DISTRIBUTION AND NUMBERS OF THE CRESTED GREBE *Podiceps cristatus* IN CANTERBURY

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ABSTRACT

The Crested Grebe is one of New Zealand's rarer breeding birds; it is now confined to the South Island. In Canterbury about 50 pairs were by 1969-70 present as regular breeding birds on 23 lakes; the nesting birds are largely clustered in five groups of lakes: the Lake Sumner group with four pairs; the Lake Pearson group with seven pairs; the Lake Coleridge group with 13 pairs; the Lake Heron group with 12 pairs; and the Lake Alexandrina group with 14 pairs. There has been a decrease of 35 - 40 per cent from some 80 plus pairs nesting on Canterbury lakes 20 - 30 years ago. Most of the breeding pairs are found in lakes above 2,000 feet altitude (up to over 2,600 feet), and with two or three exceptions (small lakes at high altitudes) these lakes do not freeze over in winter and the grebes are resident all year round.

INTRODUCTION

The Crested Grebe *Podiceps cristatus australis* (Gould) is one of our rarer breeding birds, now confined to the South Island. Its distribution and numbers are therefore of general interest, in particular as this lake-dwelling species is decreasing in numbers. It is a native species, immigrated from Australia.

Since my transfer to University of Otago in 1964 and aided by a research grant from the University Grants Committee I have been engaged upon a study of the distribution and ecology of this species in the South Island. This paper is one of a series and deals with the distribution and numbers of Crested Grebes in Canterbury. This district (and former province) is to the north bounded by the Conway River across to Mt. Humboldt, to the south by the Waitaki River across to Lake Ohau and Hopkins River, and to the west by the Southern Alps.

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FIGURE 1 — The characteristic silhouette of a Crested Grebe on the placid waters of Lake Alexandrina.

MATERIAL AND METHODS

Material on distribution and numbers of the Crested Grebe has been collected as and when opportunity permitted during 1964-70. I have personally visited all the major grebe lakes in Canterbury and have in addition received much information from co-operators.

Some 300 questionnaires were mailed to a number of people who were thought to be in possession of grebe observations: ornithologists, field officers of the Wildlife Division and acclimatization societies, national park rangers, university staff, Forest Service personnel, mountaineers, high country farmers, botanists and zoologists in various D.S.I.R. research organizations, and members of natural history societies.

Notices about the study and requests for information were published in ' Notornis ' and ' Forest and Bird ' and in the Newsletter of the Canterbury Mountaineering Club early in 1968.

Much information has also been obtained through interviewing shooters, anglers and back-country farmers living in the grebe areas. The records of Crested Grebes contained in the Ornithological Society of New Zealand Recording Scheme (in the following text abbreviated to O.S.N.Z. Rec. Scheme) were placed at my disposal by the Recording Convener, Mr. A. T. Edgar.

All information collected has been collated and has in some cases been further checked through correspondence, visits or field investigations.

Altitudes and sizes of lakes have been obtained from a number of older and newer maps, and some lake sizes and altitudes have been calculated using the largest scale maps available. Lake sizes for the 14 lakes discussed in Dr. Stout's paper (1969) are based on information supplied by the Lands and Survey Department and have been used in this paper.

DISTRIBUTION AND NUMBERS

The information collected on Crested Grebe distribution in Canterbury is shown in Fig. 2, including both present and past breeding lakes as well as observations outside the breeding range.

The northernmost lake in the Canterbury district is *Lake Tennyson,* altitude 3,619 feet above sea level; it is a high country lake in bleak surroundings with land rising steeply around it except in the southern part. There are hardly any suitable nesting sites for grebes along the shore line, and the lake looks an unlikely Crested Grebe habitat. I saw no grebes when visiting it on 25 January 1970, nor has Mr. L. G. Morris of the N.Z. Forest Service, Hanmer Springs, ever seen any during his several visits to the lake; Mr. Morris has also made enquiries from a local sport-fisherman who has made regular trips to the lake for a number of years without ever having seen any Crested Grebes. While visiting the lake I also talked with two anglers who have fished the lake for a number of years and neither had ever seen or heard of grebes being seen on this lake.

Lake Guyon (1), altitude 2,100 feet, size 190 acres. The only detailed description — and an old one at that — of the life history of the Crested Grebe in New Zealand is " Notes on the habits of *Podiceps cristatus* " by W. T. L. Travers (1870). The following is a brief summary of his main findings: The water of Lake Guyon is warm and " even in severe seasons, has never been frozen over."

