**Title:**

Increased perception of predation risk to adults and offspring alters avian reproductive strategy and performance

**Running title:**

Perceived predation risk influences avian reproduction

**Supplemental files:**

1. Appendix A: Details of playback scheme
2. Appendix B: Nest box set-up (picture)
3. Appendix C: Original data on bluebird reproduction
4. Appendix D: Model results of bluebird reproductive responses to perceived predation risk under no assumptions about second broods
5. Appendix E: Model results of bluebird reproductive responses to perceived predation risk for the first and second broods, respectively

**Appendix A: Details of playback scheme**

We prepared unique playback files for each plot, with vocalization from no more than three predator individuals for each file to avoid mimicking the presence of too many predators (Kroodsma et al. 2001). Each playback file consisted of a ‘primary’ vocalization type (i.e. the most frequent vocalization used by the species, such as territorial calls), supplemented by a smaller amount of a ‘secondary’ vocalization type (i.e. vocalization that is less frequently used but that still advertises the presence and/or activity of the species). The amount of vocalization in each playback file and the amount provided daily on each plot were determined according to natural vocalization rates suggested by the original recordings and our field experiences. The daily amount of playback on each plot was 232 primary vocalizations plus 122 secondary vocalizations for the Hawk treatment, 720 primary vocalizations plus 160 secondary vocalizations for the Jay treatment and 260 primary vocalizations plus 144 secondary vocalizations for the Owl treatment. We circulated playback files between plots within a given treatment biweekly to further reduce habituation to playback (i.e., in addition to changing the locations of playback stations on a biweekly basis).

We obtained predator vocalization recordings from various sources including museums, audio libraries, and other online databases. Whenever possible, we used recordings taken from near Southeastern United States, but some recordings from other parts of the United States were also used due to inadequate number of recordings from local regions. We processed the recordings to remove noise and augment volume using program Audacity (version 1.3 Beta), and then compiled them into unique playback files to be burnt onto CD for each plot, using vocalizations from no more than three individual birds for each playback file. Each playback file consisted mainly of a ‘primary’ vocalization type (i.e. the most frequent vocalization used by the species, such as territorial calls), supplemented by a lesser amount of a ‘secondary’ vocalization type (i.e. vocalization that is less frequently used but that still advertises the presence and/or activity of the species; however, in the case of the Cooper’s hawk, we still used territorial calls for its relative lack of variability of vocalization repertoire; Gehlbach 1995, Tarvin and Woolfenden 1999, Curtis et al. 2006). With the help of programmable timers, we created playback schemes whereby vocalizations were played in bouts throughout the day (or night for the Eastern screech-owl) at rates similar to the natural vocalization behavior of the species as suggested by original recordings. Playback schemes are displayed below along time axes, showing numbers of primary vocalizations (P) and secondary vocalizations (S) during each one-hour interval. It should be noted that as we used two playback stations on each plot that played the same playback files, the actual playback amount was twice the amount provided by a playback file. The two playback stations on each plot followed the same playback scheme, except that one station lagged five minutes behind the other.

For each playback station, we used a portable CD player with built-in speakers (four models, namely: Durabrand CD-203, Emerson PD6810KA, Memorex MP3126, and Memorex MP3851), a rechargeable 12V direct current deep-cycle marine battery (two models, namely: Werker WKA12-16NB, and Rhino SLA 24-12), and a programmable digital timer (Diehl digital timer model 884-K, Borg General Controls LLC, Elk Grove, IL). We kept the volume of the CD player at fixed values that according to our experiences mimicked the natural volumes of the three respective predators.

Figure S1. Illustration of playback scheme.



**References:**

Curtis E, Rosenfield RN, Bielefeldt J. 2006. Cooper's hawk (*Accipiter cooperii*) In: Poole A, editor. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. <http://bna.birds.cornell.edu/bna/species/075>.

Gehlbach FR. 1995. Eastern screech-owl (*Megascops asio*). In: Poole A, editor. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. <http://bna.birds.cornell.edu/bna/species/165>

Kroodsma DE, Byers BE, Goodale E, Johnson S, Liu W-C. 2001. Pseudoreplication in playback experiments, revisited a decade later. Animal Behaviour 61:1029-1033.

Tarvin KA, Woolfenden GE. 1999. Blue jay (*Cyanocitta cristata*). In: Poole A, editor. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology. <http://bna.birds.cornell.edu/bna/species/469>.

**Appendix B: Nest box set-up**

Figure S2. A typical nest box for Eastern bluebirds *Sialia sialis*. Standing next to the nest box entrance is a video camera.



