A ten-year study of herons, spoonbills and ibis at the Morpeth Wastewater Treatment Works near Maitland, NSW

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The Morpeth Wastewater Treatment Works (MWTW) and adjacent ephemeral wetlands near Maitland in NSW provide valuable habitat for waterbirds. During a ten-year study between 2001 and 2010, involving monthly surveys, six heron, three ibis and two spoonbill species were recorded. A decommissioned holding pond and pasture adjacent to the MWTW site provided foraging habitat when flooded. Waterbird species diversity and abundance decreased when these areas intermittently dried out. White-faced Heron *Egretta novaehollandiae* and Cattle Egret *Ardea ibis*, the two most frequently recorded species, were less dependent on shallow water for foraging.

There was considerable variation between species in the monthly and annual occurrence of the waterbirds. This was associated with differences in the foraging styles of the species, as well as the conditions at MWTW. Some species breed locally, while others use the MWTW and the Hunter Region as non-breeding habitat and as a drought refuge when conditions are unsuitable inland. Waterbird numbers and diversity increased during a period of prolonged drought before falling to minimum level in 2010, a La Nina year with exceptionally high rainfall in inland areas.

INTRODUCTION

Morpeth Wastewater Treatment Works (MWTW) owned by the Hunter Water Corporation (HWC) (32°44'31"S, 151°37'24"E) is located about 10 km north-east of Maitland in NSW and covers an area of 72 ha. The original plant, decommissioned in 2000, was a biological filtration works constructed in 1936.

It was recognised that the maturation pond system associated with the original MWTW constitutes an important wetland habitat of local, regional and state significance. As a condition of the Minister's Approval for decommissioning the plant, HWC was required to manage the ponds so as "to provide enhancement of wetland and riparian habitats and encourage their use by indigenous and migratory species." (Anon. 2000).

The MWTW site (**Figure 1**) is comprised of four ponds where water is permanently present (A), a sludge pond which occasionally dries out (B) and a larger ephemeral wetland, which although bunded, is subject to a wetting and drying regime (C). On the southern and western sides of MWTW, privately owned ephemeral wetlands are immediately adjacent (D). The southern wetland on occasions receives top-up water from the permanent ponds (A). To the east is an ephemeral wetland, again privately owned, which is wet only after heavy rain. This wetland was modified in 2008, and a channel on the southern side now exists which often contains water (E).

HWC invited Hunter Bird Observers Club (HBOC) to take part in developing the management plan and as a result, members commenced monthly surveys of the avian population in February 2001. Ten years of surveys have been completed. This paper deals only with the heron, spoonbill and ibis species. A previous paper (Lindsey & Newman 2002) reported the results of surveys in 2001, the first year of the study, and a recent paper discusses the occurrence of shorebirds during the ten-year period 2001 to 2010 (Newman & Lindsey 2011).

As will be discussed in this paper the importance of MWTW to heron, spoonbill and ibis species, collectively termed waterbirds, varies between species. Some species breed locally, but not at MWTW, one species uses the area as a night roost, others pass through on migration and many breed inland, with MWTW serving as non-breeding habitat and as a drought refuge.

