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# Gray Wolves (*Canis lupus*) consume free-ranging horses (*Equus ferus caballus*) on the Chilcotin plateau, British Columbia

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## Abstract

We analyzed 122 Gray Wolf (*Canis lupus*) scats, collected at all seasons during 2013–2017, to determine what wolves were eating in two adjacent study areas of the Chilcotin region, British Columbia: Brittany Triangle and Nemiah Valley. Free-ranging horses (*Equus ferus caballus*), Mule Deer (*Odocoileus hemionus*), Moose (*Alces americanus*), and small mammals contributed to wolf diet throughout the year. In both study areas, horse appeared more frequently than other species in occurrence-per-faeces (OF) and occurrence-per-item (OI) analyses. Horse occurred in 58 of 97 wolf scats from Brittany (OF 59.8%, OI 52.7%), deer in 26 (OF 26.8%, OI 23.6%), small mammals in 17 (OF 17.5%, OI 17.3%), Moose in four (OF 4.1%, OI 3.6%), and bird and fish minimally (both OF <2.5%, OI <2.5%). The sample size in the more human-developed Nemiah Valley was too small to estimate reliable patterns, but results suggest a similar ranking of dietary items. Domestic Cattle (*Bos taurus*), available in both study areas, appeared infrequently (combined area OF <3.5%, OI <3.0%). Based on our scat findings, free-ranging horses were a regular dietary item for wolves in the area. Studies elsewhere have found that, where wolves and free-ranging horses are sympatric, a predator–prey relationship exists.

Key words: Gray Wolf; *Canis lupus*; wolves; free-ranging horse; *Equus ferus caballus*; predator; prey; scat; diet; hunt; scavenge

## Introduction

Wolves (*Canis* spp.) and horses (*Equus* spp.) have coexisted for millennia in North America, Europe, and Asia (Savage 1969; Cohen 2002; Furrer *et al.* 2007; Germonpré *et al.* 2009; Hayes 2010). Despite the long history of overlapping ranges, few contemporary scientific studies have examined the dynamics of this formerly ancient, widespread, but now remnant predator–prey relationship, and none exist for British Columbia (BC). However, there are anecdotal reports of Gray Wolves (*Canis lupus*) chasing free-ranging horses (*Equus ferus caballus*) in the West Chilcotin (Davis 2009), attacking domestic horses in the Nemiah Valley (J. Tanis pers. comm. 2 June 2013), and approaching and testing free-ranging horses in the Brittany Triangle (D. Williams pers. comm. 28 February 2017).

Globally, wolves have flexible foraging patterns and strategies (Zlatanova *et al.* 2014; Newsome *et al.* 2016; Muhly *et al.* 2019). In North America, the diet of Gray Wolves is dominated by large and medium-sized wild ungulates (Newsome *et al*. 2016). Gray Wolves in Alberta's Rocky Mountain Forest Reserve are known to hunt free-ranging horses (Webb 2009; Webb *et al*. 2009). Studies in Europe (Patalano and Lovari 1993; Meriggi and Lovari 1996; Vos 2000; Lagos and Bárcena 2018) and Asia (van Duyne *et al.* 2009; Dorj and Namkhai 2013; Newsome *et al*. 2016; Chetri *et al.* 2019) also report wolves hunting free-ranging horses and/or ponies.

Our objective was to examine the annual diet of Gray Wolf in the Chilcotin (Tŝilhqot'in) region on the Interior Plateau of BC, near the Xeni Gwet'in First Nation community in the Nemiah Valley and determine whether free-ranging horses and Domestic Cattle (*Bos taurus*) were included and, if so, to what extent. (Note we use the anglicized spelling Chilcotin to refer to the geographic region and Tŝilhqot'in to refer to First Nation people.) Because wolves are known to consume free-ranging horses and/or ponies in other areas, as previously noted, we hypothesized that horse would be a part of wolf diet in our study area. Further, we hypothesized that cattle would be a part of the wolf diet given anecdotal

information (McCrory 2002; Card 2010; Lamb-Yorkski 2015).

