# Supplementary material

Andreas Otterbeck* & Andreas Lindén 2024: Temporal increase in migratoriness and increasing male bias among residents in partially migrating Swedish sparrowhawks *Accipiter nisus*. — Ornis Fennica 101: 116–130.

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## Supplementary Material S1

### *Correction for autumn migration counts at Falsterbo*

We used annual autumn totals from the standardized migration counts at Falsterbo bird observatory in 1975–2015. The main observer changed once during this 40-year period (2001), accompanied by an adjusted methodology (Kjellén 2002). We tested for any discontinuity in the temporal trend in the count numbers caused by this switch, by using a generalized additive model (GAM) in R (version 3.5.1) (R Core Team 2018), applying a logarithmic link function and negative binomial error distribution. We fitted the model using the package “mgcv” (Wood 2011) and the function “gam”, setting the annual migration total as response. We set “Observer” (binary factor variable) and “Year” (continuous variable) as explanatory variables, modelled with a smoothing function. We used the default smoothing option, *i.e.*, thin-plate spline ("tp") as the smoothing basis and a maximum of 9 degrees of freedom. Hence, we tested for any effect of “Observer” with the null hypothesis of no difference before and after 2001, adjusting for a flexible trend in time.

As we found no statistically significant effect of the observer ID (estimate: –0.043, SE = 0.223, $z$ = –0.193, $P$ = 0.847) no correction factors were applied to our time-series from Falsterbo. Although some degree of discontinuity can visually be recognized at 2001, the standard errors reveal large uncertainty, which is largely a consequence of no temporal overlap using both methods, and partially a consequence of the flexibility of the temporal trend. The observed migrating numbers of sparrowhawks at Falsterbo have increased over time.

**References:** Kjellén, N. 2002: Sträckfågelräkningar i Falsterbo förr och nu. – Anser 41: 114–23.

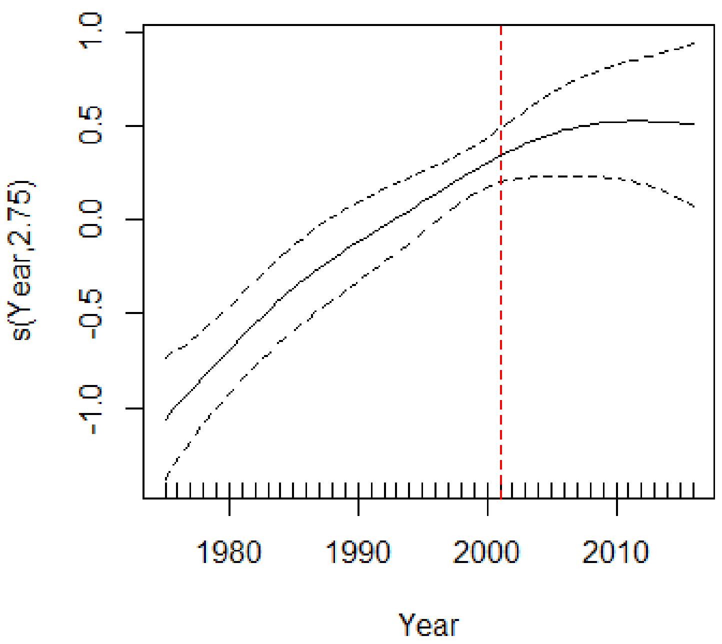


**Fig. S1.** Temporal trend in the number of migrating Sparrowhawks at Falsterbo, illustrated as the partial effect of the smoothing function of year (at the linear predictor scale). The red dashed line indicates when the observer changed.

**Table S2.** To obtain an index of annual variation in the winter prey abundance for Eurasian Sparrowhawk (*Accipiter nisus*) in Sweden, we multiplied the annual winter population indexes of the 10 most central prey species with the average annual number of observed individuals. These were further summed together, and the resulting sum was divided with its average (over all years) to provide an annual index of prey abundance.