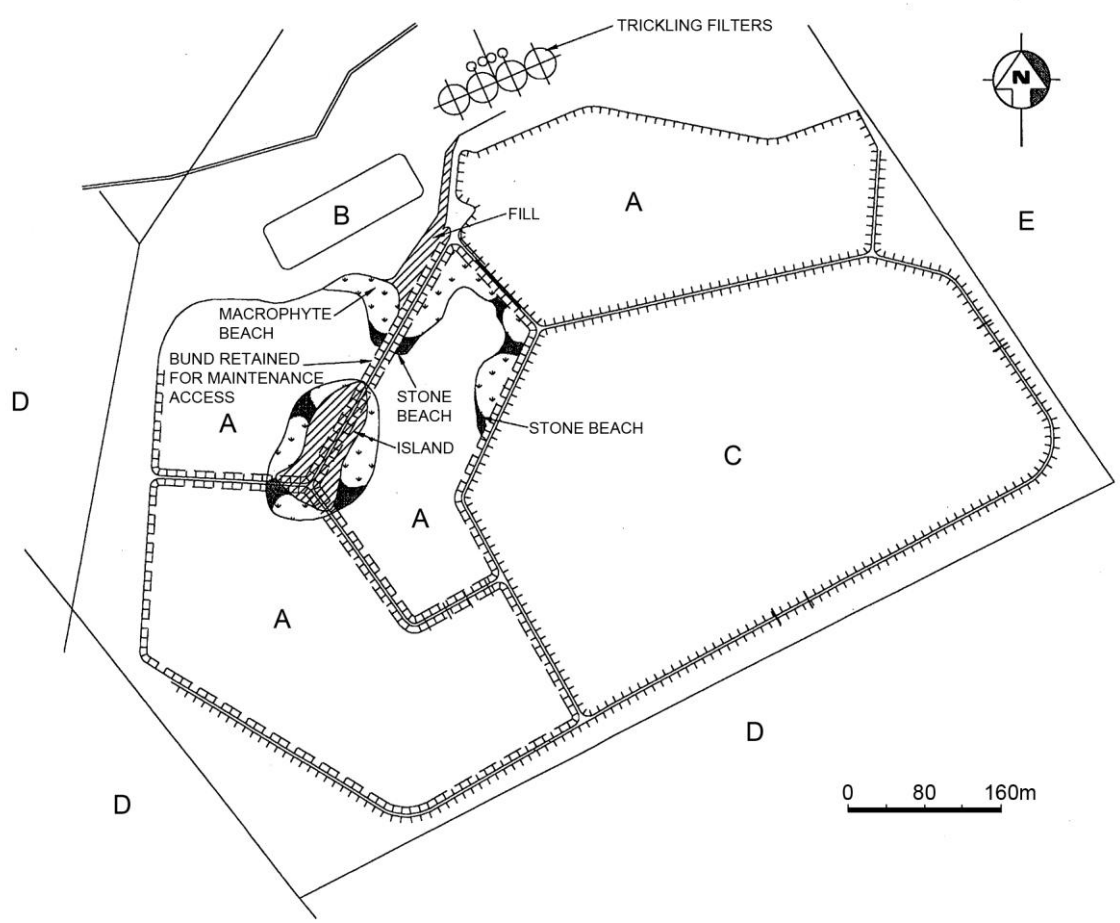

Figure 1. Morpeth Wastewater Treatment Works.
(A - Ponds with permanent water; B - Sludge pond which occasionally dries out; C - Ephemeral wetland in bunded area which intermittently floods; D & E - Privately owned ephemeral wetlands.)

METHODS

Surveys were conducted monthly commencing in February 2001. **Figure 1** provides details of the features of the area. Over a ten-year period 120 surveys were completed including two in November 2001, the second of which was carried out immediately after heavy rain, which caused flooding on area D. As will be discussed, areas B, C and D are important waterbird habitat. These are often flooded during the winter months and dry out in spring creating water meadow conditions and, during the drying-out period, muddy edges. These conditions provide ideal foraging habitat for waterbirds.

Surveys typically took three hours and involved two observers following a route around the maturation ponds, commencing between one and two hours after sunrise. All species within observable distance at all of the areas shown in **Figure 1**, including birds flying over the area, were observed using binoculars and a telescope and recorded. On occasions the flooded areas extended beyond observable distance and birds in these areas were not counted.

To minimise the risk of double counting, birds that moved between the different areas were noted and an estimate was made of the total number of the more numerous species in the MWTW area. These numbers were used as a check against the sum of the numbers of individual species counted in the separate areas.

Because there were large fluctuations in both the seasonal and annual occurrence and abundance of different species, it was difficult to identify and compare the trends. Variations in the timing of periods of both peak and abnormally low occurrence are important to understanding the fluctuations of waterbirds frequenting MWTW. Periods of high and low occurrence were defined by numbers of a species exceeding the mean numbers by 100% or being 50% or

less than the mean respectively. In the following analysis seasonal and annual trends were evaluated as variations in mean monthly (i.e. comparing monthly occurrence over ten years) and mean annual occurrence (i.e. comparing annual occurrence over ten years). Reporting rates (RR%) were used to summarise variations in the frequency of the presence of individual species. However, variations in the abundance of birds are more informative for species which are regularly present. Species abundance was calculated as mean numbers of species/survey for those surveys when the species was present (i.e. in calculating mean numbers surveys were ignored when no birds were present). For November 2001 the mean of the two surveys conducted in that month was used for the evaluation of the monthly and annual trends. The same species of waterbird were present during both the November surveys.