Although others commonly refer to free-ranging horses as Feral Horses (the terms are often used interchangeably), we prefer and use the term "free-ranging" for the horses in our study area. This term better reflects a species that lives in an area less dominated by humans and that has endured natural selective pressures for more than 300 years; McCrory (2002), Bhattacharyya *et al.* (2011), Cothran and McCrory (2014), Bhattacharyya and Murphy (2015), and Bhattacharyya and Slocombe (2017) document the presence and history of the Brittany Triangle horses.

## Study Area

Our two adjacent study areas (Brittany Triangle, ~155 000 ha, and the Nemiah Valley, ~38 000 ha), each with different anthropogenic influences, are in the West Chilcotin region of the interior of BC (Figure 1) within the traditional territory of the Tŝilhqot'in Xeni Gwet'in First Nation and their ?Elegasi Qayus Wild Horse Preserve (Eagle Lake Henry Cayuse Wild Horse Preserve; Bhattacharyya *et al.* 2011; Bhattacharyya 2012). The Xeni Gwet'in have never signed treaties. In 2014, the Supreme Court of Canada recognized their rights and title (Supreme Court of Canada 2014) to the area that covers most of our study area and also includes Dasiqox Nexwagwez?an—a land, water, and wildlife protected conservation area and expression of Indigenous governance initiated in 2014 by the Xeni Gwet'in and Yunesît'in governments and supported by the Tŝilhqot'in National Government. A part of the Brittany Triangle is also in Nunsti Provincial Park. Most of the area is roadless and unlogged.

These areas are in the Interior Douglas Fir biogeoclimatic zone (IDFdk4; Meidinger and Pojar 1991) and include the eastern ranges and foothills of the Coast Mountains. The Chilcotin is characterized by semiarid grasslands and dry forests of Lodgepole Pine (*Pinus contorta* Douglas ex Loudon) with stands of Engelmann Spruce (*Picea engelmannii* Engelmann), as well as sedge meadows and wetlands (Grasslands Conservation Council of British Columbia 2010, as cited in Bhattacharyya *et al.* 2011). It is unique in that it is one of two regions in North America where free-ranging horses still coexist with a complete guild of large carnivores, the other region being the Rocky Mountain Foothills west of Sundre, Alberta (see Downer 2015; McCrory 2015; Zomorodi and Walker 2019). A small population of free-ranging horses also occurs in Saskatchewan's west-central Bronson Forest (Government of Saskatchewan 2009) where they are sympatric with wolves (Brown 2012), although other large carnivores, including Grizzly Bear (*Ursus arctos*) and Wolverine (*Gulo gulo*), have been extirpated there (COSEWIC 2012 and 2014, respectively).

Most data were collected in the Brittany Triangle, which supports one of the three self-sustaining free-ranging horse populations in Canada (McCrory 2002). The others include the horses in the foothills of Alberta and those on Nova Scotia's Sable Island, an offshore island in the North Atlantic and a national park reserve (Parks Canada 2021). The "triangle" is formed by the natural boundaries of the Chilko and Taseko Rivers on the north, east, and west, and by the Nemiah Valley on the south. The Brittany Triangle remains largely undisturbed by industry or anthropogenic influences, although a few small herds (<80 head) of cattle free-range from spring to fall on the west side (S.P. and W.P.M. pers. obs.). Of the estimated 2787 free-ranging horses in the greater Chilcotin plateau region (Environmental Dynamics Inc. 2019), ~150–215 live in the Brittany Triangle (G. Cothran and W.P.M. unpubl. data). Genetics indicate that the free-ranging horses of the Brittany Triangle are semi-isolated from adjacent horse populations. Both the Canadian Horse and, to a lesser degree, possibly East Russia/Yakut Horses contributed to the ancestry of Brittany horses (Cothran and McCrory 2014; G. Cothran and W.P.M. unpubl. data) whereas the Chilcotin horses to the east and north of the Brittany Triangle are largely of Spanish Iberian ancestry (G. Cothran and W.P.M. unpubl. data; L. Orlando pers. comm. 19 March 2020).

