3

A review of flight initiation distances and their application to managing disturbance to Australian birds

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26 **Abstract**

27 Disturbance, the response of birds to a stimulus such as the presence of a person, is

28 considered a conservation threat for some Australian birds. The distance at which a

29 bird flees from perceived danger is defined as the Flight Initiation Distance (FID), and

30 could be used to designate separation distances between birds and stimuli which

31 might cause disturbance. We review the known FIDs for Australian birds, and report

32 FIDs for 352 species. Most FIDs are from south eastern Australia, and almost all refer

33 to a single walker as the stimulus. A number of prominent factors correlated with FID

34 are discussed (e.g. body mass and the distance at which an approach begins). FIDs

35 have not been used extensively in the management of disturbance, for a variety of

36 reasons including lack and inaccessibility of available data. We call for standardised

37 data collection and greater application of available data to the management of

38 disturbance.

39

Introduction

41   The response of birds to the presence of a stimulus such as a potential predator or a

42   human is referred to as 'disturbance' (Van Der Zande and Verstrael 1985; Fox and

43   Madsen 1997). A diverse range of *stimuli* can disturb birds. Although natural stimuli,

44   such as predators, cause disturbance (e.g. Ward *et al.* 1994; Burton *et al.* 1996), most

45   studies focus on anthropogenic sources of disturbance. These include humans

46   themselves, their companion animals, and motorised transport such as aircraft,

47   vehicles and boats (e.g. Kushlan 1979; Andersen *et al.* 1989; Buick and Paton 1989;

48   Kirby *et al.* 1993; Burger 1998; Delaney *et al.* 1999).

49

50   The *response* of birds to disturbance takes many forms, but most reported

51   responses are behavioural and can be considered vigilance or flight responses

52   (Hediger 1934; Ydenberg and Dill 1986; Hockin *et al.* 1992), where 'vigilance'

53   involves birds stopping their current activity to monitor the approaching human (e.g.

54   Fernández-Juricic *et al.* 2001) and 'flight' involves fleeing on foot, swimming, diving,

55   or on the wing (e.g. Cooke 1980). An increasing number of studies have demonstrated

56   physiological responses to stimuli, such as changes in heart rates, body temperature,

57   and plasma corticosterone levels, which can occur in the absence of any obvious

58   behavioural responses (e.g. Gabrielsen *et al.* 1977; Kanwisher *et al.* 1978; Culik *et al.*

59   1990; Wilson *et al.* 1991; Culik *et al.* 1995; Nimon *et al.* 1995, 1996; Regel and Pütz

60   1997; Weimerskirch *et al.* 2002; Walker *et al.* 2006). Responses to disturbance can

61   vary greatly between species. For example, some shorebirds do not leave their nest

62   until humans are nearby, while others leave their nests when humans are several

63   hundred metres distant (e.g. Page *et al.* 1983; Watson 1988; Yalden and Yalden

64   1989).

65

66   These behavioural and physiological responses are presumed to be costly, and

67   non-benign consequences of human disturbance have been observed among many

68   species. Disturbance induced by humans can result in ecologically significant shifts in

69   behaviour, such as changes in habitat use (e.g. Burger 1981), reduced foraging,

70   diminished parental care (e.g. Weston and Elgar 2005), compromised parental defence

71   resulting in reproductive failure (e.g. Vos *et al.* 1985), among other changes.

72   Behavioural changes, such as those associated with disturbance, are often assumed to

73   be brief, yet may ultimately have long-lasting impacts on populations (e.g. Flemming

74   *et al.* 1988). At the population level, high species sensitivity to disturbance (i.e. long

75   'Flight Initiation Distances' [FIDs]) is associated with population declines among

76   European birds (Møller 2008) and, in the Cordoba Mountains of Argentina, human

77   presence negatively influenced avian communities, guilds and populations (Heil *et al.*

78   2007).

79

80   Increasing exposure of birds to disturbance, the possibility of significant

81   negative impacts on the conservation of at least some species, and the legislative

82   requirements to conserve birds and protect bird welfare, have largely prompted a

83   dramatic increase in the number of publications on disturbance to birds over the last

84   35 years (Hockin *et al.* 1992; Hill *et al.* 1997; Price 2008). This considerable body of

85   work has emphasised the high variability of the forms and consequences of

86   disturbance to birds. Many studies of disturbance examine factors that mediate

87   responses to disturbance. For example, physical factors such as habitat, internal

88   factors such as learning, and attributes of the stimulus such as number, height and

89   width, and speed of approach can all influence avian responses (e.g. Stalmaster and

4

90   Newman 1978; Burger 1986; Keller 1989; Rodgers and Smith 1995; Jorden 2007). An

91   almost universal theme in the literature is that most forms of disturbance to birds are

92   already common and are likely to occur with greater frequency in the future. Increases

93   in disturbance to birds have been predicted for Europe, North America and Australia

94   (e.g. Boden and Ovington 1973; Goss-Custard and Verboven 1993; Kirby *et al.* 1993;

95   Flather and Cordell 1995; Gill *et al.* 1996; Hill *et al.* 1997).

96

97   Here, we briefly review Flight Initiation Distances (FID) among Australian

98   birds and some of the factors which may mediate FID. Specifically, this review

99   critically describes FID and associated concepts, describes some prominent factors

100   which mediate FID, and considers why FID estimates have not enjoyed greater

101   application in the management of avian disturbance. We redress one barrier to the use

102   of FID data in management by providing available FID data for Australian birds. We

103   are unaware of any published reviews dedicated to this topic to date (but see Lane

104   2003).

105

106   **Bridging the theoretical-applied divide: Flight Initiation Distances**

107   One of the most consistent findings of disturbance research is that the response of

108   birds is inversely related to the distance between the bird and the stimulus. The

109   distance at which a behavioural escape response occurs is known as Flight Initiation

110   Distance (FID) (Stankowich and Blumstein 2005), a concept apparently first

111   described by Hediger (1934). FID is also known as 'Flush' (Stankowich and

112   Blumstein 2005), 'Displacement' (Dandenong Valley Authority 1979) or 'Flight'

113   Distance (Hediger 1934).The distance at which a vigilance response is initiated is the

114   Alarm Initiation Distance (AD), also known as 'Agitation' Distance (Dandenong

115   Valley Authority 1979) (Fig. 1). The concept of FID is broadly applicable to wild

116   living birds, though for aggressive, highly habituated or domesticated birds, the

117   response often involves an approach to humans, and FID may not adequately reflect

118   the distance at which normal activities are disrupted. Alarm responses vary between

119   species, but many involve raising the head and communicating with nearby

120   conspecifics via alarm calls or other signals such as tail flicking among the Rallidae

121   (Woodland *et al.* 1980). Non-cryptic promulgation of alarm may also signal to

122   threatening stimuli that they have been detected (Woodland *et al.* 1980). If AD is

123   evident, it is always greater than or equal to FID (Blumstein *et al.* 2005; Cárdenas *et*

124   *al.* 2005).

125

126   Two other important distances that are often overlooked are: 1) the possible

127   existence of Detection Distance (DD), the distance at which a bird can first detect a

128   stimulus (generally assumed to be visually, though auditory cues could potentially be

129   used to detect loud stimuli such as aircraft, or the sounds of approaching predators in

130   closed habitats) without reacting in other ways, and 2) the Physiological Initiation

131   Distance (PID), the distance at which physiological response (e.g. increased heart rate

132   or corticosteroid secretion) is initiated (Fig. 1). Birds can detect stimuli while not

133   being overtly vigilant and thus DD is greater than or equal to AD (Lima and

134   Bednekoff 1999). The few studies of PID suggest that it is longer than either AD or

135   FID (Nimon *et al.* 1996), at least in 'non-startle' responses (see below).

136

137   Starting distance (the distance at which an investigator approach begins; SD),

138   is usually positively related to FID (Blumstein 2003, 2006, 2010), however where FID

139   and DD are very similar or the same, the response of the birds can be considered a

140   'startle' response, defined as an instantaneous flight response upon detection of the

141   stimulus. Startles occur at distances below which FID equals SD. Maximum startle

142   distance can be estimated from the regression of FID and SD as the point where FID

143   equals SD for a given species. DD is currently not measurable, so startles occur when

144   the distance at which an approach begins (Starting Distance; SD) equals or is very

145   similar to FID. Essentially, this represents the presentation of a stimulus to a bird

146   rather than an approach. For species with long FIDs, caution must be exercised in

147   relation to achieving sufficient starting distances during approaches; insufficient

148   starting distance may result in only the least sensitive individuals contributing to the

149   measure of FID.

150

151   **Prominent factors correlated with FID**

152   Life history characteristics influence many aspects of the behaviour of birds, and can

153   be reasonably expected to influence key aspects of decisions in relation to escape

154   behaviour such as flight (Møller and Garamszegi 2012). For example, males and

155   females, old and young individuals, and low and high quality individuals could differ

156   consistently in direction and magnitude of FID. However, studies which examine

157   these attributes in relation to FID are few (but see Thiel *et al.* 2007). FID itself can be

158   considered a life history trait, whereby FID represents the risk an individual is willing

159   to take, which is expected to be influenced by residual reproductive value (the

160   remaining reproductive value for an individual of a particular age, given it's particular

161   condition, quality etc.). Thus, associations between FID and other life history traits

162   represent correlations and do not necessarily imply causation.

163   Body mass, a life history trait, explains most of the variation in FID among

164   species (Blumstein 2006). To highlight the importance body mass, residuals from a

165   regression of FID on body mass (both logged [10]) for species with at least ten FIDs

166   and with adequate mass data are presented in Appendix 1 (no phylogenetic

167   corrections; $F_{1,138} = 131.471$, $P < 0.001$, $R^2 = 0.488$, slope = 0.296; Fig. 2). Higher

168   positive residual values indicate species most sensitive to human approaches while

169   negative values of higher magnitude indicate species least sensitive to human

170   approaches. The Hooded Plover *Thinornis rubricollis* has the highest residual value,

171   and is a species considered to be threatened by human disturbance (Dowling and

172   Weston 1999). The least sensitive species analysed was the Australian Brush Turkey

173   *Alectura lathami* which sometimes inhabits yards and other human-dominated

174   environments (Marchant and Higgins 1993).

175

176   There are several possible reasons for the general finding that FIDs and body

177   sizes are positively correlated between species. First, if larger-bodied species are more

178   at risk from predators due to their higher detectability, they may diminish depredation

179   risk by initiating the flight response earlier (Holmes *et al.* 1993). Second, if larger-

180   bodied species are less agile or aerodynamic than smaller species, they may require

181   more time or space to escape (Fernández-Juricic *et al.* 2002). Third, smaller-bodied

182   species may require more foraging time to fulfill their relatively higher energy

183   requirements and thus may react later to disturbance to maximise foraging time

184   (Bennett and Harvey 1987; Blumstein 2006). Other possibilities include that humans

185   may have discriminately hunted or hunt larger species, or that larger species may

186   exhibit higher longevities (i.e. have, on average, higher residual reproductive values)

187   and so minimise risk associated with perceived threats. A number of parameters

188   correlated with body mass may also be correlated with FID, including sensory organ

189   and brain size and the height of the eye above the substrate; some of these parameters

190   are positively correlated with FID once body mass has been accounted for (Møller and

191   Erritzøe 2010) and others remain to be investigated.

192

193   Larger group sizes are, at least sometimes, associated with longer FIDs;

194   possibly because the flock's response is dependent on the reaction of the most alert ,

195   sensitive or risk-averse constituent of the flock (Cooke 1980; Hilton *et al.* 1999;

196   Fernández-Juricic *et al.* 2002), and because at least some birds may initiate a response

197   when nearby birds respond (Hingee and Magrath 2009). However, the reduction in

198   individual vigilance associated with an increase in group size is a frequently reported

199   relationship, and is generally thought to result from a decrease in predation risk to

200   flock members, or an increase in competition among foraging flock members (Roberts

201   1996; Beauchamp 2001; Randler 2005). Flocking species may be more susceptible to

202   disturbance from humans than species that do not flock, both at the individual and

203   possibly the population levels. More studies are required to determine if a threshold in

204   group size exists above which FIDs do not increase but theory predicts that because

205   the benefits of increasing group size attenuate quickly, studies of animals in relatively

206   small group sizes will be important to describing this function.

207

208   Learning is an oft cited influence on escape behaviour such as FID, but no

209   studies on birds known to us unambiguously describe changes in FID with experience

210   i.e. learning (see below). Learning, if it occurs, could potentially influence FIDs in

211   two directions: 1) facilitation ('sensitisation'), where FIDs increase with increasing

212   exposure to humans; and, 2) habituation where FIDs decrease with increasing

213   exposure to humans. The former is generally suggested to be associated with

214   dangerous, irregular, rapid and unpredictable stimuli such as hunters (Thiel *et al.*

215 2007), and dogs which are most commonly unleashed in many bird habitats (see

216 Williams *et al.* 2009). In contrast, habituation is suggested to result from frequent

217 benign, slow and predictable stimuli like walkers (Weston and Elgar 2007). Both

218 types of learning might potentially occur within a species. Such an explanation might

219 explain examples of behaviour such as the Pacific Black Duck *Anas supercisliosa*,

220 which in urban parks, where the species is fed, actually approaches humans closely,

221 while in areas where it is hunted, flushes at many hundreds of metres (Unpubl. Data,

222 but see below). The capacity of learning, if any occurs, on the part of birds to change

223 FIDs is little studied and poorly known (but see Gould *et al.* 2004), but within species

224 variation in FID might at least partly reflect learning .

225

226   Learning has been inferred from the prevalence of humans in particular

227 habitats and the responses of birds in those habitats (i.e. a space – experience

228 substitution). For example, Black Swan *Cygnus atratus* FIDs toward walkers have

229 been measured by many observers at different sites and vary from 149 m in the

230 relatively undisturbed Coorong, SA (Paton *et al.* 2000), to only 3.6 m at the extremely

231 busy Albert Park Lake, Melbourne (Monie 2011). Such variation has been used to

232 infer habituation. However, evidence of this type does not necessarily demonstrate

233 learning, and a number of problems exist when using space-experience substitution

234 studies to infer learning. Firstly, dispersal and site fidelity of the species measured

235 will influence the experience of birds at a site and few such studies document the

236 underlying regimes in the occurrence of stimuli (e.g. density or frequency of humans)

237 which are often assumed (but see Glover et al. 2011). Additionally, site comparisons

238 are often confounded with habitat, and many comparisons of these types involve

239 urban and rural or 'natural' comparisons (e.g. Cooke 1980). Space – experience

240 substitutions may also be confounded by the possibility of selection for, or biased

241 recruitment of, less responsive birds in more disturbed habitats. Observed patterns

242 may thus reflect selective pressure or differential recruitment, rather than learning *per*

243 *se*. We are unaware of any study that examines the actual experience of free-living

244 individual birds and their response to humans, and we are similarly unaware of any

245 study which discriminates between the potential mechanisms underpinning reported

246 differences in bird responses between birds inhabiting sites experiencing different

247 disturbance regimes. The capacity, if any, for learning on the part of the birds and

248 subsequent adjustment of FIDs thus remains virtually unstudied, poorly known, and is

249 ripe for future study.

250

251 Starting distance (i.e. the distance at which an approach begins; SD) is

252 positively related to FID for most species (Blumstein 2003, 2006). It has been

253 hypothesised that this intriguing finding results from a judgement regarding the value

254 of a 'patch' under increasing risk (i.e. an approaching human; Blumstein 2003, 2006).

255 However, an alternative explanation may be that birds monitor approaches and

256 tolerate them for a certain time (and thus maintain a temporal margin of safety; Dill

257 1990) perhaps a measure of the 'persistence' of the approach. Or, individuals may

258 tolerate approaches to a certain proportion of AD such as is seen in galahs (*Cacatua*

259 *roseicapilla*; Cárdenas *et al.* 2005) and perhaps other species (Gulbransen *et al.* 2006).

260 Alternatively, animals may tolerate approach until a threshold in the perception of the

261 stimulus (e.g. increasing size) is reached (Jorden 2007). Many species of birds do not

262 have a large binocular overlap region frontally and thus may not be able to estimate

263 distance efficiently. Obviously, time and distance are highly correlated during a

264 human approach at a constant speed, which could explain the significant correlation

265   between SD and FID, although distance *per se* may not be used by birds to decide

266   when to respond to stimuli (but see Cárdenas *et al.* 2005). Further research into

267   teasing apart these alternative mechanisms remains to be conducted.

268

269   The factors listed above are those that feature prominently in the literature.

270   Blumstein (2006) suggested after body size, diet and sociality (i.e. whether a species

271   is a co-operative breeder) also explained significant variation in avian FID. However,

272   many other potential correlations with FID remain to be investigated thoroughly. For

273   example, birds with more pointed wings have longer FIDs and fly further when

274   disturbed compared with birds with more rounded wings (Fernández-Juricic *et al.*

275   2006) and 'personality' may explain some of the variation of FIDs seen within

276   species. More 'exploratory' individual Collared Flycatchers *Ficedula albicollis* tend

277   to have smaller FIDs than less exploratory individuals (Garamszegi *et al.* 2009). Other

278   potential influences on FID include age, sex, site attributes including distance from

279   cover and the presence of barriers to human movement such as fences or canals,

280   weather, clothing colour and others mentioned throughout this review (see, for

281   example, Fruziski 1977; Gutzwiller and Marcum 1993; Gould *et al.* 2004; Thiel *et al.*

282   2007; Fong *et al.* 2009).

283

284   **FID as a management tool: strengths and shortcomings**

285   One of the attractions of documenting FIDs is that they provide a scientific basis for

286   the designation of buffers or separation distances between important habitat and

287   incompatible surrounding land uses, often recreation (Blumstein and Fernández-

288   Juricic 2010). Other approaches to mitigate the impacts of disturbance include altering

289   the behaviour of the stimulus, for example by implementing 'codes of conduct',

290 hiding the stimulus (e.g. hides) or by promoting habituation, such as through the use

291 of fences (Ikuta and Blumstein 2003), which make stimuli more predictable and

292 physically separate them from birds so rendering them less threatening (Gates and

293 Gysel 1978). Despite the potential of buffers to restrict any negative effects of

294 disturbance (Davies and Lane 1995), and because of a range of competing factors,

295 FIDs have rarely been used in this way in Australia (Weston *et al.* 2009). Their use

296 has been limited by a number of ecological, scientific and social factors which are

297 discussed below.

298

299   Relatively few studies in Australia have provided measures of FIDs although

300 data on some species with global distributions are available from overseas (e.g.

301 Møller and Erritzøe 2010). Many older studies of FID relied on subjective

302 measurement of distance and so used distance categories (e.g. Woodland *et al.* 1980).

303 However, the availability of cost-effective eye-safe laser range finders, which permit

304 accurate measurements of distances at scales relevant to bird FIDs, means collecting

305 data on FIDs is now comparatively cheap and accurate. Despite this, published data

306 on FIDs of Australian birds are only available for 29.3% of the 866 species of birds

307 that occur in Australia (Table 1). Thus, comparatively few FIDs are readily available

308 to managers. Of the 352 FIDs on Australian birds we located, only 48.6% were

309 published in peer-reviewed literature. The remaining FIDs were published in reports

310 with limited circulation, or reports that are difficult to access (e.g. honours theses or

311 other 'grey literature'; a finding that is paralleled on other continents). The lack of

312 suitable data on which to make management decisions could be addressed by

313 collecting more FID on more species in more locations and encouraging its

314 publication in a form usable for managers. In the interim, estimates from the

widespread, positive relationship between body mass and FID, and the species

specific residuals from the relationship (Blumstein 2006), may be used as a first

approximation or to identify particularly sensitive species and these estimates can be

tested and refined with future study. Clearly, the later approach relies on information

regarding the species present at a site, and assumes the site is not already avoided by

particularly sensitive species.

There has been a taxonomic bias in available FIDs for Australian birds. 34.0%

(of 377 species) and 45.8% (of 489 species) of passerines and non-passerines

respectively have published FIDs. In particular, most research has targeted waterbirds,

in particular shorebirds (75.9% of 224 species; Table 1). As a result, there are many

groups of birds for which few or no FIDs are available. There has also been a regional

bias in studies of the FIDs of Australian birds, with most reported from temperate

areas (usually coastal), in eastern Australia (where most of the human population

resides; Fig. 3), and a habitat bias, with most FIDs available from wetlands, few from

grasslands, and few studies which specify the microhabitat of focal birds such as

substrate (e.g. for wetland birds, margin or water) (but see Blumstein 2006).

The great majority of reported FIDs involve non-breeding birds, although

disturbance can reduce reproductive success in some species (Davidson and Rothwell

1993) and disturbance has been associated with decline among breeding populations

of others (Møller 2008). Breeding birds potentially respond very differently to

disturbance compared with non-breeding birds (Glover *et al.* 2011), and few studies

report FIDs for dependent or flightless young.

340   FIDs are reported in non-standard ways in the scientific literature, and are

341   presented as averages (e.g. Blumstein 2006) sometimes without measures of variation,

342   as 95th percentiles (e.g. Taylor 2006), or as maxima (Glover 2009). Moreover, a

343   central repository for FID data is not available to managers. Given that virtually

344   nothing is known about the thresholds of response frequencies or intensities which

345   can be tolerated by birds, the precautionary principle suggests that an upper limit is

346   required, this could be 95th percentiles (which still assumes thresholds in tolerance), or

347   maxima (if sampling is sufficient), which would be most appropriate for the

348   designation of buffers for conservation purposes. In at least some cases the FIDs

349   evoked by tangential approaches exceed those evoked by direct approaches (e.g. Heil

350   *et al.* 2007; but see Burger *et al.* 2010) suggesting that such effects should be

351   investigated before designating buffers, leading some authors to propose various

352   inflation factors to FIDs (Fernández-Juricic *et al.* 2005; Blumstein and Fernández-

353   Juricic 2010). We believe that it would seem prudent to present full summary

354   statistics and methodological details of all FIDs in publications, to enable managers

355   access and ready interpretation of the data (thus, see Table 2). Additionally, studies of

356   experimentally implemented buffers, derived from FIDs, could inform how FIDs can

357   be used to create effective buffers, and could account for a variety of stimulus types

358   and behaviour, and if studies occur long enough, account for learning on the part of

359   the birds. Studies which examine different methods of calculating buffers in relation

360   to actual FIDs (Fernández-Juricic *et al.* 2005; Glover *et al.* 2011) are both needed and

361   useful.

362

363   FIDs from mixed species flocks are not available either because studies have

364   generally approached only single species flocks (e.g. Paton *et al.* 2000) or because

365   they assume that no species interactions occur and use a focal bird approach

366   (Blumstein *et al.* 2003). However, many species usually or often occur in mixed

367   flocks (e.g. shorebirds, small passerines) and mixed flocks of shorebirds are known to

368   'share' vigilance with other species in flocks (Metcalfe 1983). It may be that in mixed

369   flocks the FID is that of the most sensitive individual irrespective of species,

370   especially for closely or highly coordinated flocking species i.e., the 'sentinel'

371   hypothesis (Metcalfe 1983; Paton *et al.* 2000). Alternatively, it is possible that species

372   respond only to the flight of conspecifics. These possibilities can be envisaged as the

373   extremes of a spectrum. Interspecies interactive FIDs remain unstudied and their

374   study may generate novel and practical insights into managing human disturbance at

375   multi-species sites.

376

377   Another limitation of the FID data currently available is the emphasis on a

378   single walker as the stimulus (92.3% of 352 FIDs). FIDs in response to other stimuli

379   including dog walkers, joggers, powerboats, and canoes have only been reported for

380   11 species (some authors discuss the influence of different stimuli without directly

381   reporting the FIDs e.g. Glover *et al.* 2011). Although walkers are a useful standard for

382   comparative studies, FID can vary depending on the stimulus involved. For example,

383   shorebirds have larger FIDs towards dog walkers than walkers without dogs (Paton *et*

384   *al.* 2000; Glover 2009) and cars do not elicit as strong a response as walkers or

385   cyclists among ducks (Pease *et al.* 2005). Larger groups of people may evoke longer

386   FIDs (Geist *et al.* 2005). Aspects of the behaviour of stimuli also influence responses:

387   for example, tangential approaches evoke different responses, sometimes longer FIDs,

388   in comparison with direct ones (Blumstein and Fernández-Juricic 2010; Burger *et al.*

389   2010) and the behaviour of a human can dramatically influence the duration of a

390   response (Weston *et al.* 2011). Due to the strong effect of stimulus type, proper

391   management decisions can only be made if FIDs for the prevailing human activities

392   are available for the appropriate species. The use of FIDs for single walkers would

393   underestimate the required buffer needed to protect birds from dog walkers. More

394   studies of the influence of stimulus type on FID may enable some extrapolation of

395   FIDs across stimulus types, which could be cautiously used by managers until better

396   information becomes available. Indeed, currently it is not known whether birds

397   respond specifically to each stimulus or generalise responses into 'classes'. Different

398   classes of FID are presumably correlated between individuals or species;

399   understanding such patterns might provide general principles regarding what stimuli

400   are likely to cause greatest disturbance. Ultimately, FID-based buffer zones should be

401   viewed as hypotheses ripe for testing and studied in an adaptive management

402   framework (Blumstein and Fernández-Juricic 2010).

403

404   Different authors have used various protocols to measure FIDs. The standard

405   protocol, which has received the broadest patronage and thus seems logical to

406   promote to future investigators, involves a slow continuous approach toward the

407   target bird and the recording of AD and FID as the bird behaviour changes (Blumstein

408   2003). This would also seem to best mimic the behaviour of most recreationists

409   (except possibly birdwatchers or photographers). Other researchers have opted for

410   stepwise advances toward birds with behavioural observations in between each step to

411   monitor vigilance within flocks (Paton *et al.* 2000). For birds in elevated positions,

412   horizontal and vertical components of FID should be recorded and documented

413   (Møller 2010). SD should be maximised or standardised (see Møller and Garamszegi

414   2012). Standardisation of the FID measuring protocol would enhance compatibility of

415   different datasets and we advocate that the simple method described by Blumstein

416   (2003) should be adopted whenever possible.

417

418   Finally, FIDs may be impractical for planners, policy makers and other

419   stakeholders such as the public, researchers and birdwatchers (see Glover *et al.* 2011).

420   Some species exhibit FIDs of more than 100 m; the maximum FID recorded for any

421   Australian species to date is 196 m for the Eastern Curlew *Numenius*

422   *madagascariensis* (Glover *et al.* 2011); longer FIDs are likely to occur. Although

423   many Australians accept the need for buffers against human disturbance (Glover *et al.*

424   2011), large buffers which exclude humans threaten coexistence, including with

425   birdwatchers who at least occasionally cause disturbance (Clarke 1965; Sekercioglu

426   2002). Additionally, close personal encounters with wildlife such as birds, can be a

427   powerful tool for public education and the recruitment of bird researchers,

428   conservationists and advocates; strict buffers would exclude such experiences.

429   However, FIDs can provide information on managing disturbance in ways other than

430   exclusion zones. For example, constraining the extent of human presence (through

431   formed paths or barriers such as fences or canals), and the promotion of habituation

432   (by encouraging predictable and unthreatening behaviour of the stimuli), remain

433   tantalising management responses to disturbance.

434

435   If response to humans is considered a major issue for bird conservation, then

436   the lack of published FID data, and its limited use in management, seems at odds with

437   the concept of scientific management. The divide between science and its application

438   is hardly new, but it is frustrating and challenging to managers and scientists alike

439   (Australian Biosecurity CRC 2009). The publication of raw FID data often does not

440   fulfil the more theoretical expectations of scientific journals, or aspirations of

441   potential authors. Nevertheless, such data are required if the management of

442   disturbance to birds is to improve. We encourage the development of a common data

443   standard and sharing of these data to enhance the conservation of Australian birds.

444

456

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758 Table 1. Number and percentage of species in different taxonomic groups for which

759 FID of Australian birds have been reported (Paton *et al.* 2000; Blumstein *et al.* 2003;

760 Price 2003; Blakney 2004; Blumstein 2006; Taylor 2006; Kitchen *et al.* 2010; Glover

761 *et al.* 2011; Monie 2011). Blanks indicate no FIDs have been located.

Order (family)	Stimulus				Percentage of species in group
	Walker	Dog	Boat	Canoe	
Casuariiformes					25.0
Casuariidae	1				25.0
Galliformes					30.8
Megapodiidae	2				66.7
Phasianidae	2				25.0
Anseriformes					35.7
Anatidae	10	1	2	1	37.0
Podicipediformes					50.0
Podicipedidae	2				50.0
Columbiformes					32.4
Columbidae	11				32.4
Caprimulgiformes					25.0
Podargidae	1				33.3
Eurostopodidae	1				50.0
Phalacrocoraciformes					29.4
Anhingidae	1				100.0
Phalacrocoracidae	4				57.1
Ciconiiformes					58.6
Pelecanidae	1				100.0
Ardeidae	11				50.0
Threskiornithidae	5		1	1	100.0
Accipitriformes					28.6
Accipitridae	6				28.6
Falconiformes					33.3
Falconidae	2				33.3
Gruiformes					25.0
Rallidae	6				28.6
Charadriiformes					33.6
Burhinidae	1				50.0
Haematopodidae	2				66.7
Recurvirostridae	3	2	3	3	100.0
Charadriidae	10				52.6

Scolopacidae	17	3	5	5	38.6
Turnicidae	1				14.3
Laridae	7				21.9
Psittaciformes					28.6
Cacatuidae	7				50.0
Psittacidae	9				22.0
Cuculiformes					31.3
Cuculidae	5				31.25
Coraciiformes					50.0
Alcedinidae	1				33.3
Halcyonidae	4				44.4
Meropidae	1				100.0
Coraciidae	1				100.0
Passeriformes					31.6
Menuridae	1				50.0
Climacteridae	3				50.0
Ptilonorhynchidae	4				40.0
Maluridae	3				13.6
Acanthizidae	16				38.1
Pardalotidae	1				25.0
Meliphagidae	24				32.4
Pomatostomidae	2				50.0
Orthonychidae	2				100.0
Eupetidae	1				12.5
Campephagidae	3				37.5
Pachycephalidae	5				35.7
Oriolidae	2				66.7
Artamidae	7				50.0
Dicruridae	1				100.0
Rhipiduridae	3				42.9
Corvidae	2				28.6
Monarchidae	5				35.7
Corcoracidae	2				100.0
Paradisaeidae	1				25.0
Petroicidae	5				22.7
Cisticolidae	1				50.0
Acrocephalidae	1				50.0
Megaluridae	2				40.0
Timaliidae	1				14.3
Hirundinidae	2				28.6
Pycnonotidae	1				100.0
Turdidae	3				60.0
Sturnidae	2				28.6

Nectariniidae	1	33.3
Estrildidae	5	23.8
Passeridae	2	100.0
Motacillidae	2	25.0
Fringillidae	3	75.0

762

763

764   Table 2. Recommended fields for documenting Flight Initiation Distance data,

765   assuming basic methods are fully documented.

Aspect	Fields
Stimulus	Stimulus type (e.g. walker) and number of stimuli per approach
	Clothing colour
	Speed of approach
	Relative angle of approach (direct or tangential)
	Distance at which approach ceased (if required)
Response	SD (m)
	AD (m) if evident
	FID (m) if evident
	Type of escape (e.g. run, hide, swim, dive)
	Relative direction of escape
	Distance at which escape behaviour ceases
Context	Flock size and composition (e.g. number of conspecifics within 10 and 50 m)
	Age
	Sex
	Life history stage (e.g. non-breeding)
	Barriers (e.g. fences, channels)
	Height (m) if perched
	Starting behaviour
	Substrate
	Weather particularly wind speed and direction

Date, location (including tenure and indices of human presence),

species/subspecies being approached

766

767   Figure 1. Visual representation of the Detection Distance (DD;), Physiological Initiation Distance (PID;), Alarm

768   Initiation Distance (AD;) and Flight Initiation Distance (FID;). Presented to illustrate a conceptual framework; distances are

769   not to scale.

770
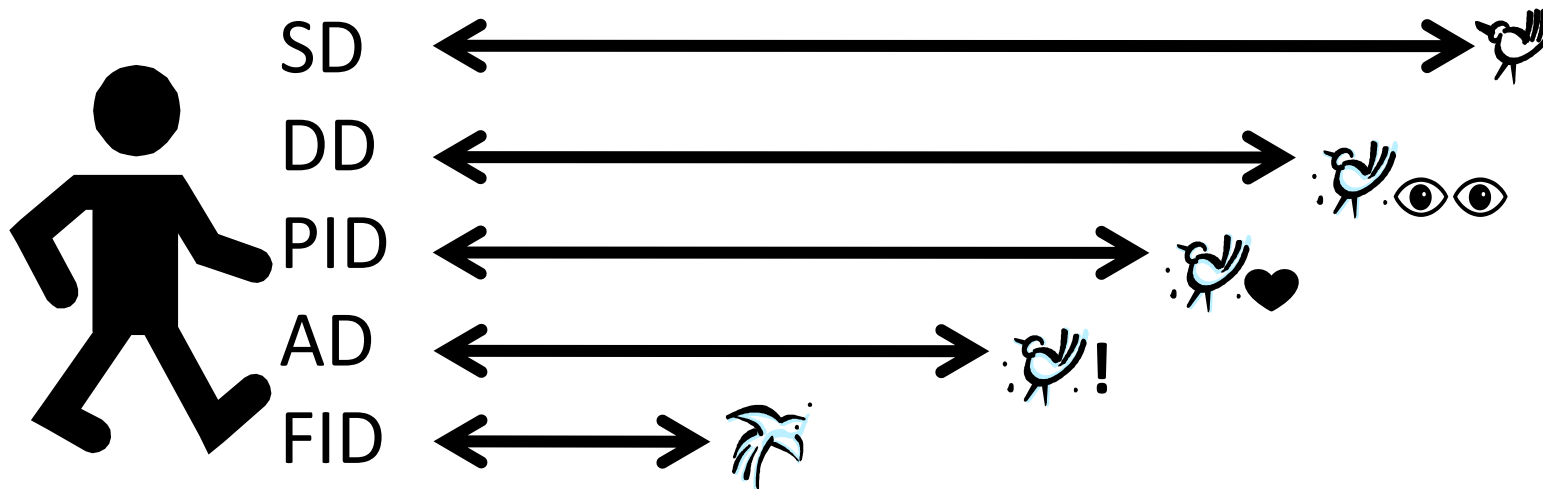
771

772   Figure 2. Linear regression of mean FIDs (from Appendix 1, where n ≥ 10), on mean
773   body mass (g; averaged across sexes and Australian masses only; Dunning 2008
774   supplemented with Higgins *et al.* 1990-2006). Residual values and ranks are presented
775   in Appendix 1.
776
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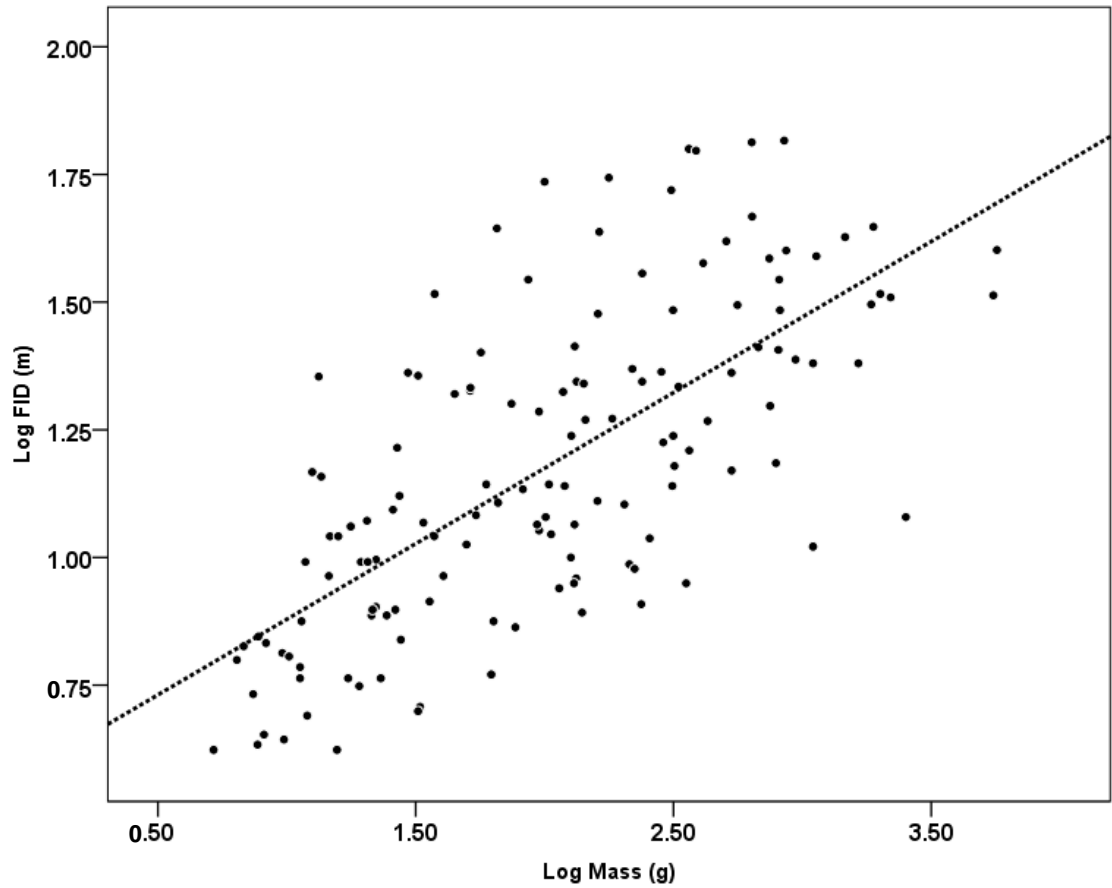
780
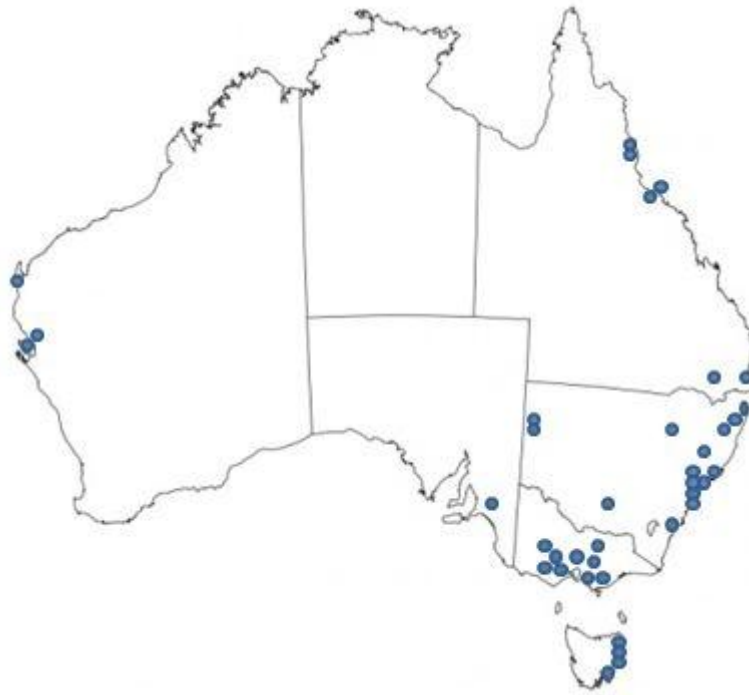
781
782   Figure 2. Locations in Australia where substantial numbers of FIDs have been

783   reported (Paton *et al.* 2000; Blumstein *et al.* 2003; Price 2003; Blakney 2004; Gould

784   *et al.* 2004; Cárdenas *et al.* 2005; Adams *et al.* 2006; Boyer *et al.* 2006; Taylor 2006;

785   Kitchen *et al.* 2010; Monie 2011). Many FIDs are not associated with locations that

786   could be mapped, and incidental collections of small numbers of FIDs have been

787   omitted.

788

789

Appendix 1. Available Flight Initiation Distances for birds in Australia (including introduced species) from published sources plus a partly unpublished database provided by DTB. Each row represents the FIDs reported by separate studies or in relation to treatment variables used in studies e.g., different habitats (thus, some taxa are in multiple rows). Only cited figures are presented, data have not been estimated from graphical presentation of results in source documents. Sources were: 1) Blumstein (2006); 2) Monie (2011); 3) Paton *et al.* (2000); 4) Taylor (2006); 5) Glover *et al.* (2011); 6) Blakney (2004); 7) Price (2003); 8) Kitchen *et al.* (2010); 9) Blumstein *et al.* (2003); 10) D. T. Blumstein Unpubl. Data; 11) Dandenong Valley Authority (1979). Residual values (and ranks, where 1 is the highest positive residual value) are also presented (see Fig. 2 and text), with highly positive values indicating FIDs substantially above that predicted by body mass, highly negative values indicating FIDs substantially below that predicted by body mass.

798

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Casuariidae	Emu	*Dromaius novaehollandiae*	58.7	36.2	6	118.1		10
Megapodiidae	Australian Brush Turkey	*Alectura lathami*	12.0	13.0	11	33.4	-0.51 (140)	1
Megapodiidae	Orange-footed Scrubfowl	*Megapodius reinwardt*	25.9	8.8	4	40.4		10
Phasianidae	Stubble Quail	*Coturnix pectoralis*	1.9	0.5	2	2.8		10
Phasianidae	Brown Quail	*Coturnix ypsilophora*	5.5	4.7	5	13.1		10
Anatidae	Musk Duck	*Biziura lobata*	18.9	1.5	2	21.4		10
Anatidae	Black Swan	*Cygnus atratus*	50.4	35.8	19	109.3		1
Anatidae	Black Swan	*Cygnus atratus*	3.6	3.8	92	9.9	-0.09 (89)	2
Anatidae	Black Swan^	*Cygnus atratus*	149.0	0.0	1	149.0		3
Anatidae	Black Swan^2	*Cygnus atratus*	113.0	0.0	1	113.0		3
Anatidae	Black Swan	*Cygnus atratus*	n/a	n/a	90	159		4
Anatidae	Black Swan	*Cygnus atratus*	40.0		n/a			11
Anatidae	Black Swan[1]	*Cygnus atratus*	53.0		n/a			11
Anatidae	Australian Shelduck^	*Tadorna tadornoides*	145.0	0.0	1	145.0		3
Anatidae	Australian Shelduck	*Tadorna tadornoides*	n/a	n/a	35	270		4
Anatidae	Australian Wood Duck	*Chenonetta jubata*	25.5	24.9	44	66.5	-0.04 (74)	1
Anatidae	Australasian Shoveler	*Anas rhynchotis*	19.2	0.0	1	19.2		10
Anatidae	Grey Teal	*Anas gracilis*	41.6	22.8	23	79.1	0.24 (24)	1

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Anatidae	Grey Teal^	*Anas gracilis*	106.9	10.1	2	123.5		3
Anatidae	Grey Teal^2	*Anas gracilis*	59.0	8.5	2	73.0		3
Anatidae	Grey Teal^3	*Anas gracilis*	49.5		1			3
Anatidae	Grey Teal	*Anas gracilis*	n/a	n/a	72	330		4
Anatidae	Chestnut Teal	*Anas castanea*	46.5	21.4	55	81.7	0.25 (18)	1
Anatidae	Chestnut Teal	*Anas castanea*	n/a	n/a	20	260		4
Anatidae	Northern Mallard	*Anas platyrhynchos*	12.8	5.0	3	21.1		10
Anatidae	Pacific Black Duck	*Anas superciliosa*	38.9	29.0	50	86.6	0.1 (41)	1
Anatidae	Pacific Black Duck	*Anas superciliosa*	n/a	n/a	28	205		4
Anatidae	Hardhead	*Aythya australis*	37.1	20.9	9	71.5		10
Podicipedidae	Australasian Grebe	*Tachybaptus novaehollandiae*	23.4	14.1	19	46.6	0.09 (46)	1
Podicipedidae	Hoary-headed Grebe	*Poliocephalus poliocephalus*	23.8	7.3	4	35.8		10
Columbidae	White-headed Pigeon	*Columba leucomela*	26.0	34.5	2	82.7		10
Columbidae	Spotted Dove	*Streptopelia chinensis*	12.9	9.0	52	27.7	-0.13 (100)	1
Columbidae	Brown Cuckoo-dove	*Macropygia amboinensis*	8.1	4.8	11	16.0	-0.38 (137)	1
Columbidae	Emerald Dove	*Chalcophaps indica*	14.2	8.8	2	28.7		10
Columbidae	Common Bronzewing	*Phaps chalcopetra*	21.6	9.1	21	36.6	0.01 (61)	10
Columbidae	Crested Pigeon	*Ocyphaps lophotes*	12.7	9.2	31	27.8	-0.16 (109)	1
Columbidae	Peaceful Dove	*Geopelia striata*	12.1	7.8	27	24.9	-0.01 (67)	10
Columbidae	Bar-shouldered Dove	*Geopelia humeralis*	22.1	14.8	93	46.4	0.13 (32)	1
Columbidae	Wonga Pigeon	*Leucosarcia picata*	18.5	10.9	22	36.4	-0.09 (90)	1
Columbidae	Pied Imperial-pigeon	*Ducula bicolor*	21.5	11.3	4	40.1		10
Columbidae	Topknot Pigeon	*Lopholaimus antarcticus*	15.0	7.2	6	26.7		10
Podargidae	Tawny Frogmouth	*Podargus strigoides*	6.2	4.4	2	13.3		10
Eurostopodidae	Spotted Nightjar	*Eurostopodus argus*	10.8	0.0	1	10.8		10
Anhingidae	Australasian Darter	*Anhinga novaehollandiae*	24.0	14.9	20	48.5	-0.15 (108)	1
Phalacrocoracidae	Little Pied Cormorant	*Microcarbo melanoleucos*	19.8	14.3	58	43.3	-0.14 (105)	1
Phalacrocoracidae	Great Cormorant	*Phalacrocorax carbo*	32.3	20.6	34	66.2	-0.06 (81)	1
Phalacrocoracidae	Little Black Cormorant	*Phalacrocorax sulcirostris*	24	15.3	38	49.2	-0.1 (94)	1
Phalacrocoracidae	Pied Cormorant	*Phalacrocorax varius*	31.3	18.0	25	60.9	-0.05 (77)	1

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Pelecanidae	Australian Pelican	*Pelecanus conspicillatus*	32.6	25.4	39	74.4	-0.18 (112)	1
Ardeidae	Australasian Bittern	*Botaurus poiciloptilus*	10.0	0.0	1	10.0		10
Ardeidae	Australian Little Bittern	*Ixobrychus dubius*	12.9	4.5	4	20.2		10
Ardeidae	White-necked Heron	*Ardea pacifica*	n/a	n/a	26	170		4
Ardeidae	White-necked Heron	*Ardea pacifica*	45.3	36.9	2	106.0		10
Ardeidae	Eastern Great Egret	*Ardea modesta*	39.9	24.8	79	80.7	0.15 (31)	1
Ardeidae	Eastern Great Egret	*Ardea modesta*	n/a	n/a	31	155.0		4
Ardeidae	Intermediate Egret	*Ardea intermedia*	n/a	n/a	27	210.0		4
Ardeidae	Intermediate Egret	*Ardea intermedia*	42.7	36.9	4	103.4		10
Ardeidae	Cattle Egret	*Ardea ibis*	63.1	46.8	11	140.1	0.46 (5)	10
Ardeidae	Striated Heron	*Butorides striata*	31.7	18.9	8	62.83		10
Ardeidae	White-faced Heron	*Egretta novaehollandiae*	31.2	20.1	33	64.3	0.1 (44)	1
Ardeidae	White-faced Heron	*Egretta novaehollandiae*	n/a	n/a	25	215		4
Ardeidae	Little Egret	*Egretta garzetta*	52.4	23.0	10	90.2	0.4 (10)	1
Ardeidae	Eastern Reef Egret	*Egretta sacra*	31.1	13.6	2	53.5		10
Ardeidae	Nankeen Night-heron	*Nycticorax caledonicus*	16.6	5.8	4	26.1		10
Threskiornithidae	Glossy Ibis	*Plegadis falcinellus*	n/a	n/a	35	195		4
Threskiornithidae	Glossy Ibis	*Plegadis falcinellus*	83.1	0.0	1	83.1		10
Threskiornithidae	Australian White Ibis	*Threskiornis molucca*	32.8	20.4	48	66.4	-0.04 (76)	1
Threskiornithidae	Australian White Ibis^	*Threskiornis molucca*	80.8	2.5	2	84.9		3
Threskiornithidae	Australian White Ibis^2	*Threskiornis molucca*	62.2	26.2	3	105.3		3
Threskiornithidae	Australian White Ibis^3	*Threskiornis molucca*	58.3	37.8	2	120.5		3
Threskiornithidae	Australian White Ibis	*Threskiornis molucca*	n/a	n/a	20	130.0		4
Threskiornithidae	Straw-necked Ibis	*Threskiornis spinicollis*	42.4	25.2	10	83.9	0.11 (39)	1
Threskiornithidae	Straw-necked Ibis	*Threskiomis spinicollis*	n/a	n/a	15	135.0		4
Threskiornithidae	Royal Spoonbill	*Platalea regia*	44.4	24.9	24	85.4	0.1 (45)	1
Threskiornithidae	Royal Spoonbill	*Platalea regia*	n/a	n/a	25	70.0		4
Threskiornithidae	Yellow-billed Spoonbill	*Platalea flavipes*	n/a	n/a	24	80.0		4
Threskiornithidae	Yellow-billed Spoonbill	*Platalea flavipes*	51.0	41.5	4	119.2		10
Accipitridae	Black-shouldered Kite	*Elanus axillaris*	23.1	14.9	10	47.6	0.05 (50)	1

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Accipitridae	Pacific Baza	*Aviceda subcristata*	18.0	0.0	1	18.0		10
Accipitridae	Whistling Kite	*Haliastur sphenurus*	28.2	12.3	3	48.5		10
Accipitridae	Black Kite	*Milvus migrans*	57.0	0.0	1	57.0		10
Accipitridae	Grey Goshawk	*Accipiter novaehollandiae*	24.6	0.0	1	24.6		10
Accipitridae	Spotted Harrier	*Circus assimilis*	22.0	0.0	1	22.0		10
Falconidae	Nankeen Kestrel	*Falco cenchroides*	43.4	44.1	14	116.0	0.4 (9)	10
Falconidae	Brown Falcon	*Falco berigora*	34.1	28.1	2	80.3		10
Rallidae	Purple Swamphen	*Porphyrio porphyrio*	34.5	21.8	68	70.4	0.4 (8)	1
Rallidae	Purple Swamphen	*Porphyrio porphyrio*	65.0	0.0	n/a	65.0		11
Rallidae	Lewin's Rail	*Lewinia pectoralis*	4.3	0.0	1	4.3		10
Rallidae	Buff-banded Rail	*Gallirallus philippensis*	8.0	0.0	1	8.0		10
Rallidae	Baillon's Crake	*Porzana pusilla*	8.2	4.6	3	15.8		10
Rallidae	Dusky Moorhen	*Gallinula tenebrosa*	14.8	10.7	37	32.4	-0.22 (120)	1
Rallidae	Eurasian Coot	*Fulica atra*	19.2	15.8	10	45.2	-0.03 (73)	1
Rallidae	Eurasian Coot	*Fulica atra*	23.0	0.0	n/a	23.0		11
Burhinidae	Bush Stone-curlew	*Burhinus grallarius*	25.9	20.7	13	59.9	-0.01 (64)	1
Haematopodidae	Australian Pied Oystercatcher	*Haematopus longirostris*	38.5	18	23	68.1	0.15 (30)	1
Haematopodidae	Australian Pied Oystercatcher^	*Haematopus longirostris*	82.5	64.4	2	188.4		3
Haematopodidae	Australian Pied Oystercatcher	*Haematopus longirostris*	41.5	16.2	21	68.1		5
Haematopodidae	Sooty Oystercatcher	*Haematopus fuliginosus*	30.5	15.8	59	56.5	0.04 (52)	1
Haematopodidae	Sooty Oystercatcher	*Haematopus fuliginosus*	64.3	43.1	14	135.1		5
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	38.3	21.1	63	73	0.24 (21)	1
Recurvirostridae	Black-winged Stilt^	*Himantopus himantopus*	39.3	22.9	3	77		3
Recurvirostridae	Black-winged Stilt^[1]	*Himantopus himantopus*	43.5	15.0	2	68.0		3
Recurvirostridae	Black-winged Stilt^[2]	*Himantopus himantopus*	33.5	2.1	2	37.0		3
Recurvirostridae	Black-winged Stilt^[3]	*Himantopus himantopus*	35.8	14.5	2	59.7		3
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	n/a	n/a	42	80		4
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	38.0	16.7	20	65.4		5
Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	30.0	0.0	n/a	30.0		11
Recurvirostridae	Red-necked Avocet^	*Recurvirostra novaehollandiae*	60.4	7.8	3	73.2		3

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Recurvirostridae	Red-necked Avocet^2	*Recurvirostra novaehollandiae*	57.0	0.0	1	57.0		3
Recurvirostridae	Red-necked Avocet^3	*Recurvirostra novaehollandiae*	43.0	0.0	1	43.0		3
Recurvirostridae	Red-necked Avocet	*Recurvirostra novaehollandiae*	n/a	n/a	20.0	110.0		4
Recurvirostridae	Red-necked Avocet	*Recurvirostra novaehollandiae*	73.0	39.2	5	137.4		5
Recurvirostridae	Banded Stilt^	*Cladorhynchus leucocephalus*	32.8	23.7	8	71.8		3
Recurvirostridae	Banded Stilt^1	*Cladorhynchus leucocephalus*	40.2	11.0	2	58.3		3
Recurvirostridae	Banded Stilt^2	*Cladorhynchus leucocephalus*	28.8	8.1	4	42.1		3
Recurvirostridae	Banded Stilt^3	*Cladorhynchus leucocephalus*	24.7	7.7	5	37.4		3
Charadriidae	Pacific Golden Plover	*Pluvialis fulva*	21.9	12.1	21	41.8	0.12 (34)	1
Charadriidae	Pacific Golden Plover	*Pluvialis fulva*	49.3	10.1	3	65.9		5
Charadriidae	Grey Plover	*Pluvialis squatarola*	36.0	18.7	41	66.8	0.27 (16)	1
Charadriidae	Grey Plover	*Pluviali squatarola*	44.0	0.0	1	44.0		5
Charadriidae	Red-capped Plover	*Charadrius ruficapillus*	22.0	7.7	16	34.7		1
Charadriidae	Red-capped Plover	*Charadrius ruficapillus*	n/a	n/a	18	45.0		4
Charadriidae	Red-capped Plover	*Charadrius ruficapillus*	32.8	15.4	20	58.1	0.47 (4)	5
Charadriidae	Double-banded Plover	*Charadrius bicinctus*	32.1	7.5	7	44.5		5
Charadriidae	Double-banded plover	*Charadrius bicinctus*	13.9	6.1	10	23.8	0.04 (54)	10
Charadriidae	Lesser Sand Plover	*Charadrius mongolus*	16.7	7.7	7	29.4		10
Charadriidae	Black-fronted Dotterel	*Elseyornis melanops*	22.7	9.3	46	37.9	0.33 (14)	1
Charadriidae	Black-fronted Dotterel	*Elseyornis melanops*	23.9	8.2	17	37.3		5
Charadriidae	Hooded Plover	*Thinornis rubricollis*	54.4	35.4	30	112.7	0.56 (1)	6
Charadriidae	Hooded Plover	*Thinornis rubricollis*	41.1	17.1	8	69.3		5
Charadriidae	Hooded Plover	*Thinornis rubricollis*	26.3	3.3	4	31.6		10
Charadriidae	Red-kneed Dotterel	*Erythrogonys cinctus*	n/a	n/a	22	40.0		4
Charadriidae	Red-kneed Dotterel	*Erythrogonys cinctus*	21.2	6.2	10	31.3	0.24 (23)	5
Charadriidae	Red-kneed dotterel	*Erythrogonys cinctus*	15.4	1.5	2	17.8		10
Charadriidae	Banded Lapwing	*Vanellus tricolor*	74.0	0.0	1	74.0		5
Charadriidae	Masked Lapwing	*Vanellus miles*	46.8	30.5	37	96.9		1
Charadriidae	Masked Lapwing	*Vanellus miles*	62.6	43.1	55	133.5	0.45 (6)	5
Scolopacidae	Latham's Snipe	*Gallinago hardwickii*	18.6	9.6	30	34.5	0.05 (51)	5

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Scolopacidae	Latham's Snipe	*Gallinago hardwickii*	13.7	7.8	8	26.6		10
Scolopacidae	Black-tailed Godwit	*Limosa limosa*	31.3	3.3	4	36.7		5
Scolopacidae	Black-tailed Godwit	*Limosa limosa*	21.0	11.3	6	39.7		10
Scolopacidae	Bar-tailed Godwit^	*Limosa lapponica*	48.6	0.9	2	50.1		3
Scolopacidae	Bar-tailed Godwit^[2]	*Limosa lapponica*	53.5	7.8	2	66.3		3
Scolopacidae	Bar-tailed Godwit^[3]	*Limosa lapponica*	41.9	4.5	2	49.3		3
Scolopacidae	Bar-tailed Godwit	*Limosa lapponica*	59.5	10.5	4	76.8		5
Scolopacidae	Bar-tailed Godwit	*Limosa lapponica*	22.1	14.8	196	46.5	0.06 (49)	10
Scolopacidae	Whimbrel	*Numenius phaeopus*	37.7	30.4	28	87.7	0.22 (25)	1
Scolopacidae	Whimbrel	*Numenius phaeopus*	90.0	0.0	1	90.0		5
Scolopacidae	Eastern Curlew	*Numenius madagascariensis*	65.5	41.6	42	133.9	0.37 (12)	1
Scolopacidae	Eastern Curlew^	*Numenius madagascariensis*	97.5	23.3	2	135.8		3
Scolopacidae	Eastern Curlew	*Numenius madagascariensis*	126.1	29.2	22	174.2		5
Scolopacidae	Common Sandpiper	*Actitis hypoleucos*	43.0	0.0	1	43.0		5
Scolopacidae	Grey-tailed Tattler	*Tringa brevipes*	17.3	8.6	45	31.4	0.03 (56)	1
Scolopacidae	Grey-tailed Tattler	*Tringa brevipes*	23.0	0.0	1	23.0		5
Scolopacidae	Common Greenshank^	*Tringa nebularia*	70.0	11.8	3	89.4		3
Scolopacidae	Common Greenshank^[1]	*Tringa nebularia*	80.3	13.0	2	102.0		3
Scolopacidae	Common Greenshank^[2]	*Tringa nebularia*	60.7	4.0	3	67.3		3
Scolopacidae	Common Greenshank^[3]	*Tringa nebularia*	51.5	3.5	2	57.3		3
Scolopacidae	Common Greenshank	*Tringa nebularia*	n/a	n/a	17	75.0		4
Scolopacidae	Common Greenshank	*Tringa nebularia*	55.4	27.8	17	101.2	0.49 (3)	5
Scolopacidae	Common Greenshank	*Trigna nebularia*	47.6	17.8	7	77.0		10
Scolopacidae	Marsh Sandpiper	*Tringa stagnatilis*	n/a	n/a	20	105.0		4
Scolopacidae	Marsh Sandpiper	*Tringa stagnatilis*	44.1	23.2	20	82.3	0.52 (2)	5
Scolopacidae	Ruddy Turnstone	*Arenaria interpres*	13.8	6.4	51	24.3	-0.06 (78)	1
Scolopacidae	Ruddy Turnstone	*Arenaria interpres*	29.7	14.3	6	53.2		5
Scolopacidae	Short-billed Dowitcher**	*Limnodromus griseus*	12.7	6.2	11	22.9		1
Scolopacidae	Red Knot	*Calidris canutus*	21.3	9.2	8	36.4		10
Scolopacidae	Sanderling	*Calidris alba*	32.0	7.9	5	44.9		5

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Scolopacidae	Red-necked Stint	*Calidris ruficollis*	16.4	8.7	61	30.7	0.21 (26)	1
Scolopacidae	Red-necked Stint^	*Calidris ruficollis*	20.0	3.5	4	25.8		3
Scolopacidae	Red-necked Stint^[1]	*Calidris ruficollis*	32.6	14.0	3	55.3		3
Scolopacidae	Red-necked Stint^[2]	*Calidris ruficollis*	28.1	1.8	3	31.1		3
Scolopacidae	Red-necked Stint^[3]	*Calidris ruficollis*	17.3	4.2	3	24.2		3
Scolopacidae	Red-necked Stint	*Calidris ruficollis*	18.7	8.7	23	33.0		5
Scolopacidae	Pectoral Sandpiper	*Calidris melanotos*	23.0	9.9	2	39.3		5
Scolopacidae	Sharp-tailed Sandpiper	*Calidris acuminata*	14.8	8.7	28	29.1		1
Scolopacidae	Sharp-tailed Sandpiper^	*Calidris acuminata*	33.2	3.9	5	39.6		3
Scolopacidae	Sharp-tailed Sandpiper^[1]	*Calidris acuminata*	39.3	3.7	2	45.4		3
Scolopacidae	Sharp-tailed Sandpiper^[2]	*Calidris acuminata*	35.7	4.2	3	42.6		3
Scolopacidae	Sharp-tailed Sandpiper^[3]	*Calidris acuminata*	28.1	4.0	4	34.7		3
Scolopacidae	Sharp-tailed Sandpiper	*Calidris acuminata*	n/a	n/a	30	55.0		4
Scolopacidae	Sharp-tailed Sandpiper	*Calidris acuminata*	20.3	7.5	31	32.7	0.16 (28)	5
Scolopacidae	Sharp-tailed Sandpiper	*Calidris acuminata*	20.0	0.0	n/a	20.0		11
Scolopacidae	Curlew Sandpiper^	*Calidris ferruginea*	34.8	6.0	4	44.7		3
Scolopacidae	Curlew Sandpiper^[2]	*Calidris ferruginea*	29.8	4.8	3	37.7		3
Scolopacidae	Curlew Sandpiper^[3]	*Calidris ferruginea*	26.8	2.9	3	31.6		3
Scolopacidae	Curlew Sandpiper	*Calidris ferruginea*	25.2	6.4	21	35.7	0.3 (15)	5
Scolopacidae	Curlew Sandpiper	*Calidris ferruginea*	24.9	6.0	8	34.8		10
Turnicidae	Red-chested Button-quail	*Turnix pyrrhothorax*	3.6	2.1	5	7.0		10
Laridae	Little Tern	*Sternula albifrons*	21.5	7.9	18	34.5	0.24 (20)	1
Laridae	Caspian Tern	*Hydroprogne caspia*	35.0	10.4	12	52.1	0.1 (43)	1
Laridae	Whiskered Tern	*Chlidonias hybrida*	21.4	8.5	3	35.3		10
Laridae	Common Tern	*Sterna hirundo*	20.5	10.9	8	38.4		10
Laridae	Crested Tern	*Thalasseus bergii*	17.3	10.7	37	34.9	-0.08 (86)	1
Laridae	Kelp Gull	*Larus dominicanus*	24.4	11.4	14	43.2	-0.08 (83)	1
Laridae	Silver Gull	*Chroicocephalus novaehollandiae*	16.8	12.1	136	36.7	-0.09 (87)	1
Cacatuidae	Red-tailed Black-cockatoo	*Calyptorhynchus banksii*	10.9	15.2	3	35.9		10
Cacatuidae	Yellow-tailed Black-cockatoo	*Calyptorhynchus funereus*	11.7	6.7	4	22.8		10

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Cacatuidae	Gang-gang Cockatoo	*Callocephalon fimbriatum*	7.5	5.6	2	16.6		10
Cacatuidae	Galah	*Eolophus roseicapillus*	8.9	5.6	64	18.1	-0.39 (138)	1
Cacatuidae	Long-billed Corella	*Cacatua tenuirostris*	3.8	0.0	1	3.8		10
Cacatuidae	Little Corella	*Cacatua sanguinea*	20.0	15.2	8	45.0		10
Cacatuidae	Sulphur-crested Cockatoo	*Cacatua galerita*	15.3	14.9	41	39.8	-0.26 (126)	1
Psittacidae	Rainbow Lorikeet	*Trichoglossus haematodus*	10.0	8.1	11	23.3	-0.21 (116)	1
Psittacidae	Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	1.0	0.0	1	1.0		10
Psittacidae	Australian King Parrot	*Alisterus scapularis*	8.7	3.8	9	14.9		10
Psittacidae	Red-winged Parrot	*Aprosmictus erythropterus*	32.3	11.1	5	50.5		10
Psittacidae	Crimson Rosella	*Platycercus elegans*	9.1	6.4	83	19.6	-0.25 (124)	1
Psittacidae	Eastern Rosella	*Platycercus eximius*	13.9	8.8	31	28.4	-0.04 (75)	1
Psittacidae	Pale-headed Rosella	*Platycercus adscitus*	21.0	8.7	3	35.2		10
Psittacidae	Australian Ringneck	*Barnardius zonarius*	14.1	9.5	3	29.7		10
Psittacidae	Red-rumped Parrot	*Psephotus haematonotus*	11.2	6.6	9	22.1		10
Cuculidae	Pheasant Coucal	*Centropus phasianinus*	30.5	42.8	14	101.0	0.16 (29)	10
Cuculidae	Asian Koel**	*Eudynamys scolopaceus*	4.6	2.2	2	8.2		10
Cuculidae	Horsfield's Bronze-Cuckoo	*Chalcites basalis*	3.5	1.6	2	6.1		10
Cuculidae	Pallid Cuckoo	*Cacomantis pallidus*	8.5	1.1	2	10.3		10
Cuculidae	Fan-tailed Cuckoo	*Cacomantis flabelliformis*	10.6	5.7	19	19.9	-0.06 (79)	1
Alcedinidae	Azure Kingfisher	*Ceyx azureus*	11.7	4.5	10	19.1	0.03 (55)	10
Halcyonidae	Laughing Kookaburra	*Dacelo novaeguineae*	13.8	12.3	54	34.0	-0.18 (113)	1
Halcyonidae	Blue-winged Kookaburra	*Dacelo leachii*	23.0	0.0	1	23.0		10
Halcyonidae	Forest Kingfisher	*Todiramphus macleayii*	11.0	4.3	11	18.1	-0.01 (65)	10
Halcyonidae	Sacred Kingfisher	*Todiramphus sanctus*	20.9	6.8	16	32.1	0.25 (19)	1
Meropidae	Rainbow Bee-eater	*Merops ornatus*	23.0	17.8	10	52.3	0.34 (13)	10
Coraciidae	Dollarbird	*Eurystomus orientalis*	25.9	22.5	23	62.9	0.20 (27)	1
Menuridae	Superb Lyrebird	*Menura novaehollandiae*	10.5	8.6	26	24.6	-0.46 (139)	1
Climacteridae	White-throated Treecreeper	*Cormobates leucophaea*	5.8	2.9	17	10.6	-0.22 (121)	1
Climacteridae	White-browed Treecreeper	*Climacteris affinis*	3.1	0.0	1	3.1		10
Climacteridae	Brown Treecreeper	*Climacteris picumnus*	5.1	3.1	13	10.2	-0.32 (133)	1

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Ptilonorhynchidae	Spotted Catbird	*Ailuroedus melanotis*	18.7	16.2	16	45.3	0.02 (59)	10
Ptilonorhynchidae	Green Catbird	*Ailuroedus crassirostris*	9.7	4.1	16	16.4	-0.29 (130)	1
Ptilonorhynchidae	Tooth-billed Bowerbird	*Scenopoeetes dentirostris*	5.2	1.1	2	7.1		10
Ptilonorhynchidae	Satin Bowerbird	*Ptilonorhynchus violaceus*	9.5	5.1	22	17.9	-0.3 (131)	1
Maluridae	Superb Fairy-wren	*Malurus cyaneus*	6.5	3.4	93	12.1	-0.06 (80)	1
Maluridae	Variegated Fairy-wren	*Malurus lamberti*	4.5	3.4	38	10.1	-0.2 (115)	1
Maluridae	Southern Emu-wren	*Stipiturus malachurus*	7.0	3.3	13	12.4	0.0 (62)	1
Acanthizidae	Pilotbird	*Pycnoptilus floccosus*	16.9	10.0	3	33.4		10
Acanthizidae	Rockwarbler	*Origma solitaria*	17.1	4.0	2	23.8		10
Acanthizidae	Yellow-throated Scrubwren	*Sericornis citreogularis*	5.6	4.3	51	12.7	-0.21 (119)	1
Acanthizidae	White-browed Scrubwren	*Sericornis frontalis*	4.2	2.5	41	8.3	-0.31 (132)	1
Acanthizidae	Atherton Scrubwren	*Sericornis keri*	4.9	4.5	11	12.3	-0.21 (118)	10
Acanthizidae	Large-billed Scrubwren	*Sericornis magnirostra*	4.4	4.4	17	11.6	-0.23 (122)	1
Acanthizidae	Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*	11.4	0.0	1	11.4		10
Acanthizidae	Striated Fieldwren	*Calamanthus fuliginosus*	8.6	0.0	1	8.6		10
Acanthizidae	Brown Gerygone	*Gerygone mouki*	4.2	1.9	32	7.3	-0.17 (111)	1
Acanthizidae	Western Gerygone	*Gerygone fusca*	5.4	0.0	1	5.4		10
Acanthizidae	White-throated Gerygone	*Gerygone albogularis*	5.1	3.8	3	11.4		10
Acanthizidae	Striated Thornbill	*Acanthiza lineata*	4.2	2.0	4	7.5		10
Acanthizidae	Yellow Thornbill	*Acanthiza nana*	6.3	2.4	17	10.2	-0.02 (71)	1
Acanthizidae	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	6.6	3.7	4	12.7		10
Acanthizidae	Buff-rumped Thornbill	*Acanthiza reguloides*	4.3	1.8	14	7.3	-0.21 (117)	1
Acanthizidae	Brown Thornbill	*Acanthiza pusilla*	6.7	9.9	28	22.9	0.0 (63)	1
Pardalotidae	Spotted Pardalote	*Pardalotus punctatus*	4.0	1.9	7	7.1		10
Meliphagidae	Eastern Spinebill	*Acanthorhynchus tenuirostris*	5.8	2.6	39	10.1	-0.13 (102)	1
Meliphagidae	Lewin's Honeyeater	*Meliphaga lewinii*	8.2	6.0	32	18.1	-0.13 (101)	1
Meliphagidae	Yellow-faced Honeyeater	*Lichenostomus chrysops*	5.8	3.6	29	11.7	-0.19 (114)	1
Meliphagidae	Singing Honeyeater	*Lichenostomus virescens*	12.0	0.0	1	12.0		10
Meliphagidae	Yellow Honeyeater	*Lichenostomus flavus*	6.4	1.2	6	8.4		10
Meliphagidae	White-eared Honeyeater	*Lichenostomus leucotis*	8.8	3.7	7	14.8		10

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Meliphagidae	Fuscous Honeyeater	*Lichenostomus fuscus*	14.6	0.0	1	14.6		10
Meliphagidae	White-plumed Honeyeater	*Lichenostomus penicillatus*	9.8	5.6	23	19	0.02 (58)	1
Meliphagidae	Bell Miner	*Manorina melanophrys*	5.0	3.0	44	9.9	-0.33 (135)	1
Meliphagidae	Noisy Miner	*Manorina melanocephala*	7.5	14.9	37	32	-0.24 (123)	1
Meliphagidae	Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	9.2	1.3	3	11.4		10
Meliphagidae	Little Wattlebird	*Anthochaera chrysoptera*	7.3	3.0	40	12.2	-0.28 (129)	1
Meliphagidae	Red Wattlebird	*Anthochaera carunculata*	8.7	6.4	15	19.2	-0.25 (125)	1
Meliphagidae	White-fronted Chat	*Epthianura albifrons*	22.6	7.8	23	35.4	0.44 (7)	1
Meliphagidae	Dusky Honeyeater	*Myzomela obscura*	2.0	0.0	1	2.0		10
Meliphagidae	Tawny-crowned Honeyeater	*Glyciphila melanops*	9.8	6.7	11	20.8	0.03 (57)	1
Meliphagidae	Brown Honeyeater	*Lichmera indistincta*	9.8	5.6	16	19.0	0.09 (48)	1
Meliphagidae	New Holland Honeyeater	*Phylidonyris novaehollandiae*	7.9	6	47	17.8	-0.08 (85)	1
Meliphagidae	White-cheeked Honeyeater	*Phylidonyris niger*	2.3	0.0	2	2.3		10
Meliphagidae	Blue-faced Honeyeater	*Entomyzon cyanotis*	30.8	0.0	1	30.8		10
Meliphagidae	Helmeted Friarbird	*Philemon buceroides*	12.0	9.6	20	27.8	-0.1 (92)	10
Meliphagidae	Noisy Friarbird	*Philemon corniculatus*	11.1	5.3	55	19.8	-0.14 (104)	1
Meliphagidae	Little Friarbird	*Philemon citreogularis*	6.8	3.1	2	11.9		10
Meliphagidae	Striped Honeyeater	*Plectorhyncha lanceolata*	4.6	2.3	5	8.4		10
Pomatostomidae	White-browed Babbler	*Pomatostomus superciliosus*	16.9	4.4	2	24.1		10
Pomatostomidae	Chestnut-crowned Babbler	*Pomatostomus ruficeps*	11.8	4.0	2	18.3		10
Orthonychidae	Australian Logrunner	*Orthonyx temminckii*	4.5	1.5	5	7.0		10
Orthonychidae	Chowchilla	*Orthonyx spaldingii*	4.0	0.0	3	4.0		10
Eupetidae	Eastern Whipbird	*Psophodes olivaceus*	5.9	3.3	50	11.3	-0.34 (136)	1
Campephagidae	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	21.1	13.2	20	42.8	0.13 (33)	1
Campephagidae	White-bellied Cuckoo-shrike	*Coracina papuensis*	7.1	2.6	4	11.4		10
Campephagidae	Varied Triller	*Lalage leucomela*	38.7	0.0	1	38.7		10
Pachycephalidae	Crested Shrike-tit	*Falcunculus frontatus*	8.5	6.6	4	19.4		10
Pachycephalidae	Olive Whistler	*Pachycephala olivacea*	3.8	1.6	6	6.5		10
Pachycephalidae	Golden Whistler	*Pachycephala pectoralis*	7.9	3.9	18	14.3	-0.11 (95)	1
Pachycephalidae	Rufous Whistler	*Pachycephala rufiventris*	5.2	2.0	4	8.5		10

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Pachycephalidae	Grey Shrike-thrush	*Colluricincla harmonica*	12.8	11.4	15	31.6	-0.01 (68)	1
Oriolidae	Australasian Figbird	*Sphecotheres vieilloti*	7.8	3.7	12	13.9	-0.33 (134)	10
Oriolidae	Olive-backed Oriole	*Oriolus sagittatus*	11.3	5.9	33	21.0	-0.12 (99)	1
Artamidae	White-breasted Woodswallow	*Artamus leucorynchus*	15.8	1.6	2	18.5		10
Artamidae	Masked Woodswallow	*Artamus personatus*	6.5	4.9	2	14.6		10
Artamidae	Black-faced Woodswallow	*Artamus cinereus*	11.8	5.6	3	21.1		10
Artamidae	Grey Butcherbird	*Cracticus torquatus*	19.3	13.3	10	41.2	0.12 (35)	1
Artamidae	Pied Butcherbird	*Cracticus nigrogularis*	9.5	4.9	8	17.5		10
Artamidae	Australian Magpie	*Cracticus tibicen*	10.9	8.7	91	25.2	-0.26 (127)	1
Artamidae	Australian Magpie˜	*Cracticus tibicen*	40.3	28.2	21	86.6		7
Artamidae	Australian Magpie‡	*Cracticus tibicen*	11.1	5.9	27	20.8		7
Artamidae	Pied Currawong	*Strepera graculina*	15.1	11.6	26	34.2	-0.15 (107)	1
Dicruridae	Spangled Drongo	*Dicrurus bracteatus*	15.4	5.3	9	24.1		10
Rhipiduridae	Rufous Fantail	*Rhipidura rufifrons*	6.4	2	11	9.7	-0.08 (82)	1
Rhipiduridae	Grey Fantail	*Rhipidura albiscapa*	6.8	4.3	37	13.9	-0.02 (72)	1
Rhipiduridae	Willie Wagtail	*Rhipidura leucophrys*	11.8	9.7	46	27.8	0.10 (42)	1
Rhipiduridae	Willie Wagtail˜	*Rhipidura leucophrys*	23.5	12.1	21	43.4		7
Rhipiduridae	Willie Wagtail‡	*Rhipidura leucophrys*	8.7	4.5	20	16.2		7
Corvidae	Australian Raven	*Corvus coronoides*	25.8	22.2	63	62.3	-0.01 (66)	1
Corvidae	Torresian Crow	*Corvus orru*	19.0	6.2	5	29.2		10
Monarchidae	Leaden Flycatcher	*Myiagra rubecula*	10.0	0.0	1	10.0		10
Monarchidae	Satin Flycatcher	*Myiagra cyanoleuca*	9.7	8.1	2	22.9		10
Monarchidae	Black-faced Monarch	*Monarcha melanopsis*	11.0	9.2	6	26.2		10
Monarchidae	Spectacled Monarch	*Symposiarchus trivirgatus*	5.7	2.9	3	10.4		10
Monarchidae	Magpie-lark	*Grallina cyanoleuca*	19.0	10.5	97	36.3	0.39 (11)	1
Monarchidae	Magpie-lark˜	*Grallina cyanoleuca*	35.0	n/a	n/a	n/a		8
Monarchidae	Magpie-lark‡	*Grallina cyanoleuca*	12.0	n/a	n/a	n/a		8
Monarchidae	Magpie-lark~	*Grallina cyanoleuca*	35.4	13.9	22	58.3		7

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Monarchidae	Magpie-lark‡	*Grallina cyanoleuca*	11.5	7.6	33	24.0		7
Corcoracidae	White-winged Chough	*Corcorax melanorhamphos*	16.2	7.3	14	28.2	-0.13 (103)	1
Corcoracidae	Apostlebird	*Struthidea cinerea*	20.7	23.8	4	59.9		10
Paradisaeidae	Victoria's Riflebird	*Ptiloris victoriae*	6.5	0.7	2	7.7		10
Petroicidae	Scarlet Robin	*Petroica boodang*	8.0	0.0	1	8.0		10
Petroicidae	Rose Robin	*Petroica rosea*	13.1	9.8	2	29.2		10
Petroicidae	Pale-yellow Robin	*Tregellasia capito*	8.5	1.7	3	11.3		10
Petroicidae	Eastern Yellow Robin	*Eopsaltria australis*	9.9	5.6	77	19.1	0.01 (60)	1
Petroicidae	Grey-headed Robin	*Heteromyias cinereifrons*	9.2	6.9	26	20.6	-0.10 (91)	9
Cisticolidae	Golden-headed Cisticola	*Cisticola exilis*	5.4	3.0	41	10.3	-0.11 (97)	1
Acrocephalidae	Australian Reed-warbler	*Acrocephalus australis*	11.5	9.4	20	26.9	0.11 (38)	1
Megaluridae	Tawny Grassbird	*Megalurus timoriensis*	6.0	3.6	7	12.0		10
Megaluridae	Little Grassbird	*Megalurus gramineus*	6.5	5.1	6	14.9		10
Timaliidae	Silvereye	*Zosterops lateralis*	6.1	3.8	34	12.4	-0.11 (98)	1
Hirundinae	Welcome Swallow	*Hirundo neoxena*	11.0	5.6	32	20.2	0.11 (36)	1
Hirundinidae	Fairy Martin	*Petrochelidon ariel*	8.9	4.5	2	16.4		10
Pycnonotidae	Red-whiskered Bulbul	*Pycnonotus jocosus*	18.4	13.2	25	40.1		1
Turdidae	Bassian Thrush	*Zoothera lunulata*	8.9	3.1	31	13.9	-0.26 (128)	1
Turdidae	Russet-tailed Thrush	*Zoothera heinei*	11.0	6.2	4	21.1		10
Turdidae	Common Blackbird~	*Turdus merula*	35.5	17.5	20	64.2	-0.10 (93)	7
Turdidae	Common Blackbird‡	*Turdus merula*	11.6	8.4	30	25.3	-0.1 (93)	7
Sturnidae	Common Starling	*Sturnus vulgaris*	13.6	9.0	32	28.4	-0.02 (69)	1
Sturnidae	Common Myna	*Sturnus tristis*	11.6	9.4	40	27.1	-0.14 (106)	1
Nectariniidae	Olive-backed Sunbird	*Nectarinia jugularis*	10.9	5.7	7	20.2		10
Estrildidae	Zebra Finch	*Taeniopygia guttata*	14.7	11.3	10	33.2	0.26 (17)	10
Estrildidae	Double-barred Finch	*Taeniopygia bichenovii*	6.2	3.5	7	12.1		10
Estrildidae	Red-browed Finch	*Neochmia temporalis*	7.5	5.1	51	15.9	-0.02 (70)	1
Estrildidae	Nutmeg Mannikin	*Lonchura punctulata*	11.0	6.3	43	21.4	0.1 (40)	1
Estrildidae	Chestnut-breasted Mannikin	*Lonchura castaneothorax*	14.4	4.5	10	21.8	0.24 (22)	1

Family	Common name	Scientific name	Mean	St. Dev.	n	95th percentile	Residual (rank)	Source
Passeridae	House Sparrow	*Passer domesticus*	13.2	8.6	18	27.3	0.11 (37)	1
Passeridae	Eurasian Tree-sparrow	*Passer montanus*	8.0	3.0	15	12.9	-0.08 (84)	1
Motacillidae	Australasian Pipit	*Anthus novaeseelandiae*	12.4	5.2	63	20.9	0.09 (47)	1
Motacillidae	White Wagtail**	*Motacilla alba*	7.7	1.8	16	10.7	-0.11 (96)	1
Fringillidae	Common Chaffinch	*Fringilla coelebs*	7.7	2.1	15	11.2	-0.09 (88)	1
Fringillidae	European Goldfinch	*Carduelis carduelis*	9.2	2.5	18	13.3	0.04 (53)	1
Fringillidae	Common Greenfinch	*Chloris chloris*	6.9	1.6	15	9.5	-0.17 (110)	1

799 [1] stimulus was dog, [2] boat, or [3] canoe; ^ data was not collected using the direct continuous method; ˜ data collected in rural habitats; ‡ data

800 collected in urban habitats, ** species vagrant in Australia.