5	4530

Constituent	Year	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Phosphorus (P)	2018	28	0	0	3262.714	992.478	0.3042	555	3122.5	3520	3905	4211.5	4420
Phosphorus (P)	2021	15	0	0	3479.2	869.3649	0.2499	818	3350	3730	3970	4182	4280
Potassium (K)	2016	37	0	0	2730.946	373.3554	0.1367	1310	2620	2780	2940	3136	3650
Potassium (K)	2017	36	0	0	2937.222	438.5796	0.1493	2150	2630	2920	3167.5	3630	4190
Potassium (K)	2018	28	0	0	3036.071	323.858	0.1067	2530	2817.5	3015	3162.5	3578.5	3960
Potassium (K)	2021	15	0	0	3132	612.3981	0.1955	1770	2905	3040	3280	4044	4450
Rubidium (Rb)	2016	37	0	0	18.0814	7.082	0.3917	6.69	12.9	18.7	24.1	29.72	32.5
Rubidium (Rb)	2017	36	0	0	14.1756	6.4821	0.4573	6.59	9.0075	13.4	16.1	25.55	37.5
Rubidium (Rb)	2018	28	0	0	20.0771	8.5462	0.4257	7.34	13.925	17.65	23.2	35.32	36
Rubidium (Rb)	2021	15	0	0	18.2553	7.2019	0.3945	4.2	15.6	18.5	21.15	29.5	32.3
Selenium (Se)	2016	37	0	0	0.8745	0.4611	0.5272	0.198	0.518	0.792	1.32	1.534	1.88
Selenium (Se)	2017	36	0	0	0.5452	0.3331	0.611	0.135	0.3482	0.441	0.6442	1.075	1.85
Selenium (Se)	2018	28	0	0	0.9588	0.5264	0.5491	0.238	0.631	0.8675	1.1525	1.805	2.74
Selenium (Se)	2021	15	0	0	1.4391	0.7539	0.5238	0.33	0.899	1.4	1.845	2.707	2.77
Sodium (Na)	2016	37	0	0	817.7703	210.9834	0.258	413	684	799	893	1226	1440
Sodium (Na)	2017	36	0	0	900.4167	230.1863	0.2556	352	777	867	1067.5	1237.5	1510
Sodium (Na)	2018	28	0	0	737.3929	158.2629	0.2146	380	640	729.5	862.75	928.15	1010
Sodium (Na)	2021	15	0	0	773.4	184.8817	0.2391	427	687.5	748	848.5	1033.2	1260
Strontium (Sr)	2016	37	3	8	0.033	0.0223	0.6758	0.01	0.014	0.027	0.049	0.0806	0.089
Strontium (Sr)	2017	36	0	0	0.0518	0.0532	1.0257	0.011	0.029	0.038	0.0545	0.1118	0.317
Strontium (Sr)	2018	28	1	4	0.0391	0.0348	0.8896	0.01	0.0218	0.028	0.0437	0.085	0.192
Strontium (Sr)	2021	15	0	0	0.0607	0.068	1.1215	0.017	0.024	0.028	0.0625	0.2076	0.23
Tellurium (Te)	2016	37	37	100	0.004	0	0	0.004	0.004	0.004	0.004	0.004	0.004
Tellurium (Te)	2017	36	36	100	0.004	0	0	0.004	0.004	0.004	0.004	0.004	0.004
Tellurium (Te)	2018	28	28	100	0.004	0	0	0.004	0.004	0.004	0.004	0.004	0.004
Tellurium (Te)	2021	15	15	100	0.004	0	0	0.004	0.004	0.004	0.004	0.004	0.004
Thallium (Tl)	2016	37	15	41	0.0006	0.0004	0.5695	0.0004	0.0004	0.0005	0.0007	0.0012	0.0019
Thallium (Tl)	2017	36	20	56	0.0005	0.0002	0.4726	0.0004	0.0004	0.0004	0.0005	0.0008	0.0017
Thallium (Tl)	2018	28	11	39	0.0008	0.0006	0.7393	0.0004	0.0004	0.0005	0.0009	0.0021	0.0022
Thallium (Tl)	2021	15	5	33	0.0006	0.0002	0.3826	0.0004	0.0004	0.0006	0.0008	0.001	0.0012
Tin (Sn)	2016	37	14	38	0.0324	0.0163	0.5047	0.02	0.02	0.027	0.037	0.0608	0.086
Tin (Sn)	2017	36	26	72	0.0249	0.0116	0.4667	0.02	0.02	0.02	0.0225	0.0493	0.075