RESULTS

During the surveys 13 waterbird species were recorded, including eight heron, three ibis and two spoonbill species. The results are summarised in **Table 1** which shows the RR, the mean numbers recorded/survey and the maximum number observed. Monthly count statistics are contained in the Hunter Region Annual Bird Report Series (Stuart 2001 to 2010).

Abundance and Reporting Rates

Only two species were regularly present, the White-faced Heron *Egretta novaehollandiae* and Cattle Egret *Ardea ibis* with RRs of 95.8 and 90.8% respectively. They were, other than two species of ibis, the most numerous species frequenting MWTW, with mean numbers of 40.6 and 10.5 respectively.

Five species, Eastern Great Egret *Ardea modesta*, Straw-necked Ibis *Threskiornis spinicollis*, Australian White Ibis *Threskiornis molucca*, Intermediate Egret *Ardea intermedia* and Royal Spoonbill *Platalea regia* occurred frequently, with RRs in the range 50 to 80%. When present, the Straw-necked Ibis was the most numerous species with a mean flock size of 63.8 and a peak count of 620. The less numerous species tended to have lower RRs. The Eastern Great Egret was an exception, which while usually present as five or less birds, had a high RR (75.6%) and was occasionally quite numerous with a peak count of 38.

Four species, the White-necked Heron *Ardea pacifica*, Little Egret *Egretta garzetta*, Yellow-billed Spoonbill *Platalea flavipes* and Glossy Ibis *Plegadis falcinellus* were irregular visitors, with RRs in the range of 5 to 25%. With the exception of the Glossy Ibis (maximum count 23), they were always recorded in small numbers.

Two species, the Nankeen Night-Heron *Nycticorax caledonicus* and Australasian Bittern *Botaurus poiciloptilus*, were reported on a single occasion. However, while apparently vagrants to MWTW, both predominantly feed at night and are skulking, secretive species which may be under reported.

Monthly Variations

At MWTW the waterbirds primarily feed in shallow water, water meadow and pasture. Consequently, the deep water of the main MWTW ponds is of little importance to these species, which were mainly observed in the decommissioned pond C and the surrounding ephemeral wetlands D and E (**Figure 1**). These areas vary from the extreme conditions of flooded to dry. Hence, it is not surprising that the diversity and numbers of waterbirds varied considerably between surveys. However, it was also found that there were considerable differences in the timing of periods when numbers peaked, or species were absent, or scarce as summarised in **Table 2**. More detailed information on the monthly variations in waterbird numbers and reporting rates is contained in the **Appendix**, **Tables A1** and **A2**.

As indicated by **Table 2**, the fluctuations in abundance of the White-faced Heron, the most frequently observed species (RR 95.8%), were less extreme than most of the other waterbird species. However, White-faced Herons were less numerous between July and November (range 3.8 to 7.4 birds/survey) than from December to June (range 12.3 to 17.4 birds/survey). This difference was statistically significant ($U=0$; $P<0.05$, Mann-Whitney U-test). In contrast, numbers of the Cattle Egret, the other very frequently observed species, peaked between February and April and were low between June and January. Eastern Great and Intermediate Egrets also had peak numbers in March and low numbers between June and September, particularly in July. The monthly trends for the above four species are compared in **Figure 2**. Little Egret numbers appeared to show yet another trend, tending to be higher in September and lower in December and January, but this species was not present sufficiently

Table 1. Summary of waterbird occurrence at MWTW 2001 – 2010.

Species	Scientific Name	Reporting Rate (%)	Mean Number When Present	Maximum Number
Australasian Bittern	*Botaurus poiciloptilus*	0.8		1
White-necked Heron	*Ardea pacifica*	24.4	3.2	11
Eastern Great Egret	*Ardea modesta*	75.6	4.2	38
Intermediate Egret	*Ardea intermedia*	52.1	7.5	25
Cattle Egret	*Ardea ibis*	90.8	40.6	378
White-faced Heron	*Egretta novaehollandiae*	95.8	10.5	56
Little Egret	*Egretta garzetta*	19.3	2.0	6
Nankeen Night-Heron	*Nycticorax caledonicus*	0.8		2
Glossy Ibis	*Plegadis falcinellus*	8.4	6.2	23
Australian White Ibis	*Threskiornis molucca*	62.2	12.7	107
Straw-necked Ibis	*Threskiornis spinicollis*	66.4	63.8	620
Royal Spoonbill	*Platalea regia*	51.3	3.4	31
Yellow-billed Spoonbill	*Platalea flavipes*	12.6	2	5

