Raptor observations at Morpeth Wastewater Treatment Works (2001-2015)

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Morpeth Wastewater Treatment Works (MWTW) and surrounding ephemeral flood plain provide excellent habitat for a range of raptor species. 16 species were detected during 178 morning surveys conducted at monthly intervals between 2001 and 2015. Although some of these species were recorded frequently, few appear to breed within the immediate vicinity of MWTW, and most observations involved single birds or pairs. The frequency of raptor observations dropped significantly during the 15-year study, suggesting a decrease in local abundance, but the diversity of species recorded remained constant. It is suggested that the apparent decrease in abundance primarily involved frequently observed species such as Whistling Kite *Haliastur sphenurus*, White-bellied Sea-Eagle *Haliaeetus leucogaster* and Swamp Harrier *Circus approximans*.

Temporal analysis suggested that Whistling Kite and Nankeen Kestrel *Falco cenchroides* decreased and similar trends were apparent when BirdLife Australia's Birdata area surveys for the Hunter Region were compared. Trends for other species were more complex, but in general there was good correspondence between the MWTW and Hunter Region trends. This highlights the potential for long-term survey sets conducted in a standardised manner to be used in monitoring raptor populations. In this case the survey program was primarily designed to estimate waterfowl and shorebird populations using the wetlands at and in the vicinity of MWTW.

Between 2001 and 2015 the volume of water processed at MWTW increased, resulting in more extensive and persistent flooding of adjacent ephemeral wetlands. Any positive impact for raptors from this change may ultimately be offset by the rapid encroachment of urban development at the perimeters of the flood plain.

The Black Falcon *Falco subniger*, an inland species generally rare in the Hunter Region, was regularly observed between 2004 and 2008, with circumstantial evidence of breeding, which is unprecedented close to the NSW coast.

INTRODUCTION

Morpeth Wastewater Treatment Works (MWTW) owned by the Hunter Water Corporation (HWC) ($32^0$44'31"S, $151^0$37'24"E) is located about 10 km north-east of Maitland in NSW, approximately 1km from the Hunter River. MWTW 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 operation constitutes 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). In addition to providing habitat for wetland birds the MWTW regularly attracts raptor species, which are the subject of this paper.

A previous paper (Lindsey & Newman 2002) described the survey methods. Subsequent papers have provided an analysis of the occurrence of the herons, spoonbills and ibis (Newman & Lindsey 2011a) and shorebirds (Newman & Lindsey 2011b) during the first ten years of the study.

METHODS & ANALYSIS

Surveys were conducted monthly between February 2001 and December 2015, usually involving two observers. Surveys commenced about 1 hour after sunrise and lasted three to four hours, thus sampling a

range of temperature and wind conditions. Observations were made from or in the vicinity of a car.

MWTW comprises a large area of ponds separated by dykes. The surrounding area is predominantly open farmland, which is intermittently flooded. During this study the volume of wastewater treated increased, resulting in more extensive and persistent flooding of ephemeral wetlands on adjacent farmland. **Figure 1** shows MWTW and surrounding wetlands. There is relatively little woodland. The open conditions were ideal for viewing raptors over distances which were sufficiently large to overcome any bias caused by the presence of observers. However, the periodic presence of raptors disrupted the waterfowl and shorebird populations and was detrimental to estimating their numbers, which was the primary purpose of the surveys.

Figure 1. Morpeth Wastewater Treatment Works shown from the entrance to the treatment plant looking down over the decommissioned maturation ponds in the foreground. The adjacent flooded farmland with a belt of trees is shown in the middle ground, with newly constructed suburban dwellings on the far slope. The photograph was taken under flood conditions in January 2016.

Annual and seasonal occurrences were compared as reporting rates (RR), the frequency of occurrence expressed as a percentage.

Variations in annual RR at Morpeth were compared with those for the entire Hunter Region using area survey data from BirdLife Australia's (BLA) Birdata archive. In making this comparison there is a trade-off between the routine survey style, but small sample size of the Morpeth data and the large sample size, but non-standard effort in BLA Birdata surveys. The significance of the trends discussed below was tested at the $p = 0.05$ level assuming linear correlation. The Hunter Region trends tended to have a higher level of statistical significance, consistent with their larger sample size compared with MWTW.

The MWTW surveys are part of the Hunter Region Birdata set evaluated in 2015 for the period 1998-2014 to provide statistics for the Hunter Region Annual Bird Report (Stuart 2015). Using the results of the existing evaluation is convenient, but may have limitations. For instance, inclusion of the more structured Morpeth results (constant survey effort spread evenly throughout the year) may influence the trends observed elsewhere in the Hunter Region. However, as indicated during the presentation and discussion of results in the following sections the size of the MWTW data set relative to the number of area surveys throughout the Hunter Region is small. Hence, the contribution of the MWTW data has little influence on the Hunter Region's annual RRs and their trends, particularly for the frequently observed and widely distributed raptor species. Consequently, we did not consider the complex re-evaluation of the Hunter Region data needed to exclude the MWTW surveys was justified. Indeed, it can be argued they should not be removed as the MWTW surveys are an important part of the unstructured area survey data set, which is the basis of our knowledge of the current status of the Hunter Region's raptors.

