# American Wigeon *Anas americana* vigilance behaviour on suburban golf courses

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**Abstract**

Behavioural data were recorded from flocks of wintering American Wigeon *Anas americana* on a southern Californian (USA) golf course to test whether vigilance was related to levels of local human activity. The study site was subject to high rates of human activity, which provided an opportunity to evaluate waterfowl anti-predatory response (vigilance) when presented with frequent disturbance stimuli. Overall, human activities had no significant effect on individual vigilance behaviour while flocks grazed on golf course fairways. Vigilance patterns were instead influenced by the distance at which flocks grazed from water, flock size and the sex of the birds. Furthermore, vigilance constituted < 7 % of the ducks' activity budget, less than that reported for American Wigeon and Eurasian Wigeon *Anas penelope* in more natural environments. This suggests that the ducks did not increase time spent in vigilance in response to high rates of human activity, but may benefit from favourable foraging opportunities associated with golf course and other human-modified habitats.

**Key words:** *Anas americana*, anti-predatory behaviour, golf course habitat, human activity, safe-habitat hypothesis.

It is important to understand the influence of human activities on waterbird behaviour given that growing human populations will invariably result in increased human-wildlife interactions (Pease *et al.* 2005; Guillemain *et al.* 2007a; Wang *et al.* 2011). Waterfowl can be adversely affected by human disturbance through increased vigilance behaviour and decreased foraging or intake rates (Bélanger & Bédard 1990; Henson & Grant 1991; Korschgen & Dahlgren 1992; Knapton *et al.* 2000). However, most studies quantifying waterfowl behavioural responses to disturbance by humans have been conducted in relatively natural environments such as wildlife refuges and conservation areas (*e.g.* Fox *et al.* 1993; Pease *et al.* 2005; Guillemain *et al.* 2007a; Madsen *et al.* 2009), with very few being conducted in urbanised or artificial environments (but see Randler 2003).

 

Although it is predicted that waterfowl should perceive humans as predators (*sensu* Frid & Dill 2002), waterfowl occurring in habitats experiencing frequent disturbance stimuli not associated with predation or other "harm" are likely to respond differently to human activity (for instance by habituating to them; Madsen 1995). Consistent with that observation, it is increasingly common for wintering and migrating waterfowl populations, including American Wigeon *Anas americana*, to use artificial habitats such as urban parks, airports and golf courses, suggesting that individuals selecting these habitats may become less responsive to human presence (Blackwell *et al.* 2008; Moul & Elliott 1994; Merola-Zwartjes & DeLong 2005).

Actively feeding waterfowl interrupt foraging bouts to scan their surroundings, potentially with greater frequency when predation risk is elevated (Pöysä 1987). One measure often used to test the level of waterfowl response to potential disturbance stimuli is to measure vigilance behaviour under different levels of human activity. Although individuals are vigilant to scan for potential competitors (Pöysä 1994), or to monitor family members and mates (Black *et al.* 1992), vigilance is primarily regarded as an anti-predator behaviour (Caro 2005; Guillemain *et al.* 2007b) and can be used as a measure of perceived predation risk (Lima & Dill 1990). In addition to human activity (Randler 2003; Severcam & Yamac 2011; Wang *et al.* 2011), other factors influence vigilance behaviour in waterfowl, including: flock size and density (Lazarus 1978), position within the flock (Inglis & Lazarus 1981; Black *et al.* 1992), pair and family status (Black & Owen 1989), sexual differences (Mayhew 1987; Guillemain *et al.* 2003), predators (Jacobson & Ugelvik 1992), distance from water or refuge habitats (Mayhew & Houston 1989), and presence of other species (Larsen 1996).

