Notes

Database of Bird Flight Initiation Distances to Assist in Estimating Effects from Human Disturbance and Delineating Buffer Areas

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Abstract

U.S. Fish and Wildlife Service biologists determine effects from disturbance to threatened and endangered bird species, and staffs of federal and state agencies estimate these effects when delineating protective buffers around habitat of bird species of concern on land management areas. These efforts can be informed by the distances at which human activities cause birds to react or move away. To that end, here we present a database of published alert distances (distances at which birds exposed to an approaching human activity exhibit alert behavior), flight initiation distances (distances at which birds exposed to an approaching human activity initiate escape behavior), and minimum approach distances (distances at which humans should be separated from wildlife). The database distinguishes between nesting and nonnesting situations. The nesting database includes 578 alert distances and 2,177 flight initiation distances from 45 studies representing 11 orders, 27 families, and 49 species of birds. The nonnesting database comprises 1,419 alert distances and 34,775 flight initiation distances from 50 studies representing 19 orders, 89 families, and 650 species.

Keywords: alert distance; biological opinion; buffer area; disturbance; Endangered Species Act; flight initiation distance; minimum approach distance

Received: August 31, 2015; Accepted February 8, 2016; Published Online Early: February 2016; Published: June 2016

Citation: Livezey KB, Fernández-Juricic E, Blumstein DT. Database of bird flight initiation distances to assist in estimating effects from human disturbance and delineating buffer areas. *Journal of Fish and Wildlife Management* 7(1):181-191; e1944-687X. doi: 10.3996/082015-JFWM-078

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Introduction

Birds display many behaviors that indicate their level of tolerance or sensitivity to humans and their activities. For example, authors have distinguished among 1) no visible reaction; 2) "scanning behavior" (head-turning); 3) "alert," "react," or "agitation" behaviors (e.g., bird raises its head, tenses its body, turns to look at the humans, flaps its wings, takes a few steps); and 4) "escape," "flush," or "flight" behaviors (bird walks, jumps, runs, flies, swims, or dives away; Brown 1990; Anthony et al. 1995; Delaney et al. 1999; Fernández-Juricic et al. 2001; Swarthout and Steidl 2001). Depending on the species and the circumstance, some of these exposures to human activities may result in adverse effects to the birds, eggs, or young. What matters is not if a bird shows alert behavior or moves away, but whether and how the behavior affects the birds or the species as a whole (Gill et al. 2001; Gill 2007). Adverse effects from human disturbance include reductions in feeding rates (e.g., Bélanger and Bédard 1989; Burger 1994; Merkel et al. 2009; Velando and Munilla 2011), reproductive success and productivity (e.g., Beale and Monaghan 2004; McClung et al. 2004; Medeiros et al. 2007; Zuberogoitia et al. 2008), and survival (Anderson and Keith 1980).

Biologists of U.S. Fish and Wildlife Service (USFWS) must estimate the distance between a human activity and endangered or threatened species at which an adverse effect is reasonably certain to occur when conducting consultations on the effects of proposed federal actions pursuant to section 7 of the U.S. Endangered Species Act (ESA 1973, as amended). In addition, staff of federal and state agencies must consider adverse effects when establishing protective buffer areas (spaces where human activity is minimized to reduce disturbance to wildlife; e.g., Madsen 1998a, 1998b; Madsen et al. 1998) around habitat of species of concern in land management areas and refuges (Fernández-Juricic et al. 2005; Whitfield et al. 2008; Weston et al. 2009; Glover et al. 2011). These efforts can be informed by minimum approach distance (MAD), which is the distance at which humans should be separated from wildlife (Fernández-Juricic et al. 2005; a linear buffer distance). Estimates of MADs can be informed by two other distances: 1) alert distance (AD), which is the distance at which a bird exposed to an approaching human activity exhibits alert behavior, and 2) flight initiation distance (FID), which is the distance at which a bird exposed to an approaching human activity initiates escape behavior (e.g., walking, running, flying, diving; see Cooper and Blumstein 2015 for a complete review; methods to determine FIDs are provided in Blumstein 2006a, Møller 2010a, and Glover et al. 2011). To help make these estimates, here we present a database of all published ADs, FIDs, and MADs known to us. The database distinguishes between nesting and nonnesting situations.

Methods

From 2009 to 2015, we gathered all published ADs, FIDs, and MADs (buffers) we could find worldwide by 1) inputting “disturbance” into the EBSCO search engine (17,647 results) and obtaining copies of all pertinent publications, 2) checking the literature cited in these publications for additional references, and 3) including all pertinent publications known by E.F.-J. and D.T.B., who have many publications in this field and are personally acquainted with many of its researchers. We placed summary statistics and other information (e.g., percent flushing, taxonomy) into a four-part database. We included species from around the world because data from ecologically analogous species can be used to supplement those from North American species and because managers worldwide need to estimate distances at which human activities affect wildlife. We grouped studies when complete data sets were used in more than one publication. We separated data obtained from birds sitting on nests vs. those away from nests because ADs and FIDs may be different between these two groups (e.g., incubating birds may be reluctant to move or leave the nest). We calculated weighted-mean FIDs and MADs for all studies that provided sample size per species per source of disturbance (Tables 1 and 2). Fernández-Juricic et al. (2005) reviewed many methods to calculate MADs. Of these, one method relied solely on FIDs; the others used ADs, standard deviation of FIDs, or the distance at which 95% of the birds alerted and flushed. Since few studies in our database reported data other than FIDs, we used the method that used only FIDs to calculate MADs (Fox and Madsen 1997; MAD $= 1.5 \times$ mean FID; Tables 1 and 2).

Results

The nesting data include 578 ADs and 2,177 FIDs from 45 studies representing 11 orders, 27 families, and 49 species of birds (*Supplemental Material* Data S1; Table 1). The nonnesting data comprise 1,419 ADs and 34,775 FIDs from 50 studies, 19 orders, 89 families, and 650 species (*Supplemental Material* Data S2; Table 2). Types of disturbance were: pedestrian, dog, bicycle, motorcycle, vehicle (car, truck, bus, all-terrain vehicle, farming vehicle), nonmotorized watercraft (canoe, raft, sailing dinghy, windsurfer), motorized watercraft (jet ski, airboat, rigid-hull inflatable, metal-hull boat, commercial ship), aircraft (fixed-winged, helicopter, jet, simulated jet), construction, sonic boom, light weapon (small arms, automatic weapon), heavy weapon (artillery, mortar, missile), and explosion. Nesting-bird MADs were from 21 studies of birds of 8 orders, 15 families, and 31 species (*Supplemental Material* Data S3), and nonnesting MADs were from 18 studies, 7 orders, 18 families, and 60 species (*Supplemental Material* Data S4).

