Managing visitor disturbance of waterbirds on Australian inland wetlands

IAIN R.TAYLOR

Institute of Land, Water and Society, Charles Sturt University, PO Box 789, Albury, New South Wales 2640, Australia (Email: itaylor@csu.edu.au)

Abstract: Predictions of the effects of global climate change suggest a progressive reduction in annual rainfall over south eastern Australia. This will result in a decrease in the extent of wetlands and emphasises the need to maximise the carrying capacity of remaining wetlands for waterbirds. One factor that could reduce carrying capacity and that should be managed carefully is disturbance caused by humans. In this study, the responses of 23 species of waterbirds to the presence of a single human observer walking directly towards them were quantified on Fivebough Swamp, New South Wales. The distances at which different species stopped feeding (alert distance) and took flight (flight initiation distance), and the distances to which they flew before re-alighting were all significantly, positively correlated with body mass. These data were used to calculated buffer distances between birds and humans to minimise the effects on waterbirds of visitors to wetlands.

INTRODUCTION

Significant reductions in annual rainfall are predicted across eastern Australia over the coming 50 years as a result of global warming (IPCC 2001, Hughes 2003) and it is likely that the extent of inland wetlands will be greatly reduced. It will become increasingly important to ensure that existing wetlands support the maximum numbers of waterbirds possible. This will mean that factors that might reduce the carrying capacity of wetlands for waterbirds must be managed appropriately. The number of people participating in nature-based recreation and ecotourism continues to increase globally and wetlands are particularly attractive to visitors, creating a potential conflict between the disturbance caused and conservation objectives. On many wetlands the frequency of disturbances caused by human activities and especially by recreation-based activities greatly exceeds those caused by natural factors such as the presence of predators (Schummer and Eddlemam 2003). Management of visitors or of wildlife viewing facilities is needed to minimise disturbance to acceptable levels.

Disturbance of waterbirds has the potential to reduce breeding success and the food intake rates of feeding birds (Werschkul *et al.* 1976, Boellstorff *et al.* 1988. Carney and Sydeman 1999). The latter may be particularly important for migratory species that have to accumulate reserves before migration (Madsen 1995) and presumably also for species that depend on temporary wetlands in Australia and may have to be highly mobile following the drying of wetlands. Their success in finding suitable alternative habitat may depend on their body condition and their ability to survive on low food intake rates until an alternative is found. If disturbance is great enough it can also lead to some species abandoning areas or reducing their use of those areas (Pfister *et al.* 1992, Burger *et al.* 1995). In this way it can be equivalent to loss of habitat. This may be particularly serious on small wetlands.

In some instances some individuals are able to habituate to less intrusive types of human disturbance but this can only occur if there is predictability in the form of the disturbance and if the same individual birds are consistently involved at the same site (Davidson and Rothwell 1993, Smit and Visser 1993, Nisbet 2000).

Two main approaches have been used to reduce disturbance of waterbirds by visitors to wetlands. Restricting observation points to hides or blinds, with concealed access routes is probably the most commonly used method, but in some situations buffer zones, which limit access to specified distances from waterbirds have been proposed (Werschkul *et al.* 1976, Erwin 1989, Rodgers and Smith 1995). Buffer zones are usually set at distances at which birds show either no alert responses, such as stopping feeding, or no flight responses. Flight responses tend to be species specific and buffer zones must also be species specific. However, there are few situations in which only single species is present and buffer zones must be set to the most sensitive species.

Some information on the flight responses of a range of Australian birds has been published (Blumstein *et al.* 2003, Blumstein 2006) but there has been no comprehensive assessment of the responses to human disturbance of the range of waterbirds most commonly encountered on Australian inland wetlands. The aim of this study was to quantify the distances at which a range of foraging waterbirds showed alert (stop feeding) and flight behaviour (flight initiation distances, FID) in response to a single human observer approaching directly towards them, in the manner of bird watchers. The distances to which birds flew before resettling were also quantified.

METHODS

The study was done at Fivebough Swamp, Leeton, New South Wales (34° 32′S, 146° 25′E) in 1998-2000. Fivebough Swamp (400 ha) is a mostly a temporary wetland with limited areas of permanent water. The vegetation consists of areas of cumbungi (*Typha* spp.), rushes (mainly *Eleocharis* spp. and *Bolboschoenus* spp.), water couch grass (*Paspalum distichum*), interspersed among extensive areas of non-vegetated open water. The wetland is a Ramsar site and attracts a high diversity and density of breeding and non-breeding waterbirds.