Table 2. Monthly variations in waterbird numbers at MWTW between 2001 and 2010.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White-necked Heron	Low[1]	Low	Low				Low				High[2]	Low
Eastern Great Egret			High			Low	Low		Low			
Intermediate Egret			High				Low			Low		
Cattle Egret	Low	High	High	High		Low	Low	Low	Low	Low	Low	Low
White-faced Heron								Low				
Little Egret	Low								High			Low
Glossy Ibis	High											High
Australian White Ibis			High					Low				
Straw-necked Ibis	Low								High	Low	Low	Low
Royal Spoonbill						Low	Low		Low		High	

[1] Months in which mean numbers were abnormally low, being equal to or less than 50% of the mean for all months.
[2] Months in which mean numbers were abnormally high, being equal to or more than double the mean for all months.

Table 3. Years in which either abnormally high or low numbers were experienced.

Species	2001	2002	2003	2004	2004	2005	2006	2007	2008	2009	2010
White-necked Heron	Low[1]		High[2]	Low	Low			High		Low	Low
Eastern Great Egret	Low	Low							High	Low	Low
Intermediate Egret			Low					Low		High	Low
Cattle Egret	Low										
White-faced Heron											
Little Egret		Low	Low						High		
Glossy Ibis	Low	Low	Low				High	High		Low	Low
Australian White Ibis			Low								
Straw-necked Ibis	High	Low	Low	Low		High		Low			Low
Royal Spoonbill	Low	Low							High	Low	Low
Yellow-billed Spoonbill						Low		High		Low	Low

[1] Years in which mean annual numbers were abnormally low, being equal to or less than 50% of the ten-year mean.
[2] Years in which mean annual numbers were abnormally high being equal to or more than double the ten-year mean.

frequently for any conclusion to be reached concerning the significance of this trend. The occurrence of the White-necked Heron was irregular and no seasonal trend was apparent, other than it was extremely scarce between December and March, with just three records involving a single bird.

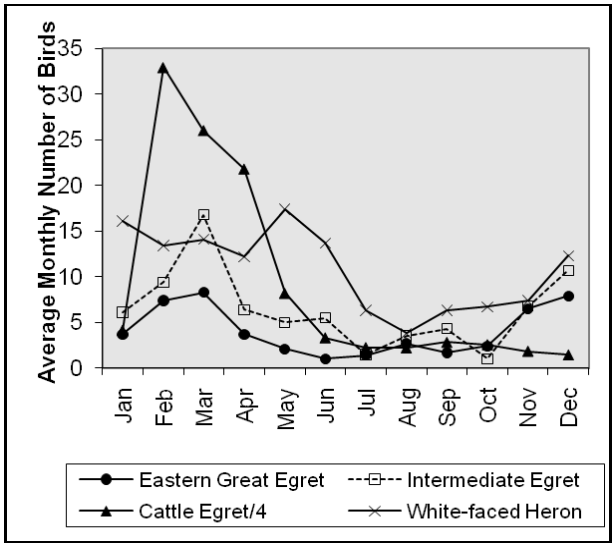

Figure 2. Monthly variations in the numbers of White-faced Heron and three species of egret at MWTW between 2001 and 2010 (Cattle Egret numbers divided by 4).

Variations in Australian White Ibis numbers were generally similar to those of the White-faced Heron. Mean monthly numbers were lower between June and November (range 1.8 to 10.7 birds/survey) than between December and May (range 10.2 to 19.3 birds/survey), which was statistically significant ($U=1$; $P<0.05$, Mann Whitney U-test), with abnormally low and high numbers in August and March respectively. In contrast Straw-necked Ibis numbers were high between February and September, when they peaked, and low between October and January, being exceptionally scarce in November. Glossy Ibis primarily occurred in December and January, but occurrences were insufficient for any clear trend to be established.

Royal Spoonbills tended to be less frequently observed and less numerous between June and September with numbers peaking in November.

The remaining three species, the Australasian Bittern, Nankeen Night-Heron and Yellow-billed Spoonbill were either vagrant, or observed too infrequently for any trend to be established.