**Appendix C: Data on bluebird reproduction**

Table S1. Data on bluebird reproduction at the brood level.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Plot | Treatment | Nest  ID | Brood  ID | Clutch  size | Clutch  mass† | Hatchling  number | 14th-day  nestling number | 14th-day  brood mass† | Total seasonal  fledgling output | Incubation  length‡ | Brood  length‡ |
| 1 | Hawk | 1 | 1 | 4 | 11.2789 | 4 | 4 | 106.41 | 8 | 17 | 18 |
|  |  |  | 2 | 4 | 11.5930 | 4 | 4 | 96.57 | 8 | NA | NA |
|  |  | 2 | 1 | 5 | 17.2780 | 4 | 4 | 116.96 | 8 | 18 | 17 |
|  |  |  | 2 | 4 | 13.9872 | 4 | 4 | 104.67 | 8 | NA | NA |
|  |  | 3 | 1 | 5 | 13.1066 | 1 | 1 | 23.62 | 3 | 17 | 19 |
|  |  |  | 2 | 4 | 10.5479 | 2 | 2 | 40.34 | 3 | NA | NA |
| 2 | Jay | 4 | 1 | 5 | 12.7507 | 5 | 4 | NA | 8 | 16 | 15 |
|  |  |  | 2 | 4 | 10.2583 | 3 | 3 | 76.37 | 8 | NA | NA |
| 3 | Control | 5 | 1 | 5 | 12.2607 | NA | NA | NA | NA | NA | NA |
|  |  |  | 2 | 5 | 12.8498 | NA | NA | NA | NA | NA | NA |
| 4 | Jay | 6 | 1 | 5 | 13.8319 | 5 | 5 | 133.02 | 5 | 18 | 17 |
|  |  |  | 2 | NA | NA | NA | NA | NA | 5 | NA | NA |
|  |  | 7 | 1 | 4 | 10.7867 | 3 | 3 | 81.38 | 6 | 15 | NA |
|  |  |  | 2 | 4 | 11.4037 | 3 | 3 | 79.52 | 6 | NA | NA |
| 5 | Jay | 8 | 1 | 5 | 16.0446 | 4 | 4 | 108.08 | 8 | 19 | 16 |
|  |  |  | 2 | 4 | 13.1055 | 4 | 4 | 105.05 | 8 | NA | NA |
| 6 | Owl | 9 | 1 | 3 | 8.5887 | 3 | 3 | 84.45 | 6 | 15 | 17 |
|  |  |  | 2 | 4 | 12.4484 | 3 | 3 | 72.44 | 6 | NA | NA |
| 7 | Control | 10 | 1 | 5 | 11.9380 | 5 | 5 | 126.47 | 9 | 17 | 17 |
|  |  |  | 2 | 5 | 12.8643 | 4 | 4 | 103.78 | 9 | NA | NA |
| 8 | Control | 11 | 1 | 5 | 14.8466 | 5 | 5 | 130.79 | 9 | 17 | 17 |
|  |  |  | 2 | 4 | 10.0470 | 4 | 4 | 98.25 | 9 | NA | NA |
| 9 | Hawk | 12 | 1 | 4 | 9.5181 | 3 | 3 | 72.08 | 3 | 19 | 15 |
|  |  |  | 2 | 5 | 12.7318 | 0 | 0 | 0.0000 | 3 | NA | NA |
|  |  | 13 | 1 | 5 | 12.9727 | 5 | 5 | 135.34 | NA | NA | NA |
|  |  |  | 2 | 4 | 11.5812 | NA | NA | NA | NA | NA | NA |
| 10 | Owl | 14 | 1 | 5 | 13.9380 | 5 | NA | NA | 8 | 17 | NA |
|  |  |  | 2 | 4 | 11.1038 | 3 | 3 | 83.61 | 8 | NA | NA |
| 11 | Jay | 15 | 1 | 5 | 13.9280 | 5 | 5 | 134.57 | 9 | 16 | 16 |
|  |  |  | 2 | 4 | 11.5029 | 4 | 4 | NA | 9 | NA | NA |
|  |  | 16 | 1 | 4 | NA | NA | NA | NA | NA | NA | NA |
|  |  |  | 2 | 4 | 11.7562 | 2 | 2 | 50.19 | NA | NA | NA |
| 12 | Control | 17 | 1 | 5 | 13.8288 | 5 | 5 | 117.30 | 8 | 16 | 19 |
|  |  |  | 2 | 5 | 12.4082 | 5 | 3 | 72.84 | 8 | NA | NA |
| 13 | Hawk | 18 | 1 | 5 | 13.2890 | 5 | 5 | 132.46 | NA | 18 | NA |
|  |  |  | 2 | 4 | 10.0589 | NA | NA | NA | NA | NA | NA |
| 14 | Jay | 19 | 1 | 5 | 12.8818 | 5 | 5 | 126.31 | 10 | NA | NA |
|  |  |  | 2 | NA | NA | NA | NA | NA | NA | NA | NA |
|  |  | 20 | 1 | 5 | 12.0983 | 5 | NA | NA | 10 | 17 | 15 |
|  |  |  | 2 | 3 | NA | 1 | 1 | 28.48 | 6 | NA | NA |
| 15 | Hawk | 21 | 1 | 4 | 11.2409 | 4 | 4 | 110.17 | 7 | 16 | 15 |
|  |  |  | 2 | 4 | 11.9804 | 3 | 3 | 60.18 | 7 | NA | NA |
|  |  | 22 | 1 | 4 | 12.2519 | 3 | 3 | 88.84 | 6 | 17 | NA |
|  |  |  | 2 | 4 | 11.7046 | 3 | 3 | 80.69 | 6 | NA | NA |
| 16 | Jay | 23 | 1 | 5 | 14.0408 | 5 | 4 | 111.77 | NA | 18 | NA |
|  |  |  | 2 | 4 | 10.5488 | 4 | NA | NA | NA | NA | NA |
| 17 | Control | 24 | 1 | 5 | 14.3721 | 5 | 4 | 104.26 | 8 | 18 | 17 |
|  |  |  | 2 | 4 | 9.8025 | 4 | 4 | 96.61 | 8 | NA | NA |
| 18 | Owl | 25 | 1 | 5 | 13.2507 | 5 | 5 | 135.91 | NA | 18 | NA |
|  |  |  | 2 | 4 | 12.1265 | NA | NA | NA | NA | NA | NA |
| 19 | Owl | 26 | 1 | 5 | 12.4377 | 5 | 5 | 126.20 | 9 | 17 | NA |
|  |  |  | 2 | 4 | 9.5352 | 4 | 4 | 103.89 | 9 | NA | NA |
|  |  | 27 | 1 | 5 | 12.4018 | 5 | 5 | 132.15 | 9 | 18 | 17 |
|  |  |  | 2 | 4 | NA | 4 | 4 | 89.53 | 9 | NA | NA |
| 20 | Hawk | 28 | 1 | 5 | 14.5509 | 5 | 5 | 146.43 | 8 | 17 | 16 |
|  |  |  | 2 | 4 | 10.9101 | 4 | 3 | 80.08 | 8 | NA | NA |
|  |  | 29 | 1 | 4 | 10.1617 | 4 | 4 | 95.53 | 4 | 17 | 17 |
|  |  |  | 2 | NA | NA | NA | NA | NA | 4 | NA | NA |
| 21 | Owl | 30 | 1 | 5 | 13.1500 | 5 | 5 | 120.30 | NA | 18 | 16 |
|  |  |  | 2 | 3 | 8.0979 | 3 | NA | NA | NA | NA | NA |
|  |  | 31 | 1 | 4 | 12.1229 | 3 | 3 | 72.52 | 3 | NA | NA |
|  |  |  | 2 | NA | NA | NA | NA | NA | 3 | NA | NA |
| 22 | Owl | 32 | 1 | 5 | 12.8757 | 5 | NA | NA | NA | 17 | NA |
|  |  |  | 2 | 5 | 12.8208 | 4 | NA | NA | NA | NA | NA |
| 23 | Control | 33 | 1 | 5 | NA | NA | NA | NA | NA | NA | NA |
|  |  |  | 2 | 5 | 16.1571 | NA | NA | NA | NA | NA | NA |
|  |  | 34 | 1 | 4 | 11.5334 | 4 | 4 | 105.38 | 9 | 16 | 16 |
|  |  |  | 2 | 5 | 15.6437 | 5 | 3 | NA | 9 | NA | NA |
| 24 | Hawk | 35 | 1 | NA | NA | NA | NA | NA | 3 | NA | NA |
|  |  |  | 2 | 4 | 11.6371 | 3 | 3 | 79.63 | 3 | NA | NA |