Discussion

An advantage in using this database is that if an MAD needs to be estimated but there are no ADs or FIDs for the species in question, data may be sorted to use taxonomically related or ecologically similar species to help inform the decision (Caro 2010). However, before assuming, for example, that all species within an order, family, or genus behave similarly, it is pertinent to note that many species- (Blumstein et al. 2003) and site-specific factors influence how humans affect birds. These factors include the bird’s level of virulent blood parasites (Møller 2008b), body mass (Blumstein et al. 2005; Blumstein 2006a; Taylor 2006; Glover et al. 2011), basal metabolic rate (Møller 2009), eye size (Møller and Erritzøe 2010), clutch size and fecundity (Blumstein 2006a; Møller

Table 1. Nesting bird flight initiation distances (FIDs) worldwide, weighted-mean FIDs, and an example of minimum approach distances (MADs) by source of disturbance and taxonomic order. Original published data were gathered from 2009 to 2015.

Disturbance	Order	*n* (families)	*n* (species)	*n* (FIDs)[a]	*n* (mean FIDs)[b]	Weighted mean FID (m)	MAD (m)[c]
Pedestrian	Anseriformes	1	3	212	12	32.5	48.8
	Charadriiformes	3	70	476	16	14.9	22.3
	Ciconiiformes	3	7	106	7	31.2	46.8
	Falconiformes	1	1	34	1	476.0	714.0
	Galliformes	1	1	44	2	79.7	119.6
	Passeriformes	6	6	442	5	8.4	12.6
	Pelicaniformes	2	3	101	2	21.4	32.1
	Sphenisciformes	1	1	186	1	22.8	34.2
Nonmotorized watercraft	Pelicaniformes	2	2	23	2	31.1	46.7
Motorized watercraft	Charadriiformes	1	1	145	14	67.5	101.3
	Ciconiiformes	2	7	123	7	17.2	25.9
	Opisthocomiformes	1	1	214	2	31.3	47.0
	Pelicaniformes	3	3	37	3	17.2	25.8
Aircraft	Falconiformes	1	1	6	1	70.0	105.0
	Strigiformes	1	1	28	1	55.0	82.5
Total				2,177	76		

[a] *n* (FIDs) = total FIDs (per row in the database, i.e., per study, source of disturbance, and species) recorded for all species in this taxonomic order for this type of disturbance.

[b] In addition, the database (*Supplemental Material* Data S1) includes 12 mean FIDs without sample sizes: 11 for pedestrian, Charadriiformes and 1 for pedestrian, Pelicaniformes.

[c] Following Fox and Madsen (1997): MAD = 1.5 × mean FID; each site-specific core area (e.g., nesting colony, group of nest trees) would be encircled in a buffer with a width of 1 MAD. Core areas are "where all (or virtually all) the distributional effects of human disturbance are completely excluded" (Fox and Madsen 1977:5).

and Garamszegi 2012), whether the bird is singing (Møller et al. 2008), whether the population is hunted (Madsen 1995, 1998a, 1998b; Madsen and Fox 1995; Laursen et al. 2005; Weston et al. 2012), presence of a predator (Adams et al. 2006; Møller and Liang 2012), nest density (Burger and Gochfield 1998), whether the species breeds cooperatively (Blumstein 2006a), experience of individual birds with people (Fraser et al. 1985), starting distance (Blumstein 2003; Glover et al. 2011; McLeod et al. 2013) and group size of the approaching pedestrian(s) (Geist et al. 2005; McLeod et al. 2013), horizontal and vertical distances between the person and the bird (Møller 2010a), static vs. mobile pedestrians (Weston et al. 2011), urban vs. rural locations (Cooke 1980; Møller 2008a, 2009, 2010b; Blumstein 2014), distance to human settlements (Bjørvik et al. 2015) and escape habitat (Guay et al. 2013a; Dear et al. 2014 for ADs), and weather (Møller et al. 2013), among others (Glover et al. 2011, 2015; McLeod et al. 2013; Møller 2015). Although many factors affect FIDs, neither previous experience (Guay et al. 2013b) nor height of people (Van Dongen et al. 2015) recording FIDs appears to do so. In addition to estimating MADs using observable ADs and FIDs, MADs may need to incorporate effects not visible to us, such as increases in corticosterone (Cyr and Romero 2007; Ellenberg et al. 2006, 2007; Thiel et al. 2011; Seltmann et al. 2012), heart rate (Ackerman et al. 2004; Holmes et al. 2005; Weimerskirch et al. 2002), and body temperature (Regel and Pütz 1997).

Decisions concerning lengths of MADs are based on many factors. The first two critical steps are to define what human activities potentially are causing disturbance (Fernández-Juricic et al. 2004, 2005), and what an acceptable level of disturbance is. These acceptable levels have been represented by various MADs including mean FID (Burger and Gochfeld 2007), mean FID + 1 standard deviation of the mean FID + 40 m (Rodgers and Smith 1995, 1997; Rodgers and Schwikert 2003), 1.5 × mean FID (Fox and Madsen 1997; Tables 1 and 2), maximum FID + 50 m (Vos et al. 1985), and mean AD (Fernández-Juricic et al. 2001; *Supplemental Material* Data S3 and Data S4). Other MADs were based on percentages of birds that would be flushed, including those aimed to protect 90% (Holmes et al. 1993), 95% (McGarigal et al. 1991; Anthony et al. 1995; Swarthout and Steidl 2001; Taylor 2006), 99% (Stalmaster and Newman 1978), and 100% (Delaney et al. 1999) of the birds from flushing (*Supplemental Material* Data S3 and Data S4). Whether managers should use some of the published methods or generate new estimates depends on anticipated risks and effects to the species in question.

Estimating distances at which human activities adversely affect species of concern and delineating buffer areas to protect them require staff of federal and state agencies to justify precise distances (e.g., 50 m vs. 55 m). These are not abstract exercises—they directly determine how, when, and where these activities are permitted. These important decisions must be made, even when the data to thoroughly justify them are lacking. Using FID data from this database for the species in question (and, if appropriate, similar species), and then producing MADs from these FIDs, should make it easier to estimate these distances and support these decisions.

Supplemental Material

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Table 2. Nonnesting bird flight initiation distances (FIDs) worldwide, weighted-mean FIDs, and an example of minimum approach distances (MADs) by source of disturbance and taxonomic order. Original published data were gathered from 2009 to 2015.