The situation is more complicated for the uncommon raptor species because Hunter Region RRs were calculated using area survey data only from the known range of each species for the period 1998-2014 and ignoring survey effort in other areas of the Hunter Region. Calculation in this manner exaggerates the frequency of occurrence of uncommon species relative to common raptor species, which has implications for the interpretation of results in the following sections.

RESULTS

Over the 15-year period 16 raptor species were seen (**Table 1**), mostly as single birds and only in two species were more than three individuals present. Three species, White-bellied Sea-Eagle *Haliaeetus leucogaster*, Whistling Kite *Haliastur sphenurus* and Swamp Harrier *Circus approximans* were seen regularly, with RRs exceeding 48%, more than twice the next most frequently seen species, Nankeen Kestrel *Falco cenchroides* (RR 22.5%). All five falcon species that regularly occur in the Hunter Region were intermittently present, each occurring in nine or more different years. The White-bellied Sea-Eagle, Australian Hobby *Falco longipennis* and Black Falcon *Falco subniger* were suspected to have bred locally (Newman & Lindsey 2007). The Black-shouldered Kite *Elanus axillaris* was the only other species which occurs regularly, being present during 12 years at an RR of 16.3%. The remaining six species, Square-tailed Kite *Lophoictinia isura*, Black Kite *Milvus migrans*, the three *Accipiter* species and Spotted Harrier *Circus assimilis* were infrequent visitors, being seen in four or less years.

Two measures were used to assess whether the occurrence of raptors as a group had changed over the 15-year period. The number of raptor species

Table 1. Summary of raptor sightings at Morpeth Wastewater Treatment Works during 178 monthly surveys between February 2001 and December 2015.

Raptor species		**Reporting Rate (%)**	**Years seen**	**Maximum number**	**Average number***
Black-shouldered Kite	*Elanus axillaris*	16.3	12	2	1.2
Square-tailed Kite	*Lophoictinia isura*	1.1	2	1	1
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	49.4	15	3	1.4
Whistling Kite	*Haliastur sphenurus*	73.0	15	9	1.6
Black Kite	*Milvus migrans*	3.4	2	1	1
Brown Goshawk	*Accipiter fasciatus*	2.8	2	1	1
Collared Sparrowhawk	*Accipiter cirrocephalus*	1.1	1	1	1
Grey Goshawk	*Accipiter novaehollandiae*	0.6	1	1	1
Spotted Harrier	*Circus assimilis*	0.6	1	1	1
Swamp Harrier	*Circus approximans*	48.9	15	3	1.3
Wedge-tailed Eagle	*Aquila audax*	2.8	4	2	1.6
Nankeen Kestrel	*Falco cenchroides*	22.5	14	3	1.2
Brown Falcon	*Falco berigora*	11.8	13	2	1.1
Australian Hobby	*Falco longipennis*	14.0	13	2	1.1
Black Falcon	*Falco subniger*	12.4	9	4	1.8
Peregrine Falcon	*Falco peregrinus*	9.6	11	1	1

*Average number recorded when present.

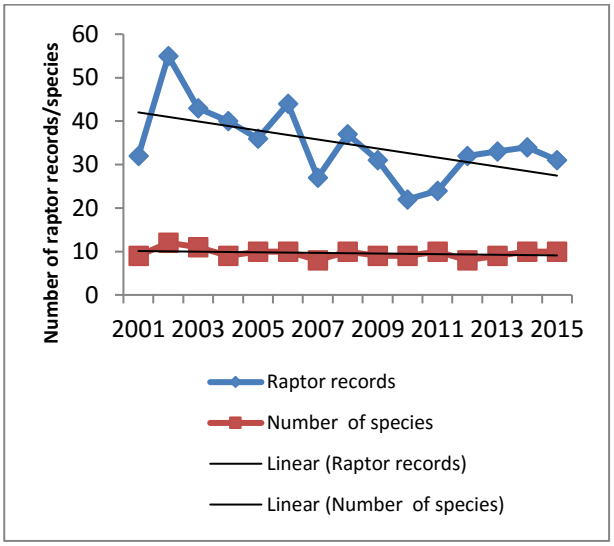

Figure 2. Variation in the annual occurrence of raptors during monthly surveys at MWTW between 2001 and 2015. Raptor records are the number of occasions raptors were present during monthly surveys (i.e. one species may be seen up to 12 times during the year if present during every monthly survey).

recorded during the year was used as an index of diversity. This measure showed little variation between years (**Figure 2**), with a range of 8 to 12 and an average of 9.6 species/annum. The total number of raptor records during the monthly surveys was used as a measure of raptor abundance. In this case the linear trend indicated a statistically significantly decrease (p <0.01) of approximately one third had occurred (**Figure 2**). In the expectation that the cause of this decrease was dominated by changes involving the three most frequently recorded species, variations in their annual RRs were evaluated.