Human disturbance was simulated by the observer walking directly towards feeding or resting birds or at a pace of about 2-3 km/hour. Because of the shortage of tall vegetation on the swamp the observer was fully visible to the birds for many minutes before starting to walk towards them. Only birds or groups of birds that showed no signs of being disturbed by the observer as the observer started to walk towards them were selected for study. The distances from the observer at which they stopped feeding and at which they took flight were recorded. A grid of posts across placed across the swamp and lines of fence posts were used to assess distances. Birds were followed through binoculars until they landed and the positions were recorded directly onto maps of the swamp. Once a disturbance had been made at one place in the swamp the observer moved to a new area where the birds were undisturbed. Observations were spread over 2.5 years to avoid the possibility altering the birds' behaviour, especially through habituation.

The responses of the birds were related to body mass for each species. For most species included in the study males were slightly larger than females. However, the sexes could not be separated during field observations and mean mass of males and females were used. Data on body mass were taken from Marchant and Higgins (1990, 1993) and Higgins and Davies (1996).

RESULTS

The responses of 23 species were quantified, representing most of the major taxonomic groups of waterbirds, Anatidae (swans and ducks) Ardeidae (herons and egrets), Threskiornithidae (ibises and spoonbills), Rallidae (crakes, rails and gallinules), Scolopacidae (sandpipers), Recurvirostridae (Stilts and avocets) and Charadriidae (plovers and dotterels).

Three responses assessed for each species, the mean distances at which birds stopped feeding and became alert (alert distance), the mean distances at which they took flight (flight initiation distance), and the distances to which they flew before re-alighting (displacement distance). Comparing species, all responses were significantly, positively correlated with log mean body mass (Fig. 1; alert distance: $r = 0.57$, $P = 0.005$, $n = 23$; flight initiation distance: $r = 0.53$, $P = 0.009$, $n = 23$; displacement distance: $r =$