The Nemiah Valley, at the south end of the Brittany Triangle, is the home and official community centre for most of the Xeni Gwet'in, one of six member nations of the Tŝilhqot'in Nation (Bhattacharyya *et al*. 2011). The Nemiah Valley has ~400 residents (Bhattacharyya and Slocombe 2017) with a few tourism businesses and a few small ranches with cattle (S.P. and W.P.M. pers. obs.). A continuum of free-ranging horses occurs in the Nemiah Valley, varying from domestic (branded and halter-broke) to those that have never been handled by humans (Bhattacharyya and Larson 2014). Horse and cattle carcasses are sometimes left on the range in Nemiah after they die. Horse and cattle numbers in the Nemiah Valley were not determined for this study.

Besides free-ranging horses and cattle, other potential dietary items for wolves in both areas included Moose (*Alces americanus*), Mule Deer (*Odocoileus hemionus*), American Beaver (*Castor canadensis*), a variety of small mammals, and autumn runs of spawning wild Pacific salmon (*Oncorhynchus* spp.). A telemetry study of a small number of male Mule Deer in the Bridge River area to the south of our study area showed that most migrated from lower elevation winter and spring range to distant summer range to

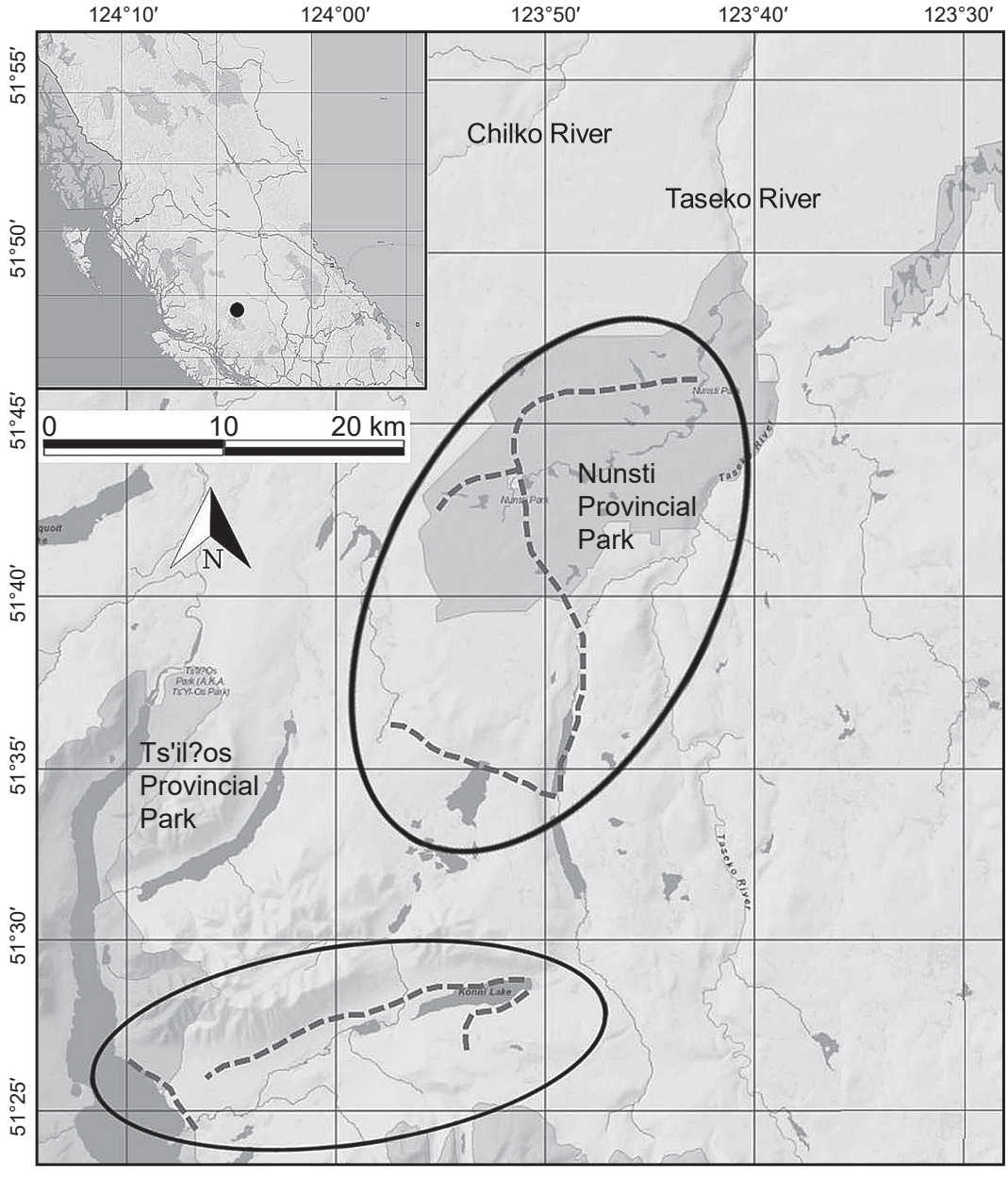


**FIGURE 1.** Approximate study areas on Chilcotin plateau, British Columbia, with transects shown as dashed lines. Top oval indicates Brittany Triangle study area and lower oval indicates Nemiah Valley area. The map inset shows the approximate location of the study area (dark circle) in British Columbia.

the west (Proctor and Iredale 2014), and Mule Deer in the study area are generally known to migrate annually to less harsh winter habitats at lower elevations along the Fraser River (Chilko Lake Study Team 1993; McCrory 2002; McCrory *et al.* 2014), leaving Moose and horse as the dominant ungulates available to predators in winter (McCrory 2002). Besides Gray Wolf, both areas host other large carnivores known to hunt free-ranging horses and large ungulates including Grizzly Bear (Clevenger *et al.* 1994; Pereira *et al.* 2021) and Cougar *(Puma concolor*; Turner *et al.* 1992; Greger and Romney 1999; Turner and Morrison 2001; Knopff 2010; Andreasen *et al*. 2021). Other resident carnivores include American Black Bear

(*Ursus americanus*), Wolverine, Coyote (*Canis latrans*), and Canada Lynx (*Lynx canadensis*).