Constituent	Year	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Tin (Sn)	2018	28	18	64	0.0297	0.0186	0.628	0.02	0.02	0.02	0.0278	0.0755	0.081
Tin (Sn)	2021	15	3	20	0.0503	0.0314	0.6248	0.02	0.025	0.046	0.06	0.0999	0.13
Uranium (U)	2016	37	35	95	0.0004	0.0001	0.2713	0.0004	0.0004	0.0004	0.0004	0.0004	0.0011
Uranium (U)	2017	36	32	89	0.0006	0.0008	1.2787	0.0004	0.0004	0.0004	0.0004	0.0014	0.0046
Uranium (U)	2018	28	25	89	0.0004	0	0.0365	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005
Uranium (U)	2021	15	12	80	0.0007	0.0007	0.9955	0.0004	0.0004	0.0004	0.0004	0.0021	0.0026
Vanadium (V)	2016	37	16	43	0.0441	0.0306	0.6952	0.02	0.02	0.033	0.059	0.0978	0.135
Vanadium (V)	2017	36	21	58	0.0424	0.0496	1.17	0.02	0.02	0.02	0.0405	0.1353	0.236
Vanadium (V)	2018	28	28	100	0.02	0	0	0.02	0.02	0.02	0.02	0.02	0.02
Vanadium (V)	2021	15	15	100	0.02	0	0	0.02	0.02	0.02	0.02	0.02	0.02
Zinc (Zn)	2016	37	0	0	32.4959	10.0201	0.3083	10.4	25.1	32.6	37.4	48.28	61
Zinc (Zn)	2017	36	0	0	31.5728	10.5032	0.3327	6.22	25.65	31.35	37.975	49.75	50.4
Zinc (Zn)	2018	28	0	0	32.7304	12.5409	0.3832	6.45	22.85	34.8	39.3	46.885	69.9
Zinc (Zn)	2021	15	0	0	35.8107	13.7868	0.385	8.46	29.1	35.9	41.25	52.46	73.6
Zirconium (Zr)	2016	37	37	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04
Zirconium (Zr)	2017	36	34	94	0.0408	0.0033	0.08	0.04	0.04	0.04	0.04	0.0432	0.055
Zirconium (Zr)	2018	28	28	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04
Zirconium (Zr)	2021	15	15	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04