(Note: NA: No data is available. †: Egg mass and brood mass were measured in grams. ‡: Incubation length and brood rearing length both were taken only for the first brood, measured as the number of days.)

Table S2. Data on bluebird reproduction at the egg level.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Plot | Treatment | Nest ID | Brood ID | Egg ID | Egg mass (g) |
| 1 | Hawk | 1 | 1 | 1 | 2.9448 |
|  |  |  |  | 2 | 2.7562 |
|  |  |  |  | 3 | 2.8239 |
|  |  |  |  | 4 | 2.7540 |
|  |  |  | 2 | 1 | 2.8315 |
|  |  |  |  | 2 | 2.8849 |
|  |  |  |  | 3 | 3.0691 |
|  |  |  |  | 4 | 2.8075 |
|  |  | 2 | 1 | 1 | 3.5431 |
|  |  |  |  | 2 | 3.4188 |
|  |  |  |  | 3 | 3.3784 |
|  |  |  |  | 4 | 3.5206 |
|  |  |  |  | 5 | 3.4172 |
|  |  |  | 2 | 1 | 3.4863 |
|  |  |  |  | 2 | 3.5257 |
|  |  |  |  | 3 | 3.4295 |
|  |  |  |  | 4 | 3.5456 |
|  |  | 3 | 1 | 1 | 2.6536 |
|  |  |  |  | 2 | 2.5841 |
|  |  |  |  | 3 | 2.5522 |
|  |  |  |  | 4 | 2.7333 |
|  |  |  |  | 5 | 2.5833 |
|  |  |  | 2 | 1 | 2.6540 |
|  |  |  |  | 2 | 2.6053 |
|  |  |  |  | 3 | 2.5634 |
|  |  |  |  | 4 | 2.7251 |
| 2 | Jay | 4 | 1 | 1 | 2.5611 |
|  |  |  |  | 2 | 2.4874 |
|  |  |  |  | 3 | 2.5737 |
|  |  |  |  | 4 | 2.5831 |
|  |  |  |  | 5 | 2.5453 |
|  |  |  | 2 | 1 | 2.3580 |
|  |  |  |  | 2 | 2.7029 |
|  |  |  |  | 3 | 2.5416 |
|  |  |  |  | 4 | 2.6558 |
| 3 | Control | 5 | 1 | 1 | 2.4577 |
|  |  |  |  | 2 | 2.3393 |
|  |  |  |  | 3 | 2.5786 |
|  |  |  |  | 4 | 2.4404 |
|  |  |  |  | 5 | 2.4446 |
|  |  |  | 2 | 1 | 2.5070 |
|  |  |  |  | 2 | 2.6671 |
|  |  |  |  | 3 | 2.7101 |
|  |  |  |  | 4 | 2.5585 |
|  |  |  |  | 5 | 2.4071 |
| 4 | Jay | 6 | 1 | 1 | 2.7587 |
|  |  |  |  | 2 | 2.6628 |
|  |  |  |  | 3 | 2.8157 |
|  |  |  |  | 4 | 2.7352 |
|  |  |  |  | 5 | 2.8595 |
|  |  | 7 | 1 | 1 | 2.6607 |
|  |  |  |  | 2 | 2.7782 |
|  |  |  |  | 3 | 2.7120 |
|  |  |  |  | 4 | 2.6358 |
|  |  |  | 2 | 1 | 2.9311 |
|  |  |  |  | 2 | 2.8348 |
|  |  |  |  | 3 | 2.9155 |
|  |  |  |  | 4 | 2.7224 |
| 5 | Jay | 8 | 1 | 1 | 3.0624 |
|  |  |  |  | 2 | 3.2510 |
|  |  |  |  | 3 | 3.2449 |
|  |  |  |  | 4 | 3.1820 |
|  |  |  |  | 5 | 3.3043 |
|  |  |  | 2 | 1 | 3.3323 |
|  |  |  |  | 2 | 3.3476 |
|  |  |  |  | 3 | 3.2969 |
|  |  |  |  | 4 | 3.1287 |
| 6 | Owl | 9 | 1 | 1 | 2.9004 |
|  |  |  |  | 2 | 2.7806 |
|  |  |  |  | 3 | 2.9077 |
|  |  |  | 2 | 1 | 3.1336 |
|  |  |  |  | 2 | 3.0696 |
|  |  |  |  | 3 | 3.1506 |
|  |  |  |  | 4 | 3.0944 |
| 7 | Control | 10 | 1 | 1 | 2.3876 |
|  |  |  |  | 2 | 2.4492 |
|  |  |  |  | 3 | 2.3682 |
|  |  |  |  | 4 | 2.3070 |
|  |  |  |  | 5 | 2.4260 |
|  |  |  | 2 | 1 | 2.5899 |
|  |  |  |  | 2 | 2.5693 |
|  |  |  |  | 3 | 2.5978 |
|  |  |  |  | 4 | 2.6270 |
|  |  |  |  | 5 | 2.4803 |
| 8 | Control | 11 | 1 | 1 | 3.0182 |
|  |  |  |  | 2 | 3.0578 |