| Year | Great tit | Blue tit | Eurasian siskin | House sparrow | Eurasian tree sparrow | Fieldfare | Common blackbird | Brambling | Robin | Common redpoll | Win. prey |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 5128 | 1676 | 396 | 1651 | 2917 | 723 | 519 | 1213 | 64 | 3163 | 0.59 |
| 1976 | 6914 | 2042 | 8710 | 1657 | 2231 | 31413 | 2498 | 24985 | 71 | 7327 | 2.96 |
| 1977 | 5865 | 1939 | 579 | 2166 | 2796 | 1496 | 772 | 1372 | 52 | 5620 | 0.76 |
| 1978 | 4175 | 1593 | 2958 | 1527 | 2362 | 946 | 987 | 600 | 16 | 334 | 0.52 |
| 1979 | 5832 | 2166 | 3662 | 1619 | 2775 | 3897 | 837 | 1723 | 56 | 6207 | 0.97 |
| 1980 | 6939 | 2240 | 3390 | 1830 | 3053 | 2163 | 491 | 440 | 47 | 999 | 0.73 |
| 1981 | 5477 | 1691 | 896 | 1597 | 2363 | 334 | 698 | 145 | 39 | 1894 | 0.51 |
| 1982 | 5607 | 1768 | 2710 | 1284 | 2449 | 1650 | 760 | 5574 | 89 | 5874 | 0.94 |
| 1983 | 6243 | 2174 | 2988 | 1756 | 1890 | 16736 | 860 | 3211 | 29 | 1966 | 1.28 |
| 1984 | 5510 | 2169 | 1455 | 1453 | 1776 | 3805 | 995 | 3955 | 43 | 4180 | 0.85 |
| 1985 | 5564 | 2079 | 965 | 1251 | 1971 | 1380 | 882 | 646 | 20 | 5785 | 0.69 |
| 1986 | 5598 | 2200 | 405 | 1535 | 2594 | 1859 | 1060 | 3170 | 46 | 1787 | 0.68 |
| 1987 | 6758 | 2584 | 3745 | 1361 | 2834 | 1661 | 399 | 9778 | 47 | 1481 | 1.03 |
| 1988 | 6075 | 2759 | 249 | 1560 | 2908 | 520 | 441 | 44 | 36 | 593 | 0.51 |
| 1989 | 6876 | 3289 | 5794 | 1464 | 2690 | 21026 | 1574 | 8797 | 60 | 2935 | 1.84 |
| 1990 | 6495 | 3139 | 348 | 1664 | 2963 | 669 | 669 | 173 | 61 | 1704 | 0.60 |
| 1991 | 5691 | 2839 | 2498 | 1275 | 2122 | 2191 | 879 | 1322 | 86 | 1422 | 0.68 |
| 1992 | 6226 | 2958 | 561 | 1435 | 2277 | 27482 | 2366 | 2893 | 99 | 195 | 1.57 |
| 1993 | 5747 | 2968 | 4072 | 1558 | 2806 | 2732 | 1175 | 19383 | 45 | 2726 | 1.46 |
| 1994 | 4544 | 2423 | 113 | 1449 | 2211 | 655 | 845 | 42 | 115 | 413 | 0.43 |
| 1995 | 5140 | 2767 | 1865 | 1684 | 1941 | 31761 | 3567 | 14357 | 118 | 4529 | 2.28 |
| 1996 | 5140 | 2647 | 542 | 1965 | 2126 | 409 | 1217 | 107 | 93 | 376 | 0.49 |
| 1997 | 5727 | 2939 | 204 | 1567 | 2003 | 1934 | 546 | 30 | 71 | 655 | 0.53 |
| 1998 | 5949 | 3286 | 3990 | 1126 | 2008 | 9629 | 1137 | 12476 | 71 | 3404 | 1.45 |
| 1999 | 5294 | 2846 | 93 | 1644 | 1868 | 403 | 742 | 52 | 71 | 173 | 0.44 |
| 2000 | 6168 | 3379 | 4367 | 1173 | 2241 | 7686 | 2527 | 54648 | 354 | 4723 | 2.94 |
| 2001 | 5194 | 2751 | 196 | 900 | 1896 | 392 | 1703 | 1364 | 134 | 962 | 0.52 |
| 2002 | 6343 | 3663 | 1414 | 1270 | 2145 | 9484 | 2079 | 1285 | 100 | 3683 | 1.06 |
| 2003 | 5744 | 3309 | 241 | 919 | 1726 | 378 | 1106 | 4 | 137 | 479 | 0.47 |
| 2004 | 6444 | 3840 | 1069 | 1080 | 1636 | 2102 | 1100 | 1219 | 129 | 959 | 0.66 |
| 2005 | 5893 | 3763 | 1165 | 1026 | 1836 | 1285 | 1487 | 4 | 141 | 1939 | 0.62 |
| 2006 | 9016 | 5265 | 2727 | 913 | 2333 | 4863 | 889 | 1598 | 152 | 3068 | 1.04 |
| 2007 | 6526 | 3904 | 448 | 648 | 1511 | 830 | 901 | 57 | 133 | 194 | 0.51 |
| 2008 | 6260 | 3830 | 258 | 867 | 1853 | 2204 | 1594 | 85 | 217 | 1407 | 0.63 |
| 2009 | 5782 | 3453 | 3851 | 708 | 1876 | 21763 | 4140 | 75584 | 140 | 1203 | 3.99 |
| 2010 | 5865 | 3256 | 193 | 625 | 1945 | 240 | 905 | 4 | 51 | 609 | 0.46 |
| 2011 | 6498 | 4007 | 2410 | 858 | 2050 | 3957 | 946 | 4544 | 150 | 1880 | 0.92 |
| 2012 | 6407 | 3659 | 890 | 855 | 1887 | 1972 | 879 | 4 | 33 | 1404 | 0.61 |
| 2013 | 6546 | 3588 | 1129 | 823 | 2243 | 3765 | 1017 | 1153 | 140 | 1342 | 0.73 |
| 2014 | 6532 | 4046 | 1687 | 901 | 2175 | 2659 | 1676 | 1522 | 249 | 1205 | 0.76 |
| 2015 | 5466 | 3834 | 619 | 641 | 1587 | 1784 | 1574 | 850 | 161 | 802 | 0.58 |
| 2016 | 6500 | 4362 | 1096 | 716 | 1634 | 2570 | 1464 | 133 | 118 | 1813 | 0.69 |