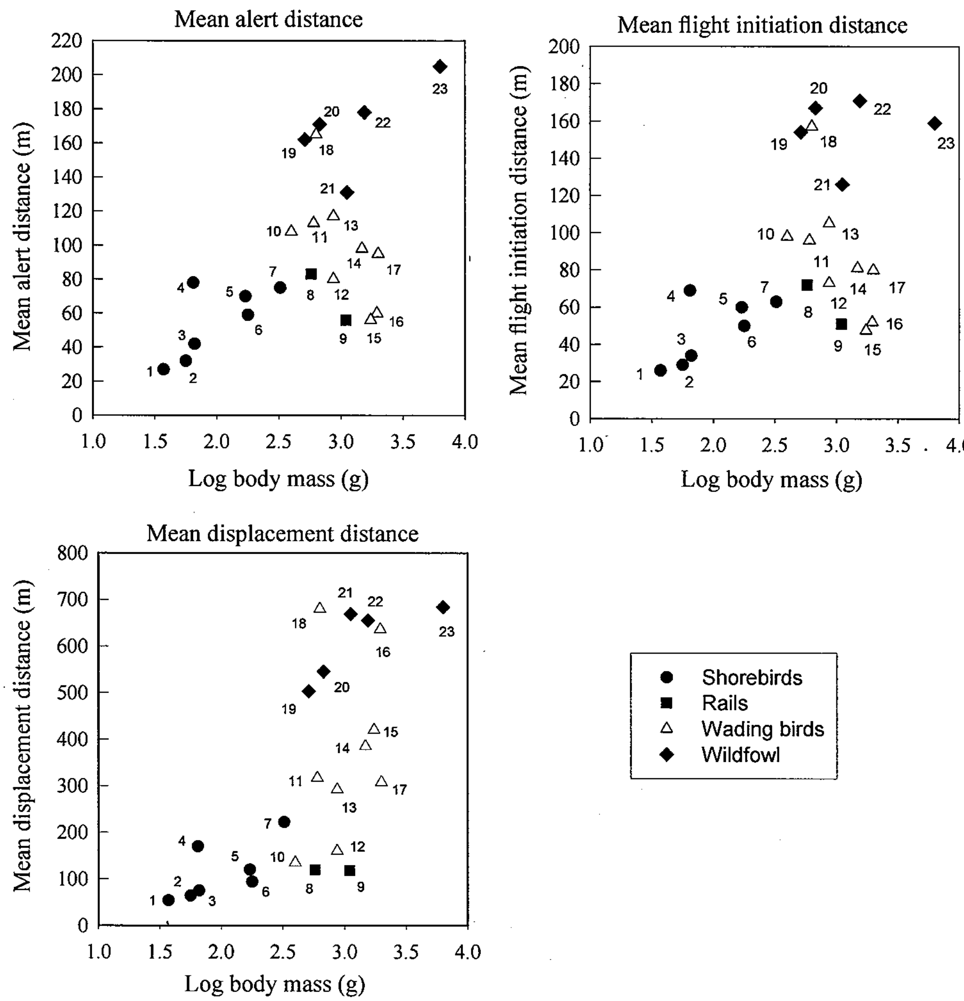

Fig. 1. Relationships between alert distances, flight initiation distances and displacement distances and log body mass among 23 species of waterbirds at Fivebough Swamp, following disturbance by a single observer walking directly towards the birds. Key to species (sample sizes): 1 – Red-capped Plover (18), 2 - Red-kneed Dotterel (22), 3 - Sharp-tailed Sandpiper (30), 4 - Marsh Sandpiper (35), 5 - Greenshank (17), 6 - Black-winged Stilt (42), 7 - Red-necked Avocet (20), 8 – Dusky Moorhen (10), 9 – Purple Swamphen (10), 10 – Intermediate Egret (27), 11 – White-faced Heron (19), 12- Pacific Heron (28), 13 - Great Egret (31), 14 - Straw-necked Ibis (15), 15 - Royal Spoonbill (25), 16 - Yellow-billed Spoonbill (24), 17 - White Ibis (20), 18 – Glossy Ibis (35), 19 – Grey Teal (72), 20 - Chestnut Teal (20), 21 - Black Duck (28), 22 - Australian Shelduck (20), 23 - Black Swan (90).

0.70, $P < 0.001$, n = 23) Heavier species stopped feeding sooner, flew off sooner and flew farther before re-alighting than did smaller species. The differences among species were substantial. The smallest species, which mostly included the sandpipers, plovers and dotterels had mean flight initiation distances of less than 35 m and mean displacement distances of less than 75 m, whereas the largest species such as the black swan and the Australian shelduck had flight initiation distances in excess of 150 m and displacement distances of more than 650 m. The fit with body mass occurred across all taxonomic groups, suggesting a common explanation, at least in part. However, as a group, the swans and ducks tended to be slightly more sensitive than predicted by body mass alone. A few individual species, such as the Glossy Ibis and Marsh Sandpiper had mean alert and flight initiation distances above those predicted.

Average alert distances were almost perfectly correlated with flight initiation distances across species ($r = 0.98$, $P < 0.001$). This arose because the differences between flight initiation distances and alert distances were relatively small and, although variable among species, were independent of body size. Alert distances were good indicators of subsequent flight. The latter generally occurred if the observer continued to approach birds for a few metres beyond the alert distance.

Displacement distances of some species were very large. This was especially so for the wildfowl. For example, the mean displacement distance of Australian Shelduck was 655 m, with some individuals flying as far as 2,000 m before re-alighting. This was not obviously related to the distribution of resources over the swamp. Most of the swamp consisted of relatively

Table 1. Suggested buffer zones for waterbirds at Fivebough Swamp. These are the distances between the birds and a single human intruder that elicited alert and flight initiation distances (FID) in less than 5% of the birds sampled. These distance left 95% of individuals undisturbed. Also shown are the distances within which 95% of individuals flew following disturbance before alighting again (displacement distances).

Species	Alert distance (m)	Flight initiation distance (m)	Displacement distance (m)	Sample size
Black swan	205	159	684	90
Australian shelduck	290	270	1910	35
Pacific black duck	250	205	1295	28
Grey teal	335	330	1030	72
Chestnut teal	275	260	1145	20
Pacific heron	140	170	955	26
White-faced heron	260	215	365	25
Great egret	170	155	225	31
Intermediate egret	220	210	260	27
Glossy ibis	205	195	2200	35
Straw-necked ibis	160	135	1250	15
White ibis	150	130	710	20
Royal spoonbill	75	70	1200	25
Yellow-billed spoonbill	85	80	1850	24
Greenshank	95	75	190	17
Marsh sandpiper	140	105	300	20
Sharp-tailed sandpiper	60	55	105	30
Black-winged stilt	105	80	310	42
Red-necked avocet	120	110	618	20
Red-capped plover	50	45	95	18
Red-kneed dotterel	45	40	90	22