## Methods

Our study took place over five years (2013–2017) during which ~300 field days were spent collecting wolf scats. Scats were collected while walking along established transects four times each year, with each sampling period ranging from two to four weeks each season. Seasons were: spring (March 1–May 31), summer (June 1–August 31), autumn (September 1–November 30), and winter (December 1–February 28). Transects were selected non-randomly to ensure even distribution and to represent areas of wolf use identified through winter tracking; they consisted of dirt roads, bush roads, old wagon trails, horse trails, meadows, and human-made firebreaks (Figure 1). Wolf scats that appeared to be less than a week old were collected along transects and opportunistically within the study area. Unless tracks could verify wolf presence, only scats >30 mm in diameter were collected to avoid collecting Coyote faeces (Urton 2004). A handheld global positioning system unit (Garmin GPS 60, Taiwan, China) was used to record the universal transverse Mercator locations of scats. Scats were stored in labelled (date and location) bags that were frozen until analysis. To roughly estimate wolf numbers and to determine whether wolves travelled between the two study areas, we recorded wolf tracks along transects in our winter field observations and did incidental backtracking when wolf tracks crossed transects.

In the lab, scats were autoclaved at 130°C for 30 min to minimize the risk of parasite transmission. A compound microscope was used to identify guard hairs to the species level, when possible, by comparing scale and medulla patterns with hair keys from the University of Calgary (U of C) Geography Department, and voucher specimens of beaver, cattle, deer, horse, and Moose collected from the study area and stored at the U of C, and reference guides (Adorjan and Kolenosky 1969; Kennedy and Carbyn 1981). Diet items were classified into eight categories: horse, cattle, deer, Moose, beaver, small mammal (including rodents, lagomorphs), bird, and fish. Beaver was classified separately from small mammals, which were identified to the lowest taxonomic level at which confidence remained high, with less-common items identified only to family/order level (Lukasik and Alexander 2011). Only S.P. analyzed each scat sample after training by two professionals from the U of C Canid Ecology Lab; ~10% were randomly re-analyzed by an independent third party trained in scat analysis at U of C, yielding a 100% rate of precision. We did not retain voucher hair specimens from our scat analyses.