Annual Variations

Years in which species were either exceptionally numerous or sparse are shown in **Table 3,** based on numbers being either more than double, or less than half the ten-year monthly mean. The years in which peak numbers occurred varied considerably between species. However, many species were either present in low numbers, or absent during the initial (2001, 2002 and 2003) and final years of the study (2009 and 2010) as indicated in **Figure 3**, which shows the cumulative number of waterbirds recorded annually (i.e. the monthly counts for all species have been combined). Waterbird abundance peaked between 2004 and 2008. Waterbird species diversity, as indicated by the cumulative annual number of all waterbird species recorded monthly (see Species Diversity Index in **Figure 3**; e.g. a species recorded in five months of the year has an annual score of 5) showed a similar trend to that of waterbird abundance (**Figure 3**), except that diversity was low in 2006 and 2007. 2010 was the year in which both waterbird abundance and diversity were lowest, although the ephemeral wetlands, which are an important area of MWTW to most of the waterbird species, were flooded for much of the year.

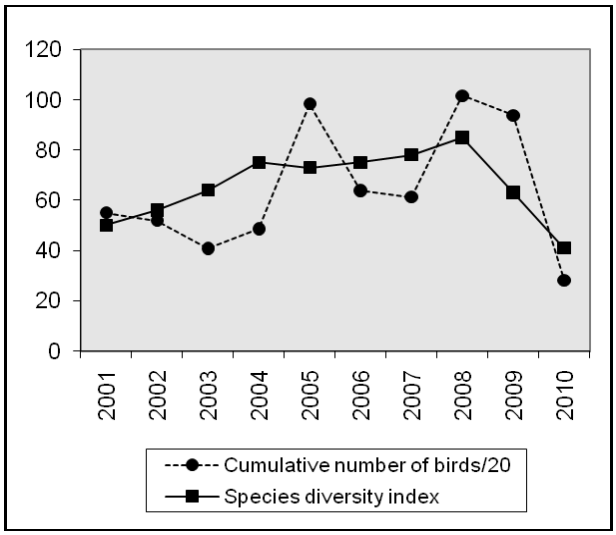

Figure 3. Variations in cumulative annual numbers and annual diversity of waterbirds.

Variation in the White-faced Heron and Cattle Egret numbers, the two species most frequently present, were less extreme than for the other species with no peak in which annual numbers were double the mean monthly annual number. However, Cattle Egrets were abnormally scarce in 2001, being 46% of the annual monthly mean.

There was a strong correspondence between the occurrence and trends in numbers of Eastern Great Egret and Royal Spoonbill (**Figure 4**), which is in marked contrast to the differences between the timing of extreme fluctuations in annual occurrence of the other species. Interestingly the trends for these two species resemble those for overall waterbird diversity in **Figure 3**.

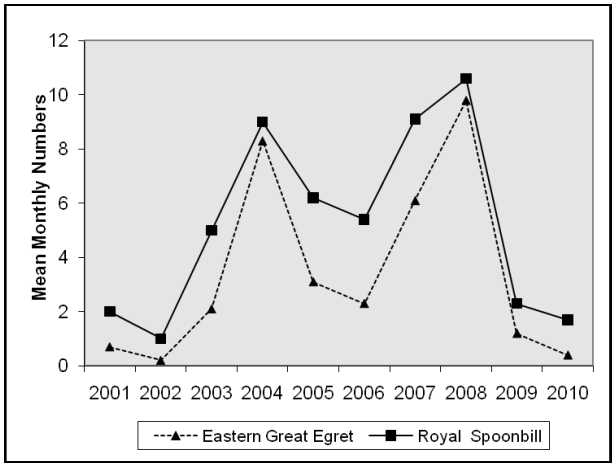

Figure 4. Correspondence of variations in the annual mean monthly numbers of the Eastern Great Egret and Royal Spoonbill.

More detailed information on the annual variations in waterbird numbers and reporting rates is contained in the **Appendix, Tables A3** and **A4**. There was no obvious evidence of continuous long-term decline in the numbers of any species.

DISCUSSION

A number of factors influence the frequency and abundance of the waterbirds occurring at MWTW including:

- whether species breed locally;
- the proximity of breeding colonies to MWTW;
- the suitability of foraging conditions at MWTW;
- whether species breed inland and move to the coastal region after breeding; and
- use of the Hunter Region as a drought refuge.

