

Changes in the summer population of shorebirds in the Tweed River Estuary, northern New South Wales between 1987 and 2003

D.A. Rohweder

PO Box 401, Alstonville, NSW 2477
sandpipereco@optusnet.com.au

ABSTRACT

Summer population estimates of shorebirds in the Tweed River Estuary are summarised for the period 1987 to 2003. Data from various sources were reviewed to determine their suitability for inclusion in the summary. The results show a significant decline in the total population of migratory shorebirds, with declines recorded for Bar-tailed Godwit *Limosa lapponica*, Curlew Sandpiper *Calidris ferruginea* and Pacific Golden Plover *Pluvialis fulva*. No evidence of a decline in the population of resident shorebirds was recorded. The population of Pied Oystercatcher *Haematopus longirostris* increased over the sample period. The specific reason for the decline in the population of migratory shorebirds is unclear and could be due to a combination of local and international factors. Local factors may include the loss of nocturnal habitat, the declining quality of high tide roosts or increased levels of human disturbance around roosts. Actions to reduce further declines are discussed.

Key words: population decline, shorebirds, Tweed River, Bar-tailed Godwit, Curlew Sandpiper, Pacific Golden Plover.

Introduction

Estuaries along the New South Wales (NSW) coastline provide habitat for a large number of individuals and numerous species of migratory and resident shorebird (Smith 1991). These estuaries are used for breeding, as drought refuges, as migration staging areas and as non-breeding habitat for palearctic migrants and resident shorebirds. Whilst each estuary may not support large populations they nonetheless represent important components of the habitat for shorebirds in the East-Asian/Australasian Flyway (the Flyway), with several species known to migrate along the east coast of Australia (Alcorn *et al.* 1994). It is important that the number of shorebirds using NSW estuaries is monitored to identify any changes in population size. Monitoring shorebird populations in estuaries can also provide an insight into the general health of estuarine systems.

Like most estuaries in NSW the Tweed River estuary is experiencing high levels of development pressure. Although development pressure may not be exerted directly on the habitats used by shorebirds there is potential for indirect impacts associated with increased levels of human recreation within estuarine and ocean beach habitats. High levels of human recreation around shorebird roosting and feeding sites can have a detrimental impact on shorebird populations (Watson 1988; Buick & Paton 1989; Pfister *et al.* 1992). In addition, the removal of important, but undocumented roosting and feeding sites can also have a detrimental impact.

The migratory behaviour of shorebirds and the myriad of impacts that the birds experience throughout the Flyway and at their breeding grounds make it

extremely difficult to determine if population changes are due solely to local factors or a combination of local and international factors. There is recent evidence of declining numbers of migratory shorebirds throughout Australia, including in the Hunter Estuary (Straw 1999), the Coorong (Wilson 2001a), in Tasmania (Reid and Park 2003) and at several sites in Victoria (Wilson 2001b). The following paper summarises the results of summer surveys for shorebirds in the lower Tweed River over a 17-year period, 1987 to 2003.

Status of shorebirds in the Tweed River

The earliest documented systematic survey of shorebirds in the Tweed River Estuary was undertaken by Martindale (1987). During that study, 976 individuals and 17 species were recorded. Based on information gathered by Martindale (1987) and using the count data available at the time, Smith (1991) classified the Tweed River Estuary as "Priority 3: Sites with counts over the 1% level for one or two species". Counts for both Whimbrel *Numenius phaeopus* and Pacific Golden Plover *Pluvialis fulva* were considered to exceed 1% of their Australian population (Smith 1991).

Watkins (1993) listed the Tweed Estuary as being nationally important for one species of migratory shorebird, Whimbrel, with an estimated maximum population of 140 individuals. A recent re-evaluation of the status of important sites within the Flyway indicates that the Tweed is not of national importance for any species of migratory shorebird (Bamford *et al.* in prep). Despite this, the Tweed Estuary is important from a state and local perspective and changes in the shorebird population could be indicative of what is occurring in other estuaries in northern NSW.

Study area and Methods

Study area

The study area covers the lower reaches of the Tweed River estuary, including all of the major high tide roosts and low tide foraging areas (Figure 1). The study area extended from the river mouth upstream to Chinderah Bay, and included Dreamtime and South Head Beaches, Cook Island, Ukerabagh Island, Terranora Creek, and the Terranora and Cobaki Broadwaters. Both the Tweed Heads west and south Sewage Treatment Works (STW) and Vintage Lakes system were also surveyed.