Although factors affecting vigilance behaviour in waterfowl are generally well understood, little information exists quantifying these effects in anthropogenic habitats where human activity may be high, but benign, while the benefit in terms of food intake rates may favour a greater tolerance of such activity. This study evaluates the effects of human activity on the vigilance behaviour of wintering American Wigeon foraging on a suburban golf course – a highly human-modified habitat – whilst also considering other variables (sex, distance from water, flock size and position of an individual in the flock) known from previous studies (Mayhew 1987; Guillemain *et al.* 2003; Berl & Black 2011) to influence alert levels in wigeon. Based on the results of these studies, vigilance by American Wigeon on suburban golf courses was predicted to: 1) be higher in males than females, 2) increase with distance from water, and 3) decrease with flock size, whilst levels of individual vigilance would not be related to 5) presence of humans or 6) levels of human activity.

## Methods

Observations of grazing American Wigeon were conducted on the Fallbrook Golf Club, a ~50 ha suburban public golf course, located 2 km southeast of Fallbrook, California, USA (33°N, 117°W). The Fallbrook Golf Club receives high levels of human activity from golfers, golf carts, bicyclists, joggers, and pedestrians (see results). American Wigeon at this site typically grazed on land, similar to those foraging on natural coastal pastures or saltmarsh (see Berl & Black 2011 for description).

Behavioural data were collected from 28 January 2012 to 22 March 2012, and resulted in 16.5 h of observation. The study period was kept short to control for seasonal influences on vigilance behaviour (Fernández-Juricic & Schroeder 2003). Vigilance behaviour was recorded using a digital video camera (Samsung HMX-F80; 65× optical zoom) centred on a focal bird. Video recordings were transferred to a computer and later analysed by a single observer (JLB). Focal birds were recorded for between 52–97 s, averaging 66 s ± 0.52 s.e. (Mayhew 1987; Berl & Black 2011). Vigilance was expressed as the percentage of time that the focal bird was vigilant (time vigilant *100/length of observation period); it also allowed for direct comparisons with previous studies (*e.g.* Mayhew 1987; Portugal & Guillemain 2011). To reduce the likelihood of pseudo-replication, focal bird recordings were restricted to 10 per observational session (Berl & Black 2011), alternating between sexes when possible. High turnover rate of wintering waterfowl populations further diminishes the probability of pseudo-replication on consecutive observational events (Portugal & Guillemain 2011). All observations and video recordings were conducted from concealed hides at distances that did not noticeably alter bird behaviour (75–200 m; Severcan & Yamac 2011).

Several variables were recorded in the field during each data collection session using 8× binoculars and 15–40× spotting scope, including flock size. American Wigeon typically graze in compact flocks, and thus only individuals within 30 m of the focal bird were considered in flock counts (Portugal & Guillemain 2011). To reduce the effect of flock size on vigilance, recordings were limited to flocks of ≥ 20 individuals, as previous studies (Mayhew 1987; Mayhew & Houston 1989) have shown that flock size does not tend to have a significant effect on vigilance rates in wigeon when flocks are greater than 20 individuals. In all cases, the bird nearest the centre of the flock was selected for recording. In instances where it was impossible to view the centremost bird (because of flock densities) the position of the focal bird in relation to the centre of the flock (in duck lengths) was recorded to check that an individual's position within the flock did not affect vigilance levels (Kruskal-Wallis analysis of variance: $H_3$ = 1.86, $P$ = 0.60, n.s.). Furthermore, each focal bird was grouped into one of four distances from water categories: 0–20 m, 21–40 m, 41–60 m, and > 61 m.

Focal bird recordings were conducted during periods of human presence and absence to determine if American Wigeon adjust vigilance investment according to human activity. Each focal recording was grouped into one of four categories based on the number of humans present: absent, low activity (1–2 people), medium activity (3–4), and high activity (≥ 5). Human activity was considered irrespective of whether this caused disturbance to the birds, and consisted primarily of golfers, golf carts, bicyclists, joggers and pedestrians which usually occurred along the golf course paths and fairways. Human activity was recorded within 50 m and 100 m radii surrounding the focal flock, selected because previous studies have shown wigeon respond to human disturbances within 100 m in natural habitats (Mori *et al.* 2001; Bregnballe *et al.* 2009). Distances were estimated visually, but were assumed to be accurate because golf course fairways had known distance markers (*i.e.* yardage markers) which provided a benchmark for measuring distance from the birds. To obtain data throughout the range of human activity levels, recordings were conducted opportunistically at varying times and days of the week to encompass low (week-day) and high (week-end) levels of human activity.