As anticipated there was a statistically significant (p <0.01) decrease in the RR of the Whistling Kite, the most frequently observed raptor at MWTW (**Figure 3**). For comparison purposes variation in RR for the Whistling Kite in Hunter Region area surveys is shown in **Figure 3.** The linear trend line is statistically significant at the p <0.05 level.

The trends of the White-bellied Sea-Eagle and Swamp Harrier are shown in **Figures 4** and **5** respectively. The modest statistically significant (p <0.05) increase in the occurrence of the White-bellied Sea-Eagle at Morpeth was in contrast to the slight decrease in the Hunter Region, which was not significant. In contrast there was a slight decline in the occurrence of the Swamp Harrier at Morpeth, whereas it appeared to increase slightly in the Region, neither of these trends being statistically significant.

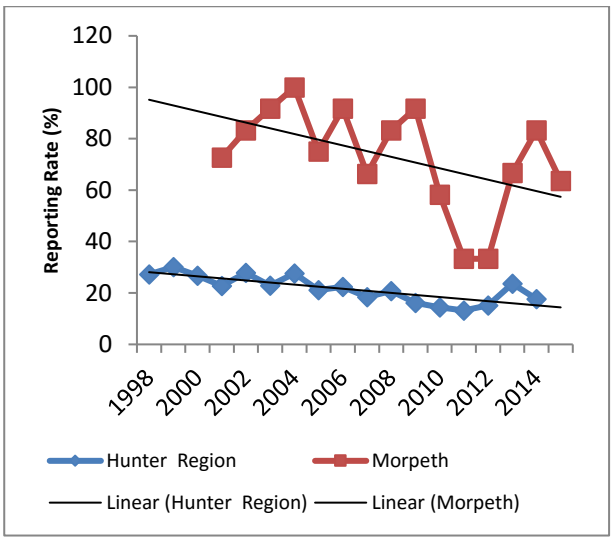

Figure 3. Annual occurrence of Whistling Kite at MWTW during monthly surveys compared with reporting rates for Birdata area surveys in the Hunter Region. The Whistling Kite observations at MWTW contributed 6.4% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from to 18.4 to 19.6%.

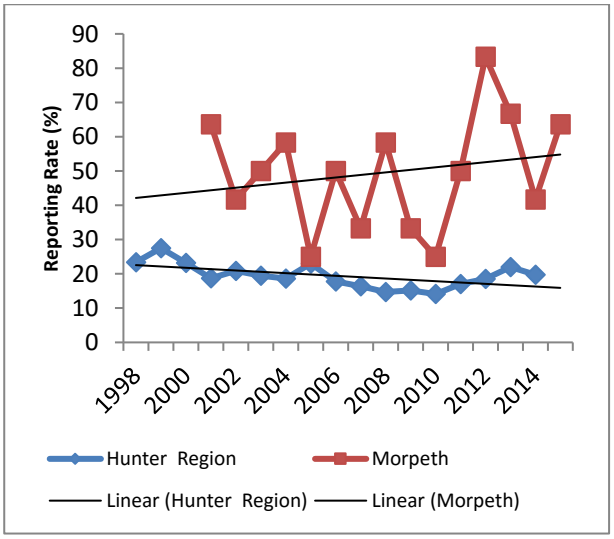

Figure 4. Annual occurrence of White-bellied Sea-Eagle at MWTW during monthly surveys compared with reporting rates for Birdata area surveys in the Hunter Region. The White-bellied Sea-Eagle observations at MWTW contributed 4.4% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from 17.8 to 18.4%.

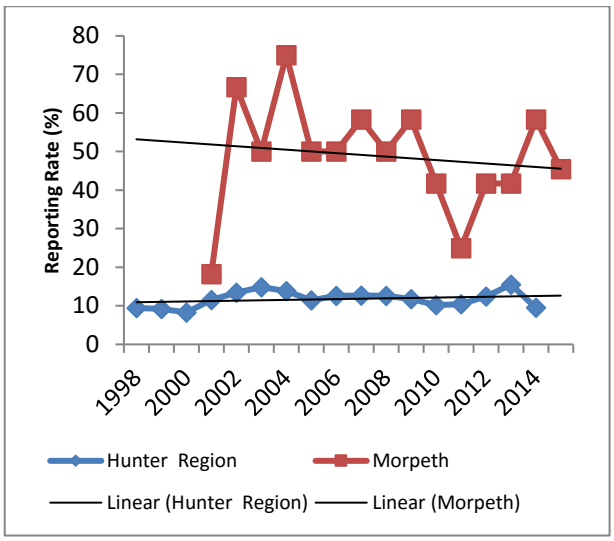

Figure 5. Annual occurrence of Swamp Harrier at MWTW during monthly surveys compared with reporting rates for Birdata area surveys in the Hunter Region. The Swamp Harrier observations at MWTW contributed 7.4% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from 11.9 to 12.6%.