The Tweed River forms one of the largest estuarine systems in NSW. The estuary is characterised by a main river channel, with several sheltered embayments, and two large Broadwaters (Terranora and Cobaki). The Broadwaters are linked to the main river by Terranora Creek. Several mangrove islands occur throughout the estuary. Shorebird habitats in the lower sections of both Broadwaters and the main river channel are characterised by a sandy substrate, whilst muddy sediments dominate habitat in the upper sections of the Broadwaters and embayments within the river.

Methods

In the last decade the shorebird population in the study area has been the subject of numerous studies. Nine surveys of shorebirds were collated for the period 1987 to 2003 and the comparability of the data gathered during each survey were assessed (Table 1).

The number of sites sampled varied substantially between surveys, although most importantly, all surveys sampled the major high-tide roosts and most included surveys at both high and low tide. High and low tide surveys are important to account for the variability in habitat use and detectability of some species (e.g. Whimbrel and Grey-tailed Tattlers *Heteroscelus brevipes*) between the two periods. Due to the roosting behaviour of shorebirds, it is feasible to attain an accurate population estimate by sampling only the primary roosts with surveys at other 'secondary' roosts having minimal influence on the population estimate. A survey was deemed appropriate for inclusion in the analysis if it included all of the primary roosts.

Most surveys used maximum counts derived over two or more days to obtain an estimate of the shorebird population. The exception was NPWS (1995), which used multiple observers to obtain a population estimate over a single

