**Anthropogenic pressures within the breeding range of the Hen Harrier *Circus cyaneus* in Ireland**

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**Supplementary Information**

**Table S1.** Pressure codes and descriptions. Reproduced from Ruddock *et al.* (2016). Adapted from the EU Birds Directive reporting matrix (http://cdr.eionet.europa.eu/help/birds\_art12).

|  |  |
| --- | --- |
| **Code** | **Description of pressure** |
| A1 | Modification of cultivation practices  |
| A2 | Agricultural intensification  |
| A3 | Mowing / cutting of grassland  |
| A4 | Abandonment / lack of mowing  |
| A5 | Intensive grazing  |
| A6 | Non-intensive grazing  |
| A7 | Abandonment of pastoral systems, lack of grazing  |
| A8 | Fertilisation (agricultural)  |
| A9 | Removal of hedges and copses or scrub  |
| B1 | Forest planting on open ground (increase in forest area, planting e.g. on grassland, heathland)  |
| B2 | Forest and plantation management & use  |
| B3 | Forest replanting (i.e. replanting on forest ground after clear-cutting)  |
| B4 | Forest clearance (clear-cutting, removal of all trees)  |
| B5 | Thinning of tree layer  |
| B6 | Fertilisation (forestry)  |
| B7 | Other forest activities (e.g. erosion due to forest clearing, fragmentation)  |
| C1 | Hand cutting of peat  |
| C2 | Mechanical removal of peat  |
| C3 | Wind energy production  |
| D1 | Paths, tracks, cycling tracks (includes non-paved forest roads)  |
| D2  | Roads, motorways (all paved/ tarred roads)  |
| D3 | Utility and service lines (e.g. power-lines, pipelines)  |
| D4 | Aircrafts or flightpaths  |
| D5 | Improved access to site  |
| E1 | Urbanisation, residential and commercial development  |
| E2 | Dispersed habitation (i.e. little or no human disturbance)  |
| F1 | Nest destruction  |
| F2 | Illegal killing (e.g. shooting, trapping, poisoning)  |
| G1 | Human intrusions and disturbances  |
| G2 | Outdoor sports and leisure activities, recreational activities  |
| G3 | Walking, horse-riding and non-motorised vehicles  |
| G4  | Motorised vehicles  |
| G5 | Off-road motorised driving  |
| G6 | Other outdoor sports and leisure activities  |
| G7 | Military manoeuvres  |
| H1 | Pollution (e.g. water pollution, fly-tipping)  |
| J1 | Natural fires  |
| J2 | Controlled burning (e.g. strip burning for grouse management)  |
| J3 | Uncontrolled burning (e.g. widespread unmanaged or malicious burning)  |
| J4  | Modification of water levels or waterbodies  |
| J5 | Reduction or loss of specific habitat features (e.g. removal of hedgerows, deep heather, scrub, walls, drains)  |
| J6  | Reduction of prey availability  |
| J7 | Anthropogenic reduction of habitat connectivity (i.e. fragmentation such as by removal of large areas of habitat or creation of barriers between habitats)  |
| K1 | Interspecific faunal relations - predation (by other birds e.g. crows)  |
| K2 | Interspecific faunal relations - predation (by mammals e.g. foxes)  |
| X | No pressures recorded  |
| O | Other pressures not listed above; noted pressures included bracken encroachment, cattle, drainage, helicopter training, quarrying and shooting. |