Non-parametric analyses were used because vigilance data were not normally distributed (Shapiro-Wilk normality test: $W = 0.798$, $P < 0.01$) and could not be normalised by transformation. Wilcoxon signed-rank tests were used to compare the percentage of time spent vigilant when humans were absent and present, and also to test for sex differences in vigilance behaviour. Kruskal-Wallis analysis of variance was used to test the effects on vigilance of human activity levels and distance from water. The relationship between vigilance and flock size was tested using the Spearman rank correlation. All analyses were made using Programme R 2.13.1 (R Development Core Team 2011) with significance set at $P = 0.05$ and data are presented as means ± standard error (s.e.).

## Results

A total of 174 focal bird recordings were conducted on American Wigeon grazing on golf course fairways. There was a high rate of human activity in the study area, averaging 54 (± 4.4) people present per hour, and 1.86 (± 0.2, range = 1–10) people recorded per focal bird observation. Overall, the percentage of time spent vigilant averaged 6.8% (± 0.50, $n = 174$), which is below vigilance rates previously reported for wigeon in more natural habitats (Table 1). Mean flock size was 60.8 (± 1.40, range = 20–100) individuals.

Individual vigilance behaviour did not differ during periods of human presence or absence within 50 m ($W_{125} = 2026$, $P = 0.86$, n.s., Fig. 1a) or 100 m ($W_{172} = 3794$, $P = 0.67$, n.s., Fig. 1b) of the focal flock, nor did vigilance differ during different levels of human activity (50 m: $H_4 = 2.47$, $P = 0.48$; 100 m: $H_4 = 1.43$, $P = 0.70$; n.s. in both cases; Fig. 1b). Males were more vigilant than females when humans were present ($W_{101} = 1692$, $P < 0.01$, Fig. 2a), whereas vigilance levels for the two sexes did not differ in the absence of human activity ($W_{69} = 697$, $P = 0.31$, n.s., Fig. 2b). Vigilance levels increased markedly as individuals foraged at progressively greater distances from water ($H_3 = 14.68$, $P < 0.01$, Fig. 3a) and in larger flocks ($r_{172} = 0.15$, $P = 0.04$, Fig. 3b).

## Discussion

Contrary to previous research documenting adverse behavioural responses of waterfowl to disturbance by humans in natural areas, this study did not find any evidence for human activity affecting the vigilance behaviour of American Wigeon feeding in a highly human-impacted environment. Rather, vigilance rates corresponded to

**Table 1.** Comparison between vigilance rates and maximum observed foraging distance from water recorded for American Wigeon (AMWI) and Eurasian Wigeon (EUWI) feeding in different habitats.

| Species | Mean % time spent vigilant | Max. observed dist. from water | Habitat | Location | Reference |
|---|---|---|---|---|---|
| AMWI | 6.8 | 80 m | Suburban golf course | Fallbrook, California, USA | This study |
| AMWI | 9.7 | 40 m | Rural pastureland | Arcata, California, USA | Berl & Black (2011) |
| EUWI | *c.* 10.0 | 35 m | Coastal tidal flats | Conwy Bay, North Wales, UK | Portugal & Guillemain (2011) |
| EUWI | 12.3–16.2 | – | Protected area (wetlands) | Rochefort, France | Guillemain *et al.* (2002) |
| EUWI | – | 50 m | Rural saltmarsh | Danish Wadden Sea, Denmark | Larsen (1996) |
| EUWI | *c.* 10.0 | 60 m | Protected area (pasture) | Solway Firth, Scotland, UK | Mayhew & Houston (1989) |

other factors known to influence alert behaviour in foraging waterfowl. There are several potential explanations for these findings.