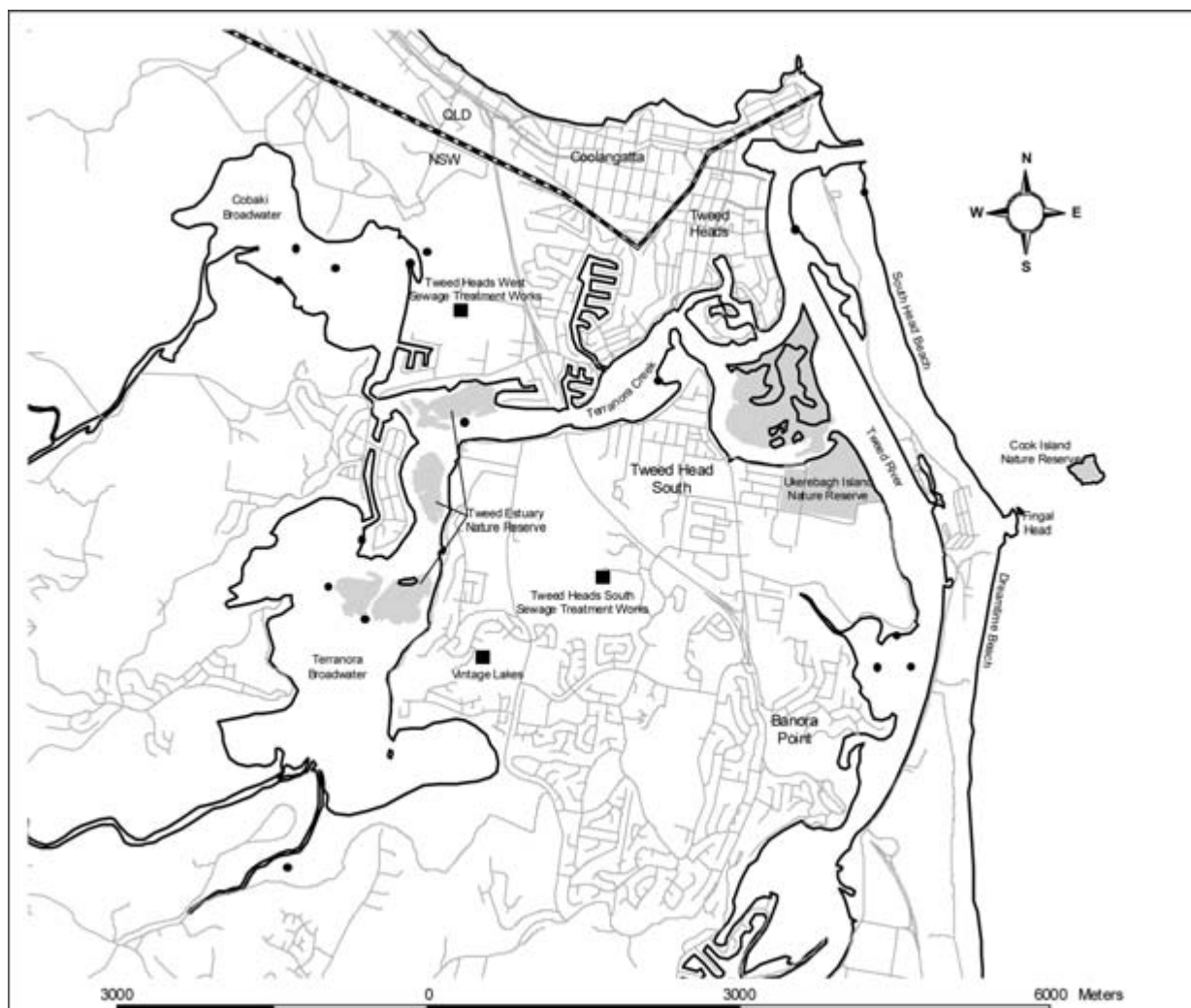


Figure 1. The Tweed River estuary, including the main river channel and Terranora and Cobaki Broadwaters. High tide roosts active in 2003 are indicated by circles.

Table 1. Summary of survey design and survey effort of shorebird surveys in the Tweed River Estuary.

Source	Duration of Sampling	Data Used	Frequency	Effort	Timing	Methods	No. sites sampled
Lewis (2003)	18/1/2003 – 20/1/2003	18-20/1 2003	Single survey	3 day survey, 1 survey period	High & low tide	Combination of simultaneous estimation and maximum count	24
Rohweder (2003)	3/1/1997 to 2/2002	2-4/2 2002, 3/1/2001 1-3/2 2000, 2-4/2 1999 3-5/2 1998	Once/season	3 days/survey, 20 survey periods	High & low tide	Combination of simultaneous estimation and maximum count	24
WBM (1996)	mid August 1995 to mid April 1996	Data not used	Once/three weeks	2 days/survey, 12 survey periods	High & low tide	Combination of simultaneous estimation and maximum count	15
QWGS (unpublished data)	1993 to 1997	2/1993, 11/2/1994 3/2/1995, 6/2/1996 14/2/1997	Once/month	Various days/month, 12 months/year	High tide, mid tide	Simultaneous estimation	13
NPWS (1995)	11/10/1994 & 15/1/1994	Data not used	Two surveys	1 day survey, 2 survey periods	High & low tide	Simultaneous estimation	25
Lawler (1994)	4-6, 8/2/1992 27/2-1/3/1994	4-6 & 8/2 1992	Two surveys	1 day/survey	High & low tide	Maximum counts	14
DPWS (1991a)	12/12/90 to 17/4/1991	Data not used	Once/fortnight	2 days/survey, 10 survey periods	High & low tide	Combination of simultaneous estimation and maximum count	12
Holmes cited in DPWS (1991b)	Summer 1988-1989	Summer count	unknown	unknown	unknown	unknown	14
Martindale (1987)	26/1/1987 to 6/2/1987	26/1 to 6/2 1987	Single survey	Survey over 12 days, 1 period	High & low tide	Combination of simultaneous estimation and maximum count	10 @ high tide

day and the 1994 surveys by Lawler (1994), which were undertaken on one day. All surveys followed the accepted procedure of counting shorebirds at high tide roosts, with an attempt made to survey all roosts within a single high tide. Maximum counts represent the highest number of individuals of each species recorded during a sampling event (i.e. high tide), and counts have not been summed across days or high and low tides.

Surveys were conducted for varying durations, although NPWS (1995) was the only survey that did not include the summer period. To increase the ability to draw comparisons between years it was preferable to compare data from the same time period. Late January and early February are regarded as the time when migratory shorebird populations are most stable (Watkins 1993). As a consequence, count data from late January and early February were used to compare shorebird population estimates between years. Preference was given to surveys that included maximum counts over consecutive days (i.e. 1-4 days) sampling as opposed to maximum counts over a month.

Three surveys were excluded from the comparison to reduce variability, these included DPWS (1991a), NPWS (1995) and WBM (1996). The Queensland Wader Studies Group (QWSG) conducted frequent surveys at several sites each month (QWSG unpublished data); however, to minimise the risk of including duplicate counts, data from two or three consecutive days only has been used. Due to the manner in which the QWSG data have been treated, it is possible that the counts represent slight underestimates. Raw count data were available for 12 of the 17 years. Maximum counts are presented in the results and linear regression has been used to determine if the changes in maximum counts follow a linear pattern. Data included in the analysis include: the combined population of migratory species, the combined population of resident species and populations of individual species that were present during 10 or more of the surveys. Migratory refers to palearctic migrants that breed in the northern hemisphere and spend the spring and summer in Australia. All other species were regarded as residents.