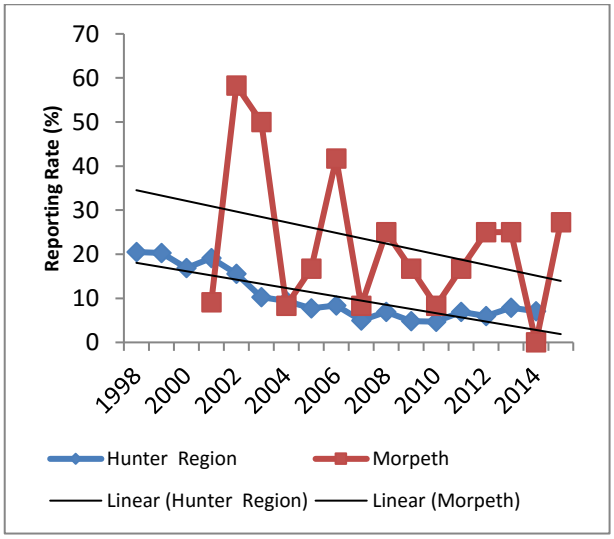

Figure 6. Annual occurrence of Nankeen Kestrel at MWTW during monthly surveys compared with reporting rates Birdata area surveys for the Hunter Region. The Nankeen Kestrel observations at MWTW contributed 3.9% of the Hunter Region records for the period 2001-2014 increasing the RR for that period from 8.4 to 8.6%.

Comparisons of the MWTW and Hunter Region RR trends for the Nankeen Kestrel are shown in **Figure 6**. Both trends indicate a decrease, the Hunter Region trend being statistically significant (p <0.05). The variation in the occurrence of the Black-shouldered Kite at MWTW (**Figure 7**) was more complex, being frequently recorded during the initial two years of the study, then becoming uncommon, with a slight recovery towards the end.

The Hunter Region trend also had a curvilinear appearance, with RRs at decreased levels between 2004 and 2011.

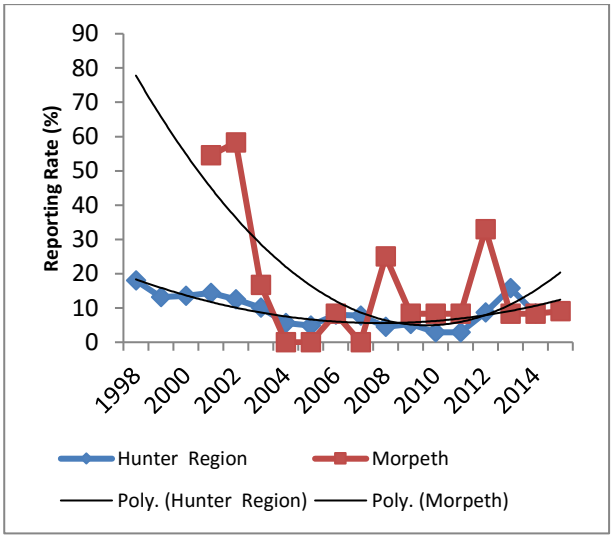

Figure 7. Annual occurrence of Black-shouldered Kite at MWTW during monthly surveys compared with reporting rates for Birdata area surveys for the Hunter Region. The Black-shouldered Kite observations at MWTW contributed 3.2% of the Hunter Region records for the period 2001-2014, increasing the RR for that period from 8.3 to 8.4%.

Black Falcon RRs peaked at MWTW between 2004 and 2008 (**Figure 8**). It was frequently recorded in 2005 and 2006, when there was evidence of local breeding involving the feeding of dependent young at MWTW (Newman & Lindsey 2007). There were insufficient Birdata area survey records to provide a Hunter Region trend for comparison.

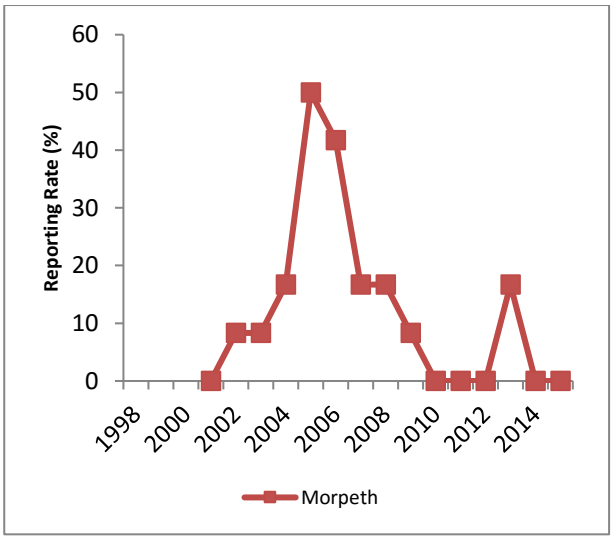

Figure 8. Annual occurrence of Black Falcon at MWTW during monthly surveys.

Collectively the seasonal occurrence of raptors (raptor records) was constant, except for a decrease between August and October (**Figure 9**). There was only minor seasonal variation in diversity with on average 10 species observed each month and a range of 8 to 12 (**Figure 9**).