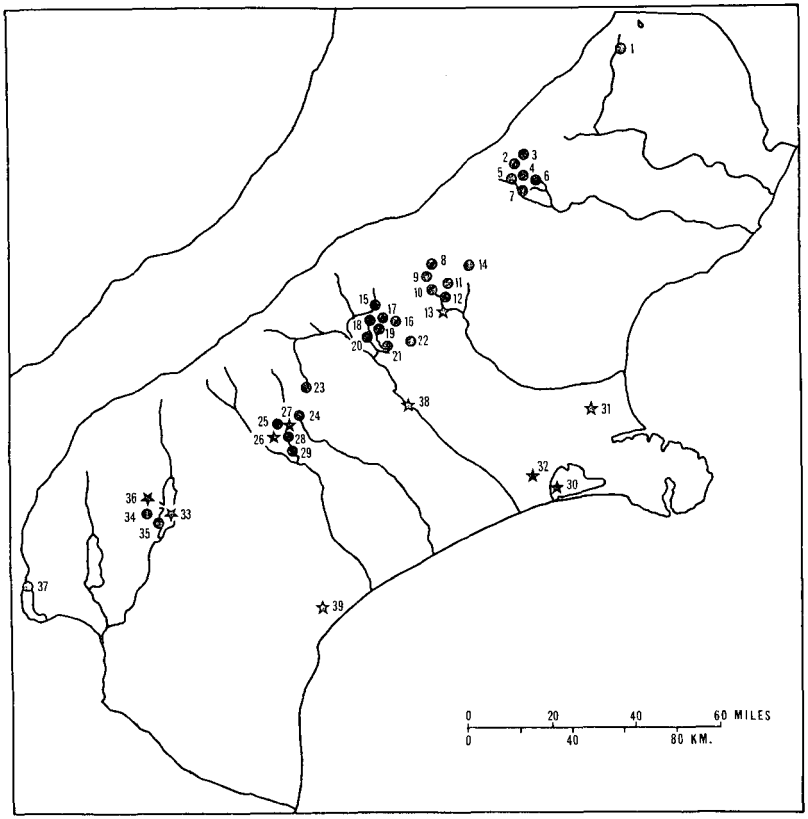

FIGURE 2 — Distribution of Crested Grebes in Canterbury. Numbers refer to numerical order of lake in the accompanying text; circles indicate present and past breeding lakes, stars show occurrence of visiting birds (including possible breeding occurrences).

Grebes are found on it throughout the year. "There are several permanent nests on the borders of the lake, which have been occupied by pairs of birds for many years in succession, from which I am led to infer that, as in the case of some of the *Anatidae,* these birds pair for life. . . . Although the Grebe reluctantly takes to flight, there is no doubt that it flies without any great difficulty, for it is found in situations which it can only reach by rising considerably above the general level of the ground. I have never seen two or more pairs associating together . . . no pair, however, appears to confine itself to any particular station, except when accompanied by young ones." An immature Crested Grebe, collected on Lake Guyon in February 1872 is now in the Dominion Museum (D.M. 1230). There is a specimen (female, with no date, AV 1225) from Lake Guyon in the Canterbury Museum. Only a few recent records are available: a pair was seen in November 1965 (N. Dennison, pers. comm.); a

pair and a single bird were seen in the early summer of 1964-65 and again in the winter of 1965; a single bird was seen early summer of 1969 (G. Roberts, pers. comm.). From being a common breeding bird, occurring in a population of several pairs, only a single pair is left, and only time will show if survival is ensured. Lake Guyon is now the northernmost breeding lake for Crested Grebes in New Zealand, and the population has almost collapsed, with new recruitment — now that the grebes have disappeared from the Rotoroa and Rotoiti Lakes to the north — only possible from the next group of lakes with permanent grebe populations, the Lake Sumner group, some 36 miles to the south as the 'grebe' flies. Some 19 miles almost due west is found another Crested Grebe lake, Lake Daniells, but separating these two lakes (effectively?) is the crest of the Southern Alps; the nearest low altitude crossing would be at Ada Pass, elevation 3,290 feet, and further south Lewis Pass, elevation 2,968 feet. In both cases flying time would be increased appreciably, and New Zealand Crested Grebes are notoriously reluctant and poor fliers.