Results

Temporal changes in the migratory shorebird population

Comparison of late summer population estimates of shorebirds in the Tweed River Estuary show a trend of decreasing population size over the 17-year period from 1987 to 2003 (Figure 2). A significant ($F_{1,12}=9.16$; $R^2=0.433$; $P < 0.02$) linear decline ($\beta = -0.658$) in the number of migratory shorebirds was recorded. The number of species using the estuary has also declined over the sample period (Table 2). During surveys between 1987 and 1992 species diversity ranged from 12 to 18 species. In contrast, species diversity from 1999 to 2003 ranged from 10 to 12.

Population trends for eight migratory species were analysed separately. Significant linear regressions were recorded for Bar-tailed Godwit ($F_{1,12} = 10.69$; $R^2 = 0.471$; $P < 0.01$; $\beta = -0.686$), Curlew Sandpiper ($F_{1,12} = 56.94$;

$R^2=0.826$; $P < 0.01$; $\beta = -0.909$) and Pacific Golden Plover ($F_{1,12}=7.94$; $R^2=0.398$; $P < 0.02$; $\beta = -0.631$). No significant relationship was recorded for Whimbrel, Eastern Curlew *Numenius madagascariensis*, Sharp-tailed Sandpiper *Calidris acuminata*, Greenshank *Tringa nebularia* or Grey-tailed Tattler.

The number of Pacific Golden Plover has declined from a peak of 83 in 1991 to fewer than 30 individuals between 1998 and 2003. Similarly, the population of Curlew Sandpiper has declined from a peak of 40 individuals in 1987 to three or less between 1998 and 2003 (Table 2). The population of Bar-tailed Godwit has declined in the later stages of the sample period, from 2001 to 2003 (Table 2).

Temporal changes in the resident shorebird populations

The population of resident shorebirds has fluctuated widely over the period sampled, and no significant ($F_{1,14}=0.17$; $R^2=0.015$; $P = 0.687$) linear regression was recorded (Figure 2). Likewise, there is no evidence of a change in species diversity (Table 2). The population of resident shorebirds is characterised by sharp declines followed by steady increases over several years. The summer population of resident shorebirds has peaked in 1991, 1995, 1999 and 2003 (Figure 2). Black-winged Stilt *Himantopus himantopus* dominate the resident shorebird population (Table 2). A significant linear relationship was recorded between

