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The effect of surrounding land use on the distribution of Southern Crested Grebes (*Podiceps cristatus australis*) on Lake Forsyth, Banks Peninsula, New Zealand

The Southern Crested Grebe (*Podiceps cristatus australis*) is a vulnerable Australasian subspecies of diving bird inhabiting lakes and lagoons across the South Island, New Zealand. The current population is estimated at less than 300 individuals, with a large proportion (over 68%) occurring in Canterbury (O'Donnell, 1988). The population has suffered a decline over the last century and this is mainly attributed to the disturbance of nesting birds and loss of habitat (Marchant & Higgins, 1991).

Freezing conditions limit the amount of habitat available to grebes in the high country during winter (Geddes, 1983), and may cause some to migrate to milder, lowland areas. Lake Forsyth, a major overwintering site for the Canterbury population, is a brackish, highly eutrophic lowland lake next to Little River township on Banks Peninsula. It is 7.6 km long, 1.3 km wide and surrounded by steep hills. Lake Forsyth supports a diverse avifauna with at least 26 wetland native species occurring in the area (Wilson, 1992). The lake is adjacent to Lake Ellesmere, a wetland of international importance where approximately 158 bird species have

TABLE 1 – Criteria for grading land uses at Lake Forsyth

Land use	Score		
	1	2	3
Traffic	infrequent use, > 10 m from shore, unsealed	infrequent use, < 10 m from shore, road > 10 m from shore	sealed road, < 10 m from shore
Farming	> 10 m from shore	>10 m lakeshore, moderate stocking rate	access to shore, high number of stop present
Houses	no properties present	1-5 properties present, > 5 m from shore	> 5 properties present, < 5 m from shore
Recreation	absent	occasional	continuous

been recorded (O'Donnell, 1985). This suggests Lake Forsyth may also provide important habitat for a number of these species due to its proximity to Lake Ellesmere. State Highway 7 runs along the northern shore of Lake Forsyth, making that part of the lake easily accessible to the public. The lake margin has been extensively modified by farming, housing and road construction. This has led to the removal of lakeside vegetation that grebes utilise as shelter (Marchant & Higgins, 1991). The Southern Crested Grebe is strongly influenced by disturbances to its habitat by various land uses such as recreation (Westerskov, 1971). Such disturbances may cause short-term interruption of feeding and resting activity.

Little research has occurred on Southern Crested Grebes in lowland habitats such as Lake Forsyth, as it was previously assumed that grebes remained in their high country habitats during winter (Sagar & O'Donnell, 1982). In 1987, 20 grebes recorded at Lake Forsyth by O'Donnell (1988) was considered an unusually high number, which led in 1988 to the first of a series of annual censuses of grebes at the lake. This was the first recorded case of 'mass movement' of Southern Crested Grebes to the coast (O'Donnell, 1988). Since that census, increasing numbers of grebes have been reported from Lake Forsyth, reaching 80 birds in 1996 (Classified Summarised Notes, *Notornis* 1988 - 1997). Our study investigated the relationship between surrounding land use and the distribution of grebes at Lake Forsyth from August to October 1997.

To observe differences in grebe distribution, we divided Lake Forsyth into 12 zones of equal size. We scanned each zone for 10 minutes once a week for 6 weeks, and recorded all grebes on or flying above each zone. We identified four main land uses we considered as disturbances to grebes using Lake Forsyth. These were farming, traffic, recreation, and housing. We scored these land uses using the criteria from Table 1 to investigate the effect of different levels of land use on grebe distribution. Land use was scored (on a scale from 4-12) during each survey to give a mean land use score for each zone over the whole sample period. This was correlated against the mean number of grebes in each zone.

A maximum of 53 Southern Crested Grebes (approximately 20% of the estimated total New Zealand population) were seen at Lake Forsyth during the study period. The distribution of grebes on the lake was consistently uneven with significantly more grebes on the southern (5.4 ± 1.5) than northern side (1.0 ± 0.3), (Kruskal-Wallis one-way ANOVA, $F_{1,118} = 6.47, P < 0.05$). This did not follow the pattern predicted by Sagar & O'Donnell (1982) and Ward & Stewart (1990) who found that grebes occurred in low densities across the whole of a lake habitat in the Canterbury high country. The difference between Lake Forsyth and high country distributions may relate to the territorial nature of grebes during the breeding season in high country habitats (P. Sagar, pers. comm.), which may be different to grebe distribution in a lowland non-breeding habitat. However, Ward & Stewart (1990) found that grebes were consistently evenly distributed across a high country lake habitat in all seasons. This suggests that factors not as prevalent in the high country lakes of previous studies may influence grebe distribution on Lake Forsyth.

The southern side of Lake Forsyth was the area with the lowest average land use scores, and this pattern resulted in a negative correlation (Spearman's rank correlation, $r = -0.3, P < 0.01$) when the overall land use scores were compared with the average number of grebes present in each zone. This suggests that the differences in land use around Lake Forsyth may be influencing grebe distribution. The main land uses affecting grebe distribution on the lake were farming (Kruskal-Wallis one-way ANOVA, $F_{1,118} = 10.47, P < 0.01$) and traffic (Kruskal-Wallis one-way ANOVA, $F_{1,118} = 10.04, P < 0.01$). There were few grebes in those zones with high scores for farming and traffic. Housing and recreation had no significant effect on grebe distribution. However, limited time meant that we did not attempt to assess the importance of variables such as weather, shelter, water quality and food which may also influence the distribution pattern of grebes observed in this study. It is important to also note that this study contained surveys that represented brief periods in time and are therefore only indicative of broad trends in grebe distribution on Lake Forsyth.

The population of grebes on Lake Forsyth is continuing to increase (S. Petch, pers. comm.), and with some 20% of the estimated New Zealand population wintering on this lake, the importance of Lake Forsyth to this vulnerable subspecies is high. Farming and roads occur very close to the lake margin, and this study suggests that proximity of these land uses affects the utilisation of some parts of Lake Forsyth by grebes. This may limit the number of grebes the lake can support in the future, or at least slow the current rate of increase.

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