|  |  |  |  | 3 | 2.9631 |
|  |  |  |  | 4 | 2.8668 |
|  |  |  |  | 5 | 2.9406 |
|  |  |  | 2 | 1 | 2.4032 |
|  |  |  |  | 2 | 2.5527 |
|  |  |  |  | 3 | 2.6903 |
|  |  |  |  | 4 | 2.4007 |
| 9 | Hawk | 12 | 1 | 1 | 2.4606 |
|  |  |  |  | 2 | 2.4856 |
|  |  |  |  | 3 | 2.2209 |
|  |  |  |  | 4 | 2.3509 |
|  |  |  | 2 | 1 | 2.5656 |
|  |  |  |  | 2 | 2.4736 |
|  |  |  |  | 3 | 2.6737 |
|  |  |  |  | 4 | 2.5868 |
|  |  |  |  | 5 | 2.4321 |
|  |  | 13 | 1 | 1 | 2.5798 |
|  |  |  |  | 2 | 2.6092 |
|  |  |  |  | 3 | 2.6379 |
|  |  |  |  | 4 | 2.6868 |
|  |  |  |  | 5 | 2.4591 |
|  |  |  | 2 | 1 | 2.9576 |
|  |  |  |  | 2 | 2.9321 |
|  |  |  |  | 3 | 2.8238 |
|  |  |  |  | 4 | 2.8677 |
| 10 | Owl | 14 | 1 | 1 | 2.8877 |
|  |  |  |  | 2 | 2.7810 |
|  |  |  |  | 3 | 2.9690 |
|  |  |  |  | 4 | 2.7097 |
|  |  |  |  | 5 | 2.5906 |
|  |  |  | 2 | 1 | 2.7895 |
|  |  |  |  | 2 | 2.7004 |
|  |  |  |  | 3 | 2.7473 |
|  |  |  |  | 4 | 2.8666 |
| 11 | Jay | 15 | 1 | 1 | 2.8025 |
|  |  |  |  | 2 | 2.9261 |
|  |  |  |  | 3 | 2.8086 |
|  |  |  |  | 4 | 2.7298 |
|  |  |  |  | 5 | 2.6609 |
|  |  |  | 2 | 1 | 2.8308 |
|  |  |  |  | 2 | 2.8389 |
|  |  |  |  | 3 | 2.9074 |
|  |  |  |  | 4 | 2.9257 |
|  |  | 16 | 1 | 1 | NA |
|  |  |  |  | 2 | NA |
|  |  |  |  | 3 | NA |
|  |  |  |  | 4 | NA |
|  |  |  | 2 | 1 | 2.8175 |
|  |  |  |  | 2 | 2.9471 |
|  |  |  |  | 3 | 2.8846 |
|  |  |  |  | 4 | 3.1069 |
| 12 | Control | 17 | 1 | 1 | 2.6677 |
|  |  |  |  | 2 | 2.7443 |
|  |  |  |  | 3 | 2.7067 |
|  |  |  |  | 4 | 2.8459 |
|  |  |  |  | 5 | 2.8643 |
|  |  |  | 2 | 1 | 2.4599 |
|  |  |  |  | 2 | 2.4660 |
|  |  |  |  | 3 | 2.4174 |
|  |  |  |  | 4 | 2.5163 |
|  |  |  |  | 5 | 2.5486 |
| 13 | Hawk | 18 | 1 | 1 | 2.6381 |
|  |  |  |  | 2 | 2.5740 |
|  |  |  |  | 3 | 2.7051 |
|  |  |  |  | 4 | 2.7576 |
|  |  |  |  | 5 | 2.6142 |
|  |  |  | 2 | 1 | 2.5752 |
|  |  |  |  | 2 | 2.3791 |
|  |  |  |  | 3 | 2.4410 |
|  |  |  |  | 4 | 2.6636 |
| 14 | Jay | 19 | 1 | 1 | 2.6072 |
|  |  |  |  | 2 | 2.5644 |
|  |  |  |  | 3 | 2.6130 |
|  |  |  |  | 4 | 2.5387 |
|  |  |  |  | 5 | 2.5585 |
|  |  | 20 | 1 | 1 | 2.4296 |
|  |  |  |  | 2 | 2.3674 |
|  |  |  |  | 3 | 2.2093 |
|  |  |  |  | 4 | 2.6560 |
|  |  |  |  | 5 | 2.4360 |
|  |  |  | 2 | 1 | NA |
|  |  |  |  | 2 | NA |
|  |  |  |  | 3 | NA |
| 15 | Hawk | 21 | 1 | 1 | 2.8232 |
|  |  |  |  | 2 | 2.8726 |
|  |  |  |  | 3 | 2.7882 |
|  |  |  |  | 4 | 2.7569 |
|  |  |  | 2 | 1 | 2.8419 |
|  |  |  |  | 2 | 2.9998 |
|  |  |  |  | 3 | 2.9874 |
|  |  |  |  | 4 | 3.1514 |
|  |  | 22 | 1 | 1 | 3.0386 |
|  |  |  |  | 2 | 3.0869 |
|  |  |  |  | 3 | 3.0082 |
|  |  |  |  | 4 | 3.1182 |
|  |  |  | 2 | 1 | 3.0544 |
|  |  |  |  | 2 | 2.9033 |
|  |  |  |  | 3 | 2.7895 |
|  |  |  |  | 4 | 2.9573 |
| 16 | Jay | 23 | 1 | 1 | 2.8465 |
|  |  |  |  | 2 | 2.8403 |