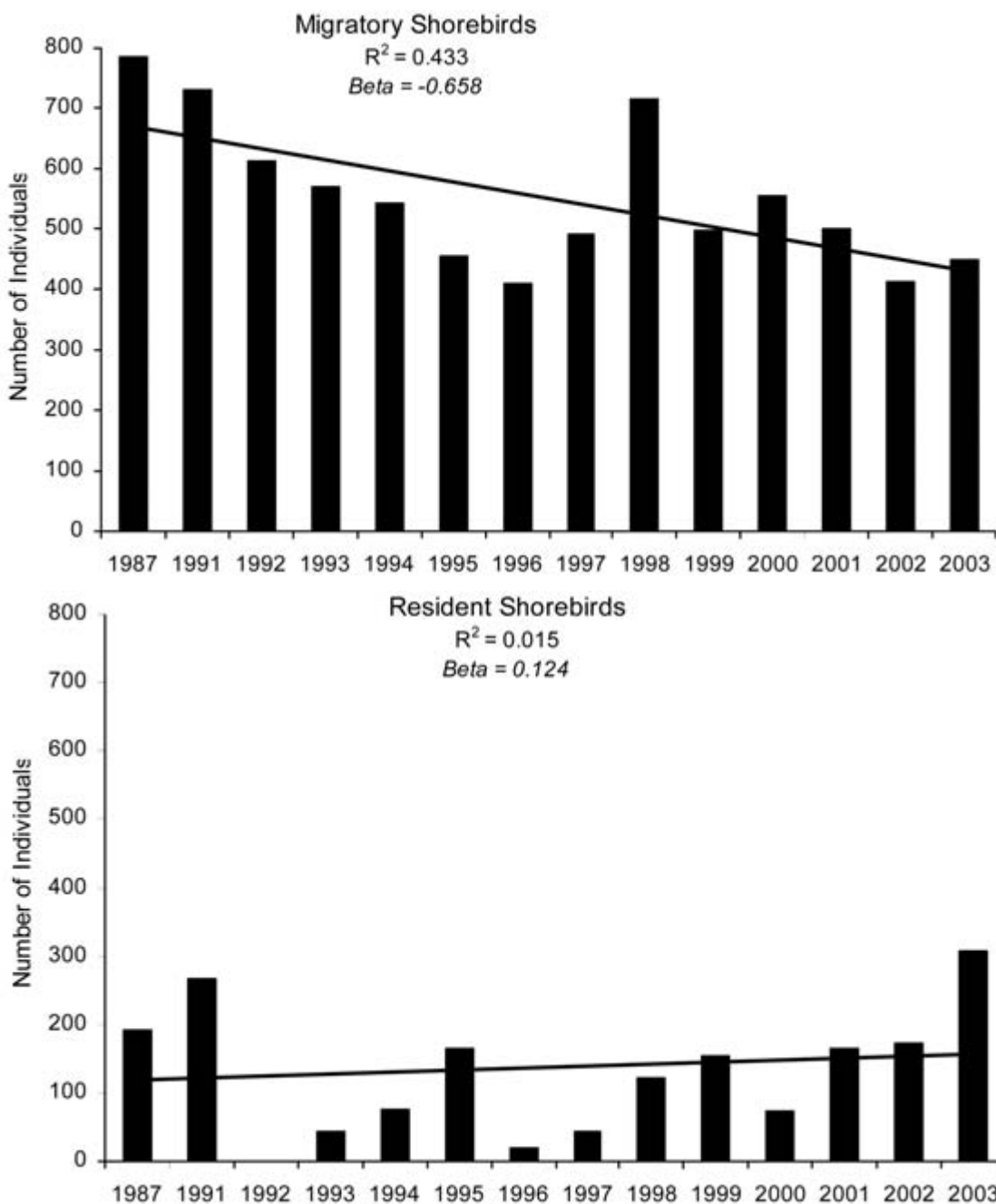


Figure 2. Temporal variation in population estimates of migratory and resident shorebirds in the Tweed River Estuary between 1987 and 2003.

Table 2. Population estimates for shorebirds in the Tweed River Estuary between 1987 and 2003. M = Martindale (1987), D2 = DPWS (1991b), La = Lawler (1994); Q = QWSG, R = Rohweder (2003), Le = Lewis Ecological Surveys (2004). ** Species listed on the NSW Threatened Species Conservation Act 1995

Year of Survey	87	91	92	93	94	95	96	97	98	99	00	01	02	03	
Source	M	D2	La	Q	Q	Q	Q	Q	R	R	R	R	R	Le	
No. of sites sampled	10	12	14	13	13	13	13	13	24	24	24	24	24	24	
Migratory Species	Population Estimate														
Latham's Snipe									1	3	3	2	2	1	1
Bar-tailed Godwit	230	338	271	314	291	191	186	133	211	180	193	232	138	156	
Black-tailed Godwit**	3														
Whimbrel	140	62	110	37	39	32		57	124	59	78	88	72	74	
Eastern Curlew	163	164	62	121	139	96	97	150	131	132	117	103	113	107	
Marsh Sandpiper		3				63	20		58						
Common Greenshank	50	24	41	30	17		44	50	44	45	47	17	20	18	
Terek Sandpiper**	7	2	2	1				2	2	1	1				
Common Sandpiper			1	1	4				2	1	1	2	1		
Grey-tailed Tattler	54	13	27	23	10		20	56	70	43	69	34	48	36	
Wandering Tattler		3										1			
Ruddy Turnstone	4	3	2	3	2		2					2	1		
Curlew Sandpiper	40	18	24	20	16	17	14	9	15		1	3	3	1	
Red-necked Stint	1														
Sharp-tailed Sandpiper		1	3	1		36	3	26	26	6	23	1	5	29	
Sanderling**															
Red Knot				1											
Great Knot**			1		7		1								
Pacific Golden Plover	80	83	37	15	14	19	20	5	29	27	24	15	9	25	
Greater Sand Plover**		2		2	2										
Lesser Sand Plover**	13	4	3				2	2							
Double-banded Plover		1										1			
No. Individuals	796	731	612	569	541	454	409	491	714	496	555	501	411	447	
No. Species	12	15	13	13	11	7	11	11	12	10	11	12	11	9	
Resident Species															
Beach Stone-curlew**												1			
Pied Oystercatcher**	4	2		2	2	2	2	7	6	5	12	9	7	7	
Sooty Oystercatcher**	2			1			2		2	3	2	2	6	4	
Black-winged Stilt	180	243		29	63	156		19	102	89	49	59	131	232	
Red-necked Avocet														54	
Black-fronted Dotterel		7		2	2	3	6	6	4	10	1	3	5		
Masked Lapwing	4	15		9	7	4	9	11	6	46	10	93	23	10	
No. Individuals	190	267		42	75	165	19	43	120	153	74	164	172	307	
No. Species	4	4		4	5	4	4	4	5	5	5	6	5	5	