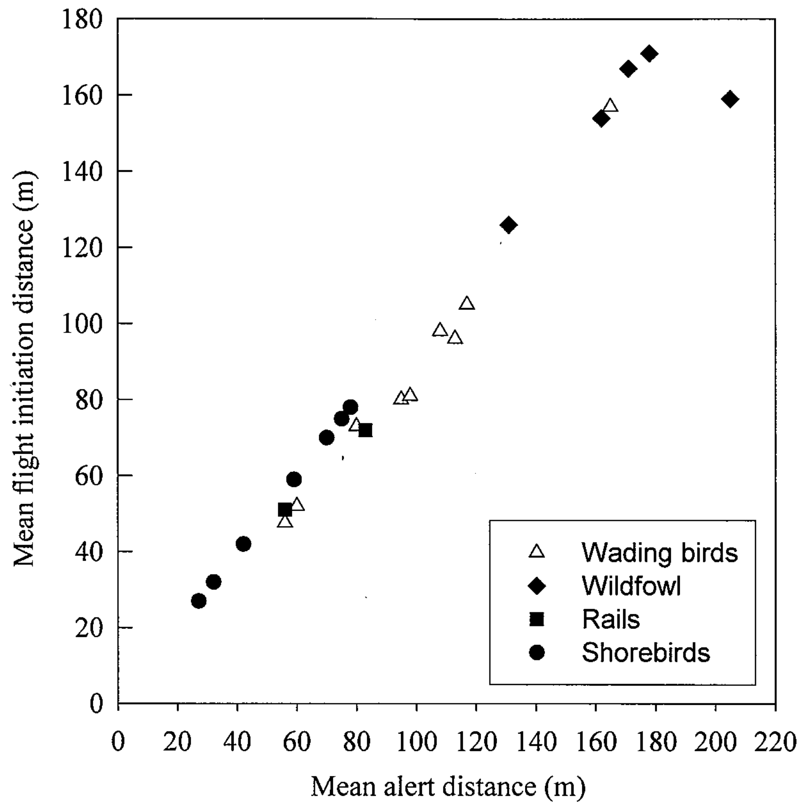

Fig. 2. Relationship between mean flight initiation distances and mean alert distances among 23 species of waterbirds at Fivebough Swamp, in response to a single observer walking directly towards the birds.

uniform areas of short vegetation less than about 20 cm in height interspersed among open areas with no emergent vegetation. Water depths were relatively uniform and mostly less than 15 cm. Also, the observations were made in all areas of the swamp and displacement distances were independent of locations where observations were made.

Buffer zones for each species were calculated from the data as the distances at which 95% of individuals did not respond, either by becoming alert or by taking flight. Thus at these distances only 5% of individuals responded (Table 1). This represents a slight compromise but extending the buffer zone calculations to avoid disturbance to all individuals would have increased the size of the zones considerably. Similar calculations were also made for displacement distances by excluding the distances flown by the extreme 5% of individuals.

For the most sensitive species, the swans, ducks and glossy ibis, buffer zones to ensure that 95% of birds remained undisturbed were 300-350 m. For the smallest species, sandpipers and plovers, this was about 50 m.

DISCUSSION

At the time of the study Fivebough Swamp was little visited by people and most activity was restricted to its southeastern edge. It is unlikely the birds had habituated to human presence and the results presented here probably represent the responses of truly wild, non habituated populations. Response distances presented here may therefore represent the maximum values for each species for this type of wetland. However, the values refer only to disturbance caused by a single observer and it is possible that responses to larger groups and noisier groups may be different. The responses were also to a human observer walking directly towards the birds and, although it has not been quantified in this or any other study, direct approaches are likely to elicit greater response distances than approaches that are more tangential.

For some highly mobile species that may have moved in and out of the swamp, response distances may also have been influenced to some extent by events away from the wetland. In a North American study most resident waterbird species were shown to be less sensitive to disturbance than migrant species and migrant ducks were most sensitive during the first two months or so after arrival (Klein *et al.* 1995). Response distances for some species, especially wildfowl, have been shown to be greater in areas where they have been subject to hunting or scaring (Meltofte 1986). Although sport hunting is banned in New South Wales, it is legal in Victoria and there may be interstate movement of birds. Also, scaring of wildfowl from rice crops is widespread within the rice growing areas of New South Wales.