After the loss of breeding grebes from Nelson-Marlborough during the latter part of last century and the early half of the 1900's, the apparently almost inevitable loss of Lake Guyon as a grebe lake would shift the northern extension of the Crested Grebe range in Canterbury to the Lake Sumner group which, as mentioned next, are now also seriously threatened as grebe lakes.

Lake Sumner (2) at an altitude of 1,725 feet, size approximately 3,520 acres, is now a developing holiday resort with fishing, boating and camping. Crested Grebes formerly were present and nested on this lake. In the Canterbury Museum is found a clutch of two eggs of Crested Grebe collected at Lake Sumner (AV 3435) but without date or further details. It is unlikely, however, that there ever was a large grebe population on this lake as the steep slopes on the one side rise straight out of the lake, while on the other side bush grows to the lake edge; there are no extensive raupo beds, and suitable nesting sites for grebes probably always were limited and are so today. Mr. G. Webb, field officer of the North Canterbury Acclimatisation Society, has visited the lake three times a year over the last four years but has never seen Crested Grebes; he has been informed by Mr. W. Dunnell that he saw a pair in October 1969. During a week-end stay (9-10 December 1967) no grebes were seen on this lake (J. McIlroy, pers. comm.). Mr. J. Stanley of Christchurch has been fishing in the Lake Sumner area for 18 years and considers, when he first went there, that some 12-20 pairs of Crested Grebes nested in Lake Sumner and associated lakes. In recent years he has seen no grebes on Lake Sumner and considers the disappearance due to illegal shooting (he knows of grebes being shot in mistake for shags); disturbance by power boating giving shooters and anglers access to all parts of the lake; and several floods at nesting time, especially in 1957 when Lake Sumner rose 13 feet in 12 hours. The decline in numbers appears to have been gradual and coinciding with increased human activity in the area: holiday campers, anglers, shooters, trampers, boaters. A careful survey of this lake is needed.

Lake Marion (3), altitude 2,200 feet, is a small lake (37 acres) to the north of Lake Sumner and draining into it. A Crested Grebe was seen in December 1967 (J. Stanley, pers. comm.). A deer shooter

in the Hope Valley entering the Kiwi Stream Valley during Easter 1968 reported sighting a Crested Grebe in company with a Blue Duck on this lake (S. C. Sparrow, pers. comm.).

Lake Katrine (4), altitude 1,800 feet, is a small lake (221 acres) connected with Lake Sumner through a channel in a marshy area; Mr. G. Webb of the North Canterbury Acclimatisation Society (pers. comm.) has visited the lake — where there is much boating as well as fishing — three or four times a year over the last four years but never saw or heard of grebes present. The lake is or rather was a good waterfowl area, but the advent of summer visitors, building of baches, use of power boats and launches, and anglers' activities have resulted in the disappearance of not only Crested Grebes but other waterbirds as well, including N.Z. Scaup. Grebes formerly nested on the lake, usually two pairs, but disappeared in the mid-sixties after the rapid increase in boating (Mrs. W. J. McEldowney, Mr. C. A. Nurse, and various anglers I talked to during a visit on 24 January 1970). No Crested Grebes were seen on this lake during a week-end visit, 9-10 December 1967 by J. McIlroy (pers. comm.).

Lake Mason (5), altitude 2,200 feet, size 256 acres, is situated a couple of miles south-west of Lake Katrine and empties into the western end of Lake Sumner. It is partly surrounded by bush, and access is difficult. A Crested Grebe nest with four eggs was found in early November 1951; the nest was situated in a sheltered bay about four feet from the shore (L. G. Morris, pers. comm.); Mr. Morris has re-visited this lake at odd intervals since 1951 but never again saw, nor heard of any one else having seen Crested Grebes there.

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FIGURE 3 — One or two pairs of Crested Grebes nest annually on Lake Sheppard which has several sheltered bays with extensive reed-beds providing suitable nest-sites.