We used two indices to estimate wolf scat contents: occurrence per faeces (OF) and occurrence per item (OI; Urton 2004). Occurrence per faeces is the frequency with which a dietary category occurs in all scat samples or a subset thereof (e.g., by season or area), with the sample size being the total number of scats examined. To account for multiple species occurring in one scat, OI was used to determine the frequency with which a dietary category occurs among all dietary categories identified (Urton 2004). Sample size for OI is thus the total number of all dietary categories found in each subset of scat analyzed.

## Results

Winter tracking, remote cameras, and direct sightings (S.P. and W.P.M. unpubl. data) suggested that at least some wolves travelled between the two study areas and that there was one or possibly two wolf packs in the combined study area; the number of wolves was not determined. Very little sign of deer was observed in winter, while direct sightings and sign of horse and Moose were more frequent (S.P. and W.P.M. unpubl. data).

We identified a variety of dietary items (Table 1) in the 122 wolf scats collected in the study area, which we grouped by season and area (Table 1). Horse, deer, Moose, and small mammal occurred in all four seasons (Figure 2a), although horse was absent from the two scats collected in the summer from the Brittany Triangle (Figure 2b). The OF for horse was largest in winter in both study areas combined (64.9%) and in the Brittany Triangle (75.0%). Overall, horse occurred in more than half of the 97 scats from the Brittany Triangle (OF = 59.8%, OI = 52.7%; Table 1, Figure 3). Only 25 wolf scats were collected from Nemiah Valley (Table 1); horse occurred there in each of the four seasons. Beaver and cattle occurred in scats only from the Nemiah Valley, and only minimally (Table 1).

## Discussion

Despite extensive ground efforts, our sample size was small and varied among years and seasons, limiting our conclusions. Gable *et al.* (2017) recommended that, to accurately estimate wolf population diet, sample sizes of 10–20 adult scats/pack/month from home sites and/or opportunistically from packs are needed to minimize the potential temporal, inter-pack, and age-class biases. Although we collected only 122 scat samples over five years, our analysis does show that Gray Wolves are consuming horses year-round in our study area, which includes western Canada's first wild horse preserve.

Although relative densities of ungulates were unknown, and much of these data are lacking, the

**TABLE 1.** Food items identified in Gray Wolf (*Canis lupus*) scats collected 2013–2017 in combined area (C), Brittany Triangle (BT), and Nemiah Valley (NV) study areas, British Columbia, Canada, by season.

| | Food items occurring in wolf scats | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Horse | Deer | Moose | Small mammal* | Beaver | Cattle | Fish | Bird | |
| Study area | | | | | | | | | |
| C (*n* = 122) | 65 | 30 | 5 | 32 | 1 | 4 | 2 | 1 | 140 |
| BT (*n* = 97) | 58 | 26 | 4 | 18 | 0 | 0 | 2 | 1 | 109 |
| NV (*n* = 25) | 7 | 4 | 1 | 14 | 1 | 4 | 0 | 0 | 31 |
| Study area and season | | | | | | | | | |
| C spring (*n* = 25) | 13 | 6 | 1 | 6 | 0 | 0 | 1 | 0 | 27 |
| C summer (*n* = 9) | 2 | 1 | 2 | 6 | 0 | 0 | 0 | 0 | 11 |
| C autumn (*n* = 32) | 13 | 10 | 1 | 16 | 0 | 0 | 1 | 0 | 41 |
| C winter (*n* = 56) | 37 | 13 | 1 | 5 | 1 | 4 | 0 | 1 | 62 |
| BT spring (*n* = 24) | 12 | 6 | 1 | 6 | 0 | 0 | 1 | 0 | 26 |
| BT summer (*n* = 2) | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| BT autumn (*n* = 23) | 10 | 8 | 1 | 10 | 0 | 0 | 1 | 0 | 30 |
| BT winter (*n* = 48) | 36 | 11 | 1 | 3 | 0 | 0 | 0 | 1 | 52 |
| NV spring (*n* =1) | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| NV summer (*n* = 7) | 2 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 9 |
| NV autumn (*n* = 9) | 3 | 2 | 0 | 6 | 0 | 0 | 0 | 0 | 11 |
| NV winter (*n* = 8) | 1 | 2 | 0 | 2 | 1 | 4 | 0 | 0 | 10 |

*Includes orders Rodentia and Lagomorpha.