the population of Pied Oystercatcher *Haematopus longirostris* ($F_{1,10}=10.17$; $R^2=0.504$; $P=0.01$) and time with the population increasing from 1987 to 2003 ($\beta=0.710$). No significant relationships were recorded for Masked Lapwing *Vanellus miles*, Black-fronted Dotterel *Elseornis melanops* or Black-winged Stilt (Table 2). The absence of resident shorebirds in 1992 is most likely due to the fact that these species were not targeted during that survey.

Discussion

Adequacy of the data

The data used in this study have been collected for a variety of purposes and by observers with varying skill levels and knowledge of the Tweed estuary. Although an attempt has been made to use surveys with similar methods, the fact that several surveys have been

used means that the results should be interpreted with some caution. The data suggest that the summer population of migratory shorebirds in the Tweed River Estuary has declined over the 17-year period between 1987 and 2003, with the most substantial declines occurring between 1987 and 1993. The fact that this decline has occurred despite an increase in survey effort from 1998 to 2003 suggests that the decline is actual and not due to sampling intensity and variability in the skills of observers.

Reasons for decline

Whilst the data suggest that the migratory shorebird population has declined, the reasons for this decline are difficult to determine. It is even more difficult to separate local issues from those operating within the Flyway and at the breeding grounds. Comparing temporal changes between resident and migratory shorebird populations could help to assess the influence of local factors; however, different processes may influence resident shorebirds. In the case of the Tweed Estuary, the numerical dominance of Black-winged Stilt makes such a comparison difficult. The occurrence of stilts may be due more to factors effecting inland wetlands as opposed to coastal wetlands (Lane 1987; Marchant & Higgins 1993) and stilts appear more tolerant of variable roosting conditions than many species of migratory shorebird.

Evidence of declining populations of migratory shorebirds has been recorded elsewhere in Australia (Straw 1999, Wilson 2001a, b). Large fluctuations in populations of migratory shorebirds can occur between years and perceived declines need to be interpreted carefully (Gosbell *et al.* 2002). Populations of small sandpipers appear to have experienced the greatest declines, although there is also evidence for some larger species (Wilson 2001b; Reid and Park 2003). The decline in the number of Eastern Curlew in Tasmania between 1948 and 2000 was attributed to the influence of both local and international factors (Reid and Park 2003).

The destruction of habitat within the Flyway is predicted to affect the Australian populations of some migratory shorebirds, particularly those that migrate through the Yellow Sea such as Bar-tailed Godwit and Curlew Sandpiper (Minton *et al.* 2005). Natural variation in shorebird populations associated with variable breeding success can affect the ability to detect population declines (Minton *et al.* 2002).

Some of the major factors that may have affected migratory shorebird habitat in the Tweed Estuary include: foreshore development, development of the floodplain, high levels of human recreation on and near roost and feeding areas, declining quality of roosting habitat through vegetation encroachment, pollution, major infrastructure projects and dredging. In addition, the construction of the river training walls is likely to have had a substantial and ongoing impact on shorebird habitat by altering the manner in which sandbars (roosts) form and erode. Increasing levels of human recreation associated with coastal development, the recent loss of a spring-tide roost and the expansion of mangroves over roosts are examples of recent and ongoing impacts.

Although the cumulative migratory shorebird population showed a significant decline, the analysis of eight frequently occurring species identified declines for Curlew Sandpiper, Pacific Golden Plover and Bar-tailed Godwit only. These species commonly share roosts in northern NSW, although Pacific Golden Plovers and Curlew Sandpipers are more likely to use rocks and saltmarsh than godwits, which seem to prefer open sandy shorelines. Decreases in the number of Curlew Sandpipers have been recorded in Victoria (Minton *et al.* 2005) and the changes recorded in the Tweed may be due to national or international factors rather than local factors.