Lake Sheppard (6), altitude 1,916 feet, size 249 acres. A pair of Crested Grebe " at first thought were breeding, but now doubt it " seen late December - early January, 1967-68 (W. C. Clark, pers. comm.). Two grebes were seen in December 1967 (J. Stanley, pers. comm.), and three grebes were seen on the lake on 5 February 1968 (W. E. Hannah, pers. comm.). Mr. G. Webb of North Canterbury Acclimatisation Society (pers. comm.) has visited this lake three to four times a year during the last four years and has always encountered at least one pair of grebes. On 1 and 2 November 1969 Webb saw two pairs, both displaying. A pair seen on 9 February 1969 (W. C. Clark, pers. comm.), and two pairs seen in northern end of lake in November 1969 (N. J. Payne, pers. comm.). A pair with one chick (about a third the size of the parents) seen in the southern bay nearest homestead on 2 January 1970 (Mrs. W. J. McEldowney, pers. comm.). I saw a pair in the northern half of the lake on 24 January 1970; there were no grebes in the southern end, near homestead, where they are most commonly seen but where during my visit two anglers were fishing for trout. Grebes are also occasionally seen on the small Lake Mary, a small pond just to the north of Lake Sheppard and emptying into it, undoubtedly only visitors from Lake Sheppard.

Lake Taylor (7) is a fair-sized lake, of 471 acres, 1,914 feet altitude, and south of Lake Sheppard. No grebes were seen during a week-end stay in December 1967 (J. McIlroy, pers. comm.), but G. Webb (pers. comm.) advises that a pair of Crested Grebes nested during the 1968-69 season and reared two chicks; the nest was at the top end of the lake. On 1 and 2 November 1969 four grebes were seen: one pair in courtship display, and the other two birds together (the young ones of the previous breeding season?). Mr. C. A. Nurse, who has managed Lake Taylor Station for many years, advises (pers. comm.) that he usually sees one or two grebes in the southern end of the lake, mostly near the northern bank covered with bush; in December 1964 he found a grebe nest with three eggs; the nest was attached to beech branches trailing in the water, near the northern shore below Conical Hill. Visiting the lake and watching carefully for grebes on 24 January 1970 I failed to see any.

Lake Sarah (8) is a small lake of 50 acres, altitude 1,970 feet, and just south of Cass. On this small lake one pair of grebes was seen during August-September 1943 (E. F. Stead, N.Z. Bird Notes 1: 66). A Crested Grebe incubating on nest in swamp between Lake Sarah and Cass Rail Station was seen from train about 1945; the large nest was built of raupo and placed in a small area of open water surrounded by raupo swamp (W. J. Harris, pers. comm.). Two pairs were seen on 18 October 1952 (E. W. Dawson, Notornis 6: 86); a pair with three young were seen in May 1963, and a pair was seen in May 1967 (C. J. Burrows, pers. comm.); on 10 November 1967 a pair was seen, and a pair has been seen regularly from time to time over the last 12 years (W. C. Clark, pers. comm.). A pair was seen late November 1969 (D. R. Maindonald, pers. comm.). On 27 January 1970 I saw a grebe fishing in the northern end of the lake; it later swam towards the dense raupo stand and disappeared into it; six minutes later it (or its mate?) came out from the raupo, possibly nest-relief (?).

Lake Grasmere (9) is situated just south of Lake Sarah and has a raupo swamp at its southern end and is at an altitude of 1,912 feet, size 154 acres. Till recently up to three pairs of grebes have nested annually on this lake; on a trip right around the lake on 7 December 1963 a total of seven Crested Grebes was seen; several old nests were found, built on rocks a few feet from the edge of the lake where beech trees border the northern side; one new nest with one egg was seen (W. J. Harris, pers. comm.). A pair was seen in December 1965 (G. Caughley, pers. comm.), and on 11 November 1967; a pair is usually seen on this lake (W. C. Clark, pers. comm.). Three grebes were seen in early January 1968 (G. L. M. Wyles, pers. comm.). Crested Grebe nests have been found several times at this lake; the last nest found contained three hatched eggs and an egg containing an unhatched and apparently abandoned chick; this lake is now a wildlife refuge, and the bush-clad shoreline on the far (north-eastern) side provides good nesting sites; Crested Grebes may survive here for some time to come (D. McLeod, pers. comm.). Four grebes were seen on lake in late November 1969 (D. R. Maindonald, pers. comm.), and I saw a pair diving and feeding not far from the western shore in the northern half of the lake on 27 January 1970.

