Sex and plumage-type ratios of the Lesser Magellan Goose in southern Chile

W.R. SIEGFRIED, P.A.R. HOCKEY, P.G. RYAN and A.L. BOSMAN

Introduction

Four of the five species of South American sheldgeese (genus *Chloephaga*) are terrestrial grass-eaters; the exception being the Kelp Goose *C. hybrida* (Delacour 1954). Three of the four terrestrial species breed in southern Patagonia, including Tierra del Fuego (Johnson 1965; Humphrey *et al.* 1970). They are the Ashy-headed Goose *C. poliocephala*, Ruddy-headed Goose *C. rubidiceps* and Magellan Goose *C. picta* which has two races, the Lesser Magellan Goose *C. p. picta* on the South American mainland, and the Greater Magellan Goose *C. p. leucoptera* on the Falkland Islands.

The Magellan Goose exhibits marked sexual plumage dimorphism, but in the other two species the sexes are similar. The Lesser Magellan Goose also differs from the other species in that adult males present a range of colour phases, from individuals with completely white underparts to birds heavily barred or blotched with black and white. In the Greater Magellan Goose, by contrast, the underparts of adult males invariably are pure white. Females in general show little variation, but the colour of the head of the Lesser Magellan Goose ranges between uniform reddish and dull grey cinnamon (Johnson 1965; Blake 1977). It has been known for a long time that the extreme colour phases presented by the Lesser Magellan Goose are more-or-less segregated in different regions and at different seasons; the barred types being most abundant in the south and the white type in the north (Johnson 1965; Humphrey *et al.* 1970). However, quantitative data supporting this are scarce.

This paper summarises the results of counts of Lesser Magellan, Ashy-headed and Ruddy-headed Geese made in the course of motoring over some 800 km of roads in southern Chile, including Tierra del Fuego, during 17-23 November 1985. These roadside counts gave quantitative data on relative abundance, group size and inter-specific association for all three species, and sex and plumage-type ratios for the Lesser Magellan Goose between *ca* 51°S and 54°S, close to the southern limit of their breeding distribution.