The approach taken in this paper of evaluating the fluctuations in waterbird occurrence and abundance against independent monthly and annual variables fails to fully represent the complexity of the observed variations. However, the simplified approach adopted provides valuable insights and the following discussion is limited accordingly.

The Cattle, Eastern Great, Intermediate and Little Egrets all nest colonially, breeding between October and January in the Hunter Region. All four species breed at the Hunter Wetlands Centre and until 2009 there was a large breeding colony of Cattle Egret at Seaham Swamp. It is anticipated that birds from these colonies, which are approximately 18 and 13 km from MWTW respectively, frequent MWTW. None of these species breeds at MWTW. Increased numbers of Eastern Great and Intermediate Egrets occurred between November and April (**Figure 2**), the period during and immediately after the breeding season. In contrast, numbers of Cattle and Little Egret peaked between February and April, after the breeding season. This suggests that the foraging ranges of the Eastern Great and Intermediate Egrets around the breeding colonies are greater than for the Cattle and Little Egrets. Numbers of all four species were low in winter consistent with the dispersal of birds away from the breeding colonies. Sightings of flagged birds have demonstrated extensive southward migration (McKilligan 2005). The peak numbers of Cattle Egret in autumn may include birds from colonies north of the Hunter Region migrating south (Max Maddock pers. comm.).

The above four species are further differentiated by the nature of their use of the area. The Cattle Egret, the most numerous species, forages at the water's edge, but more often well away from the water, usually in association with cattle which graze both within the MWTW complex and in the surrounding ephemeral wetlands. Cattle Egret often congregated on the banks of the ponds, either when loafing, or as a prelude to feeding. As indicated previously, at least at the end of the study in 2010, Cattle Egret used MWTW as a night roost. In contrast the Eastern Great and Intermediate Egrets tended to forage in shallow water, while the Little Egret had a tendency to feed actively in shallow water pools and at the overflow weir from the ponds. The preference of these species for foraging in shallow water makes MWTW unsuitable when the ephemeral wetlands dry out and their occurrence in late summer is more erratic than for the Cattle Egret, which is not similarly constrained. These differences are consistent with the comparative foraging behaviour described by McKilligan (2005).

Eastern Great Egrets usually feed alone, but sometimes in association with Royal Spoonbills

and White-faced Herons (McKilligan 2005), associations which have been noted at MWTW. The correspondence between the annual trends in abundance of the Eastern Great Egret and Royal Spoonbill is consistent with these species having similar foraging requirements. However, the higher RR of the Eastern Great Egret (75.6%) compared with the Royal Spoonbill (51.3%) reflects its greater foraging flexibility, such as its ability to feed away from water.

White-faced Herons usually build a solitary nest, sometimes well away from water, but occasionally breed at heronries (McKilligan 2005). White-faced Heron start breeding in July, earlier than the egret species. White-faced Heron numbers between December and June were approximately double those between July and November, the main breeding season. Superficially, this variation in abundance suggests that some breeding pairs move to MWTW outside the breeding season, but that there is also a non-breeding population present throughout the year. Although relatively long-legged, the White-faced Heron predominantly feeds in shallow water and in wet paddocks away from the water. Consequently, like the Cattle Egret, it is less impacted by the drying out of the ephemeral wetlands, hence its high reporting rate (90.8%). This species may also benefit from the presence of cattle which graze both within the MWTW site and on the adjacent ephemeral wetlands.

The three species of ibis differed in their monthly occurrence. The most numerous species, Straw-necked Ibis, predominantly occurred between February and September, foraging in the adjacent ephemeral wetlands, particularly when there were water meadow conditions. This species does not breed in the Hunter Region and most birds left during summer. Australian White Ibis numbers peaked between March and May and were very low between July and November. The Australian White Ibis breeds at the Hunter Wetlands Centre during the period when numbers are low at MWTW suggesting that the foraging range of breeding birds is restricted. Glossy Ibis, which do not breed in the Hunter Region, visited almost exclusively during the summer between December and February, foraging in shallow water in areas C and D as they were drying out.