Lake Pearson (10) is the largest lake in the area (525 acres) and at an altitude of 1,993 feet; it is a long, narrow and time-glass shaped lake with swamps at the northern end. Its nearness to the Arthurs Pass road has resulted in an influx of campers, anglers and boaters over the last few years; several co-operators advise that while formerly one or two pairs nested annually, now only one pair is left and even that may soon disappear; formerly illegal shooting and now boating are given as causes for this. Crested Grebes are often seen on this lake (J. R. Jackson, pers. comm.). A clutch of six eggs was taken at Lake Pearson on 31 December 1931 and is now found in the Canterbury Museum collections (AV 9964). Two Crested Grebes were seen on the lake on 19 January 1948 (G. Guy, N.Z. Bird Notes 3: 89), and a pair performing courtship display was seen on 4 September 1958 (P. Grant, Notornis 8: 197). A pair of grebes was seen on the lake near the Lake Coleridge diversion on 20 January 1959 (A. H. C. Christie, pers. comm.). Four grebes were seen on 25 November 1960 (G. Chance, pers. comm.). One grebe was seen on 31 July 1964 (G. Harrow, pers. comm.), and again a lone bird seen in October 1964 (O. Hughes, pers. comm.). W. J. Harris (pers. comm.) advises: " Perhaps 12 years ago newspapers reported that birds being shot at on Lake Pearson." A pair was seen on 2 December 1967 (A. K. Witty, pers. comm.). A pair nested during the 1967-68 breeding season (D. R. Maindonald, pers. comm.). Mr. G. C. Urquhart (pers. comm.) of Flock Hill reports that a pair has been on the lake for a number of years but while seen in 1967 was not seen in 1968: " Am of the opinion they have been shot." Five grebes were seen on the lake in late November 1969 (D. R. Maindonald, pers. comm.); in spite of careful observations, especially in the northern raupo-fringed bay, I failed to see any grebes when visiting this lake on 27 January 1970.

Lake Hawdon (11) near Craigieburn is at an altitude of 1,889 feet, size 75 acres, now much visited by anglers. In the early sixties a pair of Crested Grebes nested here but may now have disappeared

(W. J. Harris, pers. comm.). A grebe was seen on lake in December 1967 (J. Stanley, pers. comm.). A pair of grebes was observed on 27 November 1969 when 3,000 4 - 5 inch trout were liberated in the lake (D. R. Maindonald, pers. comm.). I visited this lake on 27 January 1970 and am certain that there were no Crested Grebes present; there were, however, 2 Black Shags.

Lake Marymere (12) is a small lake (56 acres), half a mile south of Lake Hawdon and at an altitude of 2,023 feet. There are no suitable raupo stands or hanging willows suitable for attachment of grebe nests, and the lake is visited by many anglers; there are, however, some matagouri bushes in places along the far shore. In spite of its apparent unsuitability, Crested Grebes appear to have nested here in the past and have also been seen recently. A clutch of two eggs from Lake Marymere was collected on 11 January 1933 by D. Hobbs; it went to the Stead collection and is now in the Canterbury Museum (AV 4293). Mr. H. McAllum (pers. comm.) in November 1962 saw a grebe feeding on this lake. A fisherman, a Mr. Logan (D. R. Maindonald, pers. comm.) found a Crested Grebe nest on 1 November 1969; the nest which contained one egg was constructed of moss and lake weeds and situated about 9 ins. above the water line amongst large rocks at the lake's edge. The bird was observed incubating the one egg, but the nest was subsequently abandoned, the cause believed to be frequent visits and being chased away accidentally by fishermen. Mr. Logan visited Lake Marymere almost every week-end between 1 November and Christmas 1969, but the pair did not build a new nest or try to nest again; the pair, however, remained on the lake and was frequently seen. Probably this pair was seen late November 1969 (D. R. Maindonald, pers. comm.), and again on 28 December 1969 (W. C. Clark, pers. comm.). When I visited the lake on 27 January 1970, the lake was very low (10 feet below normal?), exposing large stony banks. To my surprise I saw a pair of Crested Grebes feeding about 40 yards from the northern shore; these birds were quite tame in their behaviour and took little notice of me.

Vagabonds Inn (13) or Vagabond Tarn is a small barren tarn just over a mile south of Lake Marymere, altitude 2,050 feet. A pair of Crested Grebes was seen on this apparently unsuitable tarn in late November 1969 (D. R. Maindonald, pers. comm.), and were probably accidental visitors during spring looking for suitable nesting waters.

Lake Letitia (14) near Mount White is a small (approximately 60 acres) narrow lake at an altitude of 1,930 feet. A Crested Grebe was seen here on 12 January 1963 (G. Harrow, pers. comm.). A grebe was seen late November 1969 (D. R. Maindonald, pers. comm.), and a pair was seen on 30 December 1969 (W. C. Clark, pers. comm.).