**Table S2.** Summary data for all survey squares where the total number of pressures was greater than zero. SPA = location of survey site relative to Special Protection Area (SPA) boundaries: 1 = inside; 0 = outside. PI = standardised Pressure Index (see main text).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Site number** | **Total number of pressures** | **Total number of observer visits** | **Total number of Hen Harrier territories** | **SPA** | **PI** |
| 1 | 1 | 5 | 0 | 0 | 0.01 |
| 2 | 10 | 45 | 0 | 0 | 0.02 |
| 3 | 22 | 16 | 0 | 0 | 0.10 |
| 4 | 8 | 10 | 0 | 0 | 0.06 |
| 5 | 10 | 9 | 0 | 0 | 0.08 |
| 6 | 23 | 8 | 0 | 0 | 0.21 |
| 7 | 5 | 3 | 0 | 0 | 0.12 |
| 8 | 4 | 8 | 0 | 0 | 0.04 |
| 9 | 12 | 6 | 0 | 0 | 0.15 |
| 10 | 34 | 17 | 1 | 0 | 0.15 |
| 11 | 14 | 14 | 3 | 0 | 0.07 |
| 12 | 16 | 14 | 1 | 0 | 0.08 |
| 13 | 19 | 22 | 1 | 0 | 0.06 |
| 14 | 9 | 2 | 0 | 0 | 0.33 |
| 15 | 2 | 3 | 0 | 0 | 0.05 |
| 16 | 4 | 3 | 0 | 0 | 0.10 |
| 17 | 9 | 12 | 1 | 0 | 0.06 |
| 18 | 17 | 35 | 2 | 1 | 0.04 |
| 19 | 9 | 11 | 2 | 0 | 0.06 |
| 20 | 2 | 3 | 0 | 0 | 0.05 |
| 21 | 6 | 30 | 2 | 0 | 0.01 |
| 22 | 7 | 12 | 0 | 0 | 0.04 |
| 23 | 8 | 10 | 1 | 0 | 0.06 |
| 24 | 3 | 5 | 1 | 0 | 0.04 |
| 25 | 6 | 43 | 1 | 0 | 0.01 |
| 26 | 15 | 13 | 1 | 1 | 0.09 |
| 27 | 23 | 78 | 1 | 1 | 0.02 |
| 28 | 10 | 8 | 0 | 0 | 0.09 |
| 29 | 4 | 8 | 0 | 0 | 0.04 |
| 30 | 3 | 13 | 0 | 0 | 0.02 |
| 31 | 3 | 6 | 0 | 0 | 0.04 |
| 32 | 18 | 31 | 0 | 0 | 0.04 |
| 33 | 9 | 9 | 0 | 0 | 0.07 |
| 34 | 20 | 78 | 3 | 1 | 0.02 |
| 35 | 9 | 29 | 0 | 0 | 0.02 |
| 36 | 2 | 6 | 0 | 0 | 0.02 |
| 37 | 2 | 2 | 0 | 0 | 0.07 |
| 38 | 6 | 3 | 0 | 0 | 0.15 |
| 39 | 6 | 5 | 0 | 0 | 0.09 |
| 40 | 5 | 82 | 2 | 1 | 0.00 |
| 41 | 7 | 10 | 1 | 1 | 0.05 |
| 42 | 1 | 44 | 1 | 0 | 0.00 |
| 43 | 13 | 142 | 7 | 1 | 0.01 |
| 44 | 5 | 3 | 0 | 0 | 0.12 |
| 45 | 16 | 21 | 0 | 0 | 0.06 |
| 46 | 3 | 3 | 0 | 0 | 0.07 |
| 47 | 3 | 2 | 0 | 0 | 0.11 |
| 48 | 24 | 8 | 0 | 0 | 0.22 |
| 49 | 3 | 1 | 0 | 0 | 0.22 |
| 50 | 5 | 2 | 0 | 0 | 0.19 |
| 51 | 6 | 11 | 0 | 0 | 0.04 |
| 52 | 19 | 10 | 0 | 0 | 0.14 |
| 53 | 9 | 9 | 0 | 0 | 0.07 |
| 54 | 6 | 2 | 0 | 0 | 0.22 |
| 55 | 26 | 5 | 0 | 0 | 0.39 |
| 56 | 1 | 8 | 0 | 0 | 0.01 |
| 57 | 65 | 23 | 1 | 1 | 0.21 |
| 58 | 95 | 32 | 2 | 1 | 0.22 |
| 59 | 6 | 1 | 0 | 0 | 0.44 |
| 60 | 17 | 3 | 0 | 0 | 0.42 |
| 61 | 122 | 60 | 2 | 1 | 0.15 |
| 62 | 59 | 11 | 0 | 0 | 0.40 |
| 63 | 17 | 11 | 1 | 0 | 0.11 |
| 64 | 6 | 2 | 0 | 0 | 0.22 |
| 65 | 33 | 17 | 1 | 0 | 0.14 |
| 66 | 56 | 40 | 2 | 1 | 0.10 |
| 67 | 68 | 62 | 2 | 1 | 0.08 |
