How Competition Dynamics Drive Access To Shared Scavenging Opportunities Amongst a Group of Mesocarnivores in the Rocky Mountains of Alberta

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Scavenging Ecology & Competition Dynamics

Scavenging Ecology is an important pathway of energy transferability in terrestrial ecosystems (DeVault et al. 2003). In northern climate forests, scavenging represents a vital ecosystem process particularly in winter when resources are scarce (Pereira et al. 2014; Stiegler et al. 2020). Among vertebrate scavengers, mesocarnivores can account for the vast majority (sometimes upwards of 90%) of carrion consumption through facultative scavenging (Pereira et al. 2013), which may represent >30% of mesocarnivore diets (DeVault et al. 2003; Prugh et al. 2020).

Larger carnivores can facilitate or suppress access to carrion and much research has thus focused on the regulatory roles of large carnivores in scavenging dynamics of competitively subordinate species (Klauder et al. 2021). Yet, the nature of interactions between mesocarnivores at carcass sites has yet to be fully recognized as a unique and important component of scavenging ecology.

Research Objective: Determine the external factors that govern carrion acquisition by mesocarnivore scavengers a temperate montane forest of western Canada.

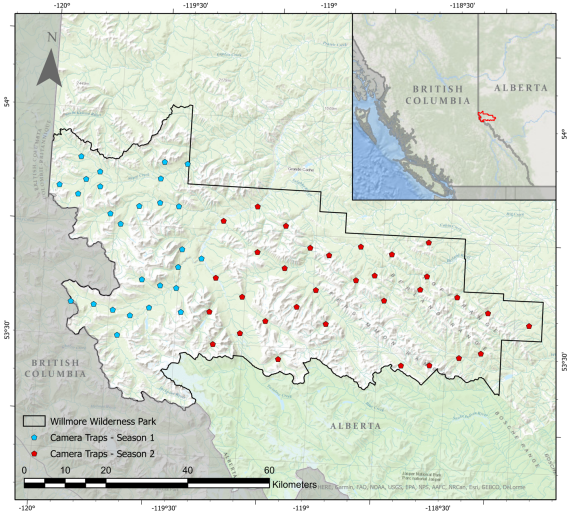

Figure 1: Willmore Wilderness Conservation Area, Alberta, Canada. Camera trap data were collected over two consecutive winter seasons during 2006/2007 (period 1, n=27, blue locations) and 2007/2008 (period 2, n=32, red locations).

Study Site and Camera Trap Data

- The Willmore Wilderness Park (WWP) is a 4,600 km^2 conservation area in the Rocky Mountain region of Alberta (Figure 1).
- Photographic data (n=59, Reconyx PM30 and PM85) provided by the Applied Conservation Macro Ecology Laboratory (ACME Lab) at the University of Victoria (see complete details: Fisher et al. 2011, 2013).
- Infrared camera traps set in a systematic sampling array and baited with beaver carcasses.
- Data collected between December – March (70-day period) over two consecutive winters during 2006/2007 (period 1, n=30) and 2007/2008 (period 2, n=36).

Figure 2: Camera trap image credit: Sandra Frey.

Focal Species and Predictor Variables

Figure 3: Camera trap images of marten (left, 22-02-2008) and wolverine (right, 03-03-2008) in the Wilmore Wilderness Park, AB.

Focal Species: Wolverine (*Gulo gulo*), American marten (*Martes americana*), Short-tailed weasel (*Mustela erminea*) *and* Lynx (*Lynx canadensis*) (Figure 3).

Environmental Predictor Variables:

- Landcover (open/closed): Alberta Satellite Land Cover (ASLC, 2018)
- Diel period (sunlight)
- Daily Snow Depth: *Canadian Meteorological Centre Daily Snow Depth Analysis Data* (Brown & Brasnett, 2010).

Methods

Zero-inflated Negative Binomial (ZINB): ZINB models are a two-tiered process that estimate the degree of influence that environmental and competition factors at camera sites have on (1) species presence/absence and (2) the rate at which sites are utilized. This provides insight into mesocarnivore spatial segregation and avoidance or attraction based on intensity of site use by competitors.