Lake Lilian (15) is a small (40 acres) high country lake two miles west of the meeting point of the Harper and Avoca Rivers, altitude 2,600 feet. A pair of grebes was seen in November 1964 (G. Caughley, pers. comm.). A pair was seen on this lake on 1 November 1969 (D. R. Maindonald, pers. comm.), and again late the same month.

Lake Catherine (16), also known as Lake Monk or Lake Constance, is a small lake (51 acres) at an altitude of 2,050 feet. There is a raupo and willow swamp in the southern end. Crested Grebes have been known to nest on this lake for many years, and usually one pair has been present (M. R. Murchison, pers. comm.). In the early 1950's a grebe nest was found (by Dr. C. J. Burrow's father) and grebes were seen (C. J. Burrow, pers. comm.). A pair was seen on three occasions, December 1966, December 1967 and January 1968, usually near the middle of the lake (J. Wills, pers. comm.). This lake is visited by a few anglers only, and is thus relatively undisturbed for the better part of the year. A pair of grebes was seen in January 1968 (S. C. Sparrow, pers. comm.). A pair with one ¼-grown chick was seen late November 1969 (D. R. Maindonald, pers. comm.). I saw a pair of grebes in the bay half way up the eastern side of lake on 26 January 1970.

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FIGURE 4 — The small Lake Ida freezes over in winter so its one or two breeding pairs must seek nearby open waters (probably Lake Coleridge) during winter.

Lake Ida (17) consists of two small lakes, together covering 24 acres, connected by a stream and surrounded by steep slopes, to the north bush-covered. Its high altitude (2,600 feet) usually results in freezing over in winter when used for ice-skating. In recent years one or two pairs of Crested Grebes have been seen regularly on this lake (M. R. Murchison, pers. comm.). Two grebes seen on 12 January 1963 (W. T. Popplewell, pers. comm.). One grebe seen on 28 October 1966 (G. Chance, pers. comm.), and again one grebe seen on 20 January 1968 (N. Etheridge, pers. comm.). Grebes were seen on this lake November-December 1969 (M. R. Murchison, pers. comm.).

This is one of the very few lakes in New Zealand which regularly freezes over in winter and which has a nesting population of Crested Grebes, which in turn must move (fly) to the nearest ice-free water for the winter; in this case that would be to Lake Selfe less than a mile away. I visited Lake Ida on 26 January 1970 but in spite of careful observation failed to see any grebes. The lake looked forbidding with no suitable nest sites along the shore and the fact that it freezes over in winter makes it even less suitable for grebes.

Lake Selfe (18) is a small (81 acres) long and narrow lake, set between Mt. Ida and Mt. Cotton; its altitude is 1,950 feet and it very seldom freezes over (H. E. M. Hart, pers. comm.). Lake Selfe has a very important place in the discovery and early history of Crested Grebes in New Zealand, as the first recorded observation and identification — although not published at the time — is Pott's (1869: 74) record: "In April, 1865, we first made its acquaintance, on a small lake, now called Lake Selfe." An old specimen, collected at this lake, in May 1899 by W. Shipley is now in the Canterbury Museum (AV 17,570). A clutch of three eggs was collected at the lake by H. Richardson on 8 December 1930; it was part of the Stead collection and is now in the Canterbury Museum (AV 4736). Each year one or two pairs of grebes are now present on the lake (M. R. Murchison, pers. comm.). Mr. H. E. M. Hart, who was the manager of the Lake Coleridge Power Station from 1923-1953, frequently passed Lake Selfe when travelling to the Harper River Diversion and reports (pers. comm.): "During this period a pair of Crested Grebe were usually to be seen on Lake Selfe. Some seasons, one, or rarely two young birds were to be seen with parent birds. No nests seen." Mr. Hugh Wilson (pers. comm.) also reports

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FIGURE 5 — Lake Selfe is a grebe lake of historical interest as the Crested Grebe was first identified and observed here in 1856 by the famed Canterbury naturalist, T. H. Potts.