Royal Spoonbills, a locally-breeding species, were recorded occasionally throughout the year, but more regularly recorded during November and December, when peak numbers occurred. Royal Spoonbills feed in shallow water as discussed previously. Dependent young have been observed at MWTW in March and it is possible that the peak occurrence in the preceding months reflects the presence of a breeding colony within foraging range.

An Australasian Bittern was flushed from an extensive bed of dense dead weed in area C (**Figure 1**) during the May 2004 survey. The weeds grow prolifically during summer and die off during autumn.

Waterbird abundance and diversity both increased during the middle of this study between 2004 and 2008. This increase is attributed to a period of prolonged drought in inland Australia and perhaps more importantly in areas of NSW such as the Macquarie Marshes and Gwydir Wetlands where many waterbirds breed. Straw-necked Ibis would be affected by the drought, using the Hunter Region wetlands including MWTW as a drought refuge. When present the Straw-necked Ibis is often the most numerous waterbird in the Hunter Region, congregating at large nocturnal roosts. Trends in the numbers recorded at MWTW can be skewed by large numbers dispersing from the nearest roost, which is approximately 10 km away at Irrawang Swamp. The Glossy Ibis, another inland-breeding species, was only recorded during the drought period.

The La Nina conditions of 2010 resulted in the lowest waterbird abundance and diversity at MWTW over the ten-year period (**Figure 3**). The absence of the Intermediate Egret throughout most of 2010 and the minimum numbers or absence of White-necked Heron, Glossy Ibis, Straw-necked Ibis and Yellow-billed Spoonbill suggest that all of these species predominantly use the Hunter Region as a drought refuge.

CONCLUSIONS

The MWTW and surrounding areas provide important foraging habitat for waterbird species. Seven species including four heron, two ibis and one spoonbill species were regular visitors with RRs ranging from 51.3 to 95.8%. A further six species occurred infrequently and in two instances were vagrants recorded on a single occasion.

Waterbirds predominantly fed in shallow water or flooded pasture land and were mainly observed in the decommissioned pond C and the ephemeral wetlands adjacent to the MWTW site when flooded. The two most frequently recorded species,

the White-faced Heron and the Cattle Egret are less dependent on wet conditions for feeding, and are able to forage in the pastures when the flooded areas have dried out.

The numbers and diversity of waterbird species present at MWTW fluctuated widely, both on a monthly and annual basis. These variations are attributed to a combination of factors, including whether species breed locally or inland, the extent to which the study area was flooded providing waterbird foraging habitat and whether inland NSW was experiencing drought conditions. For most species this combination of factors resulted in differences in the monthly and annual patterns of occurrence at MWTW. However, there were similarities in the patterns of occurrence of the Eastern Great Egret and the Royal Spoonbill, species which often forage together.

ACKNOWLEDGEMENTS

We are grateful to Hunter Water Corporation for encouraging us to undertake these surveys and allowing access to MWTW. The enthusiastic support and cooperation we have received from site manager, Shaun Clewes, and his team at MWTW has been outstanding and is deeply appreciated.

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APPENDIX

Table A1. Monthly variations in waterbird mean numbers/survey when present.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White-necked Heron	1.0	1.0	0.0	2.3	2.0	4.3	1.0	1.7	2.7	3.5	10.0	1.0
Eastern Great Egret	3.7	7.4	8.3	3.7	2.1	1.0	1.4	2.7	1.7	2.4	6.5	7.9
Intermediate Egret	6.1	9.4	16.8	6.4	5.0	5.5	1.5	3.5	4.3	1.0	6.8	10.7
Cattle Egret	16.6	131.8	104.2	87.3	32.8	13.3	9.0	8.9	11.3	10.3	7.4	5.8
White-faced Heron	16.1	13.4	14.1	12.2	17.4	13.7	6.3	3.8	6.3	6.7	7.4	12.3
Little Egret	1.0	1.5	2.3	2.7	1.3	1.0	2.0	2.0	6.0	1.5	2.0	1.0
Glossy Ibis	12.0	5.0	0.0	0.0	4.5	0.0	1.0	0.0	0.0	0.0	1.0	11.0
Australian White Ibis	10.2	13.9	25.8	13.6	19.3	6.2	10.7	1.8	6.5	9.0	3.6	17.1
Straw-necked Ibis	28.0	54.3	107.7	83.4	114.8	47.2	41.7	35.9	197.5	16.0	3.0	10.9
Royal Spoonbill	6.8	8.3	3.9	10.8	3.7	3.2	2.3	5.7	3.0	4.2	14.1	10.9
Yellow-billed Spoonbill	1.0	3.0	1.0	5.0	1.0	1.0	0.0	1.0	0.0	0.0	1.3	1.0

