**Appendix S2: Tables**

Giorgia Ausilio, Håkan Sand, Johan Månsson, Karen Marie Mathisen, Camilla Wikenros

Ecological effects of wolves in anthropogenic landscapes: potential for trophic cascade is context-dependent

*Frontiers in Ecology and Evolution*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Collinearity statistics** | | |
| **Response variables** | **Independent variables** | Tolerance | VIF | Increased SE |
| *Moose presence/abundance* | Wolf presence | 0.44 | 2.24 | 1.50 |
|  | Forest age | 0.75 | 1.32 | 1.15 |
|  | Distance main roads | 0.94 | 1.06 | 1.03 |
|  | Distance forest roads | 0.92 | 1.08 | 1.04 |
|  | Pine proportion | 0.84 | 1.18 | 1.09 |
|  | RAWO presence | 0.93 | 1.07 | 1.03 |
|  | Wolf presence:Forest age | 0.41 | 2.40 | 1.55 |
|  |  |  |  |  |
| *Browsing presence/intensity* | Wolf presence | 0.98 | 1.02 | 1.01 |
|  | Distance main roads | 0.96 | 1.04 | 1.02 |
|  | Distance forest roads | 0.94 | 1.06 | 1.03 |
|  | Pine proportion | 0.97 | 1.03 | 1.01 |
|  | RAWO presence | 0.93 | 1.07 | 1.03 |
|  | Moose pellet counts | 0.97 | 1.03 | 1.02 |
|  | Previous browsing damage | 0.97 | 1.03 | 1.01 |

**Table S1**: Variance inflation factors (VIF) and tolerance values for each independent variable obtained from the collinearity analyses performed on 1) the logistic models for moose presence and browsing presence, and the zero-inflated models for moose abundance and browsing damage intensity. For each variable, the increased standard error (SE) is also shown. Values of VIF exceeding 10 are often considered as indicating multicollinearity (Mason et al., 1989; Allison, 2001; Pallant, 2013), and tolerance values that are less than 0.1 can also indicate possibility for multicollinearity. The analysis showed that there is zero to low multicollinearity in our models, since all VIF values are below 10 (in fact they are all <2.5) and the tolerance values are all larger than 0.10.

**Table S2**: General linear mixed models used to assess the effect of wolf presence or time since wolf territory establishment (light gray under values for wolf presence), forest age stage (forest stage), distance from forest (Forest roads) and main (Main roads) roads, pine proportion and RAWO presence on **moose** **presence** in Sweden between 2003 and 2016. Moose presence (binomial variable, presence/absence) was used as the response variable, and year of survey was used as random factor to account for year effects. For each model, degrees of freedom (df), difference in AIC relative to the highest-ranked model (ΔAIC), and AIC weights (wi) are shown. Only the three top-ranked models (lowest ΔAIC; red square), univariate models, and intercept-only models are shown.

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|  | **Top ranked models** | | | **Univariate models** | | | | | | |
|  | **M1** | **M2** | **M3** | **M4** | **M5** | **M6** | **M7** | **M8** | **M9** | **M10** |
| **Response variable** |  |  |  |  |  |  |  |  |  |  |
| Moose presence | X | X | X | X | X | X | X | X | X | X |
| **Fixed effects** |  |  |  |  |  |  |  |  |  |  |
| Wolf presence  (*Time wolf estab.*) | X | X | X |  |  | X |  |  |  |  |
| Forest age | X | X | X | X |  |  |  |  |  |  |
| Forest roads | X | X | X |  |  |  | X |  |  |  |
| Main roads |  | X |  |  |  |  |  |  | X |  |
| Pine proportion | X | X | X |  | X |  |  |  |  |  |
| RAWO presence |  | X | X |  |  |  |  | X |  |  |
| Interaction1 |  |  |  |  |  |  |  |  |  |  |
| **Intercept** |  |  |  |  |  |  |  |  |  | X |
| **Random effects** |  |  |  |  |  |  |  |  |  |  |
| Year of inventory | X | X | X | X | X | X | X | X | X | X |
|  |  |  |  |  |  |  |  |  |  |  |
| **Model criteria** |  |  |  |  |  |  |  |  |  |  |
| df | 10 | 11 | 8 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| ΔAIC | **0\*** | 1.06 | 1.54 | 28.53 | 111.8 | 167.97  (169.3) | 168.4 | 178.3 | 179.5 | 184.12 |
| wi | **0.49\***  **(0.46)** | 0.29 | 0.23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| \* = best model | | | | | | | | | | |
| 1 = interaction between wolf presence and forest age stage | | | | | | | | | | |