frequently seeing Crested Grebes at this lake "some years ago. At this stage there were at least four pairs of grebes on the lakes, and since then grebes are nearly always to be seen if you are passing by Lake Selfe toward the Harper Diversion. At times when we were at the lake in January, the birds would perform beautiful courtship displays." Four grebes were seen on 25 December 1961, and again four birds on 28 October 1966 (G. Chance, pers. comm.). Four grebes were seen on 12 December 1964 (P. Crozier, O.S.N.Z. Rec. Scheme). Each year over the period 1964-67 a pair was seen on this lake (M. J. W. Douglas, pers. comm.). In May 1967 an adult grebe was seen (C. J. Burrow, pers. comm.), and usually a pair is seen. Three grebes were seen on 31 December 1967 (W. J. Harris, pers. comm.). Mrs. Marion Lane has advised that Mr. P. G. Ellis of Christchurch has been fishing at this lake each year for the last five years and found one pair nesting each year. During the 1967-68 breeding season, the nest was found and uncovered; it contained four eggs. The nest was found in the same place each year; no young ones were seen. Mrs. Lane also saw a pair on 19 October 1969 and found remnants of an old nest. A pair was seen on lake late November 1969 (D. R. Maindonald, pers. comm.), and I saw a pair in a small sheltered bay with beeches overhanging the water on 26 January 1970; this pair, which was preening and feeding, was seen near the far shore about a quarter of a mile from the top end of the lake. A Crested Grebe was reported found dead (shot) at lake edge over the New Year period 1970 (W. McKillop, pers. comm.).

Lake Evelyn (19) is a long and narrow lake immediately southeast of Lake Selfe; altitude 2,000 feet, size 36 acres. This lake has dense raupo stands along its edge; it appears to be a very suitable grebe habitat, and it does not freeze over in winter. Mrs. Marion Lane (pers. comm.) saw a pair of Crested Grebes on this lake on 19 October 1969. On 26 January 1970 I watched a grebe diving and feeding in the northern half of the lake; later on another grebe appeared from the reeds (nest?) ,and the bird I had so far been watching swam into the reeds (possibly going to the nest).

Lake Coleridge (20) is a large lake (approximately 11,520 acres) at 1,667 feet altitude. At its southern end water is diverted to the Lake Coleridge Hydroelectric Power Station. Although not a very suitable grebe lake, the presence of Crested Grebes here has been known for a long time. Potts (1869: 74) mentions that in 1868 he found a Crested Grebe nest on a pile of flax in the small boat harbour. In Canterbury Museum there are two skins of Crested Grebe from Lake Coleridge, a female taken in November 1907 (AV 372), a male dated 5 January 1917 ,AV 2887), and a clutch of three eggs from the Stead collection (AV 4734), collected on 20 December 1917. Several pairs were present on the lake in May 1944 (E. F. Stead, N.Z. Bird Notes 1: 66). Several pairs now nest annually and there may have been an increase in numbers as a result of less indiscriminate shooting (M. R. Murchison, pers. comm.). Pairs of grebes were observed in November 1962 (S. C. Sparrow, pers. comm.). Crested Grebes were seen feeding in the northern end of the lake during the winter of 1966 (G. Webb, pers. comm.). An adult grebe was seen in May 1967 (C. J. Burrow, pers. comm.). A pair observed in north end of the lake on 23 December 1967 where they have been

noticed for three years but do not seem to multiply; they keep to the shallow weedy parts of the lake (N. Etheridge, pers. comm.). A survey of the lake in late November 1969 showed a total of 11 Crested Grebes present, and the impression was that there was a pair in each of the suitable bays (D. R. Maindonald, pers. comm.). On 26 January 1970 I visited the lake and observed its waters from various vantage points; one was the bay at the end of the Ryton Road, about half way up the lake on the northern shore, but no grebes were seen; another area was the ideal waterfowl bay at the southern end of the lake, near the homestead, where I saw a pair of Crested Grebes swimming and diving. A detailed survey from land all around the lake and from a boat on a calm day is needed to establish more closely the actual number of Crested Grebes in this large body of water. The population is tentatively estimated at six pairs.

Lake Georgina (21) is a small lake (50 acres) next to the Harper Road, a couple of miles north of Lake Coleridge Station; altitude 1,800 feet. Mr. H. E. M. Hart who was Manager of the Lake Coleridge Power Station from 1923-1953 frequently travelled this road and has provided this information: " Very occasionally a pair (of Crested Grebes) was seen on Lake Georgina, and one season a nest was observed on shore of this lake close to the Harper Road, but do not think any young were raised (too much in view of public)." Mr. M. R. Murchison (pers. comm.) of the Lake Coleridge Station advises: " The only lake of any size on this property I have