Table A2. Monthly variations in waterbird Reporting Rates (%).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White-necked Heron	11	10	0	40	40	30	20	30	30	40	30	10
Eastern Great Egret	70	80	70	90	70	60	80	70	60	90	60	100
Intermediate Egret	80	70	80	80	50	20	20	20	40	50	50	60
Cattle Egret	80	100	100	100	100	80	60	90	100	80	70	80
White-faced Heron	80	100	100	100	100	90	100	90	90	100	90	100
Little Egret	10	20	30	30	30	20	10	20	10	20	20	10
Glossy Ibis	10	10	0	0	20	0	10	0	0	0	20	30
Australian White Ibis	60	70	90	100	70	90	30	60	20	30	50	70
Straw-necked Ibis	40	80	70	90	90	90	70	80	40	50	20	70
Royal Spoonbill	50	30	80	40	60	50	30	30	40	60	70	70
Yellow-billed Spoonbill	10	10	10	10	20	20	0	30	0	0	30	10

Table A3. Annual variations in mean numbers/survey when present.

Year	Royal Spoon-bill	Yellow-billed Spoon-bill	Eastern Great Egret	Inter-mediate Egret	Cattle Egret	Little Egret	White-faced Heron	White-necked Heron	Glossy Ibis	Aust-ralian White Ibis	Straw-necked Ibis
2001	2.0	1.0	0.7	7.5	19.9	1.0	6.9	1.0	0.0	16.6	177.0
2002	1.0	1.0	0.2	10.7	70.9	0.0	7.4	1.5	0.0	8.6	17.6
2003	5.0	1.3	2.1	3.7	26.8	0.0	17.1	7.0	0.0	5.3	20.9
2004	9.0	2.0	8.3	6.9	42.2	1.0	8.7	1.0	2.3	7.9	10.6
2005	6.2	0.0	3.1	7.1	26.5	1.0	14.5	1.2	5.0	14.7	153.6
2006	5.4	1.0	2.3	7.3	25.5	1.0	12.6	3.3	23.0	8.4	49.8
2007	9.1	3.0	6.1	2.7	35.7	1.0	15.9	6.0	9.5	8.0	32.9
2008	10.6	1.0	9.8	8.8	56.3	2.8	8.2	3.0	2.7	20.2	109.4
2009	2.3	0.0	1.2	24.3	68.2	1.9	7.6	1.0	0.0	25.2	116.0
2010	1.7	0.0	0.4	3.0	41.3	1.0	8.3	0.0	0.0	15.7	12.0

Table A4. Annual variations in waterbird Reporting Rates (%).

Year	Royal Spoon-bill	Yellow-billed Spoon-bill	Eastern Great Egret	Inter-mediate Egret	Cattle Egret	Little Egret	White-faced Heron	White-necked Heron	Glossy Ibis	Aust-ralian White Ibis	Straw-necked Ibis
2001	36.4	16.7	66.7	50.0	75.0	8.3	83.3	16.7	0.0	41.7	33.3
2002	16.7	25.0	66.7	25.0	83.3	0.0	83.3	33.3	0.0	66.7	66.7
2003	41.7	25.0	75.0	50.0	100.0	0.0	100.0	16.7	0.0	58.3	66.7
2004	91.7	16.7	75.0	66.7	91.7	8.3	100.0	8.3	25.0	58.3	83.3
2005	50.0	0.0	91.7	83.3	91.7	8.3	91.7	41.7	8.3	75.0	66.7
2006	41.7	16.7	50.0	66.7	100.0	8.3	100.0	58.3	8.3	75.0	100.0
2007	66.7	16.7	83.3	58.3	91.7	8.3	100.0	50.0	16.7	66.7	91.7
2008	91.7	8.3	91.7	83.3	91.7	66.7	100.0	8.3	25.0	83.3	58.3
2009	50.0	0.0	83.3	25.0	75.0	75.0	100.0	8.3	0.0	41.7	66.7
2010	25.0	0.0	66.7	8.3	66.7	8.3	91.7	0.0	0.0	50.0	25.0