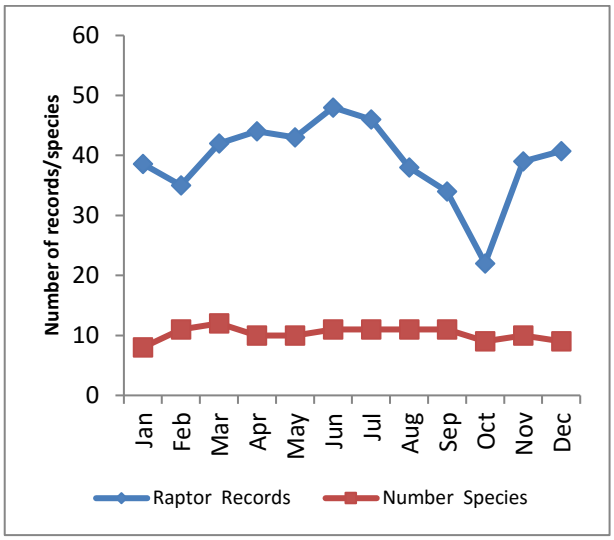

Figure 9. Variation in the seasonal occurrence of raptors during monthly surveys at MWTW between 2001 and 2015. Raptor records are the number of occasions raptors were present during monthly surveys (i.e. one species may be seen up to 15 times during the study). Number of species is the number of species present during at least one survey during the month.

The seasonal occurrence of the Whistling Kite, Swamp Harrier and White-bellied Sea-Eagle are compared in **Figure 10**. The Swamp Harrier showed the most seasonal variation, being more frequently observed between January and August. There was little seasonal variation in the presence of the other two species, apart from the abnormally low occurrence of the White-bellied Sea-Eagle in October.

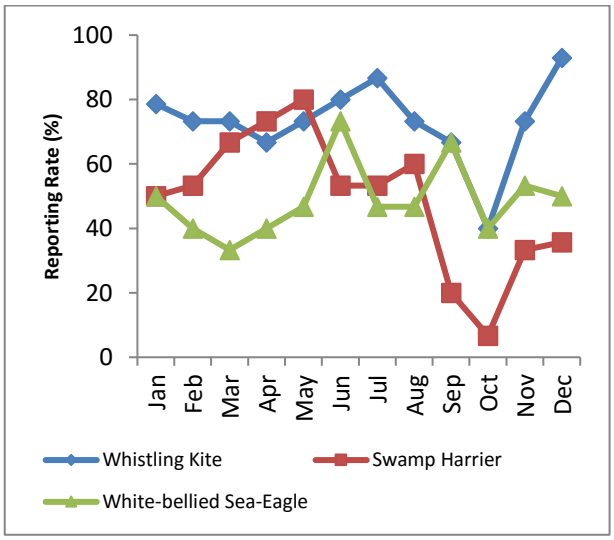

Figure 10. Seasonal occurrence of Whistling Kite, Swamp Harrier and White-bellied Sea-Eagle at MWTW during monthly surveys between 2001 and 2015.

There were similarities in the seasonal occurrence of the Nankeen Kestrel, Black-shouldered Kite and Black Falcon (**Figure 11**). This involved a complex pattern in which there was increased occurrence during the periods April to July and to a lesser extent from November to January and a marked absence between August and October.

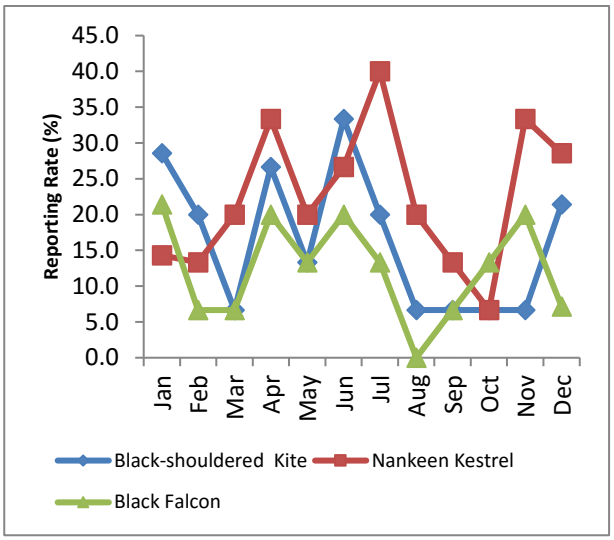

Figure 11. Seasonal occurrence of Black-shouldered Kite, Nankeen Kestrel and Black Falcon at MWTW during monthly surveys between 2001 and 2015.

DISCUSSION

Sixteen of the 21 raptor species which have been recorded in the Hunter Region (Stuart 2015) were recorded during this study, illustrating the importance of MWTW and surrounds to birds of prey. Eleven raptors had RRs which were higher than for the Hunter Region over the corresponding period. To illustrate this point we constructed **Figure 12**, which ranks the raptor species according to their RR ratio (MWTW/Hunter Region).