|  |  |  |  | 3 | 2.7644 |
|  |  |  |  | 4 | 2.7827 |
|  |  |  |  | 5 | 2.8069 |
|  |  |  | 2 | 1 | 2.4073 |
|  |  |  |  | 2 | 2.6294 |
|  |  |  |  | 3 | 2.7793 |
|  |  |  |  | 4 | 2.7328 |
| 17 | Control | 24 | 1 | 1 | 3.0478 |
|  |  |  |  | 2 | 2.9805 |
|  |  |  |  | 3 | 2.6217 |
|  |  |  |  | 4 | 2.8357 |
|  |  |  |  | 5 | 2.8863 |
|  |  |  | 2 | 1 | 2.6622 |
|  |  |  |  | 2 | 2.5233 |
|  |  |  |  | 3 | 2.2897 |
|  |  |  |  | 4 | 2.3273 |
| 18 | Owl | 25 | 1 | 1 | 2.6136 |
|  |  |  |  | 2 | 2.7480 |
|  |  |  |  | 3 | 2.7031 |
|  |  |  |  | 4 | 2.5677 |
|  |  |  |  | 5 | 2.6183 |
|  |  |  | 2 | 1 | 2.9388 |
|  |  |  |  | 2 | 2.8968 |
|  |  |  |  | 3 | 3.1312 |
|  |  |  |  | 4 | 3.1597 |
| 19 | Owl | 26 | 1 | 1 | 2.4219 |
|  |  |  |  | 2 | 2.5421 |
|  |  |  |  | 3 | 2.4626 |
|  |  |  |  | 4 | 2.4560 |
|  |  |  |  | 5 | 2.5551 |
|  |  |  | 2 | 1 | 2.2461 |
|  |  |  |  | 2 | 2.4250 |
|  |  |  |  | 3 | 2.4726 |
|  |  |  |  | 4 | 2.3916 |
|  |  | 27 | 1 | 1 | 2.4958 |
|  |  |  |  | 2 | 2.3631 |
|  |  |  |  | 3 | 2.4730 |
|  |  |  |  | 4 | 2.5740 |
|  |  |  |  | 5 | 2.4958 |
|  |  |  | 2 | 1 | NA |
|  |  |  |  | 2 | NA |
|  |  |  |  | 3 | NA |
|  |  |  |  | 4 | NA |
| 20 | Hawk | 28 | 1 | 1 | 3.0592 |
|  |  |  |  | 2 | 2.7018 |
|  |  |  |  | 3 | 2.9534 |
|  |  |  |  | 4 | 2.8857 |
|  |  |  |  | 5 | 2.9508 |
|  |  |  | 2 | 1 | 2.7434 |
|  |  |  |  | 2 | 2.6912 |
|  |  |  |  | 3 | 2.7698 |
|  |  |  |  | 4 | 2.7057 |
|  |  | 29 | 1 | 1 | 2.5544 |
|  |  |  |  | 2 | 2.4754 |
|  |  |  |  | 3 | 2.5534 |
|  |  |  |  | 4 | 2.5786 |
| 21 | Owl | 30 | 1 | 1 | 2.5896 |
|  |  |  |  | 2 | 2.6351 |
|  |  |  |  | 3 | 2.6560 |
|  |  |  |  | 4 | 2.6500 |
|  |  |  |  | 5 | 2.6195 |
|  |  |  | 2 | 1 | 2.7640 |
|  |  |  |  | 2 | 2.7033 |
|  |  |  |  | 3 | 2.6306 |
|  |  | 31 | 1 | 1 | 3.1916 |
|  |  |  |  | 2 | 2.9786 |
|  |  |  |  | 3 | 3.1631 |
|  |  |  |  | 4 | 2.7897 |
| 22 | Owl | 32 | 1 | 1 | 2.6872 |
|  |  |  |  | 2 | 2.5393 |
|  |  |  |  | 3 | 2.5828 |
|  |  |  |  | 4 | 2.6087 |
|  |  |  |  | 5 | 2.4576 |
|  |  |  | 2 | 1 | 2.6363 |
|  |  |  |  | 2 | 2.6409 |
|  |  |  |  | 3 | 2.4963 |
|  |  |  |  | 4 | 2.6335 |
|  |  |  |  | 5 | 2.4137 |
| 23 | Control | 33 | 1 | 1 | NA |
|  |  |  |  | 2 | NA |
|  |  |  |  | 3 | NA |
|  |  |  |  | 4 | NA |
|  |  |  |  | 5 | NA |
|  |  |  | 2 | 1 | 3.1387 |
|  |  |  |  | 2 | 3.2380 |
|  |  |  |  | 3 | 3.2239 |
|  |  |  |  | 4 | 3.3103 |
|  |  |  |  | 5 | 3.2462 |
|  |  | 34 | 1 | 1 | 2.8502 |
|  |  |  |  | 2 | 2.9324 |
|  |  |  |  | 3 | 2.8836 |
|  |  |  |  | 4 | 2.8672 |
|  |  |  | 2 | 1 | 3.1207 |
|  |  |  |  | 2 | 3.1979 |
|  |  |  |  | 3 | 3.0465 |
|  |  |  |  | 4 | 3.1864 |
|  |  |  |  | 5 | 3.0921 |
| 24 | Hawk | 35 | 2 | 1 | 2.8808 |
|  |  |  |  | 2 | 2.8471 |
|  |  |  |  | 3 | 2.8800 |
|  |  |  |  | 4 | 3.0291 |