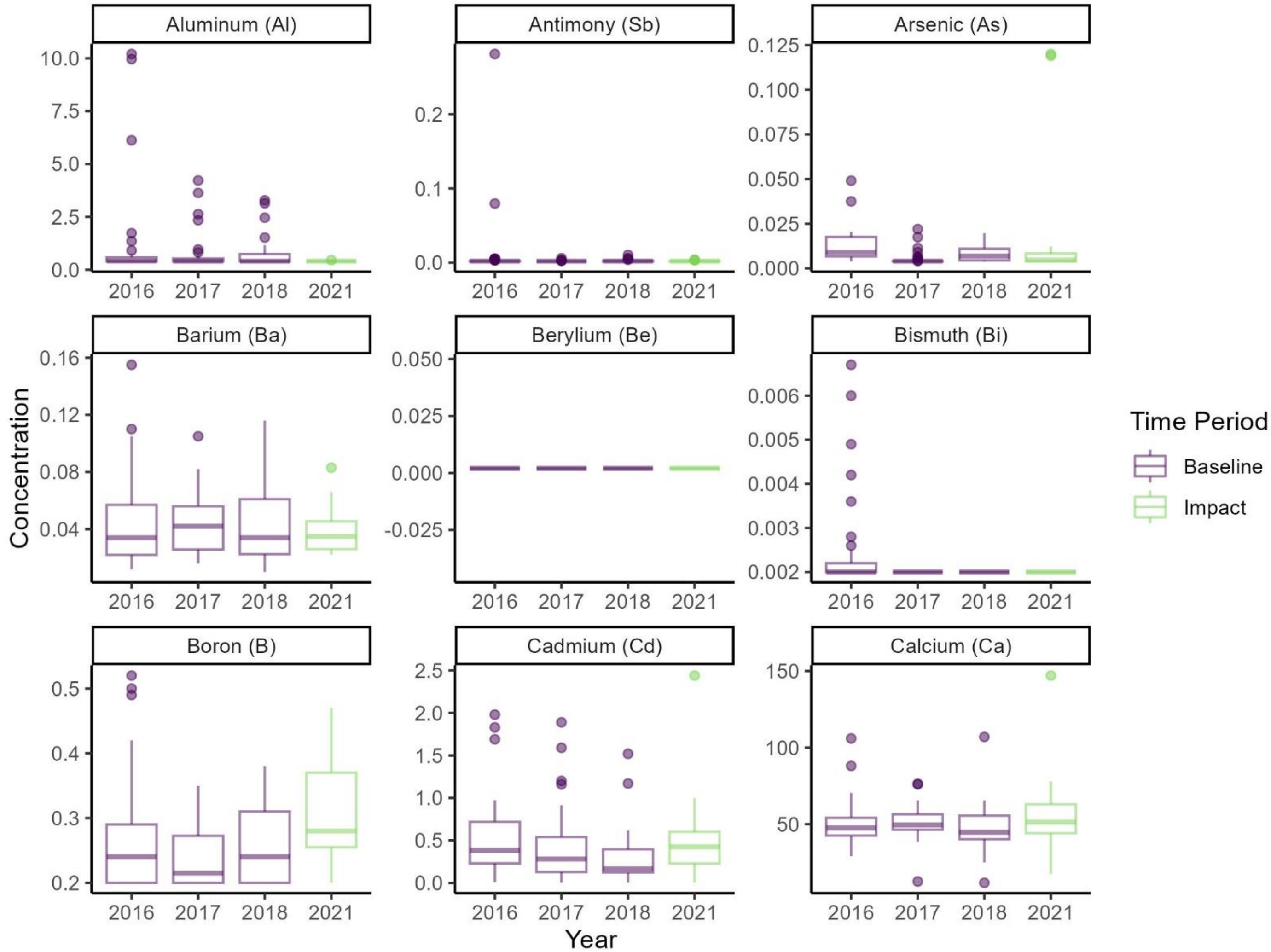

Figure A-1 Boxplots separated annually and by colour (Baseline and Impact) for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

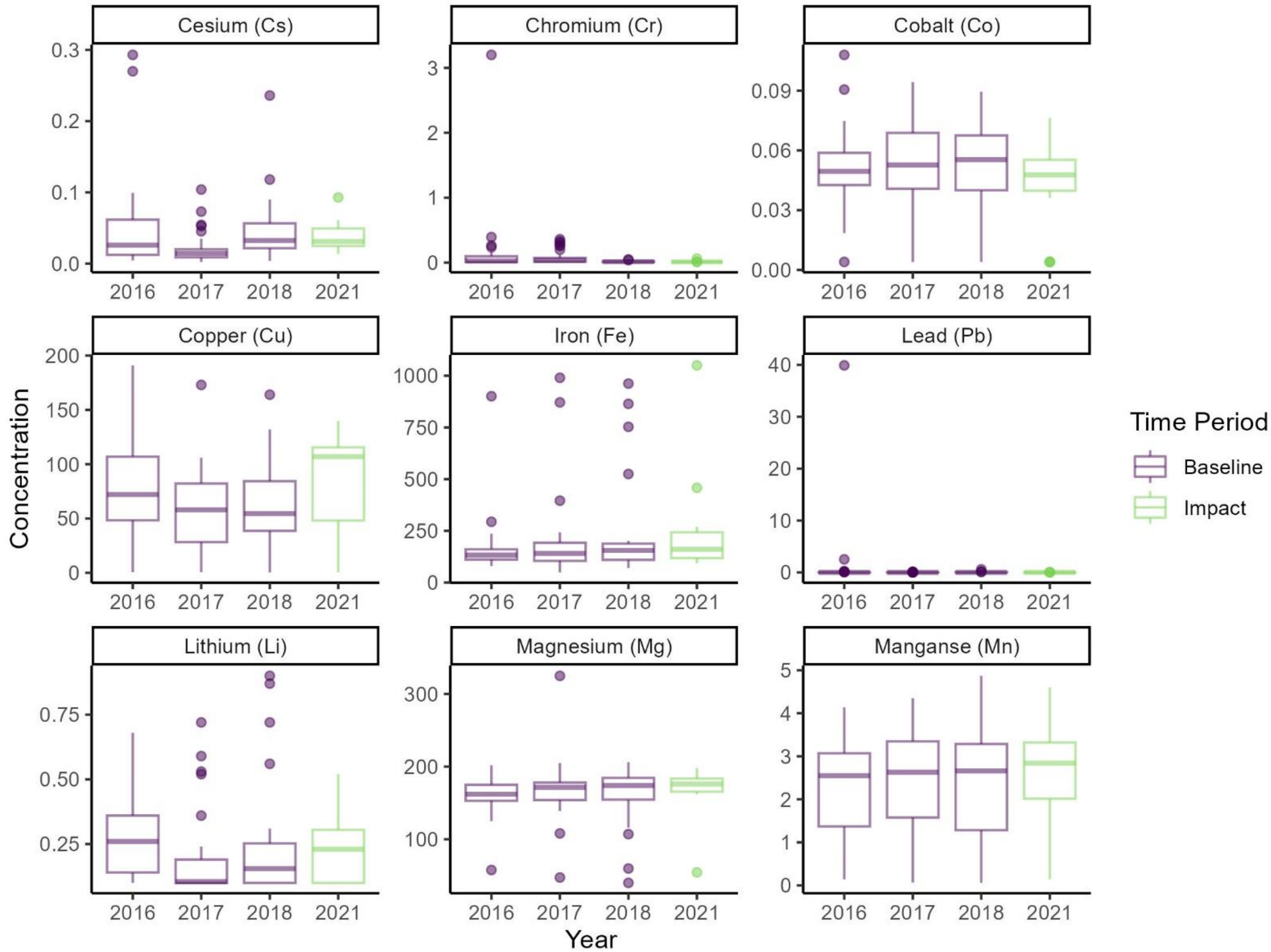

Figure A-2 Boxplots separated annually and by colour (Baseline and Impact) for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

