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Breeding and Flocking: Comparison of Seasonal Wetland Habitat Use by the Brolga *Grus rubicunda* in South-western Victoria

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Summary

Systematic investigation of temporal use of habitats by the Brolga *Grus rubicunda* is lacking. The aim of this study was to examine six wetland characteristics and their relation to Brolga flocking and breeding habitat for the south-western Victorian Brolga population. During the breeding season Brolgas were restricted to freshwater meadows and shallow freshwater marshes with an average water depth of 0.26 m (Standard Deviation, S.D. 0.06 m) and area of 15.71 ha (S.D. 18.04 ha). Breeding sites were characterised by having a substantial cover of emergent aquatic vegetation (mean 82.41%, S.D. 12.72%), which was significantly greater than that recorded for flocking sites ($Z = -5.863$, df = 56, $P<0.001$). In comparison, flocking sites had more variable salinity (fresh to saline), area (3.25–2565.17 ha) and wetland classification (shallow freshwater marsh to permanent saline). Flocking sites had significantly greater average water depth ($t = -5.542$, df = 56, $P <0.001$), wetland area ($Z = -4.829$, df = 56, $P <0.0001$) and number of water sources ($t = -6.472$, df = 56, $P <0.0001$) than breeding sites. Flocking sites potentially maintained summer inundation by being fed by two or more water sources (mean 2.21, S.D. 0.68). This variable nature of habitats used by the Brolga and the variation in habitat use create a challenge for the effective long-term management and conservation of the species.

Introduction

The Brolga *Grus rubicunda* is listed as a vulnerable species in Victoria (DSE 2003). The south-western Victorian population is thought to be discrete, but uncertainty surrounds its current demography and fecundity (Du Guesclin 2001). Brolgas are non-migratory but, in response to seasonal rains, do move between isolated, ephemeral breeding wetlands and more permanent areas where they congregate in flocks (Marchant & Higgins 1993, Meine & Archibald 1996, Herring 2001). The chronology of annual Brolga activity is presented in Figure 1.

Variation in seasonal habitat use has been documented by White (1983), Arnol *et al.* (1984), Harding (2001) and Herring (2001). Despite such studies, however, existing data are sufficient to describe seasonal Brolga habitat use only in general terms (Corrick 1995). This paper, therefore, aims to outline a systematic approach to examine the use of seasonal habitats by the Brolgas in south-western Victoria.

Methods

Study area and site selection

Sites were distributed across south-western Victoria including the Victorian Volcanic Plain (DNRE 1998), where the major land-use is sheep- and cattle-grazing, and cropping. Most of the shallow freshwater wetlands here are on private land, but many of the deeper, permanent wetlands are public reserves and persist in a modified form (DNRE 1998).

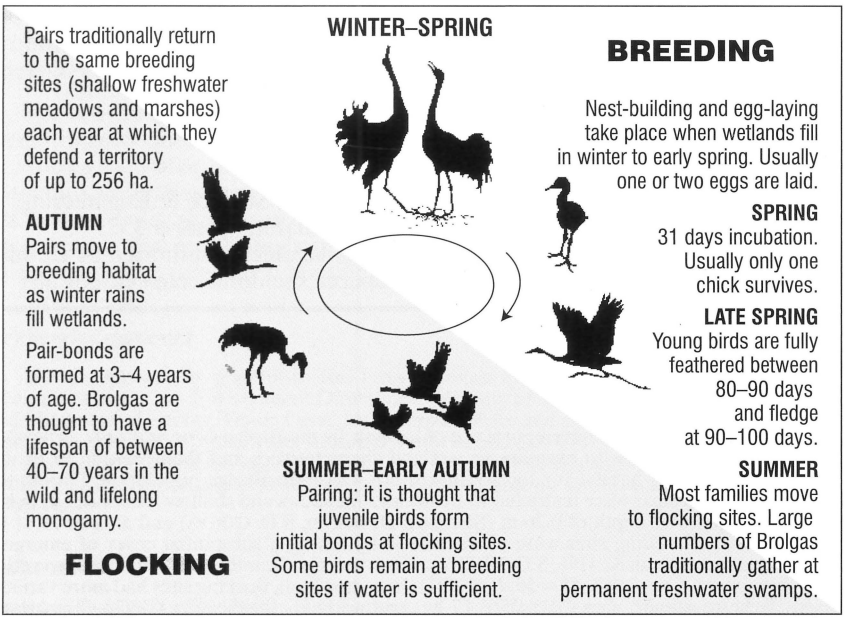

Figure 1. Annual cycle of the Brolga in southern Australia (from Harding 2001, adapted from Friends of the Brolga 1993 and McIntyre 1995).