(Note: NA: No data is available.)

Table S3. Data on bluebird reproduction at the nestling level.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Plot | Treatment | Nest ID | Brood ID | Nestling ID† |  | 14th-day nestling body mass (g) |
| 1 | Hawk | 1 | 1 | 1 |  | 26.56 |
|  |  |  |  | 2 |  | 27.40 |
|  |  |  |  | 3 |  | 26.76 |
|  |  |  |  | 4 |  | 25.69 |
|  |  |  | 2 | 1 |  | 24.88 |
|  |  |  |  | 2 |  | 25.45 |
|  |  |  |  | 3 |  | 23.56 |
|  |  |  |  | 4 |  | 22.68 |
|  |  | 2 | 1 | 1 |  | 28.98 |
|  |  |  |  | 2 |  | 29.96 |
|  |  |  |  | 3 |  | 29.32 |
|  |  |  |  | 4 |  | 28.70 |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 27.76 |
|  |  |  |  | 2 |  | 25.83 |
|  |  |  |  | 3 |  | 25.7 |
|  |  |  |  | 4 |  | 25.38 |
|  |  | 3 | 1 | 1 |  | 23.62 |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 16.65 |
|  |  |  |  | 2 |  | 23.69 |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
| 2 | Jay | 4 | 1 | 1 |  | 24.09 |
|  |  |  |  | 2 |  | 26.80 |
|  |  |  |  | 3 |  | 27.06 |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 25.3 |
|  |  |  |  | 2 |  | 25.5 |
|  |  |  |  | 3 |  | 25.57 |
|  |  |  |  | 4 |  | NA |
| 3 | Control | 5 | 1 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
| 4 | Jay | 6 | 1 | 1 |  | 27.17 |
|  |  |  |  | 2 |  | 25.71 |
|  |  |  |  | 3 |  | 27.70 |
|  |  |  |  | 4 |  | 25.87 |
|  |  |  |  | 5 |  | 26.57 |
|  |  | 7 | 1 | 1 |  | 28.92 |
|  |  |  |  | 2 |  | 26.53 |
|  |  |  |  | 3 |  | 25.93 |
|  |  |  |  | 4 |  | NA |
|  |  |  | 2 | 1 |  | 26.24 |
|  |  |  |  | 2 |  | 25.57 |
|  |  |  |  | 3 |  | 27.71 |
|  |  |  |  | 4 |  | NA |
| 5 | Jay | 8 | 1 | 1 |  | 26.98 |
|  |  |  |  | 2 |  | 27.02 |
|  |  |  |  | 3 |  | 26.33 |
|  |  |  |  | 4 |  | 27.75 |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 26.89 |
|  |  |  |  | 2 |  | 25.63 |
|  |  |  |  | 3 |  | 26.59 |
|  |  |  |  | 4 |  | 25.94 |
| 6 | Owl | 9 | 1 | 1 |  | 28.42 |
|  |  |  |  | 2 |  | 26.44 |
|  |  |  |  | 3 |  | 29.59 |
|  |  |  | 2 | 1 |  | 25.03 |
|  |  |  |  | 2 |  | 23.23 |
|  |  |  |  | 3 |  | 24.18 |
|  |  |  |  | 4 |  | NA |
| 7 | Control | 10 | 1 | 1 |  | 24.28 |
|  |  |  |  | 2 |  | 24.59 |
|  |  |  |  | 3 |  | 25.62 |
|  |  |  |  | 4 |  | 26.61 |
|  |  |  |  | 5 |  | 25.37 |
|  |  |  | 2 | 1 |  | 27.85 |
|  |  |  |  | 2 |  | 26.1 |
|  |  |  |  | 3 |  | 23.32 |
|  |  |  |  | 4 |  | 26.51 |
|  |  |  |  | 5 |  | NA |
| 8 | Control | 11 | 1 | 1 |  | 25.27 |
|  |  |  |  | 2 |  | 26.30 |
|  |  |  |  | 3 |  | 26.00 |
|  |  |  |  | 4 |  | 27.44 |
|  |  |  |  | 5 |  | 25.78 |
|  |  |  | 2 | 1 |  | 24.81 |
|  |  |  |  | 2 |  | 24.98 |
|  |  |  |  | 3 |  | 25.3 |
|  |  |  |  | 4 |  | 23.16 |
| 9 | Hawk | 12 | 1 | 1 |  | 23.71 |
|  |  |  |  | 2 |  | 24.51 |
|  |  |  |  | 3 |  | 23.86 |
|  |  |  |  | 4 |  | NA |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  | 13 | 1 | 1 |  | 25.29 |
|  |  |  |  | 2 |  | 25.69 |
|  |  |  |  | 3 |  | 29.64 |
|  |  |  |  | 4 |  | 27.02 |
|  |  |  |  | 5 |  | 27.70 |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
| 10 | Owl | 14 | 1 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 28.72 |
|  |  |  |  | 2 |  | 27.64 |
|  |  |  |  | 3 |  | 27.25 |
|  |  |  |  | 4 |  | NA |
| 11 | Jay | 15 | 1 | 1 |  | 25.71 |
|  |  |  |  | 2 |  | 26.57 |
|  |  |  |  | 3 |  | 28.47 |
|  |  |  |  | 4 |  | 26.06 |
|  |  |  |  | 5 |  | 27.76 |
|  |  |  | 2 | 1 |  | 29.54 |
|  |  |  |  | 2 |  | 29.17 |
|  |  |  |  | 3 |  | 28.47 |
|  |  |  |  | 4 |  | NA |
|  |  | 16 | 1 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  | 2 | 1 |  | 27.54 |
|  |  |  |  | 2 |  | 22.65 |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
| 12 | Control | 17 | 1 | 1 |  | 22.64 |
|  |  |  |  | 2 |  | 23.66 |
|  |  |  |  | 3 |  | 23.54 |