The decline in the Pacific Golden Plover population could be due to the removal of an unknown nocturnal foraging or roosting site. Radio-tracking and scat analysis of Pacific Golden Plovers in the Richmond Estuary showed that birds were foraging and roosting outside of the estuary during night-time high tides (Rohweder 2000). The removal of a nocturnal foraging site could affect the ability of Pacific Golden Plovers to satisfy their daily energetic needs. This, coupled with the declining quality of diurnal roosts, could affect the ability of plovers to build fat reserves for migration. In the Tweed Estuary several important spring tide roosts situated in close proximity to feeding grounds were observed to decline due to vegetation growth between 1998 and 2003.

The decrease in the population of Bar-tailed Godwits occurred later in the sample period than the other species. Three of the preferred spring tide roosts used by godwits occur in the main river. These sites have been affected by erosion, high levels of human activity and vegetation growth. Whereas godwits could once move between sites during high tide, the recent patterns of habitat degradation and recreation mean that all primary roosts are disturbed at the same time.

Not all species of migratory shorebird declined, with no evidence of declines recorded for Whimbrel, Eastern Curlew, Common Greenshank, Grey-tailed Tattler and Sharp-tailed Sandpiper. Interestingly none of these species is dependent on sandy roosts within the main river. Both Whimbrels and Grey-tailed Tattler roost in secluded mangrove trees during spring tides, whilst Greenshank and Sharp-tailed Sandpipers utilise saltmarsh roosts that experience very low levels of human disturbance. Eastern Curlews use both saltmarsh and sandy beach roosts and often co-occur with godwits at sandy beach sites.

The absence of a decline in the population of curlews could be due to their larger size which may make them more resilient to disturbance and the fact that they also use some saltmarsh roosts.

Spring tide roosts are an essential component of estuarine habitat as they provide birds with resting areas on the highest tides. At present birds foraging in Cobaki Broadwater must fly 4.5 km to reach the nearest spring tide roost, whilst birds foraging in Terranora Broadwater that prefer exposed sand or rock for roosting must fly 5.5 km. Historically birds foraging in Cobaki Broadwater could roost adjacent to the Broadwater (Martindale 1987). This habitat is now dominated by *Juncus* sp. and is used by

small numbers of Eastern Curlew, Bar-tailed Godwit and Pacific Golden Plover. The long distances between roost and feeding sites and the frequent disturbance at roosts in the main river is likely to increase energetic demands to the point where foraging may become inefficient.

Future management

To date, actions to manage shorebirds in the Tweed River Estuary have focussed on monitoring populations, identifying important habitats, providing signage at selected

localities and blocking vehicular access to important roosts. The gazettal of some areas as conservation reserves has also had a minor benefit, although more direct action is required to restore or replace degraded roosts and reduce human disturbance at roost and feeding sites. Measures proposed include the construction of spring-tide roosts close to feeding grounds and away from areas of intense human activity, further restrictions on vehicular access to important sites, designating some sites as no beaching areas for boats and increasing public awareness of the importance of roost and feeding sites.

Acknowledgements

The Tweed River Committee (TRC) provided funding for estuarine bird surveys between autumn 1997 and summer 2002. Jane Lofthouse from the TRC and Lance Tarvey from the NSW NPWS provided logistical support when required. The Murwillumbah office of the NSW NPWS

supplied a boat for surveys between 1997 and 2002. Bo Totterman, Ben Lewis and two anonymous referees provided helpful comments on the draft manuscript. Data were purchased from the QWSG. Edward Kleiber conducted surveys on behalf of the QWSG.