In attempting to understand the differences in RR ratios it is important to appreciate that the survey effort at MWTW is thought to be higher and more evenly spread throughout the year than for the BLA area surveys where the survey effort is unknown. For discussion purposes we arbitrarily suggest that the survey effort at MWTW may have been two to three times that for the average Birdata area survey. On this basis five species with ratios in the range 1.9 to 2.8 were being seen at approximately the same frequency as elsewhere in the Hunter Region, and six species with ratios greater than 3 were being observed more frequently than would be expected based on survey effort. Conversely, the four species with ratios of less than one were less frequently recorded at MWTW suggesting the area surrounding the survey site does not provide suitable habitat. It also needs to be remembered that by calculating the RR of raptors with restricted range using only surveys within their known range we have inflated the magnitude of their RRs by ignoring surveys in areas where they do not occur.

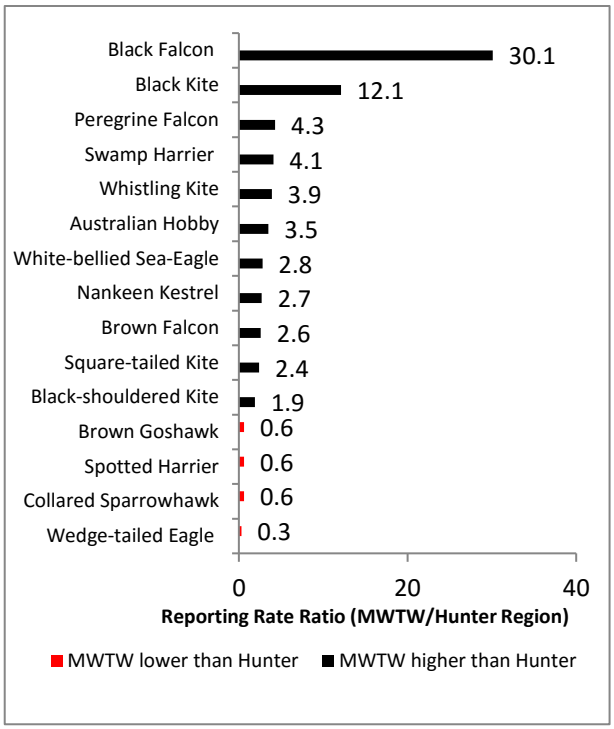

Figure 12. Comparison of occurrence of raptors at MWTW with the Hunter Region. (Hunter Region data based on BLA Birdata area surveys for the period 2001-2014 with MWTW surveys extracted). Reporting Rate ratios greater than 1.0 indicate that a species was seen more frequently at MWTW than elsewhere in the Hunter Region.

High Reporting Rate ratios (>3)

The six species falling in this category may be attracted by local abundance of food both at the MWTW and in the surrounding area (e.g. the MWTW observations involve the movements of raptors to favoured feeding locations). For instance the presence of shorebird species, which occur at MWTW, is known to attract Black Falcons *Falco subniger*, and we witnessed a Black Falcon predate a Curlew Sandpiper *Calidris ferruginea* (Newman & Lindsey 2009). Peregrine Falcon and Australian Hobby were observed hunting flocks of Rock Doves *Columba livia*, which are numerous in the Morpeth area. Swamp Harriers regularly hunted over a partially drained pond at MWTW, where waterfowl and migratory shorebirds shelter among vegetation. Pacific Black Duck *Anas superciliosa* were among species targeted (Newman 2011). Whistling Kites fed on

partially digested grain floating on the surface of the treatment plant process tanks, during a period when there was a build-up in their numbers (Shaun Clewes pers. comm.). Observations of the Black Kite probably reflect the movement of individuals joining the much larger numbers which regularly scavenged at the nearby Maitland municipal tip. Local breeding is another reason a raptor species might have an elevated RR at a regularly monitored site like MWTW. For instance, in Victoria Brown Falcon pairs have home ranges of 1.5 to 2 km^2, but defend a much smaller area of about 500m radius about the nest site (Marchant & Higgins 1993). We suspect that Black Falcon and probably Australian Hobby have nested in the area surrounding MWTW based on the observation of adults feeding dependent young (Newman & Lindsey 2007), nests and courtship behaviour respectively.

The exceptionally high RR ratios for the Black Falcon and Black Kite reflect the restricted distribution and discontinuous occurrence of these species at MWTW and in the Hunter Region (BLA Birdata records) during the study period 2001-2015.

Normal Reporting Rate ratios (1.9 to 2.8)

Five species have RR ratios which the authors consider to be typical for their range in the Hunter Region. Like the species discussed above they are often observed in the open country of the Hunter Estuary flood plains surrounding MWTW. A nest and dependent young suggests that the White-bellied Sea-Eagle breeds in the ephemeral wetlands adjacent to MWTW. Nankeen Kestrel, Brown Falcon and Black-shouldered Kite are species which favour the open country of the Hunter Estuary flood plains, and their occurrence at MWTW is typical for the area. In contrast the Square-tailed Kite prefers woodland habitat. Its occurrence at MWTW is attributed to its regular occurrence in the Maitland area, which is one of the few areas in the Hunter Region where this species is frequently recorded.