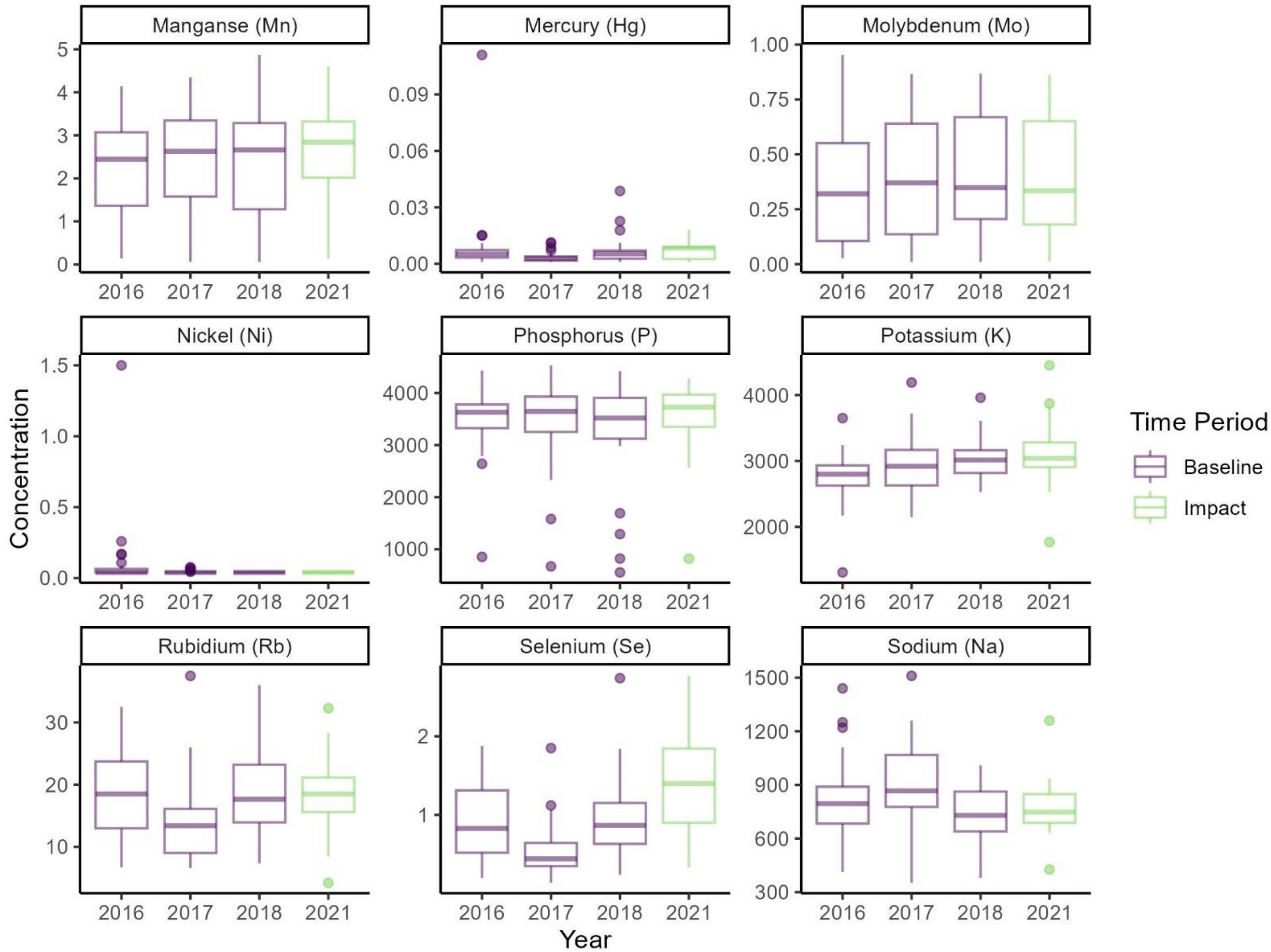

Figure A-3 Boxplots separated annually and by colour (Baseline and Impact) for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

