**Electronic Supplementary Materials**

SM1: Comparison of IAH and HHH statistically significant variables among occupied and vacant sites. We reported the neighbouring sites distance (km), p-value and standard deviation of each test.

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| **IAH** |  | **Occupied (82)** | **Vacant (56)** |
| Mean NND1 (km) | 14.09 | 10.31 |
| Standard deviation | 6.44 | 5.19 |
| t136 = 3.66, p-value < 0.05  |
| Mean NND2 (km) | 20.67 | 16.65 |
| Standard deviation | 8.60 | 7.35 |
| t136 = 2.87, p-value < 0.05 |
| Mean NND1/NNDX | 1.40 | 0.84 |
| Standard deviation | 0.91 | 0.52 |
| t136 = 4.18, p-value < 0.05  |
| **HHH** | Mean TC5 (sq. km) | 38.11 | 34.14 |
| Dev. standard | 14.45 | 10.90 |
| t136 = 1.75, p-value < 0.05  |
| Mean TF5 (sq. km) | 39.75 | 44.69 |
| Standard deviation | 14.69 | 12.54 |
| t136 = 2.06, p-value < 0.05  |
| Mean TC5/TF5 | 1.62 | 0.92 |
| Standard deviation | 2.54 | 0.65 |
| t136 = 2.00, p-value < 0.05  |
|  | Mean (NND1/NNDX)/(TCL5/TC5) | 0.59 | 0.35 |
| Standard deviation | 0.47 | 0.31 |
| t136 = 3.32, p-value < 0.05  |

SM2: Comparison of the impact of protection over IAH (NND1, Maximum mean elevation, NND1/NNDX) and HHH (TC5, TCL5) and hybrid ((NND1/NNDX)/(TCL5/TC5)) variables measured on occupied sites.

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|  | **Occupied****protected** | **Occupied****Unprotected** |
| Samples | 42 | 40 |
| **IAH** | Mean NND1 | 12.30 | 15.96 |
| Standard deviation | 6.29 | 6.13 |
| t80 = 2.67, p-value < 0.05 |
| Maximum Mean elevation (m) | 2047.14 | 1759.33 |
| Standard deviation | 323.95 | 305.36 |
| t80 = 4.14, p-value < 0.05 |
| Mean NND1/NNDX | 1.11 | 1.71 |
| Standard deviation | 0.64 | 1.04 |
| t80 = 3.25, p-value < 0.05  |
| **HHH** |  | Occupied protected | Occupied unprotected |
| Mean TC5 (sq. km) | 40.08 | 36.04 |
| Standard deviation | 16.96 | 11.07 |
| t80 = 1.27, p-value = 0.21 |
| Mean TCL5 (sq. km) | 17.92 | 16.70 |
| Standard deviation | 13.30 | 8.42 |
| t80 = 0.49, p-value = 0.62 |
|  | Mean (NND1/NNDX)/(TCL5/TC5) | 0.43 | 0.76 |
| Standard deviation | 0.34 | 0.53 |
| t80 = 3.39, p-value < 0.05 |

SM3: Comparison of NND1/NNDX ratio over vacant and occupied sites localized in protected and non-protected areas.

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| **Territories located inside Protected Areas** |
|  | **Vacant** | **Occupied** | **Tot.** |
| NND1/NNDX ≥1 | 2 | 19 | 21 |
| NND1/NNDX <1 | 6 | 23 | 29 |
| Tot. | 8 | 42 | 50 |
| Χ2 = 0.45, p-value = 0.50 |
| **Territories located outside Protected Areas** |
|  | **Vacant** | **Occupied** | **Tot.** |
| NND1/NNDX ≥1 | 8 | 26 | 34 |
| NND1/NNDX <1 | 40 | 14 | 54 |
| Tot. | 48 | 40 | 88 |
| Χ2 = 19.51, p-value < 0.05 |

SM4: Comparison of NND1/NNDX for vacant and occupied sites

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|  | **Vacant** | **Occupied** | **Tot.** |
| NND1/NNDX ≥1 | 10 | 45 | 55 |
| NND1/NNDX <1 | 46 | 37 | 83 |
| Tot. | 56 | 82 | 138 |
| Χ2 = 17.51, p-value < 0.05 |
| NND1/NNDX | 0.83+/-0.52 | 1.40+/-0.91 |  |
| t136 = 4.18, p-value < 0.05 |

SM5: Preliminary data on dead Golden Eagles in the Central Apennines in the last 20 years

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| **Date** | **Region** | **Age** | **Sex** | **Cause** | **Protected area** |
| June 2013 | Abruzzo | NA | N/A | Poisoning | Yes |
| September 2013 | Umbria | NA | N/A | Shot | No |
| November 2013 | Umbria | Subadult | N/A | Shot | No |
| March 2019 | Umbria | Subadult | Male | Poisoning | No |
| March 2019 | Umbria | Subadult | Female | Poisoning | No |
| May 2020 | Marche | Adult | Male | Shot | Yes |
| September 2021 | Marche | Juvenile | N/A | Electrocution | Yes |
| February 2022 | Lazio | NA | N/A | Shot | Yes |
| March 2023 | Lazio | Subadult | N/A | Poisoning | Yes |
| April 2023 | Abruzzo | NA | NA | NA | NA |
| April 2023 | Marche | NA | NA | NA | Yes |
| June 2023 | Lazio | Adult | Male | Poisoning | No |