Disturbance	Order	*n* (families)	*n* (species)	*n* (FIDs)[a]	*n* (mean FIDs)[b]	Weighted mean FID (m)	MAD (m)[c]
Pedestrian	Anseriformes	1	21	1,120	61	47.4	71.0
	Apodiformes	1	1	9	3	38.0	57.1
	Caprimulgiformes	2	2	3	2	7.7	11.6
	Charadriiformes	7	68	4,244	143	28.1	42.2
	Ciconiiformes	3	25	1,015	68	36.8	55.3
	Columbiformes	1	15	1,101	27	14.2	21.2
	Coraciiformes	5	10	307	17	16.8	25.2
	Cuculiformes	1	6	90	9	20.7	31.0
	Falconiformes	2	17	246	24	89.7	134.5
	Galliformes	3	9	958	16	28.6	42.9
	Gruiformes	2	11	377	20	28.5	42.8
	Passeriformes	47	230	17,037	547	10.8	16.2
	Pelicaniformes	3	11	693	29	35.7	53.6
	Piciformes	1	4	113	8	14.3	21.4
	Podicipediformes	1	2	39	5	30.9	46.4
	Psittaciformes	2	17	525	24	11.3	17.0
	Strigiformes	1	1	94	2	5.1	7.7
	Struthioniformes	1	1	6	1	58.7	88.1
	Trochiliformes	1	1	54	2	6.8	10.2
Pedestrian/dog[d]	Passeriformes	3	3	1,083	16	–	–
Dog	Charadriiformes	2	5	11	5	45.9	68.8
Bicycle	Anseriformes	1	8	64	8	74.4	111.6
	Ciconiiformes	1	1	5	1	58.3	87.5
	Gruiformes	1	3	6	3	68.5	102.8
	Pelicaniformes	3	5	25	5	54.4	81.6
	Podicipediformes	1	1	1	1	16.6	24.9
Motorized vehicle	Anseriformes	1	8	285	21	82.1	123.2
	Charadriiformes	5	13	289	16	22.3	33.5
	Ciconiiformes	2	9	94	19	62.1	93.1
	Falconiformes	2	6	164	6	79.7	119.5
	Gruiformes	1	5	86	10	58.2	87.3
	Pelicaniformes	2	5	74	12	46.8	70.2
	Podicipediformes	1	3	4	4	33.8	50.7
Nonmotorized watercraft	Anseriformes	1	3	14	4	42.0	62.9
	Charadriiformes	4	11	31	11	24.7	37.1
	Ciconiiformes	2	6	14	7	40.5	60.7
	Falconiformes	1	1	177	2	152.1	228.2
	Gruiformes	1	1	7	1	19.0	28.5
	Passeriformes	1	1	2	1	7.0	10.5
	Pelicaniformes	2	3	7	3	55.7	83.6
	Podicipediformes	1	1	2	1	26.0	39.0
Motorized watercraft	Anseriformes	1	3	17	3	98.4	147.6
	Charadriiformes	6	18	656	24	35.2	52.8
	Ciconiiformes	3	11	1,624	25	61.8	92.7
	Falconiformes	2	3	348	6	86.8	130.2
	Pelicaniformes	3	3	571	10	60.8	91.2
Total				33,692	1,233		

[a] *n* (FIDs) = total FIDs (per row in the database, i.e., per study, source of disturbance, and species) recorded for all species in this taxonomic order for this type of disturbance.

[b] In addition, the database (*Supplemental Material* Data S2) includes 23 mean FIDs without sample sizes: 3 for pedestrian, Anseriformes; 13 for pedestrian, Charadriiformes; 1 for dog, Charadriiformes; 4 for motorized vehicle, Charadriiformes; 2 for aircraft, Charadriiformes.

[c] Following Fox and Madsen (1997): MAD = 1.5 × mean FID; each site-specific core area (e.g., foraging area, roosting area) would be encircled in a buffer with the width of 1 MAD. Core areas are "where all (or virtually all) the distributional effects of human disturbance are completely excluded" (Fox and Madsen 1977:5).

[d] In addition, the database (*Supplemental Material* Data S2) includes 1,083 FIDs and 16 mean FIDs for three Passeriform species in response to pedestrians (on trail; off trail) and dogs (on leash, on trail; on leash, off trail; alone, on trail; alone, off trail) from one study (Miller et al. 2001). This study provided sample sizes for each species for all disturbances combined, and mean FIDs for each species for each type of disturbance, but did not report sample sizes for each species per type of disturbance, so weighted means could not be calculated. Adding these FIDs to the total above equals a grand total of 34,775 FIDs in the nonnesting database.

supplemental material. Queries should be addressed to the corresponding author for the article.

Data S1. Published ADs and FIDs for nesting birds gathered from 2009 to 2015. Presented data: authors, study location, continent, source of disturbance, specific group or test (if applicable), taxonomic order and family, scientific name, common name, and reference. For ADs and FIDs, data include (when provided) mean, SD of mean, standard error (SE) or mean, range, median, and *n*. In addition, data include (when provided) distance without flushing (and *n*) and percent flushed (and *n*).

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S1 (55 KB XLSX).

Data S2. Published ADs and FIDs for non-nesting birds gathered from 2009 to 2015. Presented data: authors, study location, continent, source of disturbance, specific group or test (if applicable), taxonomic order and family, scientific name, common name, and reference. For ADs and FIDs, data include (when provided) mean, SD of mean, SE or mean, range, median, and *n*. In addition, data include (when provided) distance without flushing (and *n*) and percent flushed (and *n*).

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S2 (205 KB XLSX).

Data S3. Published MADs for nesting birds gathered from 2009 to 2015. Presented data: authors, study location, continent, source of disturbance, specific group or test (if applicable), taxonomic order and family, scientific name, common name, MAD, formula and purpose of MAD, and reference.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S3 (23 KB XLSX).

Data S4. Published MADs for nonnesting birds gathered from 2009 to 2015. Presented data: authors, study location, continent, source of disturbance, specific group or test (if applicable), taxonomic order and family, scientific name, common name, MAD, formula and purpose of MAD, and reference.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S4 (28 KB XLSX).

Reference S1. Brown AL. 1990. Measuring the effect of aircraft noise on sea birds. Environment International 16:587–592.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S5 (444 KB PDF)

Reference S2. Delaney DK, LL,. Melton RH, MacAllister BA, Dooling RJ, Lohr B, Brittan-Powell BF, Swindell LL, Beaty TA, Carlile CD, Spadgenske EW. 2002. Assessment of training noise impacts on the red-cockaded woodpecker: final report. Army Corps of Engineers, Energy Research and Development Center, Champaign, Illinois, USA. 93 pp.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S6 (2519 KB PDF).

Reference S3. Guay PJ, McLeod EM, Taysom AJ, Weston MA. 2014. Are vehicles 'mobile bird hides'? A test of the hypothesis that 'cars cause less disturbance' Victorian Naturalist 131:150–155.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S7 (77 KB PDF).

Reference S4. Hume RA. 1976. Reactions of goldeneyes to boating. British Birds 69:178–179.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S8 (379 KB PDF).

Reference S5. Kitchen K, Lill A, Price M. 2010. Tolerance of human disturbance by urban Magpie-larks. Australian Field Ornithology 27:1–9.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S9 (130 KB PDF).

Reference S6. Monie L. 2011. Factors affecting alert distance and flight-initiation distance in Black Swans (*Cygnus atratus*) at Albert Park Lake, Victoria, Australia. Bachelor's thesis. Melbourne, Australia: Victoria University St Albans.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S10 (428 KB PDF).

Reference S7. Paton DC, Ziembicki M, Owen P, Heddle C. 2000. Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia. Adelaide, Australia: University of Adelaide.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S11 (1708 KB PDF).

Reference S8. Price M. 2003. Tolerance of a human observer by four ground-foraging bird species in urban and rural areas. Bachelor's thesis. Melbourne, Australia: Monash University.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S12 (8002 KB PDF).

Reference S9. Smit CJ, Visser GJM. 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin 68:6–19.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S13 (1717 KB PDF).

Reference S10. Taylor IR. 2006. Managing visitor disturbance of waterbirds on Australian inland wetlands. Pages 150–157 in Taylor IR, Murray PA, Taylor SG, editors. Wetlands of the Murrumbidgee River catchment: practical management in an altered environment. Fivebough and Tuckerbil Wetlands Trust, Leeton, New South Wales, Australia.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S14 (496 KB PDF).

Reference S11. Taylor TM, Reshkin M, Brock KJ. 1982. Recreation land use adjacent to an active heron rookery:

a management study. Proceedings of 1981 Indiana Academy of Science 91:226-236.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S15 (616 KB PDF).

Reference S12. Van Dongen WFD, McLeod EM, Mulder RA, Weston MA, Guay P-J. 2015. The height of approaching humans does not affect flight-initiation distance. Bird Study, DOI:10.1080/00063657.2015.1026309.

Found at DOI: http://dx.doi.org/10.3996/082015-JFWM-078.S16; also available at http://dx.doi.org/10.1080/00063657.2015.1026309 (131 KB PDF).

Acknowledgments

We thank the staff at the USFWS Conservation Library at the National Conservation Training Center for years of assistance in acquiring hard-to-find publications; Mike Weston for review and for sending publications with FIDs; Brendan White, Paul Phifer, and Vince Harke of USFWS for review; and Patrick-Jean Guay, an anonymous reviewer, and the Associate Editor for review and comments.

References

Ackerman JT, Takekawa JY, Kruse KL, Orthmeyer DL, Yee JL, Ely CR, Ward DH, Bollinger KS, Mulcahy DM. 2004. Using radiotelemetry to monitor cardiac response of free-living tule greater white-fronted geese (*Anser albifrons elgasi*) to human disturbance. Wilson Bulletin 116:146–151 (*Supplemental Material*, Data S2).

Adams JL, Camelio KW, Orique MJ, Blumstein DT. 2006. Does information of predators influence general wariness? Behavioral Ecology and Sociobiology 60:742–747.

Anderson DW, Keith JO. 1980. The human influence on seabird nesting success: conservation implications. Biological Conservation 18:65–80.

Anthony RG, Steidl RJ, McGarigal K. 1995. Recreation and bald eagles in the Pacific Northwest. Pages 223–241 in Knight RL, Gutzwiller KJ, editors. Wildlife and recreationists: coexistence through management and research. Washington, D.C.: Island Press (*Supplemental Material*, Data S3 and Data S4).

Arroyo B, Razin M. 2006. Effect of human activities on bearded vulture behaviour and breeding success in the French Pyrenees. Biological Conservation 128:267–284 (*Supplemental Material*, Data S1 and Data S3).

Baines D, Richardson M. 2007. An experimental assessment of the potential effects of human disturbance on Black Grouse *Tetrao tetrix* in the North Pennines, England. Ibis 149:56–64 (*Supplemental Material*, Data S1 and Data S3).

Batten LA. 1977. Sailing on reservoirs and its effects on water birds. Biological Conservation 11:49–58 (*Supplemental Material*, Data S2).

Baudains TP, Lloyd P. 2007. Habituation and habitat changes can moderate the impacts of human disturbance on shorebird breeding performance. Animal Conservation 10:400–407 (*Supplemental Material*, Data S1).

Beale CM, Monaghan P. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335–343.

Bélanger L, Bédard J. 1989. Responses of staging greater snow geese to human disturbance. Journal of Wildlife Management 53:713–719.

Bellefleur D, Lee P, Ronconi RA. 2009. The impact of recreational boat traffic on marbled murrelets (*Brachyramphus marmoratus*). Journal of Environmental Management 90:531–538 (*Supplemental Material*, Data S2 and Data S4).

Bjørvik LM, Dale S, Hermansen GH, Munishi PKT, Moe SR. 2015. Bird flight initiation distances in relation to distance from human settlements in a Tanzanian floodplain habitat. Journal of Ornithology 156:239–246.

Blumstein DT. 2003. Flight-initiation distance in birds is dependent on intruder starting distance. Journal of Wildlife Management 67:852–857 (*Supplemental Material*, Data S2).

Blumstein DT. 2006a. Developing an evolutionary ecology of fear: how life history and natural history traits affect disturbance tolerance in birds. Animal Behaviour 71:389–399.

Blumstein DT 2006b. The multi-predator hypothesis and the evolutionary persistence of antipredator behavior. Ethology 112: 209–217 (*Supplemental Material*, Data S2).

Blumstein DT. 2014. Attention, habituation, and antipredator behaviour: implications for urban birds. Pages 41–53 in Gil D and Brumm H, editors. Avian urban ecology. Oxford, UK: Oxford University Press.

Blumstein DT, Anthony LL, Harcourt R, Ross G. 2003. Testing a key assumption of wildlife buffer zones: is flight initiation distance a species-specific trait? Biological Conservation 110:97–100 (*Supplemental Material*, Data S2).

Blumstein DT, Fernández-Juricic E, LeDee O, Larsen E, Rodriguez-Prieto I, Zugmeyer C. 2004. Avian risk assessment: effects of perching height and detectability. Ethology 110:273–285 (*Supplemental Material*, Data S2).

Blumstein DT, Fernández-Juricic E, Zollner PA, Garity SC. 2005. Inter-specific variation in avian responses to human disturbance. Journal of Applied Ecology 42:943–953 (*Supplemental Material*, Data S2).

Blumstein DT, Juricic EF, Zollner PA, Garity SC. 2005. Inter-specific variation in avian responses to human disturbance. Journal of Applied Ecology 42:943–953 (*Supplemental Material*, Data S2)/

Boeker EL. 1970. Use of aircraft to determine golden eagle, *Aguila chrysaetos*, nesting activity. Southwestern Naturalist 15:136–137 (*Supplemental Material*, Data S1).

Booms TL, Whitman JS, Gardner CL. 2010. Utility of helicopters for short-eared owl nest searches and surveys. Journal of Raptor Research 44:247–248 (*Supplemental Material*, Data S1).

Bouton SN, Frederick PC, Rocha CD, Barbosa-dos-Santos AT, Bouton TC. 2005. Effects of tourist disturbance on wood stork nesting success and breeding behavior in the Brazilian Pantanal. Waterbirds 28:487–497 (*Supplemental Material*, Data S1 and Data S3).

Bratton SP. 1990. Boat disturbance of Ciconiiformes in Georgia estuaries. Colonial Waterbirds 13:124–128 (*Supplemental Material*, Data S2).

Brown AL. 1990. Measuring the effect of aircraft noise on sea birds. Environment International 16:587–592 (Gray reference: See *Supplemental Material*, Reference S1, http://dx.doi.org/10.3996/082015-JFWM-078.S5).

Buehler DA, Mersmann TJ, Fraser JD, Seegar JKD. 1991. Nonbreeding bald eagle communal and solitary roosting behavior and roost habitat on the northern Chesapeake Bay. Journal of Wildlife Management 55:273–281 (*Supplemental Material*, Data S4).

Burger J. 1981. Behavioural responses of herring gulls *Larus argentatus* to aircraft noise. Environmental Pollution 24:177–184 (*Supplemental Material*, Data S1).

Burger J. 1994. The effect of human disturbance on foraging behavior and habitat use in piping plover (*Charadrius melodus*). Estuaries 17:695–701.

Burger J, Gochfeld M. 1981. Discrimination and the threat of direct versus tangential approach to the nest of incubating herring and great black-backed gulls. Journal of Comparative and Physiological Psychology 95:676–684 (*Supplemental Material*, Data S1).

Burger J, Gochfeld M. 1993. Tourism and short-term behavioural responses of nesting masked, red-footed, and blue-footed boobies in the Galapagos. Environmental Conservation 20:255–259 (*Supplemental Material*, Data S1).

Burger J, Gochfeld M. 1998. Defensive aggression in terns: effects of species, density, and isolation. Aggressive Behavior 14:169–178 (*Supplemental Material*, Data S1).

Burger J, Gochfeld M. 2007. Responses of emperor penguins (*Aptenodytes forsteri*) to encounters with ecotourists while commuting to and from their breeding colony. Polar Biology 30:1303–1313 (*Supplemental Material*, Data S1 and Data S3).

Burger J, Gochfeld M, Jenkins CD, Lesser F. 2010. Effect of approaching boats on nesting black skimmers: using response distances to establish protective buffer zones. Journal of Wildlife Management 74:102–108 (*Supplemental Material*, Data S1 and Data S3).

Burhans DE, Thompson FR. 2001. Relationship of songbird nest concealment to nest fate and flushing behavior of adults. Auk 118:237–242 (*Supplemental Material*, Data S1).

Caro T. 2010. Conservation by proxy: indicator, umbrella, keystone, flagship, and other surrogate species. Washington, D.C.: Island Press.

Carrier WD, Melquist WE. 1976. The use of a rotor-winged aircraft in conducting nesting surveys of ospreys in northern Idaho. Raptor Research 10:77–83 (*Supplemental Material*, Data S1).

Cooke AS. 1980. Observations on how close certain passerine species will tolerate an approaching human in rural and suburban areas. Biological Conservation 18:85–88 (*Supplemental Material*, Data S2).

Cooper WE Jr, Blumstein DT, eds. 2015. Escaping from predators: an integrative view of escape decisions. Cambridge, UK: Cambridge University Press.

Cyr NE, Romero LM. 2007. Chronic stress in free-living European starlings reduces corticosterone concentrations and reproductive success. General and Comparative Endocrinology 151:82–89.

Dear EJ, Guay PJ, Robinson RW, Weston MA. 2014. Distance from shore positively influences alert distance in three wetland bird species. Wetlands Ecology and Management 23:315–318.

Delaney DK, Grubb TG, Beier P, Pater LL, Reiser MH. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60–76 (*Supplemental Material*, Data S2 and Data S4).

Delaney DK, Pater LL, Carlile LD, Spadgenske EW, Beaty TA, Melton RH. 2011. English (U.S.) Response of red-cockaded woodpeckers to military training operations. Wildlife Monographs 177:1–38 (English (U. S.) *Supplemental Material*, Data S1).

Delaney DK, Pater LL, Melton RH, MacAllister BA, Dooling RJ, Lohr B, Brittan-Powell BF, Swindell LL, Beaty TA, Carlile CD, and Spadgenske EW. 2002. Assessment of training noise impacts on the red-cockaded woodpecker: final report. Army Corps of Engineers, Energy Research and Development Center, Champaign, Illinois (English (U.S.) *Supplemental Material*, Data S1).

de Villiers MS, Cooper J, Ryan PG. 2005. Individual variability of behavioural responses by wandering albatrosses (*Diomedea exulans*) to human disturbance. Polar Biology 28:255–260 (English (U.S.) *Supplemental Material*, Data S1 and Data S3).

Dunnet GM. 1977. Observations on the effects of low-flying aircraft at seabird colonies on the coast of Aberdeesshire, Scotland. Biological Conservation 12:55–63 (English (U.S.) *Supplemental Material*, Data S1; Gray reference: See *Supplemental Material*, Reference S2, http://dx.doi.org/10.3996/082015-JFWM-078.S6).

Eason PK, Sherman PT, Rankin O, Coleman B. 2006. Factors affecting flight initiation distance in American robins. Journal of Wildlife Management 70:1796–1800 (English (U.S.) *Supplemental Material*, Data S2).

Ellenberg U, Mattern T, Seddon PJ, Jorquera GL. 2006. Physiological and reproductive consequences of human disturbance in Humboldt penguins: the need for species-specific visitor management. Biological Conservation 133:95–106.

Ellenberg U, Setiawan AN, Cree A, Houston DM, Seddon PJ. 2007. Elevated hormonal stress response and reduced reproductive output in yellow-eyed penguins exposed to unregulated tourism. General and Comparative Endocrinology 152:54–63.

Erwin M. 1989. Responses to human intruders by birds nesting in colonies: experimental results and management guidelines. Colonial Waterbirds 12:104–108 (English (U.S.) *Supplemental Material*, Data S1 and Data S3).

Fernández-Juricic E, Jimenez MD, Lucas E. 2001. Alert distance as an alternative measure of bird tolerance to human disturbance: implications for park design. Environmental Conservation 28:263–269 (English (U.S.) *Supplemental Material*, Data S2 and Data S4).

Fernández-Juricic E, Vaca R, Schroeder N. 2004. Spatial and temporal responses of forest birds to human approaches in a protected area and implications for two management strategies. Biological Conservation 117:407–416.

Fernández-Juricic E, Venier MP, Renison D, Blumstein DT. 2005. Sensitivity of wildlife to spatial patterns of recreationist behavior: a critical assessment of minimum approaching distances and buffer areas for grassland birds. Biological Conservation 125:225–235 (English (U.S.) *Supplemental Material*, Data S2 and Data S4).

Flemming SP, Chiasson RD, Smith PC, Austin-Smith PJ, Bancroft RP. 1988. Piping plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. Journal of Field Ornithology 59:321–330 (English (U.S.) *Supplemental Material*, Data S1).

Fox AD, Madsen J. 1997. Behavioural and distributional effects of hunting disturbance on waterbirds in Europe: implications for refuge design. Journal of Applied Ecology 34:1–13 (English (U.S.) *Supplemental Material*, Data S4).

Fraser JD, Frenzel LD, Mathisen JE. 1985. The impact of human activities on breeding bald eagles in north-central Minnesota. Journal of Wildlife Management 49:585–592 (English (U.S.) *Supplemental Material*, Data S1, Data S2, and Data S3).

Geist C, Liao J, Libby S, Blumstein DT. 2005. Does intruder group size and orientation affect flight initiation distance in birds? Animals, Biodiversity and Conservation 28:69–73 (English (U.S.) *Supplemental Material*, Data S2).

Gill JA. 2007. Approaches to measuring the effects of human disturbance on birds. Ibis 149:9–14.

Gill JA, Norris K, Sutherland WJ. 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97:265–268.

Glover HK, Guay P-J, Weston MA. 2015. Up the creek with a paddle; avian flight distances from canoes vs. walkers. Wetlands Ecology and Management 24:775–778 (English (U.S.) *Supplemental Material*, Data S2).

Glover HK, Weston MA, Maguire GS, Miller KK, Christie BA. 2011. Towards ecologically meaningful and socially acceptable buffers: response distances of shorebirds in Victoria, Australia, to human disturbance. Landscape and Urban Planning 103:326–334 (English (U.S.) *Supplemental Material*, Data S2).

González LM, Arroyo BE, Margalida A, Sánchez R, Oria J. 2006. Effect of human activities on the behaviour of breeding Spanish imperial eagles (*Aquila adalberti*): management implications for the conservation of a threatened species. Animal Conservation 9:85–93 (English (U.S.) *Supplemental Material*, Data S1 and Data S3).

Grubb TG, King RM. 1991. Assessing human disturbance of breeding bald eagles with classification tree models. Journal of Wildlife Management 55:500–511 (English (U.S.) *Supplemental Material*, Data S1 and Data S3).

Guay P-J, Lorenz RDA, Robinson RW, Symonds MRE, Weston MA. 2013a. Distance from water, sex and approach direction influence flight distances among habituated black swans. Ethology 119:552–558.

Guay P-J, McLeod EM, Cross R, Formby A, Maldonado S, Stafford-Bell R, St-James-Turner Z, Robinson RW, Mulder RA, Weston MA. 2013b. Observer effects occur when estimating alert but not flight initiation distances. Wildlife Research 40:289–293.

Guay P-J, McLeod EM, Taysom AJ, Weston MA. 2014. Are vehicles 'mobile bird hides'? A test of the hypothesis that 'cars cause less disturbance'. Victorian Naturalist 131:150–155 (Gray reference: (English (U.S.) *Supplemental Material*, Reference S3, http://dx.doi.org/10.3996/082015-JFWM-078.S7).

Gutzwiller KJ, Marcum HA, Harvey HB, Roth JD, Anderson SH. 1998. Bird tolerance to human intrusion in Wyoming montane forests. Condor 100:519–527 (*Supplemental Material*, Data S1).

Heyland JD, Munro WT. 1967. The use of helicopters in hunting waterfowl nests. Journal of Wildlife Management 31:200–201 (English (U.S.) *Supplemental Material*, Data S1).

Holmes N, Giese M, Kriwoken LK. 2005. Testing the minimum approach distance guidelines for incubating Royal penguins *Eudyptes schlegeli*. Biological Conservation 126:339–350.

Holmes TL, Knight RL, Stegall L, Craig GR. 1993. Responses of wintering grassland raptors to human disturbance. Wildlife Society Bulletin 21:461–468 (English (U.S.) *Supplemental Material*, Data S2 and Data S4).

Holthuijzen AMA, Eastland WG, Ansell AR, Kochert MN, Williams RD, Young LS. 1990. Effects of blasting on behavior and productivity of nesting prairie falcons. Wildlife Society Bulletin 18:270–281 (English (U.S.) *Supplemental Material*, Data S1).

Hume RA. 1976. Reactions of goldeneyes to boating. British Birds 69:178–179 (Gray reference: English (U.S.) *Supplemental Material*, Reference S4, http://dx.doi.org/10.3996/082015-JFWM-078.S8).

Ikuta LA, Blumstein DT. 2003. Do fences protect birds from human disturbance? Biological Conservation 112:447–452 (English (U.S.) *Supplemental Material*, Data S2).

Kitchen K, Lill A, Price M. 2010. Tolerance of human disturbance by urban Magpie-larks. Australian Field Ornithology 27:1–9 (Gray reference: See *Supplemental Material*, Reference S5, http://dx.doi.org/10.3996/082015-JFWM-078.S9).

Klein ML. 1993. Waterbird behavioral responses to human disturbances. Wildlife Society Bulletin 21:31–39 (English (U.S.) *Supplemental Material*, Data S2).

Knight RL, Knight SK. 1984. Responses of wintering bald eagles to boating activity. Journal of Wildlife Management 48:999–1004 (English (U.S.) *Supplemental Material*, Data S2).

Kury CR, Gochfeld M. 1975. Human interference and gull predation in cormorant colonies. Biological Conservation 8:23–34 (English (U.S.) *Supplemental Material*, Data S1).

Kushlan JA. 1979. Effects of helicopter censuses on wading bird colonies. Journal of Wildlife Management 43:756–760 (English (U.S.) *Supplemental Material*, Data S1).

Laursen K, Kahlert J, Frikke J. 2005. Factors affecting escape distances of staging waterbirds. Wildlife Biology 11:13–19.

Madsen J. 1995. Impacts of disturbance on migratory waterfowl. Ibis 137:S67–S74.

Madsen J. 1998a. Experimental refuges for migratory waterfowl in Danish wetlands. I. Baseline assessment of disturbance effects of recreational activities. Journal of Applied Ecology 35:386–397.

Madsen J. 1998b. Experimental refuges for migratory waterfowl in Danish wetlands. II. Tests of hunting disturbance effects. Journal of Applied Ecology 35:398–417.

Madsen J, Fox AD. 1995. Impacts of hunting disturbance on waterbirds: a review. Wildlife Biology 1:193–207.

Madsen J, Pihl S, Clausen P. 1998. Establishing a reserve network for waterfowl in Denmark: a biological evaluation of needs and consequences. Biological Conservation 85:241–255.

Madsen J, Tombre I, Eide NE. 2009. Effects of disturbance on geese in Svalbard: implications for regulating increasing tourism. Polar Research 28:376–389 (English (U.S.) *Supplemental Material*, Data S1 and Data S3).

Marks JS, Hendricks P. 1989. On the flushing behavior of incubating white terns. Condor 91:997–998 (English (U.S.) *Supplemental Material*, Data S1).

Martínez-Abraín A, Oro D, Conesa D, Jiménez J. 2008. Compromise between seabird enjoyment and disturbance: the role of observed and observers. Environmental Conservation 35:104–108 (*Supplemental Material*, Data S1 and Data S3).

McClung MR, Seddon PJ, Massaro M, Setiawan AN. 2004. Nature-based tourism impacts on yellow-eyed penguins *Megadyptes antipodes*: does unregulated visitor access affect fledging weight and juvenile survival? Biological Conservation 119:279–285.

McGarigal K, Anthony RG, Isaacs FB. 1991. Interactions of humans and bald eagles on the Columbia River Estuary. Wildlife Monograph 115:1–47 (*Supplemental Material*, Data S2 and Data S4).

McLeod EM, Guay P-J, Taysom AJ, Robinson RW, Weston MA. 2013. Buses, cars, bicycles and walkers: the influence of the type of human transport on the flight responses of waterbirds. PLoS ONE 8(12): e82008. doi:10.1371/journal.pone.0082008 (*Supplemental Material*, Data S2).

Medeiros R, Ramos JA, Paiva VH, Almeida A, Pedro P, Antunes S. 2007. Signage reduces the impact of human disturbance on little tern nesting success in Portugal. Biological Conservation 135:99–106.

Merkel FR, Mosbech A, Riget F. 2009. Common Eider *Somateria mollissima* feeding activity and the influence of human disturbances. Ardea 97:99–107.

Miller SG, Knight RL, Miller CK. 2001. Wildlife responses to pedestrians and dogs. Wildlife Society Bulletin 29:124–132 (*Supplemental Material*, Data S2).

Møller AP. 2008a. Flight distance of urban birds, predation, and selection for urban life. Behavioral Ecology and Sociobiology 63:63–75.

Møller AP. 2008b. Flight distance and blood parasites in birds. Behavioral Ecology 19:1305–1313 (*Supplemental Material*, Data S2).

Møller AP. 2008c. Flight distance and population trends in European birds. Behavioral Ecology 19:1095–1102 (*Supplemental Material*, Data S2).

Møller AP. 2009. Basal metabolic rate and risk taking behavior in birds. Journal of Evolutionary Biology 22:2420–2429 (*Supplemental Material*, Data S2).

Møller AP. 2010a. Up, up, and away: relative importance of horizontal and vertical escape from predators for survival and senescence. Journal of Evolutionary Biology 23:1689–1698.

Møller AP. 2010b. Interspecific variation in fear responses predicts urbanization in birds. Behavioral Ecology 21:365–371.

Møller AP. 2015. Birds. Pages 88–112 in Cooper WE Jr, Blumstein DT, editors. Escaping from predators: an integrative view of escape decisions. Cambridge, UK: Cambridge University Press.

Møller AP, Erritzøe J. 2010. Flight distance and eye size in birds. Ethology 116:458–465 (*Supplemental Material*, Data S2).

Møller AP, Garamszegi LZ. 2012. Between individual variation in risk taking behavior and its life history consequences. English (U.S.). Behavioral Ecology 23:843–853.

Møller AP, Grim T, Ibáñez-Álamo J-D, Markó G, Tryjanowski P. 2013. Change in flight distance between urban and rural habitats following a cold winter. Behavioral Ecology 24:1211–1217.

Møller AP, Liang W. 2012. Tropical birds take small risks. Behavioral Ecology 24:267–272.

Møller AP, Nielsen JT, Garamzegi LZ. 2008. Risk taking by singing males. Behavioral Ecology 19:41–53 (*Supplemental Material*, Data S2).

Monie L. 2011. Factors affecting alert distance and flight-initiation distance in Black Swans (*Cygnus atratus*) at

Albert Park Lake, Victoria, Australia. Bachelor's thesis. Melbourne, Australia: Victoria University St Albans (Gray reference: See *Supplemental Material*, Reference S6, http://dx.doi.org/10.3996/082015-JFWM-078.S10).

Müllner A, Linsenmair KE, Wikelski M. 2004. Exposure to ecotourism reduces survival and affects stress response in hoatzin chicks (*Opisthocomus hoazin*). Biological Conservation 118:549–558 (*Supplemental Material*, Data S1).

Nisbet ICT. 2000. Disturbance, habituation, and management of waterbird colonies. Waterbirds 23:312–332 (*Supplemental Material*, Data S1 and Data S3).

Paton DC, Ziembicki M, Owen P, Heddle C. 2000. Disturbance distances for water birds and the management of human recreation with special reference to the Coorong region of South Australia. Adelaide, Australia: University of Adelaide (Gray reference: See *Supplemental Material*, Reference S7, http://dx.doi.org/10.3996/082015-JFWM-078.S11).

Peters KA, Otis DL. 2006. Wading bird response to recreational boat traffic: does flushing translate into avoidance? Wildlife Society Bulletin 34:1383–1391 (*Supplemental Material*, Data S2).

Price M. 2003. Tolerance of a human observer by four ground-foraging bird species in urban and rural areas. Bachelor's thesis. Melbourne, Australia: Monash University (Gray reference: See *Supplemental Material*, Reference S8, http://dx.doi.org/10.3996/082015-JFWM-078.S12).

Regel J, Pütz K. 1997. Effect of human disturbance on body temperature and energy expenditure in penguins. Polar Biology 18:246–253.

Roberts G, Evans PR. 1993. Responses of foraging sanderlings to human approaches. Behaviour 126:29–43 (*Supplemental Material*, Data S2).

Rodgers JA, Schwikert ST. 2002. Buffer-zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard-powered boats. Conservation Biology 16:216–224 (*Supplemental Material*, Data S2 and Data S4).

Rodgers JA, Schwikert ST. 2003. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by airboats in Florida. Waterbirds 26:437–443 (*Supplemental Material*, Data S2 and Data S4).

Rodgers JA Jr, Smith HT. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology 9:89–99 (*Supplemental Material*, Data S1 and Data S3).

Rodgers JA, Smith HT. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbance in Florida. Wildlife Society Bulletin 25:139–145 (*Supplemental Material*, Data S4).

Rodriguez-Prieto I, Fernández-Juricic E, Martín J. 2008. To run or to fly: low cost versus low risk escape strategies in blackbirds. Behaviour 145:1125–1138 (*Supplemental Material*, Data S2).

Ronconi RA, St. Clair CC. 2002. Management options to reduce boat disturbance on foraging black guillemots (*Cepphus grylle*) in the Bay of Fundy. Biological Conservation 108:265–271 (*Supplemental Material*, Data S2 and Data S4).

Schwemmer P, Mendel B, Sonntag N, Dierschke V, Garthe S. 2011. Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning. Ecological Applications 21:1851–1860 (*Supplemental Material*, Data S2).

Seltmann MW, Öst M, Jaatinen K, Atkinson S, Mashburn K, Hollmén T. 2012. Stress responsiveness, age and body condition interactively affect flight initiation distance in breeding female eiders. Animal Behaviour 84:889–896.

Smit CJ, Visser GJM. 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin 68:6–19 (Gray reference: See *Supplemental Material*, Reference S9, http://dx.doi.org/10.3996/082015-JFWM-078.S13).

Smith-Castro JR, Rodewald AD. 2010. Behavioral responses of nesting birds to human disturbance along recreational trails. Journal of Field Ornithology 81:130–138 (*Supplemental Material*, Data S1).

Stalmaster MV, Kaiser JL. 1997. Flushing responses of wintering bald eagles to military activity. Journal of Wildlife Management 61:1307–1313 (*Supplemental Material*, Data S2 and Data S4).

Stalmaster MV, Kaiser JL. 1998. Effects of recreational activity on wintering bald eagles. Wildlife Monograph 137:1–46 (*Supplemental Material*, Data S2 and Data S4).

Stalmaster MV, Newman JR. 1978. Behavioral responses of wintering bald eagles to human activity. Journal of Wildlife Management 42:506–513 (*Supplemental Material*, Data S4).

Sunde P, Odderskær P, Storgaard K. 2009. Flight distances of incubating Common Buzzards *Buteo buteo* are independent of human disturbance. Ardea 97:369–372 (*Supplemental Material*, Data S1 and Data S3).

Swarthout ECH, Steidl RJ. 2001. Flush responses of Mexican spotted owls to recreationists. Journal of Wildlife Management 65:312–317 (*Supplemental Material*, Data S2 and Data S4).

Taylor IR. 2006. Managing visitor disturbance of waterbirds on Australian inland wetlands. Pages 150–157 in Taylor IR, Murray PA, Taylor SG, editors. Wetlands of the Murrumbidgee River catchment: practical management in an altered environment. Leeton, New South Wales, Australia: Fivebough and Tuckerbil Wetlands Trust (See *Supplemental Material*, Reference S10, http://dx.doi.org/10.3996/082015-JFWM-078.S14).

Taylor TM, Reshkin M, Brock KJ. 1982. Recreation land use adjacent to an active heron rookery: a management study. Proceedings of 1981 Indiana Academy of Science 91:226–236 (Gray reference: See *Supplemental Material*, Reference S11, http://dx.doi.org/10.3996/082015-JFWM-078.S15).

Thiel D, Jenni-Eiermann S, Palme R, Jenni L. 2011. Winter tourism increases stress hormone levels in the Capercaillie *Tetrao urogallus*. Ibis 153:122–133.

Thiel D, Ménoni E, Brenot J, Jenni L. 2007. Effects of recreation and hunting on flushing distance of capercaillie. Journal of Wildlife Management 71:1784–1792 (*Supplemental Material*, Data S2 and Data S4).

[ESA] U.S. Endangered Species Act of 1973, as amended, Pub. L. No. 93-205, 87 Stat. 884 (Dec. 28, 1973). Available at: http://www.fws.gov/endangered/esa-library/pdf/ESAall.pdf.

Van Dongen WFD, McLeod EM, Mulder RA, Weston MA, Guay P-J. 2015. The height of approaching humans does not affect flight-initiation distance. Bird Study DOI: 10.1080/00063657.2015.1026309 (Gray reference: See *Supplemental Material*, Reference S12, http://dx.doi.org/10.3996/082015-JFWM-078.S16).

Velando A, Munilla I. 2011. Disturbance to a foraging seabird by sea-based tourism: implications for reserve management in marine protected areas. Biological Conservation 144:1167–1174.

Vos DK, Ryder RA, Graul WD. 1985. Response of breeding great blue herons to human disturbance in north-central Colorado. Colonial Waterbirds 8:13–22 (*Supplemental Material*, Data S1 and Data S3).

Watson JW. 1993. Responses of nesting bald eagles to helicopter surveys. Wildlife Society Bulletin 21:171–178 (*Supplemental Material*, Data S1 and Data S3).

Watson JW, Pierce DJ, Cunningham BC. 1999. An active bald eagle nest associated with unusually close human activity. Northwestern Naturalist 80:71–74 (*Supplemental Material*, Data S1).

Weimerskirch H, Shaffer SA, Mabille G, Martin J, Boutard O, Rouanet JL. 2002. Heart rate and energy expenditure of incubating wandering albatrosses: basal levels, natural variation, and the effects of human disturbance. Journal of Experimental Biology 205:475–483.

Weston MA, Antos MJ, Glover HK. 2009. Birds, buffers and bicycles: a review and case study of wetland buffers. Birds in the Urban Environment 126:79–86.

Weston MA, Ehmke GC, Maguire GS. 2011. Nest return times in response to static versus mobile human disturbance. Journal of Wildlife Management 75:252–255.

Weston MA, McLeod EM, Blumstein DT, Guay P-J. 2012. A review of flight-initiation distances and their application to managing disturbance to Australian birds. Emu 112:269–286.

White DM, Sherrod SK. 1973. Advantages and disadvantages of the use of rotor-winged aircraft in raptor studies. Raptor Research 7:97–104 (*Supplemental Material*, Data S1).

White CM, Thurow TL. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. Condor 87:14–22 (*Supplemental Material*, Data S1 and Data S3).

Whitfield DP, Ruddock M, Bullman R. 2008. Expert opinion as a tool for quantifying bird tolerance to human disturbance. Biological Conservation 141:2708–2717.

Yalden DW. 1992. The influence of recreational disturbance on common sandpipers *Actitus hypoleucos* breeding by an upland reservoir, in England. Biological Conservation 61:41–49 (*Supplemental Material*, Data S2).

Yalden PE, Yalden DW. 1990. Recreational disturbances of breeding golden plovers *Pluvialis apricarius*. Biological Conservation 51:243–262 (*Supplemental Material*, Data S1).

Zuberogoitia I, Zabala J, Martínez JA, Martínez JE, Azkona A. 2008. Effect of human activities on Egyptian vulture breeding success. Animal Conservation 11:313–320.