Low Reporting Rate ratios (<1.0)

Six species, including three *Accipiter* species, fall in this category if the Grey Goshawk *Accipiter novaehollandiae*, which was recorded in 2015, is included (the **Figure 12** analysis only considered records for the period 2001-2014, because of the lack of Hunter Region Birdata for 2015 at the time of writing). *Accipiters* primarily forage in woodland and the Grey Goshawk is regularly mobbed when away from cover. The occurrence of this species at MWTW illustrates the need for woodland birds to move through open country between the ever-decreasing areas of remnant woodland in the Morpeth area. The infrequent occurrence of the Wedge-tailed Eagle *Aquila audax* and the absence of any Little Eagle *Hieraaetus morphnoides* records were unexpected. In the authors' experience both these species occur occasionally in open country elsewhere on the edges of the Hunter River flood plain (e.g. Pambalong Nature Reserve, Hexham Swamp and Woodville), which are nearer than MWTW to the vegetated foothills adjacent to the Hunter Estuary flood plains.

Status and Seasonal Variations

Bird populations experience natural fluctuations in status and in long-lived species like raptors these cycles may be long-term. In addition, Hunter Region populations may be temporarily increased by influxes of birds from other regions following adverse environmental conditions like drought in the interior of Australia. Consequently, we do not know whether the Hunter Region's raptor populations were at normal (average) levels when this study commenced in 2001 or even if the populations are stable. Indeed there are indications that some raptor species may be experiencing long-term decline (Cooper *et al.* 2014).

During the 15 years there was no obvious variation in either annual or seasonal diversity of raptor species visiting the area (**Figures 2** and **9**). However, the total annual number of raptor observations, an indicator of the abundance of raptors, declined by approximately one third (**Figure 2**), mainly as a consequence of a decline in the Whistling Kite (**Figure 3**), the most frequently observed raptor. Swamp Harrier (**Figure 5**) and Nankeen Kestrel (**Figure 6**) also showed evidence of long-term decline, offset by a slight increase in the White-bellied Sea-Eagle (**Figure 4**). The seasonal variation of raptor records, the index of abundance, indicated a slight increase in winter and more pronounced decrease in October (**Figure 9**), which is attributed to species like the Whistling Kite moving away from MWTW during the breeding season, as discussed in the following accounts for the frequently observed species.

Whistling Kite

The decreased RR at MWTW was mirrored by a long-term decline throughout the Hunter Region

(**Figure 3**). However, the occurrence at Morpeth was anomalously low in 2011 and 2012. Monthly RRs increased between January and July, before falling to minimum levels in October (**Figure 10**), which is the main breeding month in NSW (Cooper *et al.* 2014). This suggests that there is a lack of breeding sites in the immediate vicinity of MWTW. The peak levels in December may indicate post-breeding season dispersal.

White-bellied Sea-Eagle

This species increased at MWTW in contrast to a slight decrease in the Hunter Region (**Figure 4**). The increase at MWTW may be associated with the establishment of a breeding pair in the immediate vicinity of the study area. This may be in response to hydrological changes that occurred during the study increasing the extent and permanence of ephemeral wetlands adjacent to the MWTW site. However, urban development is rapidly encroaching on the wetlands, and breeding viability may prove short-term. Cooper *et al.* (2014) have foreshadowed a similar concern about potential loss of viable nest sites throughout coastal NSW. There was no obvious pattern to variations in seasonal occurrence (**Figure 10**).

Swamp Harrier

Both the MWTW and Hunter Region RR trends suggest that Swamp Harrier populations were relatively stable with increases and decreases of approximately 10% respectively (**Figure 5**). RRs increased during late summer and autumn and were lowest during September and October (**Figure 10**). The autumn build-up may be associated with the movement north of birds from further south in Australia. The Hunter Valley is towards the northern end of species' breeding distribution. However, the decreased numbers during September and October, the peak of the breeding season (Cooper *et al.* 2014) suggests that breeding does not occur at MWTW.

Nankeen Kestrel

The long-term trend for the Nankeen Kestrel at MWTW decreased by approximately 50%, but annual variation was erratic (**Figure 6**). There was a similar decrease in the long-term trend for the Hunter Region Birdata area surveys (**Figure 6**). Both data sets show some evidence of a partial recovery post-2010, which is consistent with the findings of Cooper *et al.* (2014). They suggest that the Nankeen Kestrel is adversely affected by drought, and attribute the post-2010 recovery to wetter conditions. Veerman (2003) has suggested that tree plantings may contribute to local decreases, but that is not an issue at MWTW (**Figure 1**), where we have advised against revegetation. The complex seasonal variation in RRs was consistent with the pattern suggested by Cooper *et al.* (2014), involving a combination of partial and altitudinal migration. Decreased occurrence in September and October (**Figure 11**) is attributed to the breeding season peaking in September, with limited nest sites in the immediate vicinity of MWTW.

Black-shouldered Kite

The Black-shouldered Kite was regularly present at MWTW during 2001 and 2002, but its subsequent occurrence was infrequent, with some evidence of increase post-2007 (**Figure 7**). There was a similar decline in the Hunter Region Birdata area survey trend, which decreased in the middle of the study (**Figure 7**). Cooper *et al.* (2014) suggest that long-term trends are driven by decreased breeding during periods of drought and subject to these fluctuations Black-shouldered Kite populations in NSW are relatively stable. Our results are consistent with that conclusion. Lower occurrence between August and November (**Figure 11**) coincided with the peak of the breeding season (Cooper *et al.* 2014).