Table 1

Criteria and justification for site selection of flocking and breeding records of Brolgas.

Criteria	*Justification*
General	
Recorded since 1990	To include records with greater validity than earlier records.
	To include records from wetlands that possibly persist in the landscape today.
	To ensure selection of recently used sites.
Complete dataset	To ensure all relevant data for selected characteristics were available.
Involve a wetland	To eliminate sites with records of Brolgas feeding in fields and flying overhead. This paper examines characteristics associated with wetlands.
Flocking sites	
>1 record of ≥10 birds	To include sites which had been used often or traditionally by flocking Brolgas. The assumption was made that if ≥10 birds were recorded on a wetland, the potential for flocking behaviour was likely. Flocking involves more criteria than bird numbers but, because of the nature of the data, numerical criteria were required for flock definition.
Recorded in >1 month	To include sites where Brolgas flocked for periods greater than 1 day or 1 week, i.e. as above, an attempt to include sites used traditionally for the majority of the flocking season.
Breeding sites	
Recorded as used in most years	As above, to include sites which have been used extensively by Brolgas and are representative of traditional habitat.

Table 2: Wetland categories of the Corrick classification system (Corrick & Norman 1980) used here for describing breeding and flocking sites of Brolgas.

Wetland category	*Water depth (m)*	*Duration of inundation (months/year)*
Freshwater meadow	<0.3	<4
Shallow freshwater marsh	<0.5	<6
Deep freshwater marsh	<2.0	Permanent
Permanent open freshwater	Variable	Permanent
Semipermanent saline	Variable	<4–12
Permanent saline	Variable	Permanent

Flocking sites were selected from a database which contained records of Brolga flocking sites and wetland inventory data, and breeding sites were selected from the Victorian Brolga Survey Database which contained comparable breeding data (see Harding 2000 and Sheldon 2003 for details on database creation and primary data sources). Fifty-eight sites were selected for analysis, 29 each from the breeding- and flocking-site datasets. The criteria for breeding- and flocking-site selection are presented in Table 1.

Wetland characteristic selection

The following criteria were employed in the selection of the six wetland characteristics (Tables 2,3): data had been collected for the characteristic in both breeding and flocking databases, the characteristic was related to wetland physiology, and the characteristic was noted in the literature as being important in seasonal Brolga habitat use.

Corrick's classification system categorises wetlands based on salinity, water depth, and duration of inundation (Corrick & Norman 1980, DNRE 1996). Major categories were used to convey a simplistic comparison of wetland types used extensively by Brolgas during the breeding and flocking seasons. A summary of the classification system for wetlands used in this analysis is presented in Table 2.

Salinity measures were broadly grouped into three categories: fresh, brackish and saline. Average water depth was estimated at the time of the survey by recording and averaging water depth at four different points of the wetland. Wetland area was calculated as the expected area inundated at peak inundation. The area covered by emergent aquatic vegetation was expressed as a percentage of this wetland area. The total number of water inflow sources to each wetland was recorded; water sources included local runoff, streams, channels, springs and groundwater.

Breeding and flocking sites were compared by analysing the data using SuperANOVA™ and Microsoft Excel™ software. Mann-Whitney tests were used to compare wetland area and cover of emergent aquatic vegetation, and *t*-tests were used to compare average water depth and number of water sources.

Results

Wetlands used during the breeding season were seasonal, shallow, freshwater meadows and marshes (Figure 2). These sites were generally dry for 6–8 months of the year and were <0.5 m deep at their fullest (Table 2). In comparison, habitat used during the flocking season was more variable, ranging from shallow freshwater marsh to permanent saline wetlands (Figure 2). Most flocking sites were recorded in the deep freshwater marsh (31%) and permanent open freshwater (28%) categories. Saline wetlands were also used, only during the flocking season, and accounted for 35% of flocking sites (Figure 2).

Figures 2 and 3 support the finding that breeding Brolgas were typically restricted to freshwater wetlands, with just one breeding site recorded as brackish. In contrast, flocking-site wetlands ranged from fresh to saline: 13 flocking sites were recorded as saline, and eight each as fresh and brackish (Figure 3).

