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SEASONAL PATTERNS IN ABUNDANCE OF WATERFOWL (ANATIDAE) AT A WASTE STABILIZATION POND IN VICTORIA

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The seasonal abundance of waterfowl on a waste stabilization pond at the Western Treatment Plant, Victoria, Australia, was studied over two years. The abundances of species that are considered to be highly dispersive, such as the Pink-eared Duck *Malacorhynchus membranaceus* and Grey Teal *Anas gracilis*, were erratic and inconsistent across the two years. For other species, such as the Australasian Shoveler *Anas rhynchotis*, Black Swan *Cygnus atratus*, Pacific Black Duck *Anas superciliosa* and Australian Shelduck *Tadorna tadornoides*, more consistent patterns were observed each year. Most species used the site during what would be expected to be their non-breeding season. Australian Shelducks appeared to use the site as a late-spring/early-summer moulting refuge.

INTRODUCTION

The Western Treatment Plant (WTP) at Werribee, Victoria, is known to support large numbers of waterfowl of several species (Lane and Peake 1990), and forms part of a Wetland of International Significance (Ramsar Convention Bureau 1984). A large waste stabilization pond within the WTP, known as Pond Nine in the Lake Borrie system, is considered to be of particular importance for waterfowl and other waterbirds (Elliget 1980; Hamilton 2002; Hamilton *et al.* 2002; Hamilton *et al.*, in press). There is little published quantitative information on seasonal changes in abundance of waterfowl at the site. Sewage treatment changes will be implemented at the WTP in 2005, which have the potential to affect the usefulness of the site, including the Lake Borrie ponds, to waterfowl (see Hamilton *et al.* 2002); so information on seasonal patterns of abundance could be useful in monitoring any changes and for developing management strategies for this Ramsar protected wetland.

Seasonal movements of Australian waterfowl are believed to be influenced by the availability and depth of inland temporary wetlands (e.g. Morgan 1954; Frith 1957; Frith 1959; Braithwaite and Stewart 1975; Crawford 1979; Pert 1997). It has been suggested that inland temporary floodwaters provide an abundance of food for waterfowl (Braithwaite and Frith 1969), and hence offer suitable breeding conditions for many species. Conversely, permanent wetlands, such as waste stabilization ponds, may be used as non-breeding refuges (Braithwaite and Stewart 1975). Most of the ideas on waterfowl movements are based on either banding studies or more commonly, on comparisons of seasonal changes in abundance at particular locations.

The aim of this study was to quantify seasonal changes in the abundance of the main waterfowl species found at Pond Nine of the WTP, and draw comparisons with previously published work.

MATERIALS AND METHODS

Study site

The WTP occupies an area of 10 851 hectares and is situated 35 kilometres west of Melbourne on the shores of Port Phillip Bay (38°00'S, 144°34'E). A location map is provided in Hamilton *et al.* (2004). Observations for the present study were made at a waste stabilization pond known as Pond Nine, part of a series of ponds that make up the Lake Borrie system. Unlike the other pond systems at the WTP, the Lake Borrie ponds are irregularly shaped and of differing sizes. Much of the Lake Borrie system was originally a natural wetland that was divided into a series of 30 waste stabilization ponds through the construction of impoundments in 1936. Pond Nine is the largest of these, covering an area of 109 hectares. It is also the only pond in the system with a stand of dead trees (mostly *Melaleuca lanceolata*). The average water depth is 60 centimetres (Cartwright 1996, unpubl. data). Further details of the functioning of the Lake Borrie waste stabilization ponds with respect to sewage treatment and ecology can be found in Hamilton (2002).

Sampling protocol

Data used here were collected as part of a wider study on the diurnal activity budgets of waterfowl at Pond Nine, the sampling protocol for which is described in detail in Hepworth and Hamilton (2001) and Hamilton *et al.* (2002). In summary, surveys were made from defined observation points on the embankment using a Leica® Televid 77 telescope (20–60 × zoom magnification). Sampling, which involved counting the total number of birds on the pond, was conducted at five evenly spaced times of day: sunrise, mid-morning, midday, mid-afternoon and sunset. It took approximately one hour to sample the entire pond; hence sampling for each time of day was begun 30 minutes before the midpoint of the sampling period (e.g. 30 minutes before sunrise). Sampling was undertaken on 47 dates; three times a month from 11 July 1998 to 20 June 1999 and then at approximately monthly intervals from 1 August 1999 to 9 August 2000.

For the Hardhead *Aythya australis*, a diving species, it was necessary to determine how long individuals stayed underwater during a dive so that no birds were missed whilst surveying. In a preliminary study, the dive times of 70 birds were measured. The maximum dive duration was found to be 25 seconds (mean = 13.4 seconds). Thus, each field of view was observed for at least 25 seconds so that birds surfacing from a dive, that would not have been seen in the initial scan, could be observed.

Data presentation

Both daily average and maximum values were presented for the seasonal abundance of waterfowl. Daily maxima are particularly meaningful for species that show diurnal trends in abundance since a site could still have been important to a species at a particular time of year even if it was only used by it at certain times of day. There was some diurnal variation in abundance of certain waterfowl species (see Hamilton *et al.* 2002) so this approach was justified. It was not appropriate to present a mean with an estimate of error (e.g. standard error or standard deviation) for each date since the five values for each date were pseudoreplicates of a day.

RESULTS

Pink-eared Ducks were present at the site mainly between April 1999 and March 2000, with peak numbers between October and December, but there was no evidence of a repeated seasonal pattern over two years (Fig. 1). For Australasian Shovelers there was a tendency for highest numbers to occur from late summer to early autumn in each year (Fig. 2). Numbers of Grey Teal and Chestnut Teal varied greatly from month to month, with no discernible pattern (Figs 3 and 4). The Pacific Black Duck was most abundant from late summer to mid-autumn of both years (Fig. 5). The numbers of Hardhead (Fig. 6) followed a very similar pattern to that for the Pink-eared Duck. The largest numbers, approximately 8 000 individuals, occurred at the first sampling date on 11 July 1998, with all subsequent counts being less than half this number. The Australian Shelduck showed clear peaks in abundance in November each year (Fig. 7). At this time many of the birds observed were moulting and flightless. The Black Swan was most abundant from mid-summer to mid-autumn (Fig. 8).

Small numbers of other waterfowl were seen occasionally in the study area. One or two individuals of Freckled Duck *Stictonetta naevosa* occurred on eight sample dates, and from one to five Blue-billed Ducks *Oxyura australis* were seen on 20 sample days.

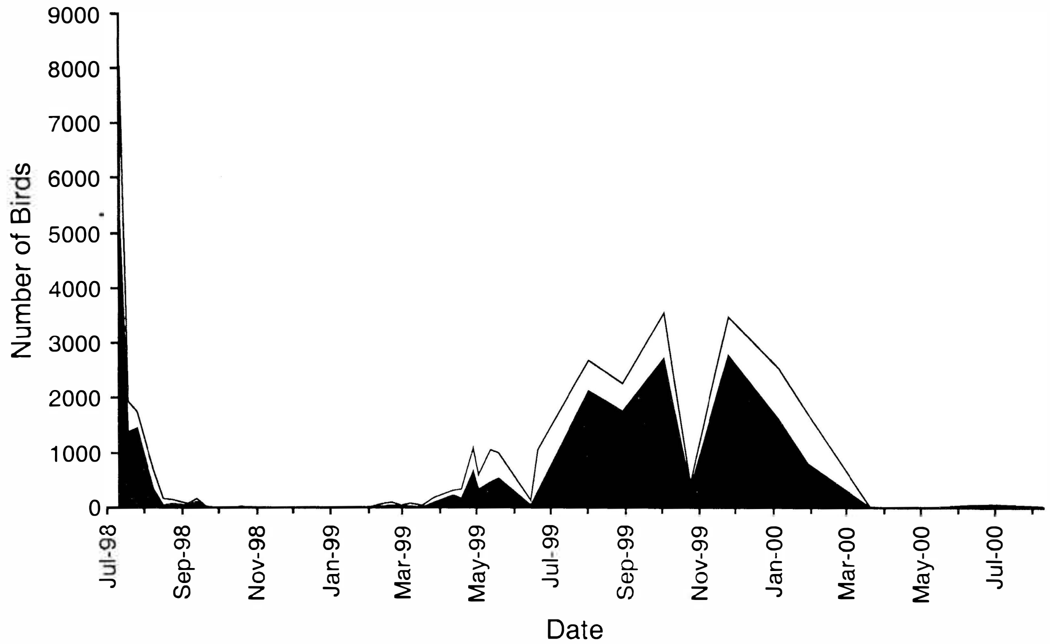

Figure 1. *Seasonal abundance of Pink-eared Duck at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

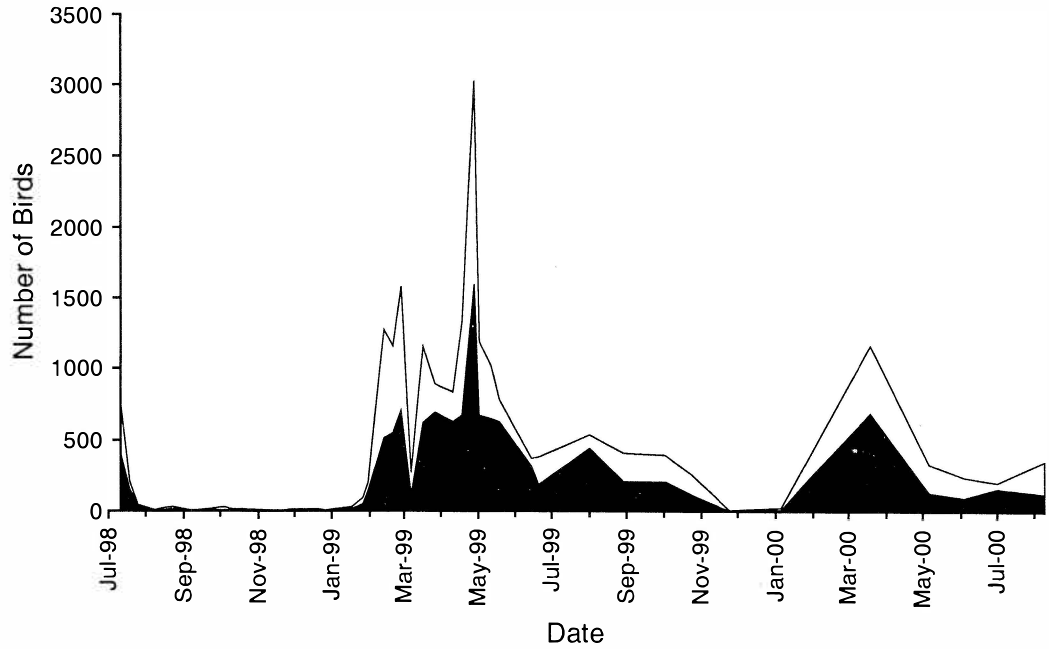

Figure 2. *Seasonal abundance of Australasian Shoveler at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

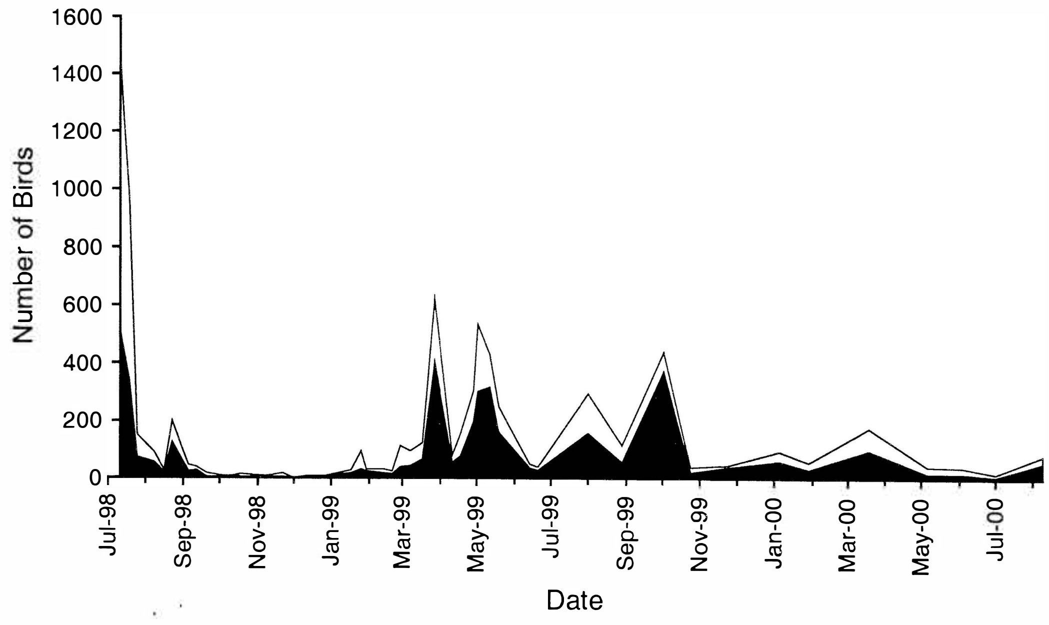

Figure 3. *Seasonal abundance of Grey Teal at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

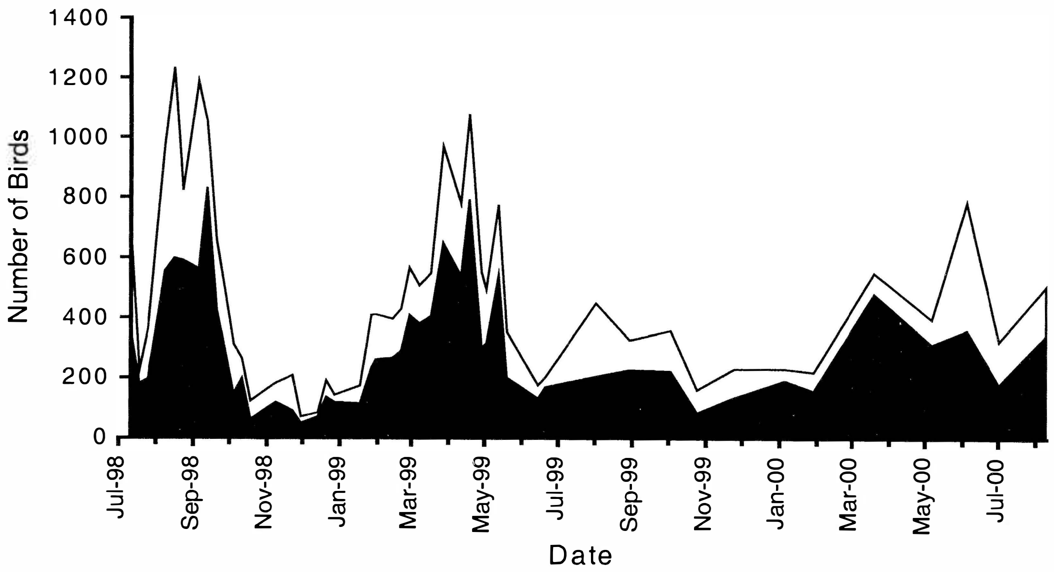

Figure 4. *Seasonal abundance of Chestnut Teal at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

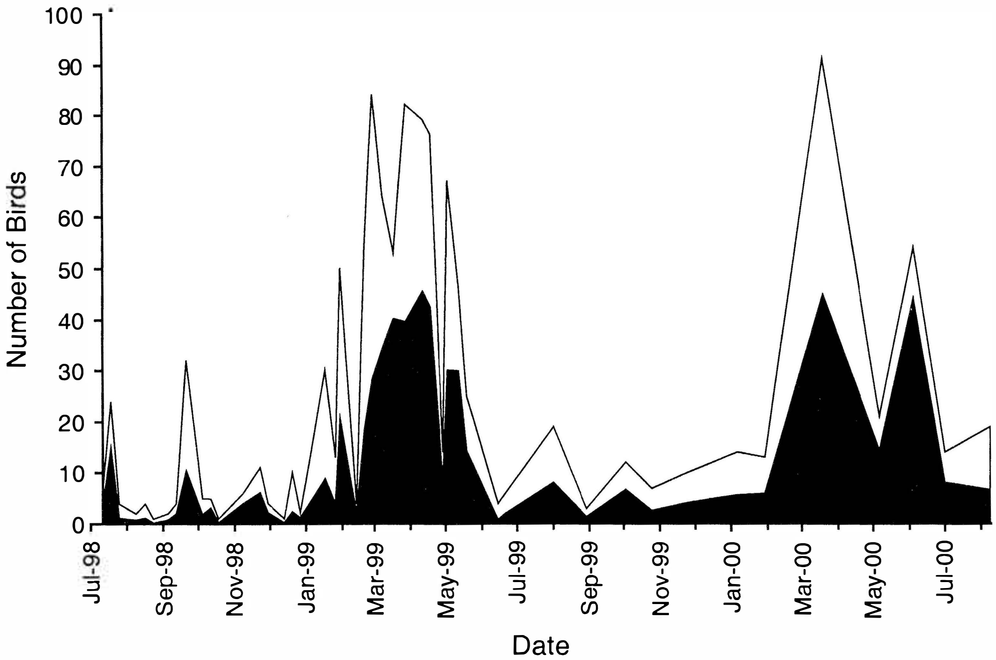

Figure 5. *Seasonal abundance of Pacific Black Duck at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

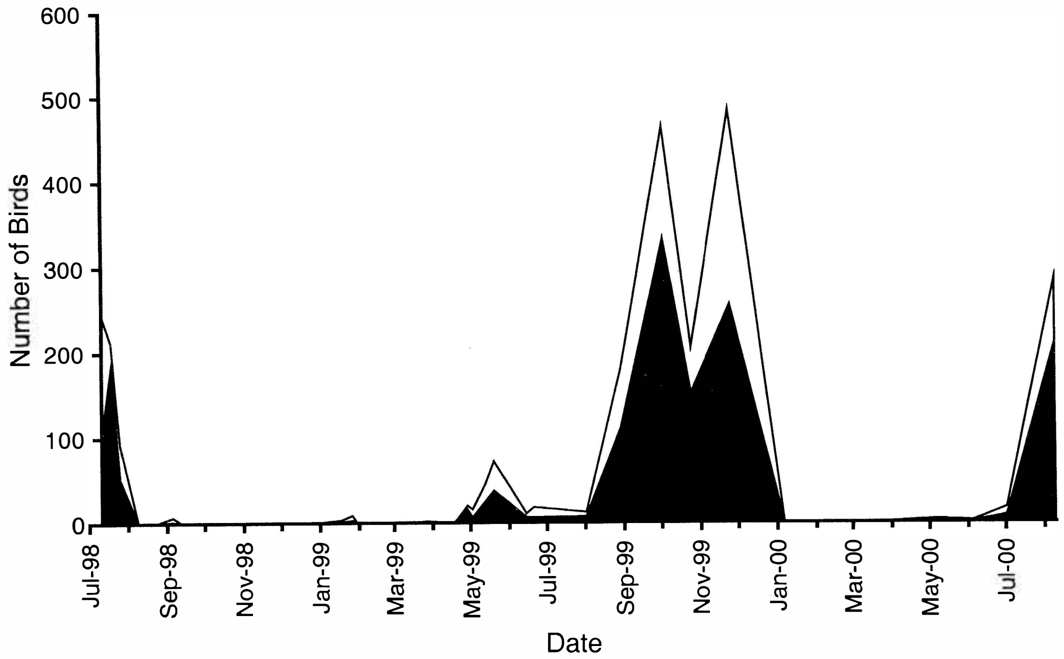

Figure 6. *Seasonal abundance of Hardhead at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

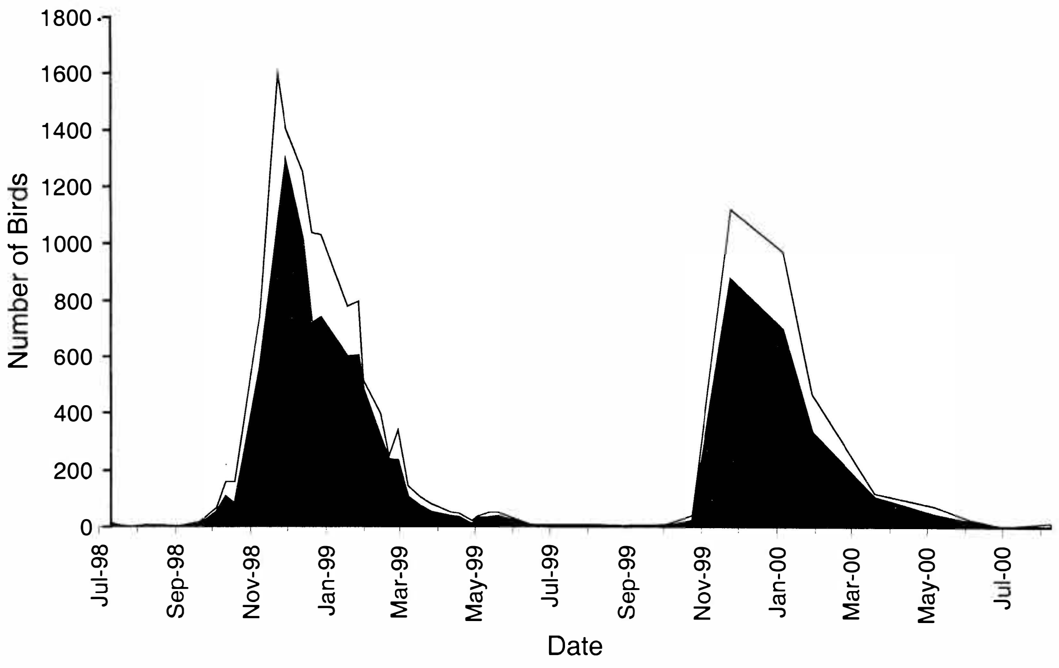

Figure 7. Seasonal abundance of Australian Shelduck at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.

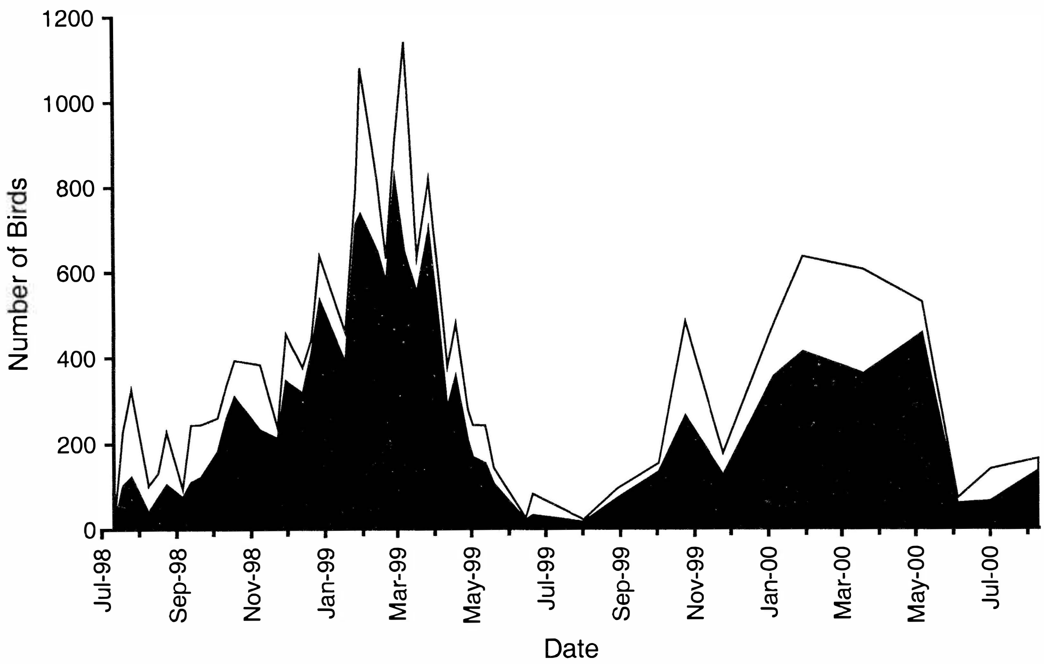

Figure 8. *Seasonal abundance of Black Swan at Pond Nine. Dark shading represents daily mean abundance; white represents daily maximum abundance. Labels on 'x' axis denote the first day of the month. The first sample date is in line with the 'y' axis, and the last is at the end of the 'x' axis.*

DISCUSSION

In general, the abundance patterns observed for waterfowl at Pond Nine were consistent with previous observations of dispersal and movement of Australian waterfowl. Pink-eared Duck, Grey Teal and Hardhead are all considered to be highly dispersive species, with movements most likely tied to inland rainfall, which is typically erratic (Serventy 1953; Morgan 1954; Frith 1982; Pert 1997). At Pond Nine, they all demonstrated irregular abundance patterns. However, despite the apparent erratic nature of dispersal for these species, some trends have been identified. The reporting rates, documented in the Atlas of Victorian Birds (Emison *et al.* 1987), for all three species are highest in spring and summer. In this current study Pink-eared Duck abundance at Pond Nine peaked in spring/summer 1999/2000, but not in the spring/summer of 1998/1999. Hardheads displayed a similar pattern. Substantial numbers of both species were also observed in late winter 1998 at the start of sampling. These comparable patterns may indicate that similar mechanisms were responsible for driving the movements of these two species. In contrast, spring/summer peaks were not evident for Grey Teals at Pond Nine. The Australasian Shoveler is also considered to be highly mobile, with movements possibly influenced by water availability in south-eastern South Australia or in the Murray-Darling Basin (Frith 1982). But unlike the species described above, numbers within Victoria have previously been reported as being reasonably consistent throughout the year with no clear seasonal trends being evident (see Marchant and Higgins 1990). In the present study there were late summer/autumn peaks in both years. It is possible that these birds arrived at Pond Nine after breeding inland. While breeding is generally considered to be erratic and dependent on inland rainfall (Frith 1982), this species most commonly breeds from August to November, often extending through to the end of summer (see Marchant and Higgins 1990).

Chestnut Teals have previously been reported leaving the coast around early summer for inland breeding (Frith 1982). However, breeding also occurs at Pond Nine in artificial nest boxes (Walker 2001). Despite this, Chestnut Teal broods were rarely seen on the water over the course of the study, and no more than two on a particular date. It appears that soon after alighting from the nest box, adults take their young to other nearby ponds (E. Walker, pers. comm.). It is not known if these birds later return to Pond Nine, and if so, in what numbers. However, this may explain the peaks observed in autumn 1999 and 2000. Chestnut Teals take about 60 to 80 days to grow to full size (Frith 1982), and in each year a peak in abundance was observed approximately three months after the end of the breeding season.

Pacific Black Ducks are generally considered to be mostly sedentary in areas of permanent water (Marchant and Higgins 1990). However, Victorian Atlas data reporting rates are greatest in spring and summer (Emison *et al.* 1987). Each year at Pond Nine numbers did not peak until the end of summer/start of autumn. It is possible that recruitment from a late winter to early spring breeding season (see Crome 1986) accounted for some of this increase. Only fully-grown birds were counted in this study, and immatures from spring breeding would have reached full size by late summer (65 days to full size, see Marchant and Higgins 1990), yet as many as three broods were seen at any one time. Because of the low numbers recorded for this species, recruitment through local breeding could have had a significant effect on changes in numbers of fully-grown birds.

Australian Shelducks have previously been reported migrating to permanent wetlands for moulting, during which they become flightless (Norman 1973; Frith 1982). It is believed that permanent water provides a refuge from predators during this vulnerable phase. Aggregations of moulting birds usually occur from around October through to February (Norman 1973; see Marchant and Higgins 1990), and the same pattern was observed clearly in both years of this study. Many flightless birds were seen at Pond Nine. Moult migrations are also well known for other shelduck species such, as the Common Shelduck *Tadorna tadorna* (Morley 1965; Salmonsen 1968). In Australia, the Australian Shelduck is the only species of waterfowl known to form large moulting congregations (Frith 1982). For other species, the timing of moulting is not as well defined and is extended over a longer period, so only a small proportion of the population is likely to be flightless at any particular time. This strategy has probably evolved in response to the unpredictable nature of the inland temporary wetlands used for breeding. If these wetlands were to dry up while most birds were flightless, a large proportion of the population could die. Australian Shelducks appear to avoid this risk by using permanent wetlands, such as those at the WTP, to moult.

Black Swan populations around permanent wetlands are generally believed to be mostly sedentary, and no seasonal variation in abundance is evident in Victorian Atlas reporting rates (Emison *et al.* 1987). However, increases in numbers on particular wetlands in south-eastern Australia in late summer/early autumn have been reported on several occasions (Hobbs 1961; Missen and Timms 1974; Davis and Reid 1975), and this was also clearly apparent in both years in the present study. The ecological significance of these gatherings is not clear. Black Swans were only occasionally seen breeding at Pond Nine (less than five breeding pairs each year), and thus recruitment through breeding would have made negligible contribution to the large numbers of birds seen there. It is possible though that breeding could occur elsewhere within the WTP.

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