timing of our research coincides with a declining Moose population trend documented for 1996–2015 in central BC (Kuzyk *et al.* 2018) and a relatively stable (i.e., unchanged) population of free-ranging horses in the Chilcotin between 2009 and 2019 (Environmental Dynamics Inc. 2019). Based on anecdotal animal sightings and observations of sign, higher densities of horse than Moose were apparent in our study area throughout the year (S.P. pers. obs.). Although deer, Moose, and small mammals were eaten throughout the year, we speculate that if our modest data set is representative of broader patterns throughout seasons and years, horse may be an important diet item for wolves, while cattle are not, although there were few scat samples from summer, when more vulnerable calves occur on the landscape. Few cattle appear to have been lost to wolves in this area; during the study, S.P. was in regular contact with local ranchers in the Nemiah Valley area, as well as with the Xeni Gwet'in Government, a Xeni Gwet'in Wild Horse Ranger, and Xeni Gwet'in Land Rangers who were informed of local events involving predators.

Scat analysis is also unable to reveal whether feeding occurred through predation or scavenging. Despite the strong possibility of wolves scavenging horses that died of other causes (i.e., scavenging is less risky than predation), predation of winter-weakened or newborn horses by wolves is likely. Predation could be expected, given the deep evolutionary history of wolves as predators of ungulates (Mech *et al.* 2015), the occurrence of horse in scats throughout the year in our combined study areas, and the documentation of wolves hunting free-ranging horses and/or ponies elsewhere (Patalano and Lovari 1993; Meriggi and Lovari 1996; Vos 2000; van Duyne *et al.* 2009; Webb 2009; Dorj and Namkhai 2013; Newsome *et al*. 2016; Lagos and Bárcena 2018; Chetri *et al.* 2019). Thus, we hypothesize that at least some of the horse in the wolf diet is from predation. Predation may also be more likely in the Brittany study area because horses there do not receive care or protection from humans. However, the details of wolves' horse-hunting behaviour remain to be studied.

Another bias arising from repeated scavenging of a carcass in one season is also possible. In addition, cattle and domestic horse carcasses left on the landscape in the Nemiah Valley may have confounded our results. Nonetheless, we found that cattle, although present in both study areas, were consumed by wolves minimally during our study. Of interest, some ranchers have suggested that free-ranging horses or ponies help minimize wolf predation on cattle (Card 2010; López-Bao *et al.* 2013). It is worth noting that although wild Pacific salmon are an important seasonal dietary resource for Gray Wolf on the BC coast (Darimont and Reimchen 2002; Darimont *et*