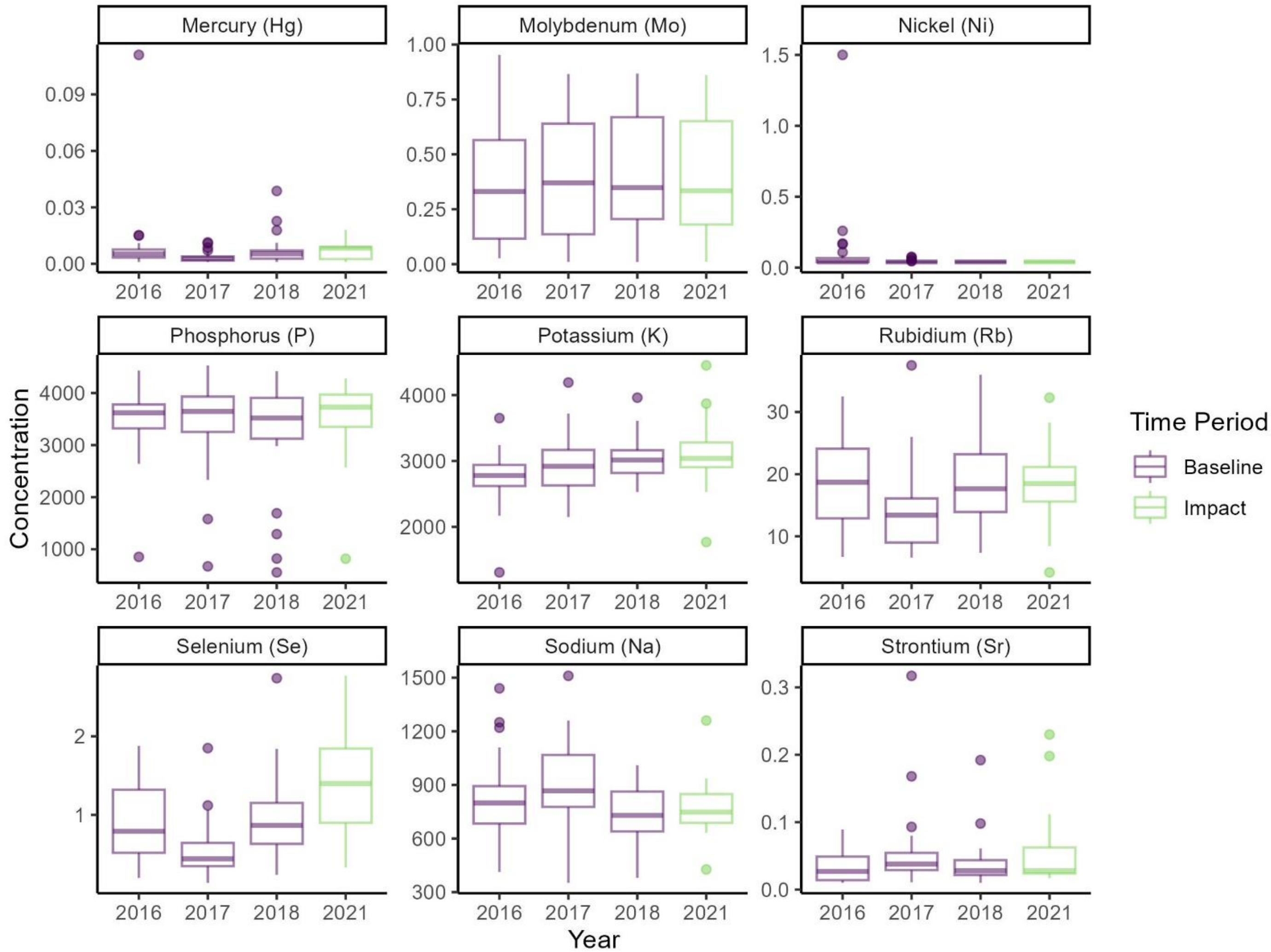

Figure A-4 Boxplots separated annually and by colour (Baseline and Impact) for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