Temporal Spacing Analysis: Analysis uses time-since data to ask whether mustelids visited carcass following a competitor in more or less time than would be expected at random. Describes overall trend in temporal attraction or avoidance for mustelids that intersect spatially.

Cox Proportional Hazard Model (CPH): CPH is a time-to-event model that assesses the role of habitat characteristics in shaping fine-scale temporal interactions. An event is defined here as a capture of a focal species subsequent to the capture of a competitor which serves as the reference point with respect to time (t = 0). These models then look at the proportional rate of events over increasing time-since, to evaluate the influence of external factors on whether the event takes place.

Results

ZINB Model Results

- **Wolverine** presence and rate of site use increased with low relative snow depth. Their presence decreased and rate of use increased in association with marten and they were notably nearly 8 times less likely to be present where lynx were found.
- **Marten** presence was highest in closed forest habitats with low relative snow depth With respect to competition, marten presence was approximately 40% lower at sites occupied by wolverine. Marten rate of site use was negatively associated with the rate at which lynx visited carcass sites.
- The frequency of **Weasel** feeding events decreased with increased snow depth. Weasel rate of site use was also sensitive to competition, decreasing with increasing site visits by marten.

Cox Proportional Hazard Model Results

- Model selection using AICc weights resulted in the removal of landcover from consideration in the analysis. Likelihood ratio tests for overall model performance revealed that the predictive factors in models for weasels or for wolverine following weasel - did not significantly explain variability in the data and were overall poor predictors of time-since measures.
- Wolverine were more likely to appear at a carrion site following a marten during the night with decreasing snow depth.
- The rate of marten events subsequent to both competitors revealed significant non-linear trends for snow depth.

Results

Temporal Spacing Analysis Results

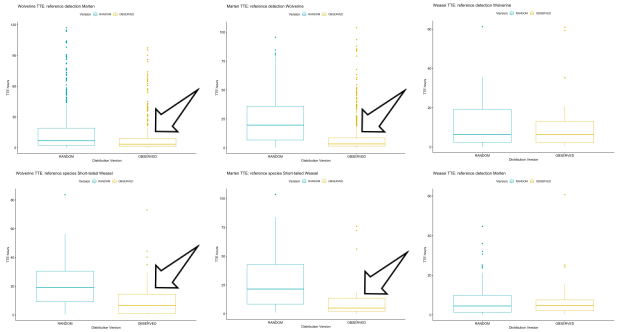

Figure 4: Temporal spacing box plots representing results of Wilcoxon rank sum test for 2-group comparison of average temporal spacing according to random (TTE_R) and observed (TTE_{obs}) time-since distributions, following a competitive threat for all focal species pairs. Reference detections represent the competitor that visited the resource first. Median time-since measures for TTE_{obs} that were found to be significantly different from TTE_R where p-value < 0.05 (Table S2), are indicated with an arrow.

Significant Findings and Conclusions

Wolverine – ***Scavenging intensity unimpeded by competition factors,*** consistent with observed tendencies for wolverine to dominate activity at carrion sites (Klauder et al. 2021).

Marten – ***Maximized access to carcasses through adaptive competitor-specific behavioural tactics.*** Wolverine possess physical adaptations for feeding on bone and frozen carcasses (Banci, 1994) and may offer a service by opening carcasses.

Weasel – Weasels, the smallest species in our study, are ***proficient at navigating arboreal and subnivean spaces and appear evade larger competitors by immediate escape*** rather than through broader spatial avoidance.

Daily Snow Depth: ***Snow Depth stood out as an important site attribute impacting scavenging behaviours.*** Varied responses to snow depth likely relate to mobility (Wright & Ernst, 2004), thermoregulation periods during severe winter conditions (Taylor & Buskirk, 1994), concealment and availability of forage in the subnivean space and at the surface.

Habitat Character Effects: ***Competitive interactions could intensify under reduced differential habitat use at carcass sites.*** Wolverine utilized all available habitats whereas marten avoided open clearings and there was no apparent influence of landcover on site usage of weasels.

Spatial-temporal responses to intraguild competition at scavenging sites is dynamic and subject to localized site conditions. Understanding the factors that drive access to these ephemeral resources provides valuable insights for anticipating impacts of climate and landscape change on facultative scavengers in the boreal forests of western Canada.

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