| 68 | 2 | 5 | 0 | 0 | 0.03 |
| 69 | 13 | 79 | 5 | 1 | 0.01 |
| 70 | 17 | 60 | 4 | 1 | 0.02 |
| 71 | 17 | 4 | 0 | 0 | 0.31 |
| 72 | 81 | 50 | 2 | 0 | 0.12 |
| 73 | 1 | 5 | 0 | 0 | 0.01 |
| 74 | 54 | 25 | 0 | 0 | 0.16 |
| 75 | 40 | 21 | 2 | 1 | 0.14 |
| 76 | 8 | 34 | 2 | 1 | 0.02 |
| 77 | 2 | 31 | 0 | 0 | 0.00 |
| 78 | 2 | 43 | 2 | 1 | 0.00 |
| 79 | 33 | 17 | 0 | 0 | 0.14 |
| 80 | 9 | 8 | 0 | 0 | 0.08 |
| 81 | 4 | 1 | 0 | 0 | 0.30 |
| 82 | 2 | 2 | 0 | 0 | 0.07 |
| 83 | 40 | 50 | 2 | 0 | 0.06 |
| 84 | 5 | 12 | 1 | 0 | 0.03 |
| 85 | 54 | 12 | 0 | 0 | 0.33 |
| 86 | 5 | 7 | 0 | 0 | 0.05 |
| 87 | 48 | 36 | 2 | 1 | 0.10 |
| 88 | 2 | 1 | 0 | 0 | 0.15 |
| 89 | 113 | 143 | 5 | 0 | 0.06 |
| 90 | 3 | 1 | 0 | 0 | 0.22 |
| 91 | 74 | 21 | 3 | 0 | 0.26 |
| 92 | 14 | 9 | 0 | 0 | 0.12 |
| 93 | 150 | 60 | 2 | 1 | 0.19 |
| 94 | 19 | 11 | 1 | 0 | 0.13 |
| 95 | 53 | 25 | 2 | 0 | 0.16 |
| 96 | 35 | 15 | 2 | 1 | 0.17 |
| 97 | 73 | 14 | 1 | 0 | 0.39 |
| 98 | 11 | 11 | 0 | 0 | 0.07 |
| 99 | 21 | 26 | 1 | 1 | 0.06 |
| 100 | 5 | 11 | 1 | 0 | 0.03 |
| 101 | 11 | 17 | 1 | 0 | 0.05 |
| 102 | 20 | 5 | 0 | 0 | 0.30 |
| 103 | 15 | 4 | 1 | 0 | 0.28 |
| 104 | 15 | 25 | 0 | 0 | 0.04 |
| 105 | 23 | 10 | 0 | 0 | 0.17 |
| 106 | 6 | 5 | 0 | 0 | 0.09 |
| 107 | 4 | 3 | 0 | 0 | 0.10 |
| 108 | 13 | 11 | 0 | 0 | 0.09 |
| 109 | 5 | 20 | 2 | 0 | 0.02 |
| 110 | 8 | 17 | 1 | 1 | 0.03 |
| 111 | 31 | 15 | 1 | 0 | 0.15 |
| 112 | 85 | 15 | 3 | 0 | 0.42 |
| 113 | 7 | 3 | 0 | 0 | 0.17 |
| 114 | 2 | 9 | 0 | 0 | 0.02 |
| 115 | 26 | 9 | 0 | 0 | 0.21 |
| 116 | 5 | 54 | 2 | 1 | 0.01 |
| 117 | 14 | 4 | 0 | 0 | 0.26 |
| 118 | 2 | 3 | 0 | 0 | 0.05 |
| 119 | 16 | 24 | 0 | 0 | 0.05 |
| 120 | 15 | 9 | 0 | 0 | 0.12 |
| 121 | 6 | 8 | 0 | 0 | 0.06 |
| 122 | 9 | 11 | 0 | 0 | 0.06 |
| 123 | 6 | 8 | 0 | 0 | 0.06 |
| 124 | 4 | 6 | 0 | 0 | 0.05 |
| 125 | 11 | 4 | 0 | 0 | 0.20 |
| 126 | 14 | 7 | 0 | 0 | 0.15 |
| 127 | 8 | 9 | 0 | 0 | 0.07 |
| 128 | 8 | 4 | 0 | 0 | 0.15 |
| 129 | 27 | 19 | 0 | 0 | 0.11 |
| 130 | 10 | 16 | 0 | 0 | 0.05 |
| 131 | 10 | 16 | 0 | 0 | 0.05 |
| 132 | 4 | 2 | 0 | 0 | 0.15 |
| 133 | 13 | 10 | 0 | 0 | 0.10 |
| 134 | 54 | 4 | 0 | 0 | 1.00 |
| 135 | 2 | 1 | 0 | 0 | 0.15 |
| 136 | 14 | 12 | 1 | 1 | 0.09 |
| 137 | 9 | 13 | 0 | 0 | 0.05 |
| 138 | 18 | 10 | 0 | 0 | 0.13 |
| 139 | 6 | 3 | 0 | 0 | 0.15 |
| 140 | 86 | 79 | 1 | 0 | 0.08 |
| 141 | 9 | 8 | 1 | 0 | 0.08 |
| 142 | 23 | 21 | 3 | 0 | 0.08 |
| 143 | 1 | 3 | 0 | 0 | 0.02 |
| 144 | 100 | 23 | 1 | 0 | 0.32 |
| 145 | 1 | 3 | 0 | 0 | 0.02 |
| 146 | 1 | 16 | 0 | 0 | 0.00 |