Body size was shown to be a good predictor of response distances. This relationship allows a degree of extrapolation to species not included in the present study. However, some care has to be taken when doing this as some species were more sensitive than indicated by body mass alone. For example, Glossy Ibis responded at greater distances than predicted. The reason for this is unknown but they may be similar to migrant wildfowl discussed above, which were more sensitive in the period immediately after arrival in non-breeding areas. The Glossy Ibis is a highly mobile, migratory species within Australia and New Guinea (Marchant and Higgins 1990) and throughout most of its global range (Matheu and del Hoyo 1992, Schogolev 1996). At Fivebough Swamp the birds are present only for about two to three months each year, a shorter period than for most species (Taylor and Schultz unpubl.). It is possible that a period of time is needed for species to become familiar with their surroundings and that until then response distances to human disturbance remain high. However, Glossy Ibis are also regularly scared from rice crops by some growers and instances of growers shooting Glossy Ibis have been recorded. The sensitivity of Glossy Ibis to human presence may be a result of this persecution.

Clearly, visitors want to see as wide a range of species as possible under optimal conditions and restrictions that prevent them achieving this will generally be undesirable and may even be counterproductive. Where financial resources are available to construct hides and concealed approaches, access can be provided to areas of high bird density without causing disturbance. Difficulties arise when this approach cannot be used and they are likely to be most severe on open wetlands that have limited areas of dense vegetation to obscure the movement of visitors. In these situations significant disturbance is likely to occur and the use of buffer zones or exclusion zones to manage disturbance is appropriate. The main question is where should visitor access be provided or permitted and how should buffer zones be applied so that disturbance can be reduced to acceptable levels. To answer this fully an understanding is first needed of the normal, undisturbed distribution of waterbirds over an individual wetland, the habitats used and preferred by each species on the wetland and the distribution of all habitats or resources that could be used by each species. Where there are major identifiable areas with concentrations of feeding or resting birds, minimum distances equivalent to at least the extent of the buffer zones suggested here should be maintained between these areas and visitors. Because larger species respond at greater distances, the buffer zones employed should be those for the largest species at the site. The species composition and distribution of birds on the wetland may change seasonally, or more irregularly, and this should also be taken into account if permanent access facilities such as walking trails are used.

The need to maintain buffer zones is likely to be most critical on small wetlands and on those that are too small to accommodate appropriate buffer zones, access may either be discouraged or permitted only at observation hides. The displacement distances following disturbance shown for many species in the present study were in excess of 1000 m. It is not known how fixed such distances are but if they are relatively inflexible it is possible that once disturbed on a small wetland some species may leave the wetland altogether. Repeated disturbance probably would result in such species abandoning the wetland. A good example of the effects of such access was provided by a study of a small wetland in southern New South Wales. The wetland of 15 ha was part of a system of seven shallow lagoons. A trail allowed visitors to walk along a section of its edge and along sections of the edges of the other lagoons. Following single disturbance events most Grey Teal abandoned about 40% of the lagoon area closest to the trail and had made no significant return to their original feeding areas by three hours later (Suesse & Taylor, in prep.). A few Grey Teal did not alter their behaviour significantly in relation to the disturbance and had probably become habituated. The extent to which different species and different individuals within species may habituate to disturbance has not been tested. However, at the same wetland system Australian Shelduck showed no evidence of long term habituation to repeated regular disturbance. After six years of operation of the walking trail with visitors almost every day, shelduck did not alter their distribution and occurred on only one lagoon, which was the only one in the system where a separation distance of at least 200 m could be achieved between the birds and visitors. Suitable habitat for the species occurred on most of the other lagoons and the birds were probably prevented from using them by the human disturbance at the site (Taylor unpubl.).

An alternative or additional approach to minimise disturbance could be directed towards the requirements of bird watchers, who are probably the main group of visitors who may be inclined to approach birds closely. A code of conduct may be suggested by which bird watchers do not approach into the flight initiation distances for waterbirds when visiting wetlands. Alert distances were closely correlated with flight initiation distances and can be used as an accurate predictor of the likelihood of a bird taking flight. Bird watchers simply have to be sensitive to the behaviour of the birds and not approach closer, or preferably retreat a little, once a bird has shown the first sign of alert behaviour.

The need to avoid disturbance will be greatest when the birds have to conserve energy, such as during drought conditions, or when migratory species are accumulating reserves before migration.