**Table S3.** The candidate GAM models were evaluated using Akaike's information criterion (AIC), and sorted according to model parsimony from best to worst. This was done for three hypotheses regarding the overwintering population; the age proportion (first year or adult), the male/female proportion and the mean latitude at which overwintering individuals were recorded throughout an average winter. "Year.C" denotes centralized year (zero mean), "Year.f" denotes year as a factor variable, "Dow" denotes day of winter, "ln.MRR.C" denotes the logarithm of the migrant-to-resident ratio (zero mean) while "is.male" represents a binary variable of male gender (1 = yes, 0 = no). We rerun the best candidate models as GAMM. "s" before parenthesis denotes a smoothing function.

| Model | Fixed | Random | Family | *n* | nLL | df | dAIC |
|---|---|---|---|---|---|---|---|
| **Sex** | | | | | | | |
| 1 | s(Dow) + Year.C | Year.f | Binomial | 17152 | 11524.48 | 24.26 | 0.00 |
| 2 | s(Dow) + ln.MRR.C | Year.f | Binomial | 17152 | 11524.96 | 23.87 | 0.19 |
| 0 | s(Dow) | Year.f | Binomial | 17152 | 11522.89 | 26.64 | 1.60 |
| | | | | | | | |
| **Age** | | | | | | | |
| 0 | s(Dow) | Year.f | Binomial | 5597 | 2364.73 | 11.35 | 0.00 |
| 2 | s(Dow) + ln.MRR.C | Year.f | Binomial | 5597 | 2364.48 | 12.01 | 0.84 |
| 1 | s(Dow) + Year.C | Year.f | Binomial | 5597 | 2364.76 | 12.13 | 1.64 |
| | | | | | | | |
| **Latitude** | | | | | | | |
| 3 | s(Dow) + is.male | Year.f | Gaussian | 17152 | 37044.80 | 34.77 | 0.00 |
| 5 | s(Dow) + is.male + ln.MRR.C | Year.f | Gaussian | 17152 | 37044.83 | 35.11 | 0.74 |
| 4 | s(Dow) + is.male + Year.C | Year.f | Gaussian | 17152 | 37044.86 | 35.10 | 0.80 |
| 0 | s(Dow) | Year.f | Gaussian | 17152 | 37056.55 | 33.95 | 21.9 |
| 1 | s(Dow) + Year.C | Year.f | Gaussian | 17152 | 37056.56 | 34.30 | 22.6 |
| 2 | s(Dow) + ln.MRR.C | Year.f | Gaussian | 17152 | 37056.55 | 34.30 | 22.6 |

**Table S4.** An overview on whether the migration intensity, the resident population (or both) drives the linear patterns in the migration to resident ratio.

| Response | Fixed | Estimate | *SE* | t | p |
|---|---|---|---|---|---|
| **log(migration)** | | | | | |
| | Intercept | –0.140 | 0.044 | –3.162 | 0.003 |
| | lnYRsums.c | –0.131 | 0.081 | –1.620 | 0.114 |
| | Temp.c | 0.104 | 0.030 | 3.457 | 0.001 |
| | Year.c | 0.034 | 0.004 | 8.862 | <0.001 |
| **log(win.pop)** | | | | | |
| | Intercept | –0.053 | 0.038 | –1.399 | 0.170 |
| | lnYRsums.c | 0.073 | 0.069 | 1.061 | 0.296 |
| | Temp.c | 0.039 | 0.026 | 1.519 | 0.137 |
| | Year.c | –0.020 | 0.003 | –6.226 | <0.001 |