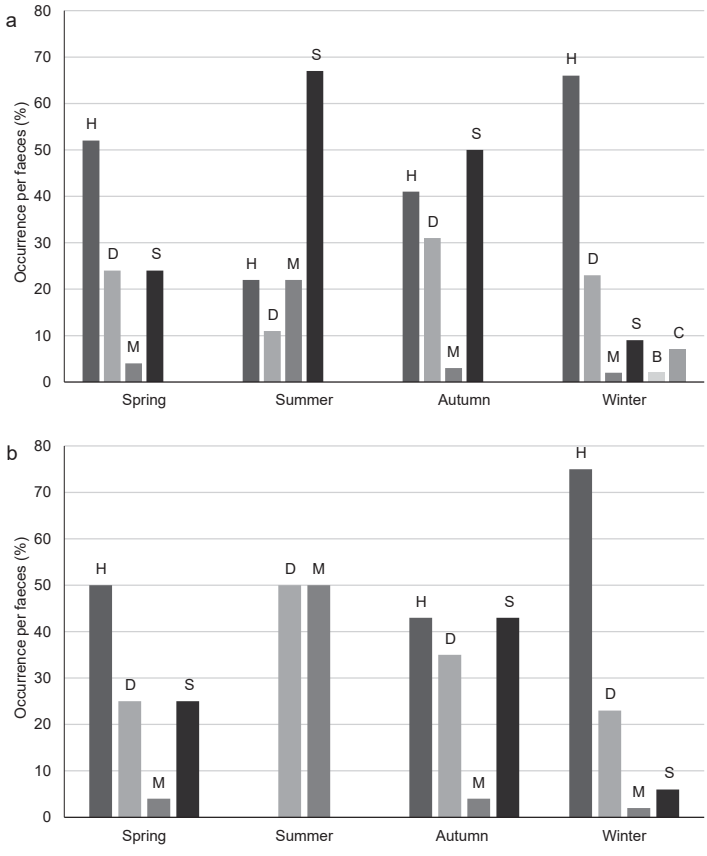


**FIGURE 2.** Seasonal variability in food items identified as occurrence per faeces (OF) in Gray Wolf (*Canis lupus*) scats collected 2013–2017 in a. combined area (spring $n$ = 25, summer $n$ = 9, autumn $n$ = 32, winter $n$ = 56); b. Brittany Triangle (spring $n$ = 24, summer $n$ = 2, autumn $n$ = 23, winter $n$ = 48), Chilcotin plateau, British Columbia. Only species with OF > 1% are included. Note: H = horse, D = deer, M = Moose, S = small mammal, B = beaver, C = cattle.

*al.* 2008) and are available in both study areas, minimal fish were detected in scats during annual spawning periods.

Finally, because our study included only a small number of wolves belonging to one or two packs, it is possible that the consistent consumption of horse we detected only reflects the habits of these specific packs and/or individuals. We also note that our study occurred over a brief period, whereas wolf prey use can vary substantially among years depending on a multitude of factors (Mattioli *et al.* 2011; Davis *et al.* 2012).

*Potential implications for management of free-ranging horse populations*

While acknowledging that concerns have been raised about the ecological interactions involving free-ranging horses and predators and the potential implications for biodiversity conservation (Boyce and McLoughlin 2021), namely through indirect competitive relationships (Wittmer et *al.* 2013; Gooch *et al.* 2017; Hall *et al.* 2018; Boyce and McLoughlin 2021), Duncan (1992) suggests that predation and horse social dynamics may be more important factors in regulating free-ranging horse populations than food supply. Based on our scat findings and given the minimum 300+ years that horses have been in this area (Storrar *et al.* 1977; McCrory 2002; Bhattacharyya *et al.* 2011; Bhattacharyya and Larson 2014; G. Cothran and W.P.M. unpubl. data) compared with millennia-scale evolutionary interactions between wolves and horses more generally, we postulate that Gray Wolves are potentially contributing as a top-down vector in limiting the size of the semi-isolated free-ranging horse population in the Brittany Triangle. Although this horse population might be influenced by a host of ecological factors, such as the harsh Chilcotin winters and other predators, it appears that wolves are consuming horses in our study area throughout all or most of the year.

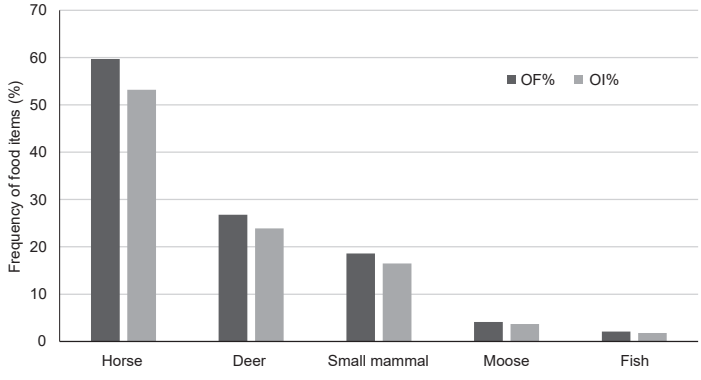


**FIGURE 3.** Occurrence per faeces (OF, $n$ = 97) and occurrence per incidence (OI, $n$ = 109) of food items detected in Gray Wolf (*Canis lupus*) scats collected in Brittany Triangle 2013–2017, Chilcotin plateau, British Columbia. Only items with OF > 2% were included.

## Author Contributions

Writing – Original Draft: S.P. and W.P.M.; Writing – Review & Editing: S.P. and W.P.M.; Conceptualization: S.P. and W.P.M.; Investigation: S.P.; Methodology: S.P. and W.P.M.; Formal Analysis: S.P. and W.P.M.; Funding Acquisition: S.P. and W.P.M.

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