The results presented here relate only to feeding and resting birds. The responses of nesting birds were not assessed and published information for Australian species is not available. Some instances of the reactions of colonially nesting wading birds to humans entering colonies have been reported for North America. Some have reported significant losses of eggs or young chicks resulting from uncontrolled access by bird watchers, whereas other have reported no effects from controlled visits by researchers (Nisbet 2000).

REFERENCES

Blumstein, D.T., 2006. Developing an evolutionary ecology of fear: how life history and natural history traits affect disturbance tolerance in birds. Animal Behaviour **71**, 389-399.

Blumstein, D.T., Anthony, L.L., Harcourt, R.G., Ross, G. 2003. Testing a key assumption of wildlife buffer zones: is flight initiation distance a species-specific trait. Biological Conservation **110**, 97-100.

Boellstorff, D.E., Anderson, D.W., Ohlendorf, H.M, O'Neill, E.J., 1988. Reproductive effects of nest marking studies in an American White Pelican colony. Colonial Waterbirds **11**, 215-219.

Burger, L., Gochfield, M., Niles, L.J., 1995. Ecotourism and birds in coastal New Jersey: contrasting responses of birds, tourists and managers. Environmental Conservation **22**, 56-65.

Carney, K.M, Sydeman, W.J., 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds **22**, 68-79.

Davidson, N.C. Rothwell, P.I. 1993. Human disturbance to waterfowl on estuaries: conservation and coastal management implications of current knowledge. Wader Study Group Bulletin **68**, 97-106.

Erwin, M.R., 1989. Responses to human intruders by birds nesting in colonies: experimental results and management guidelines. Colonial Waterbirds **12**, 104-108.

Higgins, P.J. & Davies, S.J.J.F. 1996. Handbook of Australian, New Zealand and Antarctic Birds. Vol 3. Snipe to Pigeons. Oxford University Press. Melbourne.

Hughes, L. 2003. Climate Change and Australia: Trends, predictions and impacts. Austral Ecology *28*, 423-443.

IPCC. 2001. Climate Change 2001: Impacts, adaptation and vulnerability. Report from Working Group II. Intergovernmental panel on Climate Change, Geneva.

Klein, M.L., Humphrey, S.R., Percival H.F., 1995. Effects of ecotourism on distribution of waterbirds in a wildlife reserve. Conservation Biology **9**, 1454-1465.

Madsen, J. 1995. Impacts of disturbance on migratory waterfowl. Ibis **137**, S67-S74.

Marchant, S. & Higgins, P.J. 1990. Handbook of Australian, New Zealand and Antarctic Birds. Vol 1. Ratites to Ducks. Oxford University Press, Melbourne.

Marchant, S.& Higgins, P.J. 1993. Handbook of Australian, New Zealand and Antarctic Birds Vol 2. Raptors to Lapwings. Oxford University Press, Melbourne.

Matheu, E., del Hoyo, J. 1992. Family Threskiornithidae (Ibises and Spoonbills). In: Handbook of Birds of the World. Vol I. Ostrich to Ducks. (eds J.del Hoyo, A. Elliot & J. Sargatal) pp 472-491. Lynx Editions, Barcelona.

Meltofte, H. 1986. Hunting as a possible factor in the decline of Fenno-Scandian populations of Curlews *Numenius arquata*. Vår Fågelvard. Supplement **11**, 135-140.

Nisbet, I.C.T., 2000. Disturbance, habituation and management of waterbird colonies. Waterbirds **23**, 312-332.

Pfister, C., Harrington, B.A., Lavine, M., 1992. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation **60**, 115-126.

Rogers, J.A. and Smith, H.T., 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology. **9**, 89-99.

Schogolov, I.V. 1996. Migration and wintering grounds of Glossy Ibis (*Plegadis falcinellus*) ringed at the colonies of the Dnester Delta, Ukraine, Black Sea. Colonial Waterbirds 19, 152-158.

Schummer, M.L., Eddleman, W.R., 2003. Effects of disturbance on activity and energy budgets of migrating waterbirds in south-central Oklahoma. Journal of Wildlife Management **67**, 789-795.

Smit, C.J., Visser, J.M., 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.

Werschkul, D.F., McMahon, E., Leitschuh, M. 1076. Some effects of human activities on the great Blue Heron in Oregon. Wilson Bulletin **88**, 660-662.