The comparative ecology of waterfowl in north Queensland

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Introduction

While the ecology of waterfowl in temperate Australia has been investigated by Frith (e.g. 1961), less is known about the tropical species. Indeed relatively few studies have been made on waterfowl in the tropics. From 1958 to 1964, therefore, detailed investigations were made on each of the species of Anatidae occurring in Queensland north of the Tropic of Capricorn.

These investigations have been the subject of a series of detailed papers (Lavery 1966a, b, c, d; 1967a, b, c, d, e; 1969a, b; 1970a, b, c, d; Lavery *et al.* 1968). The present paper seeks to summarise this work and to point out the main ecological conclusions that can be drawn from it.

The study region (outlined in Figure 1) is that around Townsville (19°18′S., 146° 49′E.) from Ingham extending 200 miles south-eastwards to Bowen and westwards to Powlathanga, approximately 100 miles inland across the Great Dividing Range, which was used to separate the region into Coastal and Inland areas.

The species studied

Fifteen species inhabited the study areas during the period of investigation. Four were vagrants, namely: Black Swan *Cygnus atratus*, Chestnut-breasted Teal *Anas*

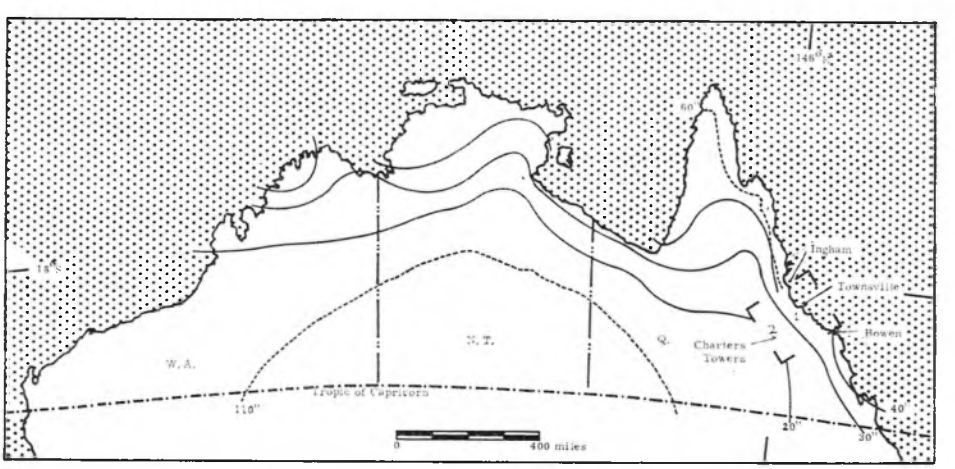

Figure 1. Map of northern Australia showing locations of Coastal Study Area (1) and Inland Study Area (2) and relationships of these to rainfall (—) and evaporation rates (- - -).

castanea, Australian Shoveler *Anas rhynchotis rhynchotis* and Freckled Duck *Stictonetta naevosa*, with only the Black Swan breeding at a few new artificial wetlands. One species, the Australian Black Duck *Anas superciliosa rogersi*, was found nesting throughout the region. The rest fell predominantly into two breeding groups, inland and coastal. The inland breeders were Australian Grey Teal *Anas gibberifrons gracilis*, Pink-eared Duck *Malacorhynchus membranaceus*, Australian White-eyed Duck *Aythya australis* and Maned Goose *Chenonetta jubata*. The coastal breeders were Magpie Goose *Anseranas semipalmata*, Plumed Whistling Duck *Dendrocygna eytoni*, Australian Wandering Whistling Duck *Dendrocygna arcuata australis*, Australian Radjah Shelduck *Tadorna radjah rufitergum*, Green Pygmy Goose *Nettapus pulchellus* and the Australian Pygmy Goose *Nettapus coromandelianus albipennis*. The last named has such a limited distribution that comparative studies involving it could only be undertaken in north-eastern Queensland. (Plate VII, p. 64.)

The English names are those used by Scott (1961). However, other vernacular names are preferred in Australia, particularly for the Whistling Ducks. Lavery (1965) proposed the names Grass for the Plumed and Water for the Australian Wandering Whistling Ducks.

Habitat

Within the study region there were 161 separate localities frequented by waterfowl. These can be grouped as nine habitat types (Table I), essentially similar to those in southern Australia (see, for example Frith 1961). The greater part of the habitat was available only seasonally. The rainfall of the tropics is regular, 80% occurring during the late summer (November-April), emphasising the changes in wetland acreage. Rather surprisingly the decrease during the dry season was more marked in the artificial wetlands (mainly cattle watering impoundments) which lost 95% of the 6,585 acres; natural wetlands only lost 70% of 4,725 acres. In most parts of northern Australia the inland areas show the greatest loss, having lower rainfall and higher evaporation rates (Figure 1).

The coastal breeding species have phylogenetic affinities with the largely tropical forms, for example Dendrocygnini and Cairinini, while the remaining species have affinities with the largely temperate-zone forms, for example Anatini. The peculiar but common Magpie Goose (Anseranatini) of northern Australia was more or less confined to the bulkuru sedge *Eleocharis dulcis* swamps which were the largest single areas of waterfowl habitat in the tropics. On the other hand, the uncommon Radjah Shelduck, with temperate-zone Tadornini affinities, occupied no widespread habitat type. The widespread distribution of the Black Duck suggests the potentially more aggressive and successful nature of temperate-zone forms; nevertheless the Black Duck in northern coastal Queensland remained dispersed and utilized marginal habitat types such as creeks. The Black Swan in recent years has also invaded brackish-water swamps of coastal club rush *Scirpus littoralis* on impounded saltpans while the Grey Teal has increasingly invaded inland breeding grounds formed by stock watering dams.

Table I. Waterfowl habitat types, their abundance and seasonal fluctuations, in the north Queensland study areas.

Type	*Permanency and water nature**	*Number of localities*		*Total acreage*	
		Inland	*Coastal*	*Wet (April)*	*Dry (November)*
Grassland	P.	—	8	200	200
Lake	P. F. St. D.	3	—	1225	620
River	P. F. R. D.	6	6	135	75
Lagoon	P. F. St. Sh.	14	35	595	310
Bay	P. S. Td. D.	—	1	2	2
Tidal Flat	P. S. Td. Sh.	—	4	100	100
Creek	T. F. R. Sh.	3	6	6	3
Swamp	T. F. St. Sh.	11	60	8940	430
Meadow	T. F. St. Vsh.	—	3	7	—
Saltpan	T. S. St. Sh.	—	1	100	—
		37	124	11310	1740

* Temporary (T) or Permanent (P); Fresh (F) or Saline (S); Static (St.) or Running (R) or Tidal (Td.); Deep, >10 ft. (D), Shallow, <10 ft. (Sh.) or Very Shallow, <2 ft. (Vsh.).

Breeding

In north Queensland waterfowl nest almost entirely during and immediately following the wet season (Lavery *et al.* 1968).

Within the breeding ranges all species, with the exceptions of the colony-nesting Magpie Geese and Black Swans, were widely distributed and intermingled on the almost unlimited breeding grounds, having similar simple nesting requirements.

In nearly all species except the longer-maturing Magpie Geese and Black Swans, most pairs laid eggs annually and did so repeatedly within each year until a single clutch was successful or until breeding conditions ceased to be suitable. The timing of reproduction in all instances coincided with a number of factors obviously important for success which developed with the rains. These were water depth, percentage of vegetation cover and food production (measured by the number of awnless barnyard grass *Echinochloa colonum* seed heads per square yard). All these, and gonad size, increased sharply with the rains. The relation between the last two for the Wandering Whistling Duck and the Black Duck over a number of years is shown in Figure 2. A severe drought, such as that

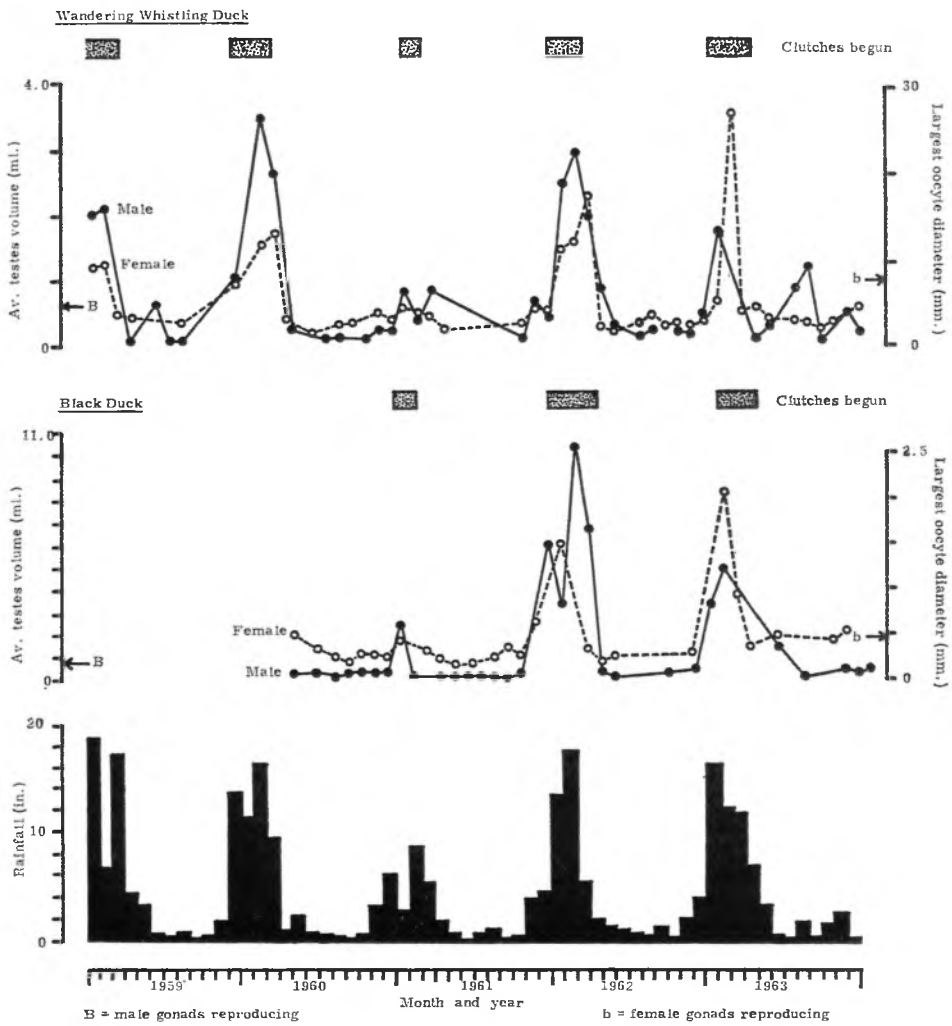

Figure 2. Relationship of reproduction of Wandering Whistling Ducks and Black Ducks to rainfall in north Queensland study areas, where 1961 was a year of severe drought (after Lavery 1970a).

experienced in 1961, results in the absence of any of these favourable factors and in the complete cessation of reproduction.

Clutch sizes varied somewhat from year to year. Thus for 1961, 1962 and 1963 the Black Swans averaged 3.50±0.38 (24 clutches); 5.12±0.24 (58 clutches); and 4.25±0.18 (101 clutches). The 1961 clutches were significantly smaller (P= 5%). The Black Swan and the other colonial breeder, the Magpie Goose, tended to fledge a higher proportion of the young hatched than did the solitary-nesting Wandering Whistling Duck and Black Duck (Table II). However, the colonies were sometimes completely destroyed by flooding. Thus after four inches of overnight rain on 25th February 1962, 20 out of 32 Magpie Goose nests forming a colony at Thornley Park, Townsville, were abandoned. The remainder, all floating, were saturated and eventually these were also abandoned.

The growth curves of the above four species were also investigated by using birds raised under aviary conditions at Townsville. The three northern species reached fledging in rather similar times; Magpie Goose in 76 days (20 birds), Wandering Whistling Duck in 98 days (two birds) and Black Duck in 100 days (three birds). The southern Black Swan, however, did not take flight until 171 days (two birds).

Table II. Reproductive success of some waterfowl species breeding in north Queensland, 1959-63.

	Young downy broods		*Old flapper broods*		
Species	*No. examined*	*Average size*	*No. examined*	*Average size*	*Ratio*
Magpie Goose	3	8.67±1.67	11	5.82±0.87	0.67
Wandering Whistling Duck	26	10.66±0.65	14	4.64±0.89	0.44
Black Swan	40	4.38±0.24	11	4.09±0.46	0.93
Black Duck	21	6.95±0.52	5	2.00±1.06	0.29

Movements

Parents which had nested in grasslands led their young to the adjacent temporary wetland habitat for feeding. Sooner or later these evaporated, causing birds, including the young which were mostly fledged, to move again. The major habitat utilization change then was from swamp to lagoon type. This was studied by means of fortnightly counts, supported by some band recoveries.

Concurrently, the numbers of inland-breeding and vagrant waterfowl were increased by flocks from southern Australian populations. The sizes of these influxes were related to breeding and post-breeding conditions there, and were readily discernible from resident population patterns. Thus the White-eyed Ducks in June 1969 soared to approximately 1,800 birds, whereas the usual population was less than 200. Many of these nomadic flocks continued to move through north Queensland along fairly well-defined paths (Lavery 1966b).

Parasites and predators

Parasitism and predation are liable to increase when birds become concentrated. For the Black Duck (collected 1959-63) 13 out of 42 of those taken in the wet seasons had intestinal helminths, while 102 out of 143 collected in the dry seasons were similarly parasitized, i.e. relatively more than twice as many.

Various parasite groups occurred on and in all waterfowl species and many of these parasites had specific hosts (Lavery 1967a). High incidences of certain potentially debilitating forms, such as intestinal helminths, were probably a consequence simply of the hosts' feeding habits in relation to the parasites' life cycles (Table III). Thus deep-water divers were most prone to infection.

Natural predators were varied but uncommon and non-specific; these were thought to have little primary effect on the size of waterfowl populations.

The most extensive single method of predation was duck shooting. From 1952 to 1963 total annual harvests varied enormously, from none in years of extreme drought, such as 1961, and of flooding, 1953, to 100,000 - 150,000 birds in years immediately after those of widespread flooding when populations were largest and dispersed (1954). During 1963 an estimated 70,000 birds were harvested in north Queensland.

After investigating the proportions taken and numbers remaining, and the habits of both species and shooters, it was concluded that such harvesting had no

Table III. Incidences of intestinal helminths in common north Queensland waterfowl species collected in 1959-1963.

Host species	*No. of birds examined*	*No. of birds parasitized* No.	%	*Host species' main feeding habits*
White-eyed Duck	58	55	95	Deep-water diver; foods commonly include freshwater gastropod molluscs
Wandering Whistling Duck	221	193	87	Deep-water diver; foods include freshwater gastropod molluscs
Black Duck	160	100	62	Shallow freshwater dabbler; foods include gastropod molluscs
Magpie Goose	11	4	36	Shallow-water digger
Grey Teal	58	18	31	Shallow fresh- and saltwater dabbler
Maned Goose	22	3	14	Dry-land grazer
Australian Pygmy Goose	30	2	7	Deep-water dabbler
Plumed Whistling Duck	122	9	7	Dry-land grazer

Table IV. Foods of young Australian Wandering Whistling Ducks collected in north Queensland study areas, 1959-1963.

Food	*Percentage volume in various age groups (weeks)* 0-6	7-10	11-14
Number of gizzards examined	44	18	10
Plants (seeds)			
From temporary wetlands e.g. *Echinochloa colonum*	64.1	30.2	27.5
From seasonal wetlands e.g. *Polygonum lapathifolium*	33.5	57.5	61.0
From permanent wetlands e.g. *Nymphaea ?gigantea*	Nil	5.5	10.6
Animals (insects)	2.4	6.8	0.9

Table V. Major wet season food sources of waterfowl species commonly in north Queensland study areas, 1958-1964.

Species	*Number of gizzards examined*	*Food sources* *Plant family*	*Volume (%)*	*Frequency of occurrence (%)*
Magpie Goose	40	Cyperaceae	62.3	72
Plumed Whistling Duck	72	Cyperaceae	50.9	93
Wandering Whistling Duck	774	Gramineae	26.2	47
		Cyperaceae	17.4	54
Black Duck	26	Cyperaceae	81.2	81
Grey Teal	49	Cyperaceae	53.9	55
Australian Pygmy Goose	12	Hydrocharitaceae	37.0	8
		Cyperaceae	24.1	25

discernible effect on total population sizes within north Queensland (Lavery 1969a).

Foods

The young birds took some insects in their diets, increasing the proportion as they became more adept at catching these (Table IV). Otherwise the young and the adults of all species ate only aquatic foods, that is those inundated by water at least once a year; mostly plant seeds were taken and the plant species involved were all of those commonly occurring in tropical wetlands (Lavery 1970b). In the wet season there was little difference in the diets of the different species (Table V).

There was a seasonal change in diet from shallow water to deep water plant material during the dry season (Figure 3).

This involved major divergences of habit; specialized feeding methods became apparent and foods differed markedly (Table VI). The birds' movements and distributions were also different in consequence. Thus the Grey Teal showed successive peaks on swamp, lagoon and tidal flats each year (Figure 4).

Discussion

The characteristic ecology of all resident waterfowl species in north Queensland (i.e. coastal, inland and widespread species) was governed by their feeding habits during the prolonged dry seasons. Each species then ultimately became

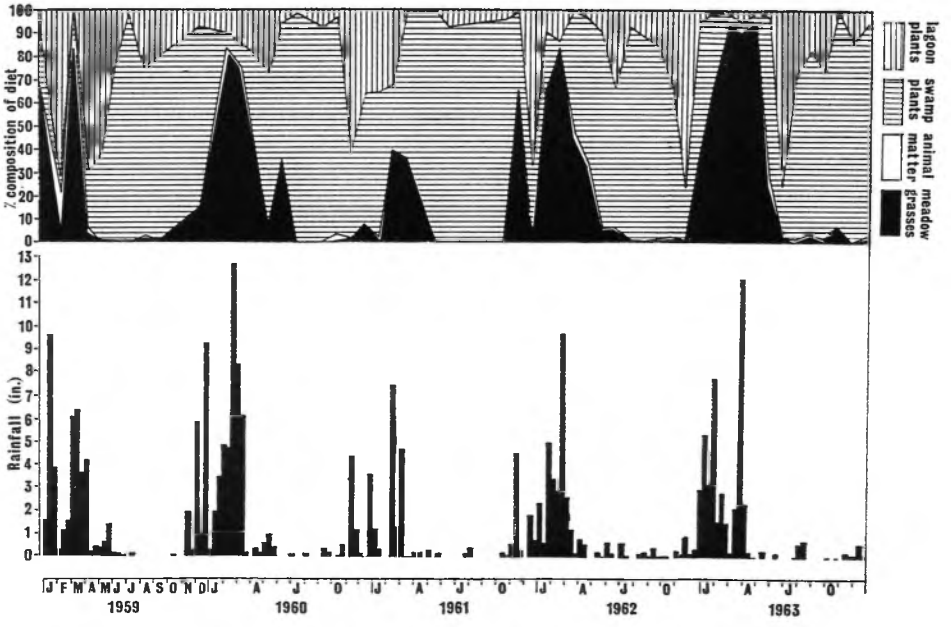

Figure 3. Seasonal diet of 1,087 Wandering Whistling Ducks from north Queensland study areas in relation to rainfall (after Lavery 1970b).

Table VI. Major dry season food sources of waterfowl species commonly in north Queensland study areas, 1958-1964.

Species	*Number of gizzards examined*	*Food sources* *Group*	*Volume (%)*	*Frequency of occurrence (%)*
Magpie Goose	40	Cyperaceae (tubers)	62.3	72
Plumed Whistling Duck	279	Gramineae	68.4	93
Wandering Whistling Duck	19	Gentianaceae	32.6	74
Black Duck	2346	Cyperaceae (seeds)	29.3	61
		Polygonaceae	24.6	33
Grey Teal	258	Gentianaceae	23.1	29
		Cyperaceae (seeds)	22.7	69
		Animal material	18.5	20
White-eyed Duck	214	Polygonaceae	25.5	33
		Nymphaceae	21.8	21
Maned Goose	46	Gramineae	60.7	88
Green Pygmy Goose	32	Nymphaceae	29.9	28
		Potamogetonaceae	11.2	25
Australian Pygmy Goose	77	Potamogetonaceae	53.9	43

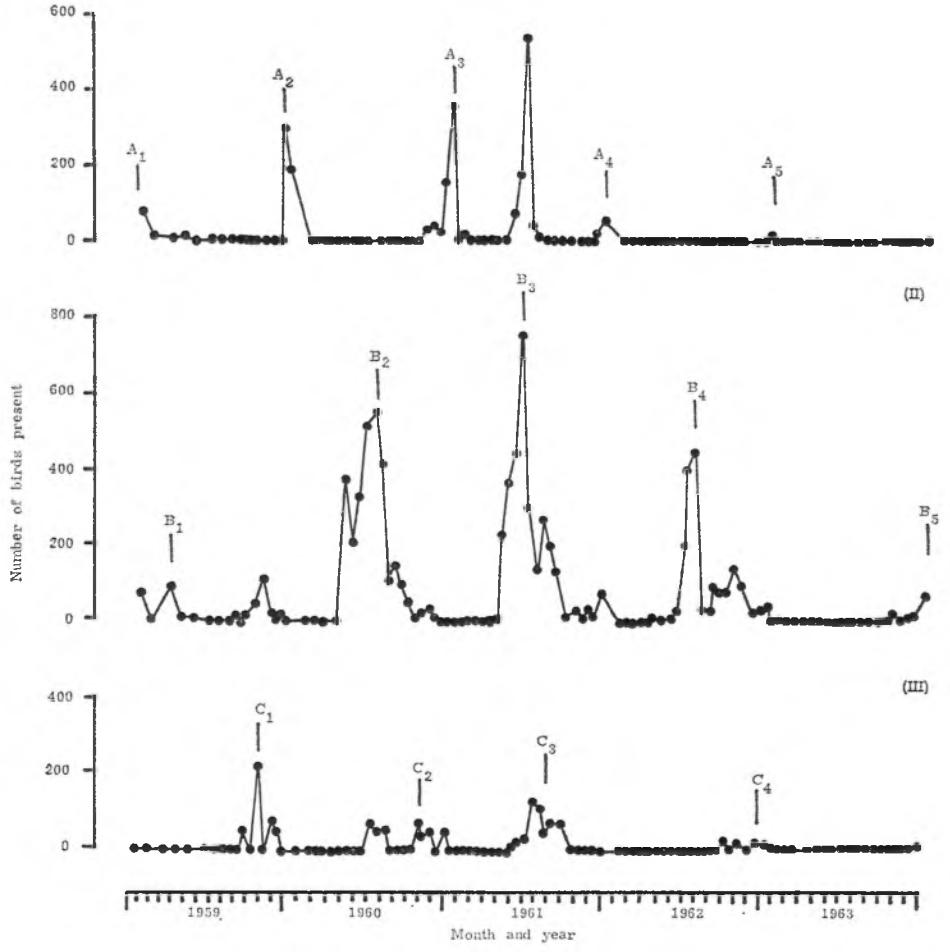

Figure 4. Numbers of Grey Teal counted fortnightly at (i) swamp, (ii) lagoon, and (iii) tidal flat habitat types in the Townsville district of north-eastern Queensland, 1959-63. Peaks (A, B, C) respectively show annual sequence of utilization by birds at these localities (after Lavery 1970c).

Table VII. Breeding ranges of the northern waterfowl species relative to dry season habitat types.

Dry season food habitat	*Species*	*Main breeding range*
Grassland/meadow	Plumed Whistling Duck	Coastal
	Maned Goose	Inland
	Black Duck	widespread
Lake/river/lagoon		
—sub-surface	Wandering Whistling Duck	Coastal
	White-eyed Duck	Inland
—surface	Australian Pygmy Goose	Coastal
	Green Pygmy Goose	Coastal
	Pink-eared Duck	Inland
	Black Duck	widespread
Tidal flat	Radjah Shelduck	Coastal
	Grey Teal	Inland
	Black Duck	widespread
Swamp		
—sub-surface (only coastal)	Magpie Goose	Coastal

isolated as a result of food specialization. Moreover, species closely associated in the dry season were least closely associated during reproduction in the wet season (Table VII). Breeding habitat was then sufficiently widespread to permit species of similar habits to nest over the whole of north Queensland and the birds became abundant. Later, all species had to utilize limited, mainly coastal habitat and invariably only one of each of the similar-habit species remained common. It is thus not surprising that inland species in north Queensland are generally less common than their coastal ecological counterparts. In this respect also it is noteworthy that the Green Pygmy Goose is distributed primarily in north-western Australia and the Australian Pygmy Goose occurs only in north-eastern Australia (Lavery 1966c; Frith 1967). This geographic subdivision occurs in other water birds; for example the Magpie Goose and the Brogla *Grus rubicundus*, both highly specialized to utilize bulkuru sedge, were likewise separated (Lavery and Blackman 1969). The existence of a 'Carpentaria Barrier', i.e. a barrier between the Flinders and Leichhardt Rivers blocking gene exchange among passerine species of the Torresian sub-region (Macdonald 1969), perhaps also applies to water birds.

These distributions can be used to indicate priorities for species' conservation. In northern Australia the coastal species should receive attention before the more aggressive cosmopolitan, inland and southern vagrant forms even though these may be less common at present. There is a danger that these latter species may eliminate completely the restricted northern species when they are likewise seeking refuge from drought. Such a situation is possibly already well under way (as a consequence of direct and indirect interference by man) between Grey Teal and Black Swan on one hand and the Radjah Shelduck on the other.

Because of its primitive and peculiar nature the Magpie Goose should be conserved before others; its management could most effectively be undertaken in north-western Australia rather than in north Queensland. The Radjah Shelduck should receive next attention but management anywhere to preserve this uncommon species may be rather difficult. In north-western Australia and north Queensland respectively the Green Pygmy Goose and Australian Pygmy Goose are of limited distribution and numbers, but both make important use of artificial habitat that is plentiful after rain. Wandering Whistling Ducks and Plumed Whistling Ducks also utilize this artificial habitat and are widespread in distributions and numbers at present. Habitat manipulation for any of these species will benefit the other Australian waterfowl that do not require perennial deep-water habitat, which is more or less confined to the temperate zone.

The fundamental divergence of feeding habits of Australian waterfowl has led elsewhere to other conclusions. For example it is generally supposed that the stresses which instigate divergent behaviour, such as competition for the obviously limited food supply, continue during drought, since the differences are maintained throughout a dry season. In north Queensland, evidence contrary to this conclusion was noted for species at drought refuges. Since the important artificial habitat referred to above is less permanent than the natural habitat (Table I), specific investigations related to conservation are being undertaken. The objectives are to determine the precise nature of, and the extent and causes of mortality at, an ultimate drought refuge in north Queensland.

Summary

Ecological investigations of all the waterfowl species occurring in north Queensland during 1958-1964 are reviewed.

Habitat types were similar to those of southern Australia but the area available varied more markedly between the well-defined wet season (November-April) and the prolonged dry season. Artificial wetlands, nowadays predominating, did not increase seasonal stability of the habitat.

Birds bred during most wet seasons in the coastal region (six species), in the inland region (four species) or throughout (one species). Habitat then was abundant and requirements for breeding and results of reproduction were similar.

Parents and fledged young moved from the temporary breeding habitat types to more permanent localities, mostly coastal, as wetlands evaporated in the dry seasons. Large concentrations occurred, with some readily discernible influxes of more distant breeding populations.

Populations were unaffected by either parasitism, disease, or shooting.

Habitat became extremely limited by drought and birds annually became isolated according to characteristic feeding habits. Such isolation provides the basis for practicable conservation priorities.

In north Queensland special care should be taken of four coastal species — the Radjah Shelduck *Tadorna radjah rufitergum*, Australian Pygmy Goose *Nettapus coromandelianus albipennis*, Wandering Whistling Duck *Dendrocygna arcuata australis* and Plumed Whistling Duck *Dendrocygna eytoni*. Artificial impoundments are used widely, but are less stable than natural habitat and the species may remain susceptible to drought.

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