|  |  |  |  | 4 |  | 23.02 |
|  |  |  |  | 5 |  | 24.44 |
|  |  |  | 2 | 1 |  | 23.04 |
|  |  |  |  | 2 |  | 25.61 |
|  |  |  |  | 3 |  | 24.19 |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
| 13 | Hawk | 18 | 1 | 1 |  | 25.35 |
|  |  |  |  | 2 |  | 28.14 |
|  |  |  |  | 3 |  | 26.32 |
|  |  |  |  | 4 |  | 25.27 |
|  |  |  |  | 5 |  | 27.38 |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
| 14 | Jay | 19 | 1 | 1 |  | 26.07 |
|  |  |  |  | 2 |  | 25.36 |
|  |  |  |  | 3 |  | 23.55 |
|  |  |  |  | 4 |  | 25.35 |
|  |  |  |  | 5 |  | 25.98 |
|  |  | 20 | 1 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 28.48 |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
| 15 | Hawk | 21 | 1 | 1 |  | 28.93 |
|  |  |  |  | 2 |  | 26.18 |
|  |  |  |  | 3 |  | 26.21 |
|  |  |  |  | 4 |  | 28.85 |
|  |  |  | 2 | 1 |  | 17.96 |
|  |  |  |  | 2 |  | 21.91 |
|  |  |  |  | 3 |  | 20.31 |
|  |  |  |  | 4 |  | NA |
|  |  | 22 | 1 | 1 |  | 30.35 |
|  |  |  |  | 2 |  | 30.37 |
|  |  |  |  | 3 |  | 28.12 |
|  |  |  |  | 4 |  | NA |
|  |  |  | 2 | 1 |  | 27.28 |
|  |  |  |  | 2 |  | 26.9 |
|  |  |  |  | 3 |  | 26.51 |
|  |  |  |  | 4 |  | NA |
| 16 | Jay | 23 | 1 | 1 |  | 27.45 |
|  |  |  |  | 2 |  | 28.20 |
|  |  |  |  | 3 |  | 29.05 |
|  |  |  |  | 4 |  | 27.07 |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
| 17 | Control | 24 | 1 | 1 |  | 24.85 |
|  |  |  |  | 2 |  | 25.24 |
|  |  |  |  | 3 |  | 27.50 |
|  |  |  |  | 4 |  | 26.67 |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | 24.75 |
|  |  |  |  | 2 |  | 23.14 |
|  |  |  |  | 3 |  | 23.95 |
|  |  |  |  | 4 |  | 24.77 |
| 18 | Owl | 25 | 1 | 1 |  | 29.85 |
|  |  |  |  | 2 |  | 25.87 |
|  |  |  |  | 3 |  | 26.17 |
|  |  |  |  | 4 |  | 25.78 |
|  |  |  |  | 5 |  | 28.24 |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
| 19 | Owl | 26 | 1 | 1 |  | 23.94 |
|  |  |  |  | 2 |  | 24.66 |
|  |  |  |  | 3 |  | 25.50 |
|  |  |  |  | 4 |  | 26.45 |
|  |  |  |  | 5 |  | 25.65 |
|  |  |  | 2 | 1 |  | 25.27 |
|  |  |  |  | 2 |  | 25.99 |
|  |  |  |  | 3 |  | 26.89 |
|  |  |  |  | 4 |  | 25.74 |
|  |  | 27 | 1 | 1 |  | 26.67 |
|  |  |  |  | 2 |  | 26.33 |
|  |  |  |  | 3 |  | 27.51 |
|  |  |  |  | 4 |  | 26.95 |
|  |  |  |  | 5 |  | 24.69 |
|  |  |  | 2 | 1 |  | 22.02 |
|  |  |  |  | 2 |  | 22.42 |
|  |  |  |  | 3 |  | 22.62 |
|  |  |  |  | 4 |  | 22.47 |
| 20 | Hawk | 28 | 1 | 1 |  | 29.88 |
|  |  |  |  | 2 |  | 29.89 |
|  |  |  |  | 3 |  | 30.18 |
|  |  |  |  | 4 |  | 29.04 |
|  |  |  |  | 5 |  | 27.44 |
|  |  |  | 2 | 1 |  | 25.89 |
|  |  |  |  | 2 |  | 28.23 |
|  |  |  |  | 3 |  | 25.96 |
|  |  |  |  | 4 |  | NA |
|  |  | 29 | 1 | 1 |  | 22.06 |
|  |  |  |  | 2 |  | 23.47 |
|  |  |  |  | 3 |  | 24.34 |
|  |  |  |  | 4 |  | 25.66 |
| 21 | Owl | 30 | 1 | 1 |  | 26.41 |
|  |  |  |  | 2 |  | 20.28 |
|  |  |  |  | 3 |  | 25.89 |
|  |  |  |  | 4 |  | 23.38 |
|  |  |  |  | 5 |  | 24.34 |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  | 31 | 1 | 1 |  | 24.31 |
|  |  |  |  | 2 |  | 24.20 |
|  |  |  |  | 3 |  | 24.01 |
|  |  |  |  | 4 |  | NA |
| 22 | Owl | 32 | 1 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
| 23 | Control | 33 | 1 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  |  | 2 | 1 |  | NA |
|  |  |  |  | 2 |  | NA |
|  |  |  |  | 3 |  | NA |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
|  |  | 34 | 1 | 1 |  | 26.00 |
|  |  |  |  | 2 |  | 27.29 |
|  |  |  |  | 3 |  | 26.65 |
|  |  |  |  | 4 |  | 25.44 |
|  |  |  | 2 | 1 |  | 27.15 |
|  |  |  |  | 2 |  | 25.76 |
|  |  |  |  | 3 |  | 26.41 |
|  |  |  |  | 4 |  | NA |
|  |  |  |  | 5 |  | NA |
| 24 | Hawk | 35 | 2 | 1 |  | 26.04 |
|  |  |  |  | 2 |  | 27.02 |
|  |  |  |  | 3 |  | 26.57 |
|  |  |  |  | 4 |  | NA |