Black Falcon

Most of the MWTW records occurred between 2004 and 2008 (**Figure 8**) with evidence of breeding in 2005, when an adult fed two dependent young (Newman & Lindsey 2007). There was a further circumstantial indication of breeding in 2006, and it was concluded that the Black Falcons were resident, this being the first evidence of near coastal breeding by this species, which usually breeds to the west of the Great Dividing Range (Cooper *et al.* 2014). However, residence was temporary, with two observations in 2013, the only MWTW records since 2008. There were insufficient Birdata area survey results to draw any conclusions concerning the change in status of this species, which is, with the exception of a few locations, rare in the Hunter Region. In our earlier paper we concluded that the first Black Falcon records at MWTW coincided with drought conditions in the Hunter Valley (see Figure 2 *in* Newman 2012), which caused an abnormal influx of dry country species towards the coast. It also resulted in a build-up of Sharp-tailed Sandpipers *Calidris acuminata*, which together with other shorebird species, are known prey of Black

Falcons (Marchant & Higgins 1993). At MWTW we have observed Black Falcons taking Curlew Sandpiper *Calidris ferruginea* (Newman & Lindsey 2007), Rock Dove and Magpie-Lark *Grallina cyanoleuca.* There were Black Falcon records at MWTW throughout the year, with the exception of August (**Figure 11**). Black Falcons may benefit from agriculture increasing the abundance of prey (Debus 1998) and it is tentatively suggested that irrigation areas adjacent to the Hunter River may have assisted the recently observed spread to the coast.

Value of long-term systematic surveys

An aspiration of this paper was to determine whether a standard survey conducted at regular intervals would provide useful insights into the local status of raptor species and whether the conclusions could be extended to provide useful inferences at the wider regional scale. The analysis presented above provides useful measures of the status of those raptor species which occur commonly in the open areas of the Hunter Estuary flood plain. For some of the frequently observed species changes in local status were apparent.

The MWTW trends usually corresponded with those indicated by the Hunter Region Birdata area surveys (e.g. decreases in the Whistling Kite and Nankeen Kestrel) and in other cases the differences were minor (e.g. White-bellied Sea-Eagle). Consequently, the dual evidence provided by the two data sets reinforces the conclusions drawn independently from the two approaches, both of which have limitations. For instance the Birdata area surveys lack standardisation (i.e. differences in sites, duration, observers and annual survey numbers) and there are concerns that observed trends are affected by variations in survey effort (e.g. number of surveys, survey location and length of surveys). The MWTW surveys eliminate these variables, but sample only one location and habitat type and hence are not representative of the Region. This is illustrated by the potentially anomalous data generated for species which are sparsely distributed in the Hunter Region (e.g. Black Kite, Black Falcon and Square-tailed Kite).

Although not specifically designed for monitoring the occurrence of raptors, the MWTW survey protocol, involving spending an extended period (3 to 4 hours) in an open area with unimpeded vision, had several important attributes. In most instances raptors hunt over a much larger range than the MWTW survey site and its immediate surrounds. Consequently, it is important to survey over an extended period, which includes changes in wind and thermal conditions (i.e. suitable for soaring species). In addition MWTW and its surrounds attract raptors by providing a diversity of prey types, as indicated by the examples provided in the species accounts.

CONCLUSIONS

MWTW and immediate surrounds attract an eclectic set of raptor species, although few occur sufficiently regularly to be considered locally resident. The frequently observed species exploit prey associated with the wetland habitat, including water fowl and shorebirds. Other species like the falcons hunt the open spaces of the adjacent flood plains and benefit from the abundance of introduced species like the Rock Dove.

A statistically significant trend (p <0.05) in observation rates over 15 years suggests that raptors as a guild have decreased at MWTW, although there was no apparent change in species diversity. This suggests that the decreased occurrence of raptors is primarily associated with most frequently observed species.

Whistling Kites and Nankeen Kestrels decreased, consistent with the trend throughout the Hunter Region. White-bellied Sea-Eagles increased, which may have been associated with breeding in the vicinity of MWTW. Other species showed more complex annual variation, but were generally consistent with trends throughout the Hunter Region as indicated by Birdata area surveys. In several instances seasonal RRs of the frequently observed species decreased during their breeding season, suggesting that they do not nest in the immediate vicinity of MWTW.

The RRs for Black Falcons were anomalously high for the Hunter Region, consistent with MWTW being within the home range of a resident pair for several years, with feeding of dependent young providing evidence of breeding. However, decreased RRs during the breeding season (**Figure 7**) suggest that MWTW lies outside the smaller area defended around the nest site when breeding.

The survey method, involving an extended period of 3 to 4 hours of continuous observation in mornings on a monthly basis, proved effective in monitoring raptors, sampling a range of wind and thermal conditions. The results of this study have provided valuable insights into the status of raptors in the Lower Hunter.

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