**Table S3.** Linear mixed-effects model results for pressures – expressed as Principal Components (PC) - associated with confirmed Hen Harrier territories (present/absent). Factors retained in the top subset of *n* models (< Δ2 AIC) are highlighted. Constituent pressures along with pressure codes and associated loadings (coefficients in parentheses) are given. Pressure codes are taken and descriptions are abbreviated from those given in Ruddock *et al.* (2016; see online Table S1). Regression coefficients (*β* ± SE) and significance of contributory PCs are given, where \* = *P* < 0.05, \*\* = *P* < 0.01, and \*\*\* = *P* < 0.001. For constituent pressures in PC1-3, see Table 2 in the main text.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Principal Component****(% variance explained)** | **Pressure** | ***β*** | **± SE** | ***t*** |  |
| PC1 |  | 0.025 | 0.007 | 3.52 | \*\* |
| PC2 |  | -0.046 | 0.009 | -5.05 | \*\*\* |
| PC3 |  | 0.044 | 0.011 | -3.91 | \*\* |
| PC4 | Non-intensive grazing (A6; 0.51) | 0.010 | 0.013 | 0.78 |  |
| (5%) | Agricultural fertilisation (A8; 0.32) |  |  |  |  |
|  | Urbanisation, residential and commercial development (E1; 0.50) |  |  |  |  |
| PC5 | Hand cutting of peat (C1; -0.40) | -0.004 | 0.014 | -0.27 |  |
| (5%) | Aircrafts or flightpaths (D4; -0.30) |  |  |  |  |
|  | Reduction of prey availability (J6; -0.52) |  |  |  |  |
|  | Other pressures not listed (O; -0.38) |  |  |  |  |
| PC6 | Agricultural intensification (A2; 0.27) | -0.005 | 0.014 | -0.38 |  |
| (4%) | Hand cutting of peat (C1; -0.25) |  |  |  |  |
|  | Roads, motorways (D2; 0.34) |  |  |  |  |
|  | Dispersed habitation, i.e. little or no human disturbance (E2; 0.37) |  |  |  |  |
|  | Off-road motorised driving (G5; -0.38) |  |  |  |  |
|  | Other outdoor sports and leisure activities (G6; 0.29) |  |  |  |  |
| PC7 | Hand cutting of peat (C1; 0.29) | 0.006 | 0.015 | 0.41 |  |
| (4%) | Dispersed habitation, i.e. little or no human disturbance (E2; 0.28) |  |  |  |  |
|  | Pollution (H1; 0.26) |  |  |  |  |
|  | Modification of water levels or waterbodies (J4; 0.27) |  |  |  |  |
|  | Reduction of prey availability (J6; -0.27) |  |  |  |  |
|  | Other pressures not listed (O; -0.32) |  |  |  |  |

**Reference**

**Ruddock, M., Mee, A., Lusby, J., Nagle, T., O’Neill, S. & O’Toole, L. 2016.** *The 2015 National Survey of Breeding Hen Harrier in Ireland*. Irish Wildlife Manuals No. 93. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Dublin, Ireland.