As predicted, individual vigilance was most strongly influenced by sexual differences and distance from water. Males were significantly more vigilant than females when humans were present, but not in the absence of human activity. This lends support to the well-established suggestion that males will become more alert during relatively "risky" situations for reasons related to mate guarding or protection (Guillemain *et al.* 2002). Vigilance also increased as flocks grazed at greater distances from water (*i.e.* from their refuge habitat). American Wigeon foraging in rural grass pastures are also known to increase vigilance rates while foraging on land and away from water, and excessive human disturbance (such as direct approach to within a few meters) would induce flock responses (flying or quickly walking) to ponds or lakes in the vicinity (Berl & Black 2011). Bregnballe *et al.* (2009) described a

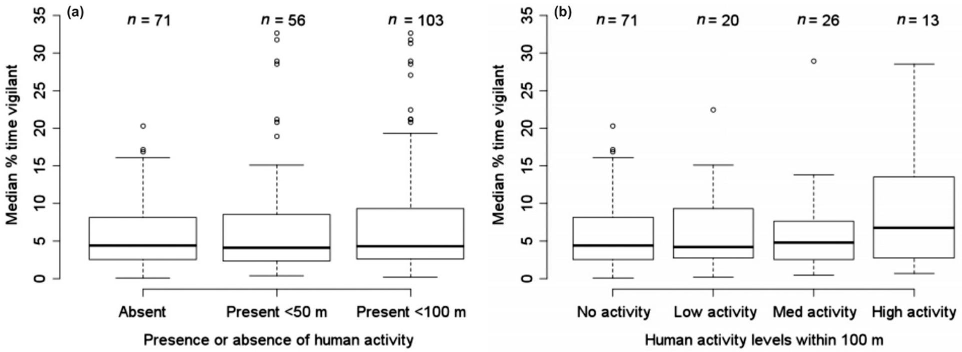


**Figure 1.** American Wigeon vigilance behaviour (median percentage of time spent vigilant) in relation to: a) the presence or absence of human activity within 50 m and 100 m of the focal flock, and b) different levels of human activity within 100 m of the focal flock, while flocks grazed on suburban golf courses near Fallbrook, California, USA from 28 January – 22 March 2012.

similar behaviour in Eurasian Wigeon *Anas penelope* in reaction to experimental pedestrian disturbance on a wetland restoration area in Denmark. Although not directly quantified in this study, this suggests that American Wigeon flocks are still somewhat reliant on open water habitat such as golf course ponds as predator-free refuges in an urbanised environment, and will use them to escape from major disturbances. Interestingly, vigilance levels increased with larger flock sizes. This contrasts with the long held supposition that vigilance should decrease with increasing flock sizes (Inglis & Lazarus 1981), but may reflect the correlation (Spearman rank correlation: $r_{172} = 0.24$, $P < 0.05$) between flock size and distance from water (*sensu* Mayhew 1987).

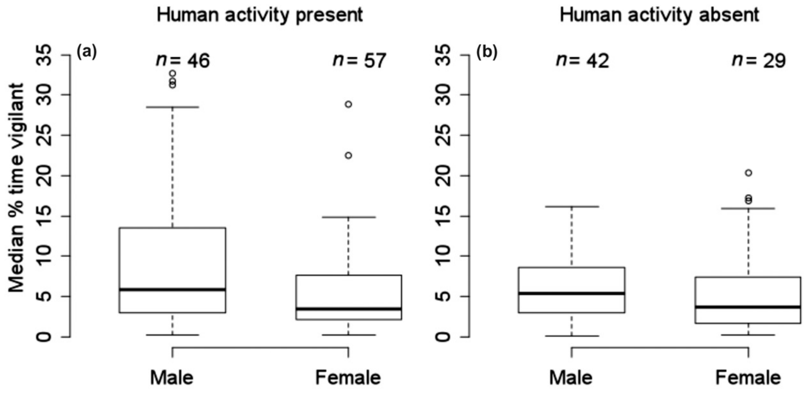


**Figure 2.** Difference between male and female American Wigeon vigilance activity (median percentage of time spent vigilant) in the: a) presence, and b) absence of humans, while flocks grazed on suburban golf courses near Fallbrook, California, USA from 28 January – 22 March 2012.