(Note: NA: No data is available. †: ID’s of nestlings did not match those of eggs as shown in Table S2.)

**Appendix D: Model results of bluebird reproductive responses to perceived predation risk under no assumptions about second broods**

Table S4. Bluebirds’ reproductive responses to perceived predation risk under no assumptions about second broods.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Reproductive response | Treatment effect (over Control)† | | | |
| Treatment | Mean | SE | p-value |
| Clutch size | **Owl** | **-0.473** | **0.189** | **0.015** |
|  | **Jay** | **-0.449** | **0.187** | **0.020** |
|  | **Hawk** | **-0.508** | **0.200** | **0.014** |
| Clutch mass | **Owl** | **-1.360** | **0.660** | **0.044** |
|  | Hawk | -1.320 | 0.699 | 0.064 |
| Egg mass | **Hawk** | **0.104** | **0.045** | **0.022** |
| Hatching rate | Jay | -1.963 | 1.090 | 0.072 |
|  | **Hawk** | **-2.287** | **1.109** | **0.039** |
| 14th day nestling number | Hawk | -0.794 | 0.462 | 0.093 |
| 14th day nestling mass | **Jay** | **1.504** | **0.451** | **0.001** |
|  | **Hawk** | **1.337** | **0.491** | **0.007** |

(Note: Table shows treatment effects that had a *P* < 0.1 (Wald test), with statistically significant treatment effects with a *P* < 0.05 highlighted in bold. Sample size for each analysis is provided in Figures 1 through 4. †: The only effects found for nesting density were a positive effect on egg mass (β = 0.098, SE = 0.029, *P* = 0.001), and a weak tendency of negative effect on 14th-day nestling mass (β = -0.511, SE = 0.275, *P* = 0.065).)

**Appendix E: Model results of bluebird reproductive responses to perceived predation risk for the first and second broods, respectively**

Table S5. Bluebirds’ reproductive responses to perceived predation risk for the first and second broods.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nesting attempt | Reproductive response | Treatment effect (over Control)† | | | |
| Treatment | Mean | SE | p-value |
| First | 14th day nestling mass | **Jay** | **1.383** | **0.537** | **0.011** |
|  |  | **Hawk** | **1.909** | **0.582** | **0.001** |
| Second | Clutch size | **Owl** | **-0.714** | **0.237** | **0.006** |
|  |  | **Jay** | **-0.857** | **0.237** | **0.001** |
|  |  | **Hawk** | **-0.674** | **0.240** | **0.009** |
|  | Clutch mass | Owl | -1.696 | 0.895 | 0.070 |
|  |  | Hawk | -1.791 | 0.873 | 0.051 |
|  | Egg mass | Jay | 0.132 | 0.073 | 0.073 |
|  | Hatching rate | **Jay** | **-3.313** | **1.341** | **0.013** |
|  |  | **Hawk** | **-3.350** | **1.271** | **0.008** |
|  | 14th day nestling mass | **Jay** | **1.718** | **0.779** | **0.031** |

(Note: Table shows treatment effects that had a *P* < 0.1 (Wald test), with statistically significant treatment effects with a *P* < 0.05 highlighted in bold. Sample size for each analysis is provided in Figures 1 through 4. †: The only effects found for nesting density was a positive effect on egg mass for the second clutch (β = 0.177, SE = 0.043, *P* < 0.001), and a weak tendency toward heavier clutch mass for the second clutch (β = 0.895, SE = 0.518, *P* = 0.097).)