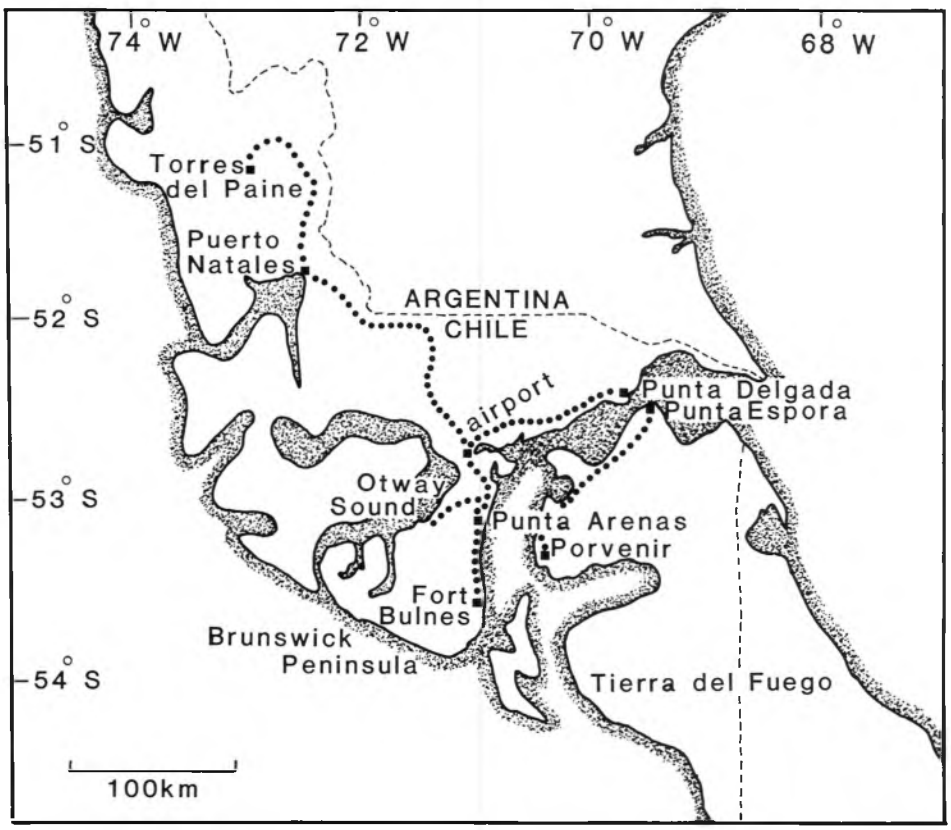
Methods

Sheldgeese were counted whenever seen within approximately 500 m of the roadside. Hence the relative abundance of sheldgeese is expressed as numbers of birds per km^2. The main routes traversed extended from Torres del Paine, in the north, via Puerto Natales and Punta Arenas, to Fort Bulnes in the south; from Punta Arenas, across the Brunswick Peninsula, to Otway Sound; from Punta Arenas, along the Straits of Magellan, north-east to Punta Delgada; and, on Tierra del Fuego, from Porvenir north-east to Punta Espora (see Figure 1). The sheldgeese on the route between Torres del Paine and Punta Arenas were surveyed only once, but the southern routes were travelled more frequently. In such cases, however, the surveys were restricted to separate days. A total of 310 encounters with sheldgeese were recorded in the extended road-strip, covering 808 km.

Sheldgeese were observed carefully, using binoculars and telescopes, and their behaviour, in terms of feeding, nesting and association between sexes, was recorded. The birds' habitats and any association between the birds and domestic livestock were also recorded. Three categories of males were recognised based on the extent of barring on their underparts: completely white; intermediate; and, completely barred. Delacour (1954) implies that belly colour of immatures reflects the adult colour phase, and thus the presence of immature and sub-adult birds in flocks should not bias analyses of plumage-type ratios. Females were also grouped in three categories, based on head coloration: greyish cinnamon; intermediate; and, reddish cinnamon. Birds were classified as 'indeterminate' when poor light, cover or some other factor prevented them from being categorised accurately. Birds were adjudged to be paired when individual males and females associated and moved closely together, usually within a metre of each other. In some flocks it was not possible to determine paired/unpaired ratios: such flocks were used only in analyses of sex ratio and group size.

Wildfowl 39 (1988): 15-21

Fig. 1. Map of the study area in southern Chile. Dotted lines indicate routes taken during surveys.



Results

Relative abundance

Totals of 1,941 (95%) Lesser Magellan, 78 (4%) Ashy-headed and 20 (1%) Ruddy-headed Geese were recorded. The Lesser Magellan Goose was markedly more abundant in the north of the survey area (Torres del Paine to Puerto Natales) and in northern Tierra del Fuego than elsewhere. Ruddy-headed and Ashy-headed Geese were uncommon in all three areas (Table 1). Highest densities of the Ashy-headed Goose were found on the Brunswick Peninsula, normally in association with indigenous forest patches. Several pairs were found breeding along the intermittently forested Rio San Juan to the south of Fort Bulnes. The Ruddy-headed Goose was most abundant, although still rare, in the grasslands of northern Tierra del Fuego, where the Ashy-headed Goose was absent.

Based on relative abundance of the geese

Table 1. Relative abundance of three species of sheldgeese in southern Patagonia, November 1985.

Survey route	Area surveyed (km^2)	Mean density of birds per km^2		
		Lesser Magellan Goose	Ashy-headed Goose	Ruddy-headed Goose
Torres del Paine – Puerto Natales	150	4.03	0.04	<0.01
Puerto Natales – Punta Arenas	188	0.99	0.06	0.00
P. Arenas Airport – Punta Delgada	240	0.99	0.04	0.03
Brunswick Peninsula	88	1.18	0.26	0.00
Porvenir – Punta Espora	142	5.35	0.00	0.06

Table 2. Percentage frequency of group size and the proportions (percentages) of paired birds in the Lesser Magellan Goose in three regions of southern Patagonia, November 1985.

Region	Group size			Sample size	Proportion of paired birds			Number of pairs observed with broods of small young
	2	3–10	>10	(no. groups)	Males	Females	Overall	
North	67	20	14	66	65	95	77	5
Central	60	18	22	62	44	45	45	0
South	71	18	10	168	52	55	53	1

species, three regions were recognised *a posteriori* within our study area: North (Torres del Paine – Puerto Natales); Central (mainland south of Puerto Natales); and, South (Tierra del Fuego) (Figure 1). These regions were used in subsequent analyses.

Group size

Group sizes of Ashy-headed and Ruddy-headed Geese varied between one and 24 and one and eight birds, respectively. Data bases for these two species are too small to allow further statistical analysis aimed at revealing any geographical differences in group size.

In the Lesser Magellan Goose, group size ranged between two and 152 birds. In all regions, a group size of two was most frequent (Table 2) and in only one instance did these observations not relate to presumed mated pairs. There was a tendency for groups to be largest in the Central region where density was lowest (Tables 1 and 2), corresponding with a lower proportion of paired birds in this region. However, group-size frequency was not significantly different between the regions (X^2=6.05, df=4, P>0.05).

Sex ratio and plumage types

Sex ratios of the Lesser Magellan Goose were very close to parity in all three regions: North, males = 52.2%; Central, males = 47.7%; and, South, males = 52.5%.

There was a clear latitudinal cline in male plumage-type frequency, with white birds predominating in the North and barred-bellied birds in the South. Intermediate type birds were more frequent in the North and Central regions than in the South (X^2=29.28, df=2, P<0.002) (Table 3). The pattern among females was less obvious. There was a clear gradient of grey-headed birds, decreasing towards higher latitudes, although intermediate females were numerically dominant in all regions and became increasingly so in the South (Table 3). The proportion of paired red-headed females in the Central region was greater than expected (X^2=10.34, df=2, P<0.01). These trends are reflected in the frequency distributions of the plumage-type combinations of paired birds in the three regions (Table 4).

Assuming that solitary males indicated actively breeding birds, there was no difference in their abundance relative to the occurrence of mated, but not actively breeding, males in each of the three regions (X^2=2.86, df=2, P>0.05). Similarly, there was no difference between plumage-type ratios of breeding males and mated males in the South region (X^2=2.92, df=2, P>0.05), or between similar ratios of white and intermediate males in the North region (X^2=0.06, df=1, P>0.05). Sample sizes for barred males in the northern region, and for all plumage-types in the Central region were too small for statistical analysis.

Table 3. Percentage frequency of three plumage types in male and female populations of the Lesser Magellan Goose in three regions of southern Patagonia, November 1985.

Region	Males Plumage-types				Females Plumage-types			
	White	Intermediate	Barred	N	Greyish	Intermediate	Reddish	N
North	61	32	7	127	33	51	16	70
Central	27	30	43	153	14	57	29	169
South	12	19	69	317	8	72	20	307

Table 4. Percentage frequency of the nine possible plumage-type pairings of the Lesser Magellan Goose in three regions of southern Patagonia, November 1985.

Region		Male plumage-type White	Intermediate	Barred	Total	
North						
female	Greyish	12	41	9	62	
plumage	Intermediate	16	10	7	33	
type	Reddish	3	2	0	5	
Total		31	53	16	100	n=58 pairs
Central						
female	Greyish	5	16	0	21	
plumage	Intermediate	0	19	5	24	
type	Reddish	0	17	38	55	
Total		5	52	43	100	n=58 pairs
South						
female	Greyish	3	5	1	9	
plumage	Intermediate	0	17	1	18	
type	Reddish	1	51	21	73	
Total		4	73	23	100	n=151 pairs

Associations between species

Of the observed Ashy-headed and Ruddy-headed Geese, 70% and 60%, respectively, occurred in association with groups of Lesser Magellan Geese. In instances where Ashy-headed Geese (A) occurred with Lesser Magellan Geese (L), the numbers of the two species in the flocks were correlated positively ($nA=0.07nL+1.41$, $r=0.89$, $df=8$, $P<0.001$).

In all three regions, most groups of the Lesser Magellan Goose were not associated with domestic animals (Table 5). To clarify this relationship, the incidence of domestic livestock was noted between Punta Delgada and Punta Arenas, and in Tierra del Fuego. The following group frequencies were recorded: Lesser Magellan Goose only = 173; sheep only = 77; cattle only = 2; geese and sheep = 11; and, geese and cattle = 5. These data suggest that there may indeed be a positive association between geese and cattle, but the sample is too small for statistical testing. For sheep, however, the observed frequencies of association are very different from those expected (assuming independence, $X^2=108.13$, $df=2$, $P<0.001$), demonstrating a clear negative relationship between the presence of sheep and Lesser Magellan Geese, which may be due to avoidance or subtle differences in habitat requirements. There were marked latitudinal differences in the habitats used by the Lesser Magellan Goose which reflect habitat availability (Table 6, $X^2=77.57$, $df=4$, $P<0.001$).

Table 5. Percentage frequency of association between groups of the Lesser Magellan Goose and domestic livestock in three regions of southern Patagonia, November 1985.

Region	Frequency of association None	With sheep	With cattle	No. records
North	92	5	3	66
Central	81	8	11	62
South	95	5	0	168

Table 6. Percentage frequency of habitat utilisation by the Lesser Magellan Goose in three regions of southern Patagonia, November 1985.

Habitat	Region North	Central	South
Grassland	37	76	89
Scrub	33	4	3
Water associated	30	20	8
No. records	66	55	160

Discussion

Lesser Magellan Geese in Chile lay eggs in November (Johnson 1965), therefore the mid-November surveys should have coincided with the incubation phase. However, although more than half of the birds were paired, single males assumed to have incubating mates hidden from view com-

prised only 5% of all males recorded, and only six pairs were recorded with small young. Thus, while no comment can be made on the proportion of breeding birds in the populations surveyed, it can be assumed that data on group size, sex ratio, abundance and geographical distribution are relatively free of biases which might have occurred if a large proportion of the population was breeding at the time of the surveys.

Relative abundance

The information on the relative abundance of the Ruddy-headed, Ashy-headed and Lesser Magellan Geese in southern Patagonia presents a pattern similar to those reported in the more recent literature (Humphrey *et al.* 1970). In effect, the Lesser Magellan Goose outnumbers its two congeners by two orders of magnitude, with the Ruddy-headed Goose now occurring with some regularity only in Tierra del Fuego and southern Buenos Aires Province. In Tierra del Fuego, our survey included nine Ruddy-headed Geese out of a total of 775 sheldgeese, accounting for 1.2%, in comparison to <0.1% (6 in 6000) recorded in 1973 (King 1981).

After an initial increase at the turn of the century, which made it one of the commonest sheldgeese in northern Tierra del Fuego (Scott 1954), the Ruddy-headed Goose decreased dramatically after the 1950s to an estimated population of fewer than 1,000 birds on Tierra de Fuego in the late 1970s (Rumboll 1975; King 1981). The population has been classified as "endangered" (King 1981), with the main factors for its decrease being given as: persecution by man (egg destruction and shooting); predation by the introduced Patagonian Grey Fox *Dusicyon griseus*; and, competition with domestic sheep for forage. The allegation that sheep deprive the sheldgeese of forage is unsubstantiated (Summers 1985).

Cattle were introduced into southern Patagonia during the middle of the nineteenth century and sheep some 25 years later. The extensive cattle industry declined towards the end of the century and, sheep ranching expanded to cover most of the area occupied today. During these changes, forests were cleared, burned and converted to grasslands. We hypothesise that the combination of forest clearing (that continues today) and cattle ranching favoured an initial increase of the Ruddy-headed Goose. The Lesser Magellan Goose presumably benefited through these actions as well. It is suggested, however, that the Ashy-headed Goose may have decreased with the destruction of the forest, since it appears that the species breeds mainly in forest clearings that are associated with ponds and other wetlands (Johnson 1965; Humphrey *et al.* 1970, pers. obs.). The short cropping of vegetation by the sheep (Crawshay 1907; Summers and Dunnet 1984), and perhaps by rabbits (Jaksic and Yanez 1983), possibly initially benefited two of the three species of sheldgoose. However, it may also have resulted in the ground becoming drier and changes occurring in the composition of the grassy vegetation as well as an encroachment of semi-arid adapted scrub at the expense of grass cover. It would follow that a change in both the quantity and quality of the grass cover, and not competition with sheep for forage (Summers and Grieve 1982), has been a major factor contributing to the recent decrease of the Ruddy-headed Goose in southern Patagonia. Other major factors are undoubtedly persecution and the introduction of predators. The Lesser Magellan Goose may be less selective in its feeding and nesting requirements than the Ruddy-headed Goose and, consequently, has not (yet) been so affected by these relatively recent changes in habitat. Summers and Grieve (1982) found that Greater Magellan Geese in the Falkland Islands consumed a greater diversity of vegetable material than did Ruddy-headed Geese, but sample sizes for the latter were small. Alien meadow-grasses *Poa* spp. dominated the diets of both species, and abundance of *Poa* was related to the activities of sheep.

Plumage variation

The occurrence of male Lesser Magellan Geese in two colour phases, white *versus* barred, and the separation of these phases along a north-south axis has been known for a long time (Delacour 1954; Humphrey *et al.* 1970). It is somewhat surprising, however, that there has been little investigation of its evolutionary origin and of the factors responsible for the phenomenon.

Greater Magellan Goose females apparently do not normally breed until they are two years old, and males usually delay onset

of breeding until they are three years old (Summers 1983a). Comparable information is not available for the Lesser Magellan Goose. The present data, however, demonstrate that birds of all three plumage types belonging to both sexes occurred as apparently mated members of pairs, and as parents of broods. Clearly, then, we have a situation either of variation in fully adult plumage (true colour polymorphism) or of certain individuals being able to breed successfully while not yet having full definitive adult plumage. It is necessary to provide a caveat here in admitting that our ratios of female plumage types might not be free of error, since varying conditions of light intensity could have affected our judgement in distinguishing between shades of head colour, and head colour itself may change between moults, which can be irregular (Summers 1983b).

Based on the data for group size, and incidence of pairs and parents with broods (Table 2), it appears that breeding started earlier in the north-western than in the south-eastern areas of southern Patagonia. The north-western area is generally more mesic, with relatively many small lakes and other wetlands, and is more varied topographically than the south-eastern area which has a longer established and more intensive system of domestic livestock grazing. Does this suggest that the north-western area, in which white-phase males predominate, provides relatively superior breeding habitat for the Lesser Magellan Goose? This question cannot be answered at present, but existing ecological theory would be satisfied if the Lesser Magellan Goose's dense north-western breeding population consisted mainly of older experienced birds exploiting optimal habitat, causing younger subordinate individuals to travel farther south where habitat is less suitable and breeding occurs later. This, of course, begs the question of age-related plumage types, particularly in the case of females.

Notwithstanding the preceding suggestions and qualifications, it would seem that the Lesser Magellan Goose does indeed exhibit two, or more, 'definitive' colour phases, at least in fully adult males. The data, thus, serve to reaffirm a previously noted tendency for pure white males to predominate in the north and barred males in the south, of southern Patagonia (Humphrey *et al.* 1970). The data also point, for the first time, to a decrease in the intermediate-plumage type in accord with the north to south gradient. The situation in November 1985 was somewhat different to that in March 1953 (Scott 1954) when white males accounted for almost 50% of males on the mainland around Punta Arenas, but well under 1% in Tierra del Fuego. There is also a segregation of plumage types over a comparably narrow latitudinal range on the wintering grounds in Argentina (Martin *et al.* 1986), with barred birds dominating along the coast, and white birds dominating inland to the north. Bearing in mind our reservation concerning head-colour, our data suggest that there might be a north-south cline in the distribution of at least greyish cinnamon females on the breeding grounds as well. Given the state of our knowledge at present, we cannot improve on the speculation of Humphrey *et al.* (1970) that, prior to the arrival of European settlers and sheep, the two colour phases of the Lesser Magellan Goose might have been ". . . more separated ecologically during the breeding season and that this separation may have diminished during the past 75 or 100 years because of changes in the environment brought about by sheep."

Acknowledgements

This paper is based on part of the FitzPatrick Institute's 25th Anniversary Expedition to Chile. The work was supported by the South African CSIR and the University of Cape Town. We thank Dr Janet Kear and an anonymous referee for their comments on the manuscript.

Summary

Sex ratios in sheldgeese, especially the Lesser Magellan Goose *Chloephaga p. picta* were determined from roadside counts over 800 km in southern Chile and on Tierra del Fuego. They were close to parity. Males with white underparts predominated in the north and those with barred underparts in the south. There may also be a north/south cline in the greyish-headed females *versus* those with reddish heads. The interactions with other species of sheldgeese and with cattle and sheep are discussed.

References

Blake, E.R. 1977. *Manual of Neotropical Birds.* Vol. 1. Univ. Chicago Press, Chicago.
Crawshay, R. 1907. *The Birds of Tierra del Fuego.* Bernard Quaritch, London.
Delacour, J. 1954. *Waterfowl of the World.* Vol. 1. Country Life Ltd., London.
Humphrey, P.S., Bridge, D., Reynolds P.W. and Peterson, R.T. 1970. *Birds of Isla Grande (Tierra del Fuego).* Smithsonian Institution, Washington, D.C.
Jaksic, F.M. and Yanez, J.L. 1983. Rabbit and fox introductions in Tierra del Fuego: history and assessment of the attempts at biological control of the rabbit infestation. *Biol. Conserv.* 26:367–374.
Johnson, A.W. 1965. *The Birds of Chile and Adjacent Regions of Argentine, Bolivia, and Peru.* Vol. 1. Platt Establecimientos Graficos S.A., Buenos Aires.
King, W.B. 1981. *Endangered Birds of the World: the ICBP Bird Red Data Book.* Smithsonian Institution, Washington, D.C.
Martin, S.I., Tracanna, N. and Summers, R.W. 1986. Distribution and habitat use by sheldgeese populations wintering in Buenos Aires Province, Argentina. *Wildfowl* 37:55–62.
Rumboll, M.A.E. 1975. El Cauguen de Cabeza Colorada (*Chloephaga rubidiceps*): una nota de alarma. *El Hornero* 11:315–316.
Scott, P. 1954. South America – 1953. *Wildfowl Trust. Ann. Rep.* 5:54–72.
Summers, R.W. 1983a. The life cycle of the Upland Goose *Chloephaga picta* in the Falkland Islands. *Ibis* 125:524–544.
Summers, R.W. 1983b. Moult-skipping by Upland Geese *Chloephaga picta* in the Falkland Islands. *Ibis* 125:262–266.
Summers, R.W. 1985. The size and composition of sheld-geese populations and their food consumption on different vegetation types in the Falkland Islands. *J. Appl. Ecol.* 22:1–17.
Summers, R.W. and Dunnet, G.M. 1984. Sheld-geese and man in the Falkland Islands. *Biol. Conserv.* 30:319–340.
Summers, R.W. and Grieve, A. 1982. Diet, feeding behaviour and food intake of the Upland Goose (*Chloephaga picta*) and Ruddy-headed Goose (*C. rubidiceps*) in the Falkland Islands. *J. Appl. Ecol.* 19:783–804.

Prof. W.R. Siegfried, Dr P.A.R. Hockey, Peter G. Ryan and Dr Alison L. Bosman, FitzPatrick Institute, University of Cape Town, Rondebosch 7700, South Africa.