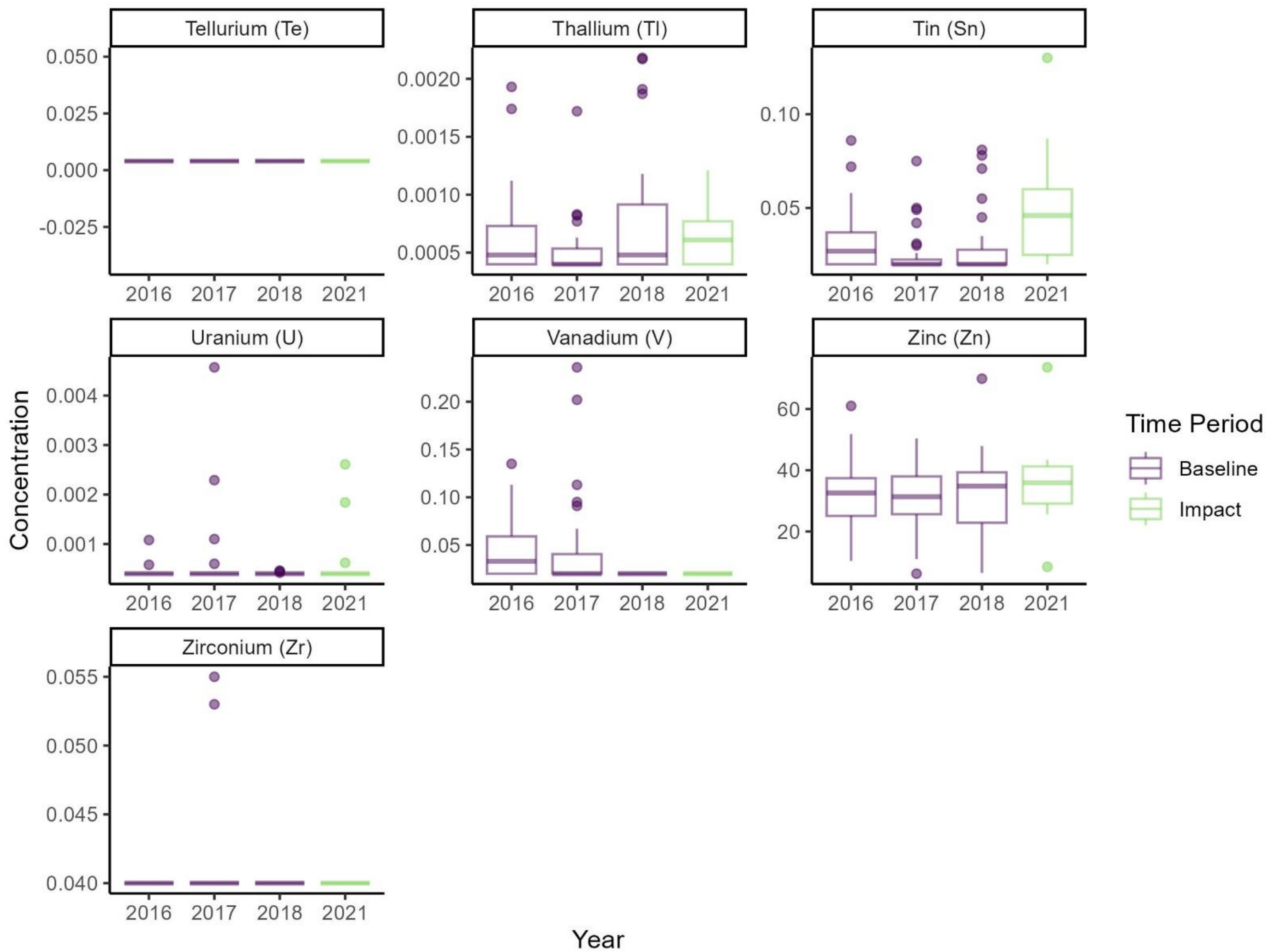

Figure A-5 Boxplots separated annually and by colour (Baseline and Impact) for deer tissue chemical constituents. Note centre line of box is median, box is the 25th–75th interquartile range (IQR), whiskers extend to the highest datapoint within 1.5xIQR, and points are those outside of 1.5xIQR.

Table A-2 Time period (Baseline 2016–2018 and Impact 2021) summary statistics for deer tissue chemical constituents.

Note: n is number of samples; n<DL and %<DL are number and percentage of samples less than detection limit (DL), respectively; SD is standard deviation, CV is coefficient of variation, Min is minimum, Max is maximum, and Q represent percentiles (e.g., Q25 = 25th percentile).

Constituent	Time Period	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Aluminum (Al)	Baseline	101	56	55	0.9373	1.5853	1.6913	0.4	0.4	0.4	0.58	3.28	10.2
Aluminum (Al)	Impact	15	14	93	0.4033	0.0129	0.032	0.4	0.4	0.4	0.4	0.415	0.45
Antimony (Sb)	Baseline	101	72	71	0.006	0.0287	4.7878	0.002	0.002	0.002	0.0022	0.0054	0.281
Antimony (Sb)	Impact	15	11	73	0.0023	0.0007	0.2959	0.002	0.002	0.002	0.002	0.0038	0.004
Arsenic (As)	Baseline	101	37	37	0.0087	0.0071	0.8107	0.004	0.004	0.0063	0.0114	0.0197	0.0491
Arsenic (As)	Impact	15	5	33	0.0209	0.0401	1.9194	0.004	0.004	0.0048	0.0084	0.1193	0.12
Barium (Ba)	Baseline	101	1	1	0.0435	0.0266	0.6122	0.01	0.023	0.036	0.061	0.089	0.155
Barium (Ba)	Impact	15	0	0	0.0393	0.0173	0.4406	0.022	0.026	0.035	0.0455	0.0711	0.083
Beryllium (Be)	Baseline	101	101	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Beryllium (Be)	Impact	15	15	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Bismuth (Bi)	Baseline	101	91	90	0.0022	0.0007	0.3318	0.002	0.002	0.002	0.002	0.0028	0.0067
Bismuth (Bi)	Impact	15	15	100	0.002	0	0	0.002	0.002	0.002	0.002	0.002	0.002
Boron (B)	Baseline	101	38	38	0.2548	0.07	0.2749	0.2	0.2	0.22	0.3	0.38	0.52
Boron (B)	Impact	15	1	7	0.3093	0.0846	0.2736	0.2	0.255	0.28	0.37	0.463	0.47
Cadmium (Cd)	Baseline	101	0	0	0.4331	0.4343	1.0027	0.0011	0.147	0.297	0.589	1.52	1.98
Cadmium (Cd)	Impact	15	0	0	0.5321	0.5994	1.1265	0.0038	0.229	0.426	0.6015	1.4299	2.44
Calcium (Ca)	Baseline	101	0	0	49.9213	13.7456	0.2753	11.8	43.2	48.1	55.6	70.4	107
Calcium (Ca)	Impact	15	0	0	57.8267	28.9128	0.5	17.6	44.15	51.4	63.05	98.63	147
Cesium (Cs)	Baseline	101	0	0	0.038	0.0483	1.2699	0.0024	0.012	0.0212	0.0461	0.0993	0.293
Cesium (Cs)	Impact	15	0	0	0.0385	0.021	0.5453	0.0138	0.0248	0.0312	0.0493	0.0706	0.0929
Chromium (Cr)	Baseline	101	22	22	0.085	0.3237	3.8095	0.01	0.011	0.019	0.045	0.27	3.2
Chromium (Cr)	Impact	15	12	80	0.0137	0.0134	0.9792	0.01	0.01	0.01	0.01	0.027	0.062
Cobalt (Co)	Baseline	101	6	6	0.0509	0.0225	0.4419	0.004	0.0408	0.0515	0.0663	0.0878	0.108
Cobalt (Co)	Impact	15	3	20	0.0426	0.022	0.5172	0.004	0.0398	0.0477	0.0553	0.0661	0.0763