**Table S3**: General linear mixed models used to assess the effect of wolf presence or time since wolf territory establishment (light gray under values for wolf presence), forest age stages (forest stage), distance from forest (Forest roads) and main (Main roads) roads, pine proportion and RAWO presence on **moose** **abundance** in Sweden between 2003 and 2016. Moose abundance (the number of pellet counts) was used as the response variable, and year of survey was used as random factor to account for year effects. For each model, degrees of freedom (df), difference in AIC relative to the highest-ranked model (ΔAIC), and AIC weights (wi) are shown. Only the three top-ranked models (lowest ΔAIC; red square), univariate models, and intercept-only models are shown. Zi(X) corresponds to zero-inflated (X) and indicates that the explanatory variable was only important in the zero-inflated part of the model, whereas X+ Zi(X) indicates that the explanatory variable was important in both the conditional and zero-inflated parts of the model.

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|  | **Top ranked models** | | | | | **Univariate models** | | | | | | | | |
|  | **M1** | **M2** | **M3** | **M5** | **M6** | | **M7** | | **M8** | | **M9** | **M10** | **M11** |
| **Response variable** | |  |  |  |  | |  | |  | |  |  |  |
| Moose abundance | X | X | X | X | X | | X | | X | | X | X | X |
| **Fixed effects** | |  |  |  |  | |  | |  | |  |  |  |
| Wolf presence  *(Time wolf estab.)* | X | X | X |  |  | |  | | X | |  |  |  |
| Forest age | X | X | X | X |  | |  | |  | |  |  |  |
| Forest roads | X + Zi(X) | X + Zi(X) | X |  | X | |  | |  | |  |  |  |
| Main roads | X + Zi(X) | X | X |  |  | | X | |  | |  |  |  |
| Pine proportion | Zi(X) | Zi(X) | Zi(X) |  |  | |  | |  | |  |  | X |
| RAWO presence |  | X | X |  |  | |  | |  | |  | X |  |
| Interaction1 |  |  |  |  |  | |  | |  | |  |  |  |
| **Intercept** |  |  |  |  |  | |  | |  | | X |  |  |
| **Random effects** | |  |  |  |  | |  | |  | |  |  |  |
| Year | X | X | X | X | X | | X | | X | | X | X | X |
|  |  |  |  |  |  | |  | |  | |  |  |  |
| **Model criteria** | |  |  |  |  | |  | |  | |  |  |  |
| df | 13 | 14 | 13 | 3 | 3 | | 3 | | 3 | | 3 | 3 | 2 |
| ΔAIC | **0\*** | 0.95 | 1.38 | 43.2 | 163.4 | | | 165.5 | | 167.0  (169.3) | 175.2 | 183.2 | 191.2 |
| wi | **0.3\* (0.24)** | 0.19 | 0.13 | 0 | 0 | | 0 | | 0 | | 0 | 0 | 0 |
| \* = best model | | | | | | | | | | | | | | |
| 1 = interaction between wolf presence and forest age stage | | | | | | | | | | | | | | |
| Zi(X) = variable in the zero-inflated part of the model | | | | | | | | | | | | | | |
| X + Zi(X) = variable in both the conditional and zero-inflated parts of the model | | | | | | | | | | | | | | |

**Table S4:** General linear mixed models used to assess the effect of wolf presence or time since wolf territory establishment (not present in table as not significant), moose abundance, distance from forest roads (Forest roads) and main roads (Main roads), pine proportion, RAWO presence on **browsing** **damage** **presence** (Damage presence) in Sweden between 2003 and 2016. Browsing damage presence (binomial variable, presence/absence) was used as the response variable, and year of survey was used as random factor to account for year effects. For each model, degrees of freedom (df), difference in AIC relative to the highest-ranked model (ΔAIC), and AIC weights (wi) are shown. Only the three top-ranked models (lowest ΔAIC; red square), univariate models, and intercept-only models are shown.