 

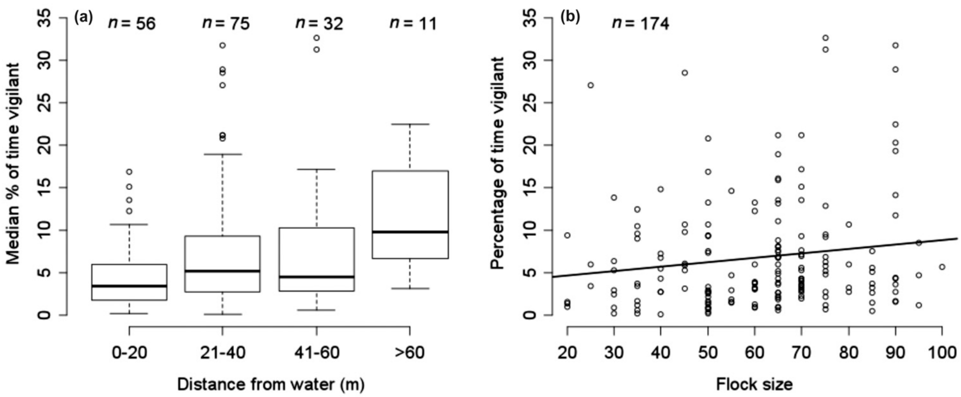


**Figure 3.** American Wigeon vigilance behaviour in relation to: a) distance from water (median percentage of time spent vigilant), and b) flock size, while flocks grazed on suburban golf courses near Fallbrook, California, USA from 28 January – 22 March 2012.

Overall, vigilance levels in this study were below rates previously reported for American Wigeon and the closely related Eurasian Wigeon in less human-impacted habitats (Table 1). This indicates that wintering flocks on golf courses generally did not exhibit elevated anti-predatory behaviour in response to human activity and frequent disturbance stimuli. Using similar methods, Randler (2003) found that an urban population of feral Swan Geese *Anser cygnoides* had equivalent vigilance levels to other goose species in more natural environments. Golf course flocks also grazed at greater distances from water (maximum = 80 m) than previously recorded for wigeon in more natural conditions (Table 1). On land, grazing is known to be a "risky" foraging environment (Mayhew & Houston 1989; Portugal & Guillemain 2011); thus, the willingness of flocks to graze at such distances from water can be interpreted as reduced anti-predatory behaviour in a human-modified area.

The majority of published research quantifying adverse waterfowl behavioural responses to humans has occurred in relatively undisturbed habitats, in which birds may not be accustomed to human intrusion. Several studies have shown that wildlife occurring in human-modified habitats can habituate to humans when there are frequent interactions with no human persecution (review by Whittaker & Knight 1998). For example, Donaldson *et al.* (2007) demonstrated that several waterbird species had relatively relaxed behaviours towards an approaching observer in developed as opposed to undeveloped study sites. In this study, American Wigeon may have become accustomed to high levels of human activity which have no adverse effects on their individual fitness, to the extent that human presence did not induce an anti-predatory response. These findings may provide some support to the "safe-habitat hypothesis", which postulates that environments frequently used by humans can offer relatively predator- or risk-free habitats while providing enhanced individual fitness such as increased intake rate associated with lower anti-predatory behaviour (Sorace 2002; Valcarcel & Fernández-Juricic 2009).

Golf courses are likely attractive habitats for wintering and migrating American Wigeon because they provide ideal grazing substrate (*i.e.* fertilised grass fairways, maintained at a short sward height) and minimal time spent in head-up vigilance (as illustrated by vigilance accounting for only < 7 % of the activity budget, Table 1) which may allow birds to allocate more time to fitness-enhancing behaviours, such as resting, maintenance, and feeding. Golf courses therefore may be suitable supplementary habitats for American Wigeon in areas where conversion of their natural habitat (*i.e.* coastal saltmarsh or pastureland) to other land uses (*e.g.* residential development) has occurred, although further research is needed to determine how they utilise golf courses throughout the annual cycle, at larger spatial scales, and in conjunction with natural habitats.

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**Photograph:** American Wigeon, by Leslie Scopes Anderson.