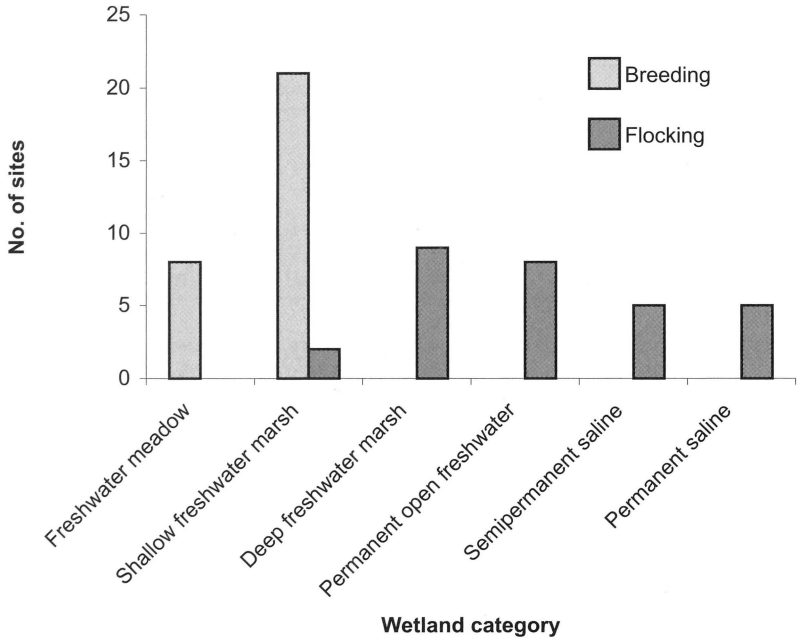

Figure 2. **Number of sites recorded in each wetland category (of Corrick & Norman 1980) for breeding and flocking sites of Brolgas in South-western Victoria.**

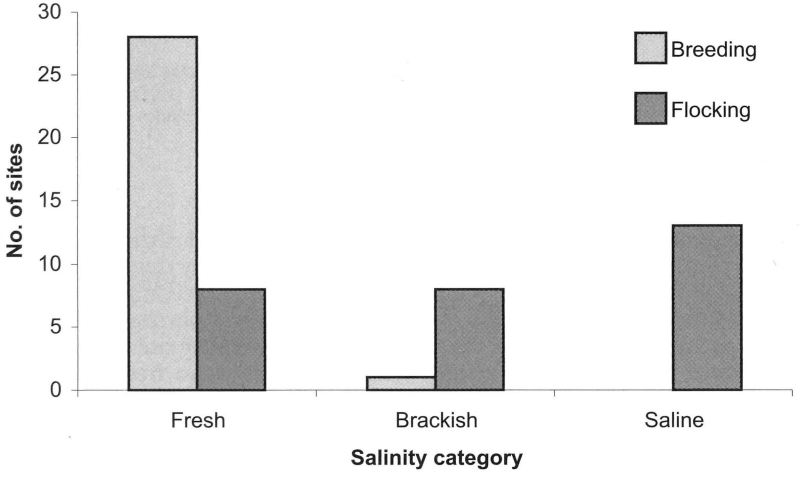

Figure 3. **Number of sites recorded in each salinity category for breeding and flocking sites of Brolgas in South-western Victoria.**

Table 3

Summary of statistics [mean, standard deviation (S.D.), minimum, and maximum] for wetland characteristics for breeding and flocking sites of Brolgas in South-western Victoria: average water depth, wetland area, cover of emergent aquatic vegetation, and number of water sources.

Statistics	*Average water depth (m)*		*Wetland area (ha)*		*Cover of emergent aquatic vegetation (%)*		*No. of water sources*	
	Breeding	*Flocking*	*Breeding*	*Flocking*	*Breeding*	*Flocking*	*Breeding*	*Flocking*
Mean	0.26	0.50	15.71	420.61	82.41	20.69	1.24	2.21
S.D.	0.06	0.23	18.04	684.36	12.72	27.02	0.44	0.68
Minimum	0.10	0.20	1.30	3.25	50.00	0.00	1.00	1.00
Maximum	0.40	1.00	79.80	2565.17	100.00	80.00	2.00	3.00

Mean average water depth was significantly greater for flocking sites than for breeding sites ($t = -5.542$, df = 56, $P < 0.001$). Wetland area followed a similar trend ($Z = -4.829$, df = 56, $P < 0.0001$), although it was highly variable for flocking sites (Table 3). Emergent vegetation cover showed the opposite trend: breeding habitat had a significantly greater cover of emergent vegetation than did flocking sites ($Z = -5.863$, df = 56, $P < 0.001$). However, the vegetation cover for flocking wetlands was variable (Table 3). Flocking sites had a significantly greater number of water sources than did breeding sites ($t = -6.472$, df = 56, $P < 0.0001$) (Table 3).

In summary, sites used by flocking Brolgas were significantly greater in area, average depth and number of water sources than those used for breeding. However, breeding sites contained a significantly greater cover of emergent aquatic vegetation. The existence of different types of wetlands in the one region seems to be important for the conservation of Brolgas (DCE 1992).

Discussion

Variable nature of Brolga habitat

Brolgas were found to be essentially restricted to freshwater meadows and shallow marshes during the breeding season, which supports research by White (1983) and Harding (2001). White (1983) and Arnol *et al.* (1984) suggested that the time of year, period of inundation, water depth and amount of emergent vegetation may influence nest-site selection. White (1983) indicated that emergent vegetation was significant in screening of the nest-site and providing nest-building material, which may explain why emergent aquatic vegetation seemed to be more important here in breeding habitat than at flocking sites (Table 3).

Wetlands used by breeding Brolgas in south-western Victoria were mostly smaller than 50 ha (93%) and all sites had >50% emergent vegetation cover. No breeding site had an average water depth >0.4 m, which supports Meine & Archibald's (1996) finding that Brolgas fed and nested in shallow water

<0.5 m deep. In contrast with the present results, Herring (2001) found breeding wetlands to have a greater mean area (>50 ha) and a lower mean emergent vegetation cover of 25%. In his study, breeding wetlands ranged from 2.5 to 1280 ha (Herring 2001). The mean average water depth recorded in this study (0.26 m, S.D. 0.06 m) was similar to that (0.3 m) recorded by Herring (2001). Water depths ideal for Brolgas are likely to be closely associated with the ecology of emergent vegetation (Herring 2001).

Results in this study indicated that flocking sites were commonly recorded in open environments, with 86% of flocking sites having a vegetation cover of less than 60% (Table 3). Herring (2001) noted the importance of open water in facilitating the detection of ground predators.

Salinity is as an important determinant of wetland use by waterbirds in south-western Australia (Halse *et al.* 1993). In the present study, saline wetlands were found to be extensively used by flocking Brolgas (45%) (Figure 3) but not by breeding Brolgas. In accordance with Halse *et al.* (1993), the scarcity of freshwater wetlands (because of increased salinisation and the ephemeral nature of many freshwater sites) may have resulted in the movement of waterbirds (including Brolgas) into wetlands in their upper limit of salinity tolerance. Larger, saline wetlands of the Volcanic Plain used by flocking Brolgas were perhaps the only remnant wetlands to retain water throughout the flocking season. Wetlands fed by more than one water source are more likely to retain water throughout the summer flocking period. Ephemeral wetlands used for breeding had fewer water sources on average than more permanent flocking sites (Table 3).

Implications for conservation and management

Many other characteristics beyond the scope of this study are likely to influence seasonal habitat selection in the Brolga. Halse *et al.* (1993), for example, indicated that the occurrence of Brolgas on a wetland may be influenced by conditions in areas remote from the wetland, such as tenure and use of surrounding land. McIntyre (1995) suggested that the location of nesting sites in relation to flocking sites was potentially important in the determination of suitable Brolga breeding habitat. Harding (2001) referred to land tenure as a significant factor, yet no systematic method has been employed to determine the significance of habitat characteristics for nest-site selection. Although characteristics concerning habitat preferences have been discussed by many authors (Arnol *et al.* 1984, Hill 1992, McIntyre 1995), no consistent set of characteristics has been accepted (Harding 2001).

Habitat value in the long-term management of the Brolga is vital. However, little is known about what constitutes optimal Brolga habitat, although efforts to protect, restore and recreate wetland habitat require practical information about wetland characteristics, such as the ones examined in this paper.

In conclusion, Meine & Archibald (1996) referred to the Brolga as the most opportunistic and variable of all crane species in terms of habitat selection. A significant challenge in the identification and conservation of Brolga habitat is the fact that sites are not used to the same extent each year (Herring 2001). However, perhaps the greatest challenge in managing wetlands for the Brolga relate to addressing major issues such as wetland drainage, changes to water regimes and salinisation (DSE 2004). These are particular problems on private agricultural land that require a cooperative effort between landholders and relevant government agencies to address them effectively.

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