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|  | **Top ranked models** | | | **Univariate models** | | | | | | | |
|  | **M1** | **M2** | **M3** | **M4** | **M5** | **M6** | **M7** | **M8** | **M9** | **M10** | **M11** |
| **Response variable** | |  |  |  |  |  |  |  |  |  |  |
| Damage presence | X | X | X | X | X | X | X | X | X | X | X |
| **Fixed effects** | |  |  |  |  |  |  |  |  |  |  |
| Wolf presence |  |  | X |  |  |  |  | X |  |  |  |
| Moose abundance | X | X | X |  | X |  |  |  |  |  |  |
| Forest roads |  |  |  |  |  |  | X |  |  |  |  |
| Main roads | X | X | X |  |  | X |  |  |  |  |  |
| Pine proportion |  |  | X |  |  |  |  |  |  |  | X |
| RAWO presence | X |  | X |  |  |  |  |  |  | X |  |
| Previous browsing | X | X | X | X |  |  |  |  |  |  |  |
| **Intercept** |  |  |  |  |  |  |  |  | X |  |  |
| **Random effects** | |  |  |  |  |  |  |  |  |  |  |
| Year | X | X | X | X | X | X | X | X | X | X | X |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Model criteria** | |  |  |  |  |  |  |  |  |  |  |
| df | 6 | 5 | 7 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| ΔAIC | **0\*** | 0.24 | 1.27 | 7.89 | 24.93 | 39.41 | 40.07 | 40.13 | 40.27 | 41.01 | 41.50 |
| wi | **0.2** | 0.14 | 0.10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| \* = best model | | | | | | | | | | | |

**Table S5**: General linear mixed models used to assess the effect of wolf presence or time since wolf territory establishment (not present in table as not significant), forest successional stages (forest stage), distance from forest (Forest roads) and main (Main roads) roads, pine proportion and RAWO presence on **browsing** **damage intensity** (Damage intensity) in Sweden between 2003 and 2016. Browsing damage intensity (number of trees with browsing damage) was used as the response variable, and year of survey was used as random factor to account for year effects. For each model, degrees of freedom (df), difference in AIC relative to the highest-ranked model (ΔAIC), and AIC weights (wi) are shown. Only the three top-ranked models (lowest ΔAIC; red square), univariate models, and intercept-only models are shown. Zi(X) corresponds to zero-inflated (X) and indicates that the explanatory variable was only important in the zero-inflated part of the model, whereas X+ Zi(X) indicates that the explanatory variable was important in both the conditional and zero-inflated parts of the model.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Top ranked models** | | | **Univariate models** | | | | | | | |
|  | **M1** | **M2** | **M3** | **M4** | **M5** | **M6** | **M7** | **M8** | **M9** | **M10** | **M11** |
| **Response variable** | |  |  |  |  |  |  |  |  |  |  |
| Damage intensity | X | X | X | X | X | X | X | X | X | X | X |
| **Fixed effects** | |  |  |  |  |  |  |  |  |  |  |
| Wolf presence |  |  |  |  |  |  |  |  |  | X |  |
| Moose abundance | X + Zi(X) | X + Zi(X) | X + Zi(X) |  | X |  |  |  |  |  |  |
| Forest roads | X | X | X |  |  |  | X |  |  |  |  |
| Main roads | X | X |  |  |  |  |  |  | X |  |  |
| Pine proportion |  | Zi(X) |  |  |  |  |  | X |  |  |  |
| RAWO presence | X | X | X |  |  | X |  |  |  |  |  |
| Previous browsing | X + Zi(X) | X + Zi(X) | X + Zi(X) | X |  |  |  |  |  |  |  |
| **Intercept** |  |  |  |  |  |  |  |  |  |  | X |
| **Random effects** | |  |  |  |  |  |  |  |  |  |  |
| Year of inventory | X | X | X | X | X | X | X | X | X | X | X |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Model criteria** | |  |  |  |  |  |  |  |  |  |  |
| df | 11 | 12 | 10 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| ΔAIC | **0\*** | 0.63 | 0.73 | 9.6 | 25.8 | 39 | 39.1 | 40.1 | 42.2 | 43.1 | 44.1 |
| wi | **0.17** | 0.13 | 0.11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| \* = best model | | | | | | | | | | | |
| Zi(X) = variable in the zero-inflated part of the model | | | | | | | | | | | |
| X + Zi(X) = variable in both the conditional and zero-inflated parts of the model | | | | | | | | | | | |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |