Important aspects of duck hunting in Australia, with particular reference to western Australia

J. A. K. Lane

SUMMARY

LANE, J.A.K. (1985). Important aspects of duck hunting in Australia, with particular reference to western Australia.
Proc. Symp. Birds & Man, Johannesburg 1983: 281-307.

Australia is an arid continent with limited waterfowl diversity. Waterfowl populations are normally confined to higher rainfall areas near the coast, and to the Murray-Darling basin. The arid interior is utilized in wet years. Wildlife management is a responsibility of the states. Regulations governing hunting vary somewhat from state to state however these variations are of little significance to waterfowl populations. All states protect rare and vulnerable species, restrict hunting to the post-breeding period and provide refuges. All but one impose bag limits. There are approximately 82 000 licensed shooters in Australia (0,6% of the population) and 87% are in the populous south-east. Nationally the most important game species are Grey Teal, *Anas gibberifrons*, and Black Duck *A. superciliosa*. Australian Shelduck, *Tadorna tadornoides*, and Chestnut Teal, *A. castanea*, are of local importance. The average annual duck harvest for 1972-1977 is estimated to be 1,3 million with a range of 0,14 to 5,1 million. Current concerns include the possibility of regional populations being over-harvested in dry years. A system which operates in Western Australia of varying open season specifications (duration, bag limit, etc.) according to environmental conditions is described. The merits of this system are discussed, as are the author's views on future research and management priorities. The importance of habitat in the long term maintenance of present duck numbers is emphasised.

Introduction and aims

This paper has three aims:-

The first is to provide an overview of waterfowl and waterfowl hunting in Australia. Various aspects are considered including species diversity, distribution and abundance, the regulation of hunting activities, the number and distribution of hunters,

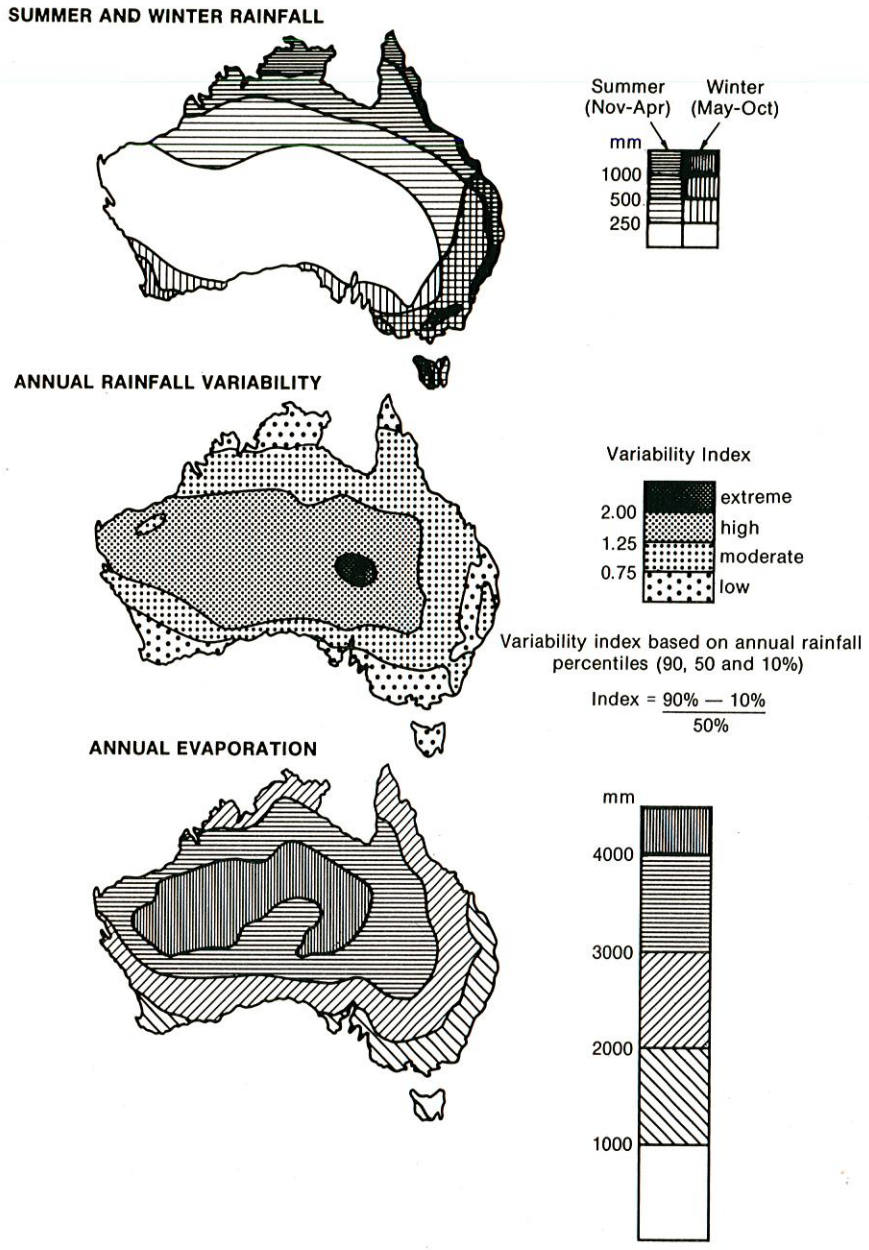

Figure 1. Rainfall, rainfall variability and evaporation in Australia.

and the composition and size of the harvest.

The second aim is to outline three current concerns which relate to waterfowl hunting and to describe how one of these concerns, that of possible over-exploitation of duck populations in dry years, has been addressed in Western Australia.

The third aim is to present the author's views on future research and management priorities, in particular the need for some minimum form of waterfowl abundance monitoring and for more attention to be given to urgent problems of habitat protection and management on privately-owned land.

The Australian environment

Antarctica aside, Australia is the world's driest continent. 30% of the total land area receives less than 200 mm of rain per annum and 71% receives less than 500 mm (Anon. 1982). Northern parts of the continent receive their rainfall during summer months, southern areas during winter and south-eastern areas in all seasons (Fig. 1). Rainfall regimes of the arid interior reflect those of adjacent areas. High rainfall areas exhibit low to moderate rainfall variability and low rainfall areas of the interior exhibit extreme variability. Evaporation rates are very high in all but southernmost areas. 75% of the continent has annual evaporation exceeding 2 500 mm.

As a consequence of low rainfall and high evaporation average annual runoff to the oceans is very low and corresponds to a depth of only 45 mm over the whole continent. This may be compared with Africa (160 mm), Asia (220 mm), Europe (230 mm), North America (260 mm) and South America (490 mm) (Anon. 1977).

Australia's waterfowl

The diversity, distribution, abundance, movements and breeding schedules of Australian waterfowl reflect the above characteristics of thier environment.

The species

Australia is the poorest of all continents in terms of number of species of waterfowl. There are 148 species in the world and of these only nineteen are native to Australia (Table 1). There are also two occasional visitors and two introductions. This may be compared with North America which has 43 indigenous breeding species and 5 regular visitors (Bellrose 1978). Even Britain, 1/33 the size of Australia, has 17 indigenous breeding species (Sharrock 1977).

The nineteen Australian species comprise the Magpie Goose *Anseranas semipalmata* (tribe Anseranatini), two tree-ducks (Dendrocygnini), one swan (Cygnini), the Freckled Duck *Stictonetta naevosa* (Stictonettini), Cape Barren Goose

TABLE 1

Native Australian Waterfowl

Subfamily	Tribe	Species	
Anseranatinae	Anseranatini	**Anseranas semipalmata*	Magpie Goose
Anserinae	Dendrocygnini	*Dendrocygna arcuata*	Wandering Whistling Duck
		Dendrocygna eytoni	Plumed Whistling Duck
	Cygnini	*Cygnus atratus*	Black Swan
	Stictonettini	**Stictonetta naevosa*	Freckled Duck
	Cereopsini	**Cereopsis novaehollandiae*	Cape Barren Goose
Anatinae	Tadornini	*Tadorna tadornoides*	Australian Shelduck
		Tadorna radjah	Radjah Shelduck
	Anatini	*Anas superciliosa*	Pacific Black Duck
		Anas gibberifrons	Grey Teal
		Anas castanea	Chestnut Teal
		Anas rhynchotis	Australasian Shoveler
		**Malacorhynchus membranaceus*	Pink-eared Duck
	Aythyini	*Aythya australis*	Hardhead
	Cairinini	**Chenonetta jubata*	Maned Duck
		Nettapus pulchellus	Green Pygmy Goose
		Nettapus coromandelianus	Cotton Pygmy Goose
	Oxyurini	**Biziura lobata*	Musk Duck
		Oxyura australis	Blue-billed Duck

* endemic genera

Introduced species are Mallard *Anas platyrhynchos* and Mute Swan *Cygnus olor*.
Occasional visitors are Garganey *Anas querquedula* and Northern Shoveler *Anas clypeata*.

TABLE 3

Waterfowl shooting seasons in relation to breding.

		Western[1] Australia (south-west)	South Australia	Victoria	New South Wales	Tasmania	Queens-land (south)	Queens-land (north)	Northern[4] Territory	Western[5] Australia (outside south-west)
Major Breeding Period		August-December					Jan-May	February-June		Jan-Apr and erratic
Shooting	Date	Early Jan	Late Feb.	Mid March		Early March	Approx. 1st June	Approx. 1st July	1st July	Continuous
Season	Day	Saturday							-	Open
Opening	Time	18h00	1hr before sunrise	06h00	1 hr before sunrise		00h00			Season
Season length (weeks)		10	17	10			12		18	
Daily Bag Limit		10	12	20 Opening Day[2] 10 Thereafter		10[3]	12		No Limit	10

Notes:

1. Restricted seasons in the south-west of W.A. open at 06h00 on Sunday for 4 weeks with a bag limit of 5.
2. No more than 10 birds of one species may be taken on Opening Day in Victoria and shooting is prohibited on Sundays.
3. Limit of 2 Australian Shelducks per day in Tasmania.
4. Magpie Goose season in N.T. opens on 1st August for 22 weeks.
5. Breeding season is Jan-Apr in Kimberleys and erratic in interior.

TABLE 2

Game status of Australian waterfowl.

Status	Species	Western Australia (South-west-	Western Australia (outside south-west)	South Australia	Victoria	New South Wales	Tasmania	Queens-land	Northern Territory
Protected Throughout Normal Range (8 species)	Freckled Duck *Stictonetta naevosa*						O		OX
	Cape Barren Goose *Cereopsis novaehollandiae*		O			O		O	O
	Radjah Shelduck *Tadorna radjah*	O		O	O	O	O		
	Cotton Pygmy Goose *Nettapus coromandelianus*	O	O	O	O	O	O		OX
	Green Pygmy Goose *N. pulchellus*	O		O	O	O	O		
	Black Swan *Cygnus atratus*								O
	Blue-billed Duck *Oxyura australis*		O					O	OX
	Musk Duck *Biziura lobata*							O	OX
Protected in part of Normal Range (6 species)	Magpie Goose *Anseranas semipalmata*	O		O	O	O	O		X
	Plumed Whistling Duck *Dendrocygna eytoni*	OX	X	O	O		O	X	X
	Australasian Shoveler *Anas rhychotis*	X	X	X	X	X			OX
	Pink-eared Duck *Malacorhynchus membranaceus*			X	X	X			X
	Hardhead *Aythya australis*	X	X	X	X	X		X	X
	Maned Duck *Chenonetta jubata*	X	X	X	X	X		X	OX
Game Species Throughout Normal Range (5 species)	Wandering Whistling Duck *Dendrocygna arcuata*	OX	X	O	O	O	O	X	X
	Australian Shelduck *Tadorna tadornoides*	X	X	X	X	X	X	O	OX
	Pacific Black Duck *Anas superciliosa*	X	X	X	X	X	X	X	X
	Grey Teal *A. gibberifrons*	X	X	X	X	X	X	X	X
	Chestnut Teal *A. castanea*	X	O	X	X	X	X	O	OX
Total Game species (excluding OX's)		7	8	8	8	8	4	6	7
Total Protected species (excluding O's)		6	7	5	5	5	8	8	2

KEY: X = declared game species; O = outside normal range.

Cereopsis novaehollandiae (Cereopsini), two shelducks (Tadornini), seven dabbling ducks (Anatini), one pochard (Aythyini), two perching ducks (Cairinini) and two stiff-tailed ducks (Oxyurini). The two introductions are the Mallard, *Anas platyrhynchos*, and the Mute Swan, *Cygnus olor*, neither of which occurs in large numbers. Six of the thirteen genera are endemic and each of these is monotypic.

Their distribution

The general limits of distribution of all species of Australian waterfowl have been known for many years. Frith (1977) recognized three broad categories: northern (6 species), southern (8) and continental (5). Distributions have been defined more precisely in recent years by the Royal Australasian Ornithologist Union's 'Atlas of Australian Birds' due to be published in 1984. This project, which involved the mapping of distributions and breeding distributions of all Australian birds on a 1° lat. long. grid during the period 1977-81, will significantly advance our knowledge of the distribution, relative abundance, movements and breeding schedules of Australian waterfowl.

Abundance

Although reasonably comprehensive assessments of the abundance of two of the rarer species of waterfowl (Freckled Duck and Cape Barren Goose) have been undertaken (unpublished and Eberhard & Pearse 1981) as have a number of regional surveys of all species (e.g. Brown and Deerson 1982 and Jaensch 1982), there has as yet been no attempt to assess populations of the remaining 17 species on a national scale. The actual numbers of most species of Australian waterfowl and all game species are therefore not known. Whilst this is true, one can reasonably assume, on the basis of data from regional population surveys, hunter surveys and banding studies (see below), that total waterfowl numbers in Australia are in the order of millions to tens of millions. The great majority of these birds inhabit those parts of the continent which receive on average more than 500 mm of rain per year, and the Murray-Darling basin, most of which receives less than 500 mm but whose headwaters flow from the high rainfall belt of the Great Dividing Range. These are the northern, southern and Murray-Darling 'waterfowl regions' of Frith (1977) (Fig. 2). The remainder of the continent, Frith's 'central region', with its low rainfall and high evaporation rates is of little use to waterfowl in most years. However, whilst average rainfall is low, the variability in rainfall is high (Fig. 1) and in some years widespread falls of up to 400 mm in a few days may occur (Anon. 1982). These may cause extensive flooding of inland lakes and watercourses and in doing so create vast albeit shortlived areas of suitable habitat. The channel-country of south-western Queensland is believed to be particularly important in this regard.

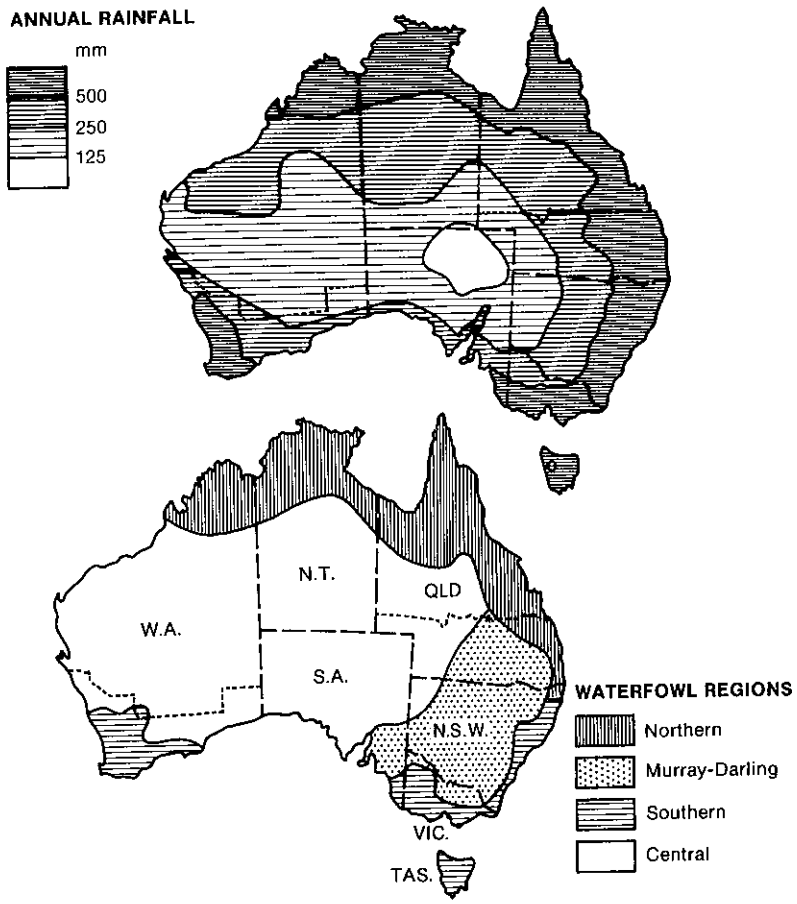

Figure 2. Rainfall distribution, waterfowl regions (based on Frith, 1977).

Movements

There are no regular large-scale migrations of waterfowl in Australia as there are for example in North America or Europe. Large-scale waterfowl movements in Australia are characteristically erratic in both timing and direction. Because of the high variability of rainfall over much of the continent dramatic and unpredictable changes in the availability and distribution of suitable habitat may occur. Many species, particularly Grey Teal *Anas gibberifrons*, and Pink-eared Duck, *Malacorhynchus membranaceus*, travel widely in response to these changes.

Some regular small-scale movements do occur however. In the south-west for example there is a regular movement of birds towards the more-permanent wetlands of the coast during the summer dry season and a return movement to seasonal wetlands of the inland south-west in winter. Similar movements occur in the south-east. In the north of the continent there is a regular east-west movement with many birds congregating on the more-reliable wetlands of the east during the winter dry season and dispersing westwards when the summer monsoons begin (Frith 1977).

Breeding

Some species of Australian waterfowl, typically those which are associated with deep, permanent lagoons (e.g. Musk Duck *Biziura lobata*, and Blue-billed Duck *Oxyura australis*) have regular breeding seasons which are little affected, in timing at least, by variations in rainfall. In most species, however, breeding is controlled by rainfall and its effects on water levels. In the south, where the main rain is in the winter, waterfowl breed in late winter and early spring; in the north, where the rain is in the summer, they breed in late summer and autumn. In the inland, where the rainfall is erratic, breeding can occur at any time of the year that the swamps fill (Frith 1973).

Regulation of waterfowl hunting in Australia

Australia is a federation of six sovereign states (Fig. 2) and under the Constitution of the Commonwealth (Commonwealth of Australia Constitution Act 1900) each state has sole responsibility for the conservation and management of all wildlife within its borders. The Commonwealth Government has direct administrative control of wildlife only in its own territories, only one of which (the Northern Territory, hereinafter included in the term 'state') is of significance in the context of waterfowl exploitation. Each state therefore has its own laws governing the hunting of wild waterfowl.

Regulations vary somewhat from state to state, partly due to differences of approach by the regulatory authorities concerned, but mainly due to differences of circumstance, either social (e.g. local tradition) or environmental (e.g.

climatic differences). On the whole however these variations are of little significance to the status of waterfowl populations.

Protected species

All states agree on the need to protect those species which are least abundant and most vulnerable in terms of either ease of shooting or reproductive potential or both. Thus the Freckled Duck, Cape Barren Goose, Radjah Shelduck *Tadorna radjah*, Cotton Pygmy Goose, *Nettapus coromandelianus* and Green Pygmy Goose, *N. pulchellus*, are protected throughout their normal range (Table 2). Other species which are protected throughout their normal range are the Black Swan, *Cygnus atratus*, Blue-billed Duck and Musk Duck; the swan primarily for sentimental reasons and the latter two because they are reluctant fliers during daylight and therefore unsuited for game shooting.

Species which are protected in part but not all of their normal range are the Magpie Goose, Plumed Whistling Duck *Dendrocygna eytoni*, Australasian Shoveler *Anas rhynchotis*, Pink-eared Duck, Hardhead *Aythya australis* and Maned Duck *Chenonetta jubata*. Each of these is declared game in those states where it is most abundant and protected in one or more states where it is less so.

Species which are declared game throughout their normal range are the Wandering Whistling Duck *Dendrocygna arcuata*, Australian Shelduck *Tadorna tadornoides*, Pacific Black Duck *Anas superciliosa*, Grey Teal and Chestnut Teal *A. castanea*.

It is apparent from Table 2 that states vary somewhat in their approach to the determination of game and non-game species. In Tasmania and Queensland for example the only waterfowl declared game are those species of ducks which are locally abundant. In the Northern Territory on the other hand, the Magpie Goose and all species of ducks except those which are both uncommon and vulnerable and of which the Territory holds a large proportion of total Australian populations (i.e. the Radjah Shelduck and Green Pygmy Goose), are declared game. Other states adopt an intermediate approach.

Closed and open seasons

All states agree on the desirability of confining shooting to the post-breeding period. The relationship between breeding and shooting seasons in each state is shown in Table 3.

In Western Australia little rain falls in the south-west of the state from November to April and so the area of water available for ducks and shooters decreases rapidly during this period. The shooting season is therefore held immediately after completion of breeding in order to minimise the impact of shooting on duck populations and to provide local shooting

TABLE 4

Numbers of licensed duck shooters in Australia, 1977-83.

Year	Western Australia	South Australia	Victoria	New South Wales	Tasmania	Queensland	Northern Territory	Total
1977	4 703	9 032	52 188	12 000	?	?		
1978	487[1]	6 658	47 934	11 000	3 988	1 555		
1979	4 022	?	57 000	13 000	3 673	1 396+		
1980	184[1]	6 728	56 000	11 000	3 420	1 314+	Licence	
1981	81[1]	5 834	53 000	10 000	3 277	1 802	not	
1982	4 217	5 657	figures unobtainable	?	2 831	1 587	Required	
1983	4489 ~~9 015~~	0	0	0	?	?		
Average[2]	4400 ~~5 500~~	6 800	53 000	11 400	3 400	1 650	-	82 000
(% of total)	~~(77)~~ (5)	(8)	(65)	(14)	(4)	(2)		(100)
Shooters as % of males ages ≥ 16 years	0.9 ~~1.2~~	1.4	3.8	0.6	2.3	0.2	-	1.6

Notes:
1. No seasons were declared in the south-west of W.A. in 1978, 1980 and 1981.
2. Averages do not include years when no season was declared or for which data are not available or are incomplete.
3. Northern Territory is only 0.8% of the total population of Australia.

opportunities for people who live in inland areas which are dry and therefore devoid of ducks by March or April.

In Victoria and New South Wales, where rainfall is less seasonal and water levels do not decline as dramatically in summer and autumn, duck seasons do not commence until 2-2½ months after peak breeding. This is to enable adult birds of the main game species, Grey Teal and Pacific Black Duck to complete their post-nuptial moult of flight feathers before shooting commences. In Western Australia shooting at birds on the water is illegal on Game Reserves at least, and moult is not considered to be an important factor so far as the setting of seasons is concerned.

Shooting is permitted all year round in only one part of Australia, that is Western Australia outside the south-west. This is because of the vastness of the area, the very small numbers of inhabitants, the difficulty of access to breeding areas following rain, and the unpredictability of rains over most of the area concerned.

The duration of duck shooting seasons varies from state to state. Most states have seasons of 10-12 weeks, whilst South Australia has a season of 17 weeks and the Northern Territory 18 weeks. In the south-west of Western Australia where a full season is 10 weeks, restricted seasons of only 4 weeks may at times be declared. The Magpie Goose season in the Northern Territory is 22 weeks.

The choice of closing dates appears to be based on a consideration of three main factors. Firstly a desire to provide adequate opportunity for shooters to pursue their sport; secondly the need to close the shooting season prior to the commencement of the following breeding season, and thirdly a generally-held view that in those parts of the continent where the area of water available for waterbirds and shooters decreases markedly during the annual dry season (e.g. the south-west of Western Australia), an unacceptable level of kill would occur if hunting were permitted to continue for too long a period.

Bag limits

All states except the Northern Territory impose limits on the number of birds which may be taken per person, per day during the open season. These limits vary from 10-12 depending upon the state concerned (Table 3). Exceptions to the 10-12 limit are Victoria and New South Wales, where the opening day bag limit (20) is twice the daily limit which applies for the remainder of the season, and the south-west of W.A. where the limit is reduced in a restricted season from 10 birds to 5. The elevated opening day limit in Victoria is probably due to the fact that in this state, unlike other states of Australia, sport shooting of any kind is prohibited on Sundays. The absence of bag limits in the Northern Territory is presumably due to a scarcity of keen shooters

(though no figures are available) and the fact that very few areas of Crown Land are available for hunting.

'Split' bags (i.e. bags in which some distinction is drawn between different game species) are declared in Tasmania, where no more than 2 of the 10 birds may be Australian Shelduck, and the south-west of W.A., where there is at present no limit on the number of shelduck which may be taken. The Australian Shelduck is a conspicuous and readily identifiable species and is the least abundant of the four game species in the island state of Tasmania. It is also a local breeder whose numbers receive little augmentation from the mainland. Tighter controls than apply to other game species are therefore considered desirable. In Western Australia, where much salting of the landscape has occurred due to clearing of native vegetation for agriculture, the Australian Shelduck is a particularly successful species as it is well-adapted for utilizing saline habitats and makes extensive use of farm dams for breeding. Its abundance, its propensity for grazing germinating crops and for fouling farm dams, and its tendency to fly high out of range when shooting commences have together led to the lifting of the bag limit for this species.

Refuge areas

All states agree on the need for no-shooting or refuge areas, primarily to ensure that a proportion of the game bird population can avoid being shot at, particularly on opening day when shooting pressure in some districts may be intense. Refuges are thus considered to be an important means of preventing an unacceptable level of kill. Refuges may also be declared to prevent accidental shooting of non-game species such as Freckled Duck, and disturbance of sensitive species such as colonial-nesting egret, heron, ibis or spoonbill. Wetlands may also be closed to shooting because of their proximity to urban areas, partly for safety reasons but also to provide recreational opportunities for those who wish to see birds rather than have them driven away by shooting. Thus in 1892 when Perth Water, Western Australia's first waterfowl refuge, was about to be declared, the then Colonial Secretary, Hon. G. Shenton stated '... a general wish has long been expressed that all shooting on Perth water should be stopped, so that native game might settle there as it used to do years ago before it was driven away by the shooting. The Government propose to give effect to that wish...' (Lane, in prep.).

Comprehensive information concerning the number of declared refuges in Australia and the areas and types of habitats involved is particularly difficult to obtain and is therefore not presented here. In any case this information would not provide a true indication of the total refuge available as much public and private land not controlled by state wildlife authorities is also closed to shooting. In addition, even in areas which are open to shooting, considerable natural refuge exists in the form of large expanses of open water and other 'un-shootable' habitat.

Game reserves

Four states see a need to provide areas of public land specifically for waterfowl hunting. In Western Australia for example the Fauna Protection Advisory Committee of the early 1950's adopted a policy of 'setting aside a system of lakes for each district where it is possible to ensure that future generations of duck shooters would have the opportunity to conduct their sport and that wetland duck habitats might be kept in perpetuity' (Lane in prep.). The committee was 'concerned that the State should profit from experiences in the U.S.A. and more recently in Victoria of setting aside such reserves and protecting waterfowl habitat before they were alienated and despoiled and had to be re-purchased by the Crown'. From the early 1950's to 1982 the number of such 'game reserves' in the south-west of Western Australia has grown from 0 to 84.

Other states which provide game reserves are Victoria (37), South Australia (6) and New South Wales (2).

Whilst game reserves are primarily facilities for hunters they are also useful for regulatory authorities in that they enable greater control to be exercised over hunting methods. Thus in Western Australia the use of boats, pooling of bags and shooting of birds (except wounded birds) less than 3 m above the water are all activities which are not permitted on game reserves. Game reserves also facilitate law enforcement by enabling Wildlife Officers to order miscreants and others to leave any particular reserve for the duration of the shoot. The number of shooters on a reserve at any one time may also be limited, though this power has not been used.

In addition to game reserves, all states have a system of nature reserves where habitat is protected and shooting is not permitted. These reserves are quite distinct from game refuges which, though closed to shooting, may include public and private land where habitat is not protected.

Other controls

There are many additional controls on the activities of duck hunters. Some of these are designed to protect waterfowl and some to protect hunters. Included are bans on the sale of wild ducks and on the use of boats, snares, traps, nets, spotlights and explosives. Also banned are shooting at night (some states) and the use of firearms other than approved types of shotguns. The 'pooling' of bags is also prohibited and limits may be imposed on the number of birds which a person may have in his possession at any one time.

In most cases these additional controls have been introduced in response to local problems. They therefore vary somewhat from state to state. Except for possession limits and bans on sale and on the use of nets and traps, they are probably of little consequence so far as the status of game bird

TABLE 5

Species composition of duck shooters' bags.

Region	Licensed Shooters 1982	Period of Bag Check Data[3]	Total Waterfowl Examined	Grey Teal %	Black Duck %	Pink-eared Duck %	Maned Duck %	Shoveler %	Hardhead %	Australian Shelduck %	Chestnut Teal %	Wandering Whistling Duck %
Western Australia (south-west)	4 217	1974-82[a]	13 113	65	12	1	2	2	1	18	1	-
South Australia Victoria New South Wales	Approx. 60 000	1972-81[b]	82 000	52	24	8	7	3	3	2	1	-
Tasmania	2 831	1982[c]	?	14	61	-	-	-	-	5	20	-
North Queensland (Townsville area)	620	1959-63[d]	19 465	5	81	1	1	1	7	-	1	7

Notes:
1. Species which comprised < 1% of the bag in all States for which data are available are not listed.
2. No data are available for W.A. outside the south-west (100-200 licensed shooters), Queensland outside the Townsville area (970 licensed shooters) and Northern Territory (unknown numbers of shooters).
3. Sources of data: (a) Author, unpublished data; (b) Braithwaite 1981; (c) Tasmanian National Parks and Wildlife Service, unpublished data; (d) Lavery 1969.

populations is concerned.

Hunters

Duck hunting is a moderately popular sport in Australia, with 82 000 licensed followers (Table 4). This represents approximately 1,6% of the 'adult' (16 years or more) male population and 0,6% of the total population. In the United States of America the corresponding figure (total population) in 1976 was 1,0% and in Canada 2,1% (Cooch, 1978). Duck hunting is most popular in Victoria and Tasmania (3,8 and 2,3% respectively of males 16 years and over) and least popular in New South Wales and Queensland (0,6 and 0,2%). Popularity of the sport in the Northern Territory (0,8% of the total population of Australia) is not known as licences are not required for duck hunting in this state.

87% of licensed shooters are found in the populous south-eastern corner of the continent, i.e. Victoria, New South Wales and South Australia. The number of licences sold in these states and in Tasmania has declined in recent years and this may in part be due to declining interest in the sport. It is more likely however that the drop off in numbers has been caused by the drought which began in this part of the continent in 1978 and which still (March 1983) continues. In Western Australia a similar decrease in licence sales occurred during the prolonged dry period of 1976-80 however with improved rains in 1982 and 1983 a ~~dramatic~~ increase in the number of licenced shooters has occurred.

Harvests

Species composition

Recent data on the species composition of the harvest are available for all states except Queensland and the Northern Territory. These data are presented in Table 5, together with earlier data from northern Queensland. Data for Western Australia, South Australia, Victoria and New South Wales were collected during opening weekend whereas data for Tasmania and Queensland were collected throughout the season. The average number of licences sold in each region from 1977-1982 is also provided so that an impression may be gained of the importance of each game species in an Australia-wide context. Data are inadequate to permit calculation of the actual species composition of the total Australian harvest.

Grey Teal and Pacific Black Duck are obviously the most important game species of waterfowl in Australia. Species of lesser importance overall but of significance locally are the Australian Shelduck in Western Australia and Chestnut Teal in Tasmania.

TABLE 6

Estimate of annual waterfowl harvest in Australia, 1972-77.

Year	Black Duck and Teal Harvest in Victoria (thousands)[a]	Black Duck, Teal as % of Opening Day Vic. Bag[b]	Vic. Shooters as % of Total Aust. Shooters[c]	Total Australian Harvest (thousands)
1972	281 ± 125	88		491 ± 219
1973	58 ± 15	63		142 ± 37
1974	422 ± 292	69	65	941 ± 651
1975	2 413 ± 672	73		5 085 ± 1 429
1976	181 ± 44	76		366 ± 89
1977	471 ± 71	81		895 ± 135
Average	638			1 320

Sources of data: (a) Norman *et al.* 1981, (b) Braithwaite *et al.* 1974, 1976, 1977, and 1981, (c) Table 4, average % for 1977-83.

TABLE 7

Specifications of standardized duck shooting seasons in Western Australia.

	Full	Restricted	No
Opening Date	2nd weekend in January	2nd weekend in January	-
Opening Day	Saturday	Sunday	-
Opening Time	18h00	06h00	-
Season Length	10 weeks	4 weeks	-
Bag Limit	10 birds of any game species	5 birds of any game species	-

Size of the harvest

Only two serious attempts have been made to calculate the size of the harvest in parts of Australia. None has been made for the whole continent though McTaggart Cowan (1973) and Bekle (1983) have made rough estimates.

The total harvest of waterfowl in north Queensland in 1963 was calculated by Lavery (1969) using data from 8 137 shot birds and 78 band recoveries to be 70 000 birds. Annual harvests for the period 1952-63 were estimated to vary from none in years of extreme drought to 100 000 - 150 000 in years immediately following widespread floods.

Norman and Powell (1981) used licence numbers, bag data (2 912 bags), cripple data (2 774 interviews) and band returns (10 631 from 1953-1977) to estimate annual harvests of Grey Teal, Black Duck and Chestnut Teal in Victoria from 1972-1977. Further manipulation of the data which they present suggests that the average annual harvest of these three species during the period concerned was approximately 640 000 with a range of 58 000 in 1973 to 2 413 000 in 1975 (Table 6).

Since the species composition of the opening day harvest in Victoria is known (Braithwaite & Norman 1974, 1976, 1977 and 1981) and the ratio of licensed shooters in Victoria to licensed shooters in the whole of Australia may be calculated (Table 4), crude estimates of total Australian harvests may be attempted (Table 6). Assuming that the number of ducks taken per shooter per season for the whole of Australia is similar to that of Victoria, total annual waterfowl harvests by licensed shooters in the period 1972-1977 would have averaged 1,3 million with a range of 0,14 to 5,1 million. This wide range of values reflects annual variations in the size of Grey Teal, Pacific Black Duck and Chestnut Teal harvests in Victoria. These in turn are due to the combined effects of annual variations in average bag sizes for these species and in the number of licensed shooters. Thus in Victoria, at least, more shooters buy licences in 'good' seasons, when average bag sizes are high, than in 'poor' years, when average bags are low (Norman and Powell 1981).

The average figure of 1,3 million birds per year may be compared with McTaggart Cowan's (1973) estimate of 655 000 ducks taken during 1970 (includes estimate of harvest by unlicensed hunters) and Bekle's (1983) estimate of 930 000 during 1982.

Current concerns

Three aspects of duck hunters' activities in Australia are currently causing concern.

Protected species

The problem which is receiving most publicity is that of protected species, in particular Freckled Duck, being shot. In March 1980 an estimated 1 400-1 650 Freckled Duck were shot on opening day at Bool Lagoon in South Australia (Casperson 1980). One year later 800 of an estimated 3 000 in Victoria were shot (Corrick 1982). Smaller numbers have also been taken at shoots in New South Wales and Western Australia. Such incidents are viewed with particular concern because of the rarity of the species. A recent (February 1983) survey of Freckled Duck numbers in eastern Australia, coordinated by the Royal Australasian Ornithologists Union and funded by state governments, produced a total of only 7 500 birds (Martindale pers. comm.).

Since the Bool Lagoon incident various measures have been taken in an attempt to prevent a repetition. These include advance publicity of the whereabouts of Freckled Duck concentrations on opening day, closure of certain favoured areas, increased law enforcement activity and distribution of Freckled Duck identification pamphlets. These measures, plus adverse public reaction to such events will almost certainly result in fewer Bool Lagoon-type incidents.

Local over-harvest

A second matter which is causing some concern is the over-harvest of duck populations at particular localities. Recent unpublished studies suggest that more than 60% of birds at some popular shooting sites have been shot on opening day. Such incidents are not in keeping with sound management practices and do little to enhance the image of hunting in the eyes of the public in general and bird watchers in particular. How this problem will be tackled has yet to be seen.

Regional over-harvest

The third aspect of hunting which is causing some concern is the fact that in all states except Western Australia there are at present no regulatory procedures (except for the non-declaration of shooting seasons in years of extreme drought) for adjustment of the size of the harvest to the status of populations. Thus season specifications (bag limits, season length etc.) remain virtually unchanged from year to year regardless of whether the year has been excellent, good, fair or poor for duck survival and breeding. This may not be of concern in the less populous states however there is some concern that in the south-east of the continent at least, continuation of this situation may lead to over-exploitation of duck populations (see Maher 1982, Frith 1973 and Braithwaite 1981b). A decline in the proportion of Pacific Black Duck in shooters' bags in Victoria from 13-44% in 1972-76 (Braithwaite and Norman 1974, 1976, and 1977) to 2,5-13% in 1977-81 (Brown and Deerson 1982) has added to this concern.

In considering this matter of adjusting shooting season specifications (and thereby the size of the harvest) according to variations in the status of populations it is useful to examine recent events in Western Australia.

Open seasons in Western Australia

Fixed seasons

From 1874 (when controls on duck-hunting in Western Australia were first introduced.) until 1968, shooting seasons were declared every year and there were no year to year adjustments of specifications. There was however some tightening, with season length being gradually shortened from 6 to 3½ months and a daily bag limit being imposed, initially (in 1937) 20 birds per person and later (1951) 15 birds. In 1969 severe drought caused the declaration of a 'no season'. There had been earlier droughts however this was the first occasion on which a shooting season was not declared.

Variable seasons

In 1970 a decision was taken to determine future seasons on a biological basis, that is to vary season specifications each year according to the results of an assessment of waterfowl numbers, breeding success and timing, and vulnerability of birds to shooters. Although this step undoubtedly represented a significant advance in thinking, it did have several practical difficulties associated with it. The first was that the assessment of duck numbers, breeding success etc. was a largely subjective process since staff numbers (4) were inadequate for the task. This subjectivity led to frequent disagreement between those whose views determined the season and the shooting community whose views tended to be rather different. A second difficulty was that with all season parameters (date, day and time of opening, bag limits species composition, season length etc.) being, in theory at least, infinitely variable it was inevitable that the recommendations of the shooting community would differ from those of the wildlife department. Annual conflict was thereby assured. This 'infinite variability' also led to debates over the finest of details, details of little or no biological significance. In 1979 an unusually restrictive and unconventional season declaration led to exceptional levels of conflict and it became obvious that some changes to the system were needed.

Standardized seasons

On the advice of the author and in consultation with representatives of the duck-shooting community three things were done. The first was to standardize season declarations by reducing the number of options to three, either Full, Restricted or No seasons, each with predetermined specifications (Table 7). A second step was to clearly state that the wildlife department did not have the resources necessary to undertake annual assessments of breeding

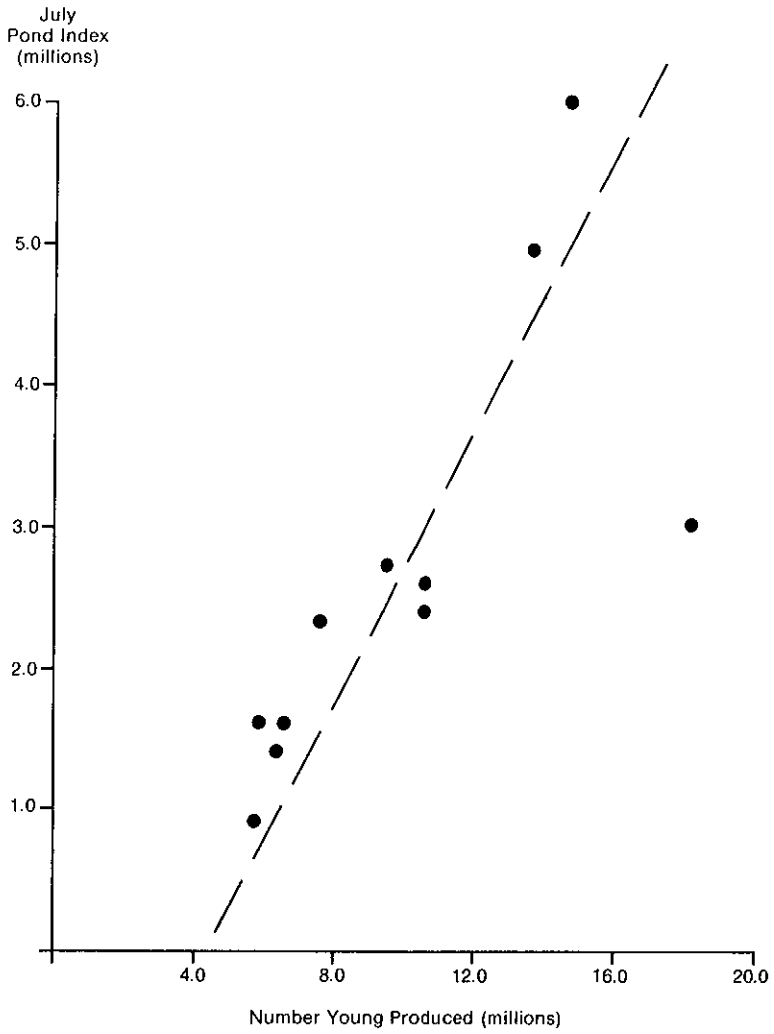

Figure 3. Relationship between number of water areas in pothole breeding habitat and continental (North America) production of Mallard *Anas platyrhynchos* young (from Crissey, 1970).

populations, production, shooter-induced and natural mortality etc. and that shooting seasons would therefore in future be based on biological principles, chiefly the principle that production is directly related to the area of water available for breeding, i.e. to conditions (see Crissey 1970 and Fig. 3). The third step, which naturally followed from the second, was to develop an objective method for the assessment of conditions. The use of satelite (Landsat) imagery for this purpose was considered (see Gilmer and Klett 1976 for an example of the application of this technique) however it was rejected for the time being at least because of the high cost of purchasing the necessary computer compatible tapes, the presently excessive time lag between satellite pass and receipt of tapes, but above all because of the inability of Landsat's multi-spectral scanners to penetrate cloud cover thereby making it an unreliable tool for the purpose. Instead of using Landsat to measure water area it was decided to use guages to measure water depth.

Assessment of conditions

From 1978 to 1983 depth guages were installed on 119 lakes and swamps throughout the south-west shooting area. These guages have made it possible to precisely monitor water levels of important breeding, shooting and refuge sites. Monitoring is undertaken at two month intervals by department research staff with valuable assistance from members of the Western Australian Field and Game Association. The water level data are used in conjunction with rainfall data (which extend back to 1913 and therefore enable present day conditions to be viewed in a long term context) to assess the 'normality' of conditions each year (Lane and Munro 1981, 1982, and 1983). The department's new approach is to declare 'Full' shooting seasons when conditions for waterfowl breeding have been average or better than average, Restricted seasons when conditions have been poor, and 'No' seasons when conditions have been particularly poor for a number of years. The principal objective of this system is to ensure that shooting does not cause a serious reduction in the size of the breeding stock during dry years or periods of prolonged drought.

Monitoring of populations

The regulatory procedures outlined above have been widely accepted as a fair means of providing shooters with adequate opportunity to pursue their sport whilst at the same time providing duck populations of the south-west of Western Australia with adequate protection from possible over-exploitation. There is still a problem however in that without some population data one cannot be entirely confident that the latter is true. Some minimum form of population monitoring is required to ensure that major changes which may occur in the status of waterfowl populations do not go undetected. A proposal which is presently being considered is the establishment of biannual 'abundance index' counts of all species of ducks, plus Black Swan and eurasian Coot *Fulica atra*,

in the south-west of the state. Other species of waterbirds may also be included. These counts would be organized along the lines of the Wildfowl Trust's monthly wildfowl counts in Great Britain (see Atkinson-Willes 1963 and Salmon 1981). A professional ornithologist with a small secretariat (initially one person) would coordinate the efforts of a large team of trained amateur observers who would conduct simultaneous counts on a representative selection of important waterfowl sites. A total count would not be attempted; the data would instead be used to provide indices of abundance. A pilot study is underway (Lane 1981).

In summary then, current thinking is that in the south-west of Western Australia duck season decisions (i.e. whether the shooting season is to be 'Full', 'Restricted' or 'No') will continue to be based on annual assessments of conditions. Biannual abundance index monitoring will be used to warn of significant changes in the status of game species and from time to time (but not annually) the specifications of 'Restricted' and 'Full' seasons may be varied if this seems necessary or desirable in the light of abundance data. Thus, for example, a persistent upward trend in numbers of an easily recognizable species such as the Australian Shelduck could lead to a relaxation of the bag limit for that species; or a continued downward trend for all or most game species could lead to a reduction in bag limits generally, and a shortening in the season.

Concluding remarks

The system described above of regulating duck shooters activities according to the results of annual assessments of wetland conditions is a simple one which the author is confident will, with the added safeguards of refuge areas and biannual abundance monitoring, provide adequate safeguards against possible over-exploitation of game species of ducks in the south-west of Western Australia.

The most important feature of this system is that unlike for example a North American-style programme which requires a very large commitment of personnel and funds for breeding population, production, winter population, hunter and banding studies (see Geis 1969 and Crissey 1970), it requires only a small commitment of staff and other resources. The system will therefore allow more attention to be given to the other important problem which confronts waterfowl today, that of habitat.

Numerous studies around Australia have shown that a large amount of waterfowl habitat has been lost since the advent of European man (see Riggert 1966 and Goodrick 1970 for examples). These losses have been due primarily to agricultural, urban and industrial development and involve a range of activities including dam construction, flood mitigation, drainage, landfill, clearing and grazing, as well as secondary salinisation due to catchment clearing. These losses have been partially

offset by the construction of farm dams and reservoirs (Braithwaite, 1981a) and by rises in water table resulting from clearing of catchments however in Western Australia at least it is clear that these additions have gone only a very small way towards restoring lost habitat of most species of waterfowl. A study of waterfowl habitat on the Swan Coastal Plain for example (Riggert 1966) has shown that the total area of wetland was reduced by some 62 000 hectares or 55% from 1954 to 1965.

As rural and urban developments expand and intensify these losses of habitat continue. Such losses can only be partly prevented by the creation of nature reserves and other conservation areas since much of the habitat being destroyed is privately owned and therefore to all intents and purposes unavailable for reservation. In any case it is clear that only a small proportion (presently 5,6% in Western Australia (Hinchey 1982) of the total land area can be set aside as reserves for conservation. There can be little doubt therefore that if present waterfowl numbers are to be maintained it will be necessary for all land users, and particularly farmers and water supply and drainage authorities, to accommodate waterfowl needs wherever possible by protection of natural habitat and by appropriate design and management of farm dams, reservoirs and other man-made water bodies which are potentially valuable habitat.

A substantial and sustained campaign by both government and non-government bodies concerned with wildlife conservation will be necessary if this change is to occur. This places a significant responsibility on the duck shooting community. If duck shooters were to concentrate their efforts on pressuring government to permit them to harvest every last available (surplus) duck each year the inevitable result, politics being what they are, would be for a disproportionate amount of government effort to be spent on researching every last detail of waterfowl population dynamics whilst the pressing problems of protection and creation of habitat would continue to receive less than adequate attention. If duck shooters in Western Australia are prepared to accept (as they have done in recent years, much to their credit) a simplified system of shooting season determinations and a moderate level of restraint on their activities, then more attention can be given to this most urgent problem of habitat. There is no question that this will be in the best long term interests of the shooting community both in terms of the number of ducks available for harvest in 30 years time, and in the public acceptability of their sport. (It is worth noting here that the research section of the West Australian Field and Game Association has already made its own start on habitat protection and enhancement projects on several wetland areas in the south-west of the state).

Wildlife managers also have a responsibility. This is to get on with the difficult task of persuading and enticing private landholders and relevant public bodies to wherever possible

make some allowance for the requirements of waterbirds in general and ducks in particular. This then is where government energies should be directed.

The late H.J. Frith, who in his time was undoubtedly Australia's foremost authority on waterfowl conservation and management, had a few words for both hunters and managers. 'Groups with special interests, like hunters, have much to gain from direct participation in wildlife production. The principle of paying for hunting privileges is not widespread in Australia yet. But, if paid a reasonable franchise, many landholders would be prepared to do the necessary work to ensure good game crops. There are places in the United States of America where the farmers income from game production is greater than it would be if the same land were used purely for agricultural production. In some of the more closely settled agricultural districts similar possibilities seem to exist here already' (Frith 1973). And for wildlife managers: 'One of the difficulties in wildlife conservation in Australia is that the management of the resource as a concept and as a practice is very slow to emerge. There is a widespread misapprehension, and not only among the public, that National Parks and reserves of various kinds constitute wildlife conservation and that little more is needed..... Reserves are not all that is needed by a very long way. That great numbers of species cannot be maintained in discrete areas is often overlooked..... These (migratory and nomadic species, including waterfowl) can only be conserved effectively if diverse elements of the countryside and seashores are retained in something like their natural condition, even though they might also serve an agricultural, pastoral or resort purpose'.

It remains to be seen how effectively the challenge will be taken up.

Acknowledgements

I am indebted to Technical Officer Don Munro for the sound advice he has provided on all aspects of waterfowl management during my period of involvement (July 1977 onwards) in this area.

The Fisheries and Wildlife Division of the Victorian Ministry for Conservation; the Queensland, South Australian and Tasmanian National Parks and Wildlife Services, and the Conservation Commission of the Northern Territory kindly provided information on duck hunting regulations and numbers of licensed shooters and their assistance is gratefully acknowledged. Thanks are also due to Sue Briggs, Ian Norman and Hans Wapstra for assistance with additional queries, Andrew Burbidge for helpful comments on the manuscript, Tony Birman for preparing the figures and four of the tables, Cliff Young for preparing transparencies for the presentation, and Raelene Hick and Thelma Woodward for typing the manuscript. Grant Pearson, Nick Caputi and Roger Jaensch provided additional assistance which is also acknowledged.

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James A.K. Lane, Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife, PO Box 51, Wanneroo 6065 Western Australia.