References

- Alcorn, M., Alcorn, R. & Fleming, M. 1994. *Wader movements in Australia*. RAOU Report No. 94. Royal Australasian Ornithologists Union, Melbourne.
- Bamford, M., Watkins, D., Bancroft, W., Tischler, G., Wahl, J. In Prep. *Migratory Shorebirds of the East Asian Australasian Flyway – Population Estimates and Important Sites*. Wetlands International Oceania, Canberra Australia. Wetlands International Global Series and International Wader Studies.
- Buick, A. M. & Paton, D. C. 1989. Impact of off-road vehicles on the nesting success of hooded plovers *Charadrius rubricollis* in the Coorong region of South Australia. *Emu* 89: 159-172.
- DPWS 1991a. *Reviving the Tweed – Feasibility Study: technical summaries – ecological environment report no. 2.3*. Report prepared by NSW Public Works for the Tweed Estuary Management Committee.
- DPWS 1991b. *River Management Plan – Lower Tweed Estuary: Ecological Assessment Technical Report No. 1*. Report prepared by NSW Public Works for the Tweed Estuary Management Committee.
- Gosbell, K., Collins, P., & Christie, M. 2002. Wader surveys in the Coorong and coastal lakes of southeastern South Australia during February 2002. *Stilt* 42: 10-29.
- Lane, B. 1987. *Shorebirds in Australia*. Thomas Nelson, Melbourne.
- Lawler, W. 1994. *Shorebird Counts on New South Wales North Coast Estuaries*. Environmental survey and research branch, NSW National Parks and Wildlife Service.
- Lewis, B. D. 2003. Proposed runway extension: impact assessment on avifauna. Report prepared for Gold Coast Airports Limited by Lewis Ecological Surveys.
- Marchant, S & Higgins, P. J. (eds) 1993. *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings*. Oxford University Press, Melbourne.
- Milton, D., Minton, C. D. T. & Gosbell, K. 2005. Are populations of migratory shorebirds in the East Asian Australasian Flyway at risk of decline? pages 153-158 in *Status and Conservation of Shorebirds in the East Asian-Australasian Flyway*, Proceedings of the Australasian Shorebirds Conference, Ed P. Straw, Wetlands International Global Series 18, International Wader Studies 17, Sydney, Australia.
- Minton, C., Jessop, R., Collins, P. & Hassell, C. 2002. Year 2001 arctic breeding success, as measured by the percentage of first year birds in wader populations in Australia in the 2001/2002 Austral summer. *Stilt* 42: 32-36.
- Minton, C., Jessop, R., Collins, P. & Gosbell, K. 2005. Monitoring shorebird breeding productivity by the percentage of first year birds in populations in S.E. Australian non-breeding areas, pages 73-85 in *Status and Conservation of Shorebirds in the East Asian-Australasian Flyway*, Proceedings of the Australasian Shorebirds Conference, Ed P. Straw, Wetlands International Global Series 18, International Wader Studies 17, Sydney, Australia.
- Martindale, J. 1987. *A Study of Estuarine Birds in The Lower Tweed River Estuary*. Unpublished report for the NSW National Parks & Wildlife Service.
- NPWS 1995. *Vertebrates of Upper North East NSW*. A study by the NSW NPWS for the Natural Resource Audit Council, NSW National Parks and Wildlife Service.
- 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.
- Reid, T. & Park, P. 2003. Continuing decline of Eastern Curlew, *Numenius madagascariensis*, in Tasmania. *Emu* 103: 279-283.
- Rohweder, D. A. 2000. *Day-Night Habitat Use by Five Species of Migratory Shorebird in the Richmond River Estuary, Northern NSW, Australia*. Unpublished PhD Thesis, Southern Cross University.
- Rohweder, D. 2003. *Monitoring Estuarine Birds in the Tweed River Estuary 1997 – 2002: Summary Report*. Unpublished report prepared by Sandpiper Ecological Surveys for the Tweed River Management Committee.
- Straw, P. 1999. *Hunter River Estuary Wader Habitat Investigation*. Report to the NSW National Parks and Wildlife Service.
- Smith, P. 1991. *The Biology and Management of Waders (Suborder Charadrii) in NSW*. New South Wales National Parks and Wildlife Service.

Watkins, D. 1993. *A National Plan for Shorebird Conservation in Australia*. Australasian Wader Studies Group, Royal Australian Ornithologists Union and World Wide Fund for Nature. RAOU Report No. 90.

Watson, A. 1988. Dotterel *Charadrius morinellus* numbers in relation to human impact in Scotland. *Biological Conservation* 43: 245-256.

WBM 1996. *Tweed River Entrance Sand Bypassing Project Bird Monitoring Program*. Unpublished report prepared for the NSW Department of Land and Water Conservation.

Wilson, J. R. 2001a. Wader surveys in the Coorong, South Australia in January and February 2001. *Stilt* 40: 38-54.

Wilson, J. R. 2001b. The January and February 2001 Victoria wader count. *Silt* 40: 55-63.