Constituent	Time Period	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Copper (Cu)	Baseline	101	0	0	66.3856	41.6327	0.6271	0.389	39.3	62.9	90.1	143	191
Copper (Cu)	Impact	15	0	0	79.7015	49.8785	0.6258	0.468	48.15	107	115.5	134.4	140
Cyanide	Baseline	101	49	49	0.1278	0.0779	0.6092	0.028	0.1	0.1	0.14	0.314	0.41
Cyanide	Impact	15	0	0	0.4607	0.1569	0.3405	0.23	0.315	0.48	0.565	0.708	0.75
Iron (Fe)	Baseline	101	0	0	190.9931	188.3973	0.9864	49.3	107	140	182	753	990
Iron (Fe)	Impact	15	0	0	240.1867	243.3681	1.0132	94	118.5	161	243	635.6	1050
Lead (Pb)	Baseline	101	27	27	0.4451	3.9735	8.9279	0.004	0.004	0.0069	0.0226	0.113	39.9
Lead (Pb)	Impact	15	4	27	0.0094	0.0099	1.0545	0.004	0.0046	0.006	0.0066	0.0311	0.0379
Lithium (Li)	Baseline	101	35	35	0.2337	0.1809	0.7742	0.1	0.1	0.17	0.29	0.59	0.9
Lithium (Li)	Impact	15	5	33	0.2347	0.1404	0.5983	0.1	0.1	0.23	0.305	0.506	0.52
Magnesium (Mg)	Baseline	101	0	0	164.1881	34.0289	0.2073	39.9	154	167	181	200	325
Magnesium (Mg)	Impact	15	0	0	169.4267	33.6955	0.1989	54.4	165.5	176	183.5	196.6	198
Manganese (Mn)	Baseline	101	0	0	2.4034	1.1984	0.4986	0.058	1.41	2.61	3.28	4.14	4.87
Manganese (Mn)	Impact	15	0	0	2.4771	1.371	0.5535	0.139	2.015	2.84	3.32	4.18	4.6
Mercury (Hg)	Baseline	101	6	6	0.0064	0.0117	1.8188	0.001	0.0024	0.0041	0.0064	0.0151	0.111
Mercury (Hg)	Impact	15	1	7	0.0068	0.0046	0.6724	0.001	0.0026	0.0083	0.0088	0.0131	0.018
Molybdenum (Mo)	Baseline	101	0	0	0.3773	0.2669	0.7075	0.01	0.135	0.357	0.628	0.824	0.953
Molybdenum (Mo)	Impact	15	0	0	0.3926	0.304	0.7744	0.0118	0.1805	0.334	0.651	0.8379	0.861
Nickel (Ni)	Baseline	101	84	83	0.063	0.1474	2.341	0.04	0.04	0.04	0.04	0.088	1.5
Nickel (Ni)	Impact	15	15	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04
Phosphorus (P)	Baseline	101	0	0	3410.396	770.978	0.2261	555	3200	3590	3870	4150	4530
Phosphorus (P)	Impact	15	0	0	3479.2	869.3649	0.2499	818	3350	3730	3970	4182	4280
Potassium (K)	Baseline	101	0	0	2889.059	402.443	0.1393	1310	2660	2900	3080	3600	4190
Potassium (K)	Impact	15	0	0	3132	612.3981	0.1955	1770	2905	3040	3280	4044	4450
Rubidium (Rb)	Baseline	101	0	0	17.2425	7.6406	0.4431	6.59	11.6	15.8	20.9	33.2	37.5
Rubidium (Rb)	Impact	15	0	0	18.2553	7.2019	0.3945	4.2	15.6	18.5	21.15	29.5	32.3
Selenium (Se)	Baseline	101	0	0	0.7805	0.4715	0.6041	0.135	0.417	0.609	1.06	1.63	2.74
Selenium (Se)	Impact	15	0	0	1.4391	0.7539	0.5238	0.33	0.899	1.4	1.845	2.707	2.77

Constituent	Time Period	n	n<DL	%<DL	Mean	SD	CV	Min	Q25	Q50	Q75	Q95	Max
Sodium (Na)	Baseline	101	0	0	824.9455	213.4214	0.2587	352	687.5	807	921	1220	1510
Sodium (Na)	Impact	15	0	0	773.4	184.8817	0.2391	427	687.5	748	848.5	1033.2	1260
Strontium (Sr)	Baseline	101	4	4	0.0414	0.0395	0.9542	0.01	0.022	0.033	0.049	0.089	0.317
Strontium (Sr)	Impact	15	0	0	0.0607	0.068	1.1215	0.017	0.024	0.028	0.0625	0.2076	0.23
Tellurium (Te)	Baseline	101	101	100	0.004	0	0	0.004	0.004	0.004	0.004	0.004	0.004
Tellurium (Te)	Impact	15	15	100	0.004	0	0	0.004	0.004	0.004	0.004	0.004	0.004
Thallium (Tl)	Baseline	101	46	46	0.0006	0.0004	0.6495	0.0004	0.0004	0.0004	0.0007	0.0017	0.0022
Thallium (Tl)	Impact	15	5	33	0.0006	0.0002	0.3826	0.0004	0.0004	0.0006	0.0008	0.001	0.0012
Tin (Sn)	Baseline	101	58	57	0.0289	0.0157	0.5434	0.02	0.02	0.02	0.033	0.071	0.086
Tin (Sn)	Impact	15	3	20	0.0503	0.0314	0.6248	0.02	0.025	0.046	0.06	0.0999	0.13
Uranium (U)	Baseline	101	92	91	0.0005	0.0005	0.9656	0.0004	0.0004	0.0004	0.0004	0.0006	0.0046
Uranium (U)	Impact	15	12	80	0.0007	0.0007	0.9955	0.0004	0.0004	0.0004	0.0004	0.0021	0.0026
Vanadium (V)	Baseline	101	65	64	0.0368	0.0362	0.9829	0.02	0.02	0.02	0.037	0.095	0.236
Vanadium (V)	Impact	15	15	100	0.02	0	0	0.02	0.02	0.02	0.02	0.02	0.02
Zinc (Zn)	Baseline	101	0	0	32.2319	10.8384	0.3363	6.22	25.1	32.6	39	49.7	69.9
Zinc (Zn)	Impact	15	0	0	35.8107	13.7868	0.385	8.46	29.1	35.9	41.25	52.46	73.6
Zirconium (Zr)	Baseline	101	99	98	0.0403	0.002	0.0488	0.04	0.04	0.04	0.04	0.04	0.055
Zirconium (Zr)	Impact	15	15	100	0.04	0	0	0.04	0.04	0.04	0.04	0.04	0.04

A.2 Correlations of deer tissue constituents with distance to RRM

Table A-3 Spearman's rho (ρ) and associated p-value for Baseline and Impact time periods for constituent concentrations against deer sample distance from mine.

Constituent	Baseline		Impact	
	Spearman's ρ	p-value	Spearman's ρ	p-value
Aluminum (Al)	-0.09	0.36	-0.32	0.25
Antimony (Sb)	-0.05	0.62	-0.24	0.39
Arsenic (As)	-0.05	0.62	0.14	0.61
Barium (Ba)	0.04	0.70	0.10	0.71
Boron (B)	-0.16	0.12	-0.47	0.08
Cadmium (Cd)	0.04	0.67	0.11	0.70
Calcium (Ca)	-0.14	0.15	0.10	0.72
Cesium (Cs)	-0.07	0.48	0.21	0.45
Chromium (Cr)	-0.03	0.77	0.00	1.00
Cobalt (Co)	0.02	0.86	0.01	0.96
Copper (Cu)	0.09	0.39	-0.27	0.34
Cyanide	0.06	0.55	0.16	0.56
Iron (Fe)	0.10	0.33	-0.04	0.89
Lead (Pb)	0.11	0.28	-0.32	0.24
Lithium (Li)	-0.13	0.19	-0.29	0.30
Magnesium (Mg)	-0.07	0.50	0.30	0.28
Manganese (Mn)	0.06	0.58	-0.12	0.66
Mercury (Hg)	-0.06	0.53	-0.04	0.88
Molybdenum (Mo)	-0.03	0.78	0.00	0.99
Nickel (Ni)	-0.01	0.92	NA	NA
Phosphorus (P)	0.11	0.26	-0.21	0.45
Potassium (K)	-0.13	0.18	-0.17	0.55
Rubidium (Rb)	-0.05	0.64	0.13	0.64
Selenium (Se)	-0.06	0.53	-0.29	0.29
Sodium (Na)	0.06	0.55	0.19	0.49
Strontium (Sr)	0.04	0.66	0.03	0.91
Thallium (Tl)	-0.05	0.65	0.07	0.81
Tin (Sn)	-0.04	0.67	-0.02	0.93
Uranium (U)	-0.13	0.18	0.15	0.59
Vanadium (V)	0.19	0.05	NA	NA
Zinc (Zn)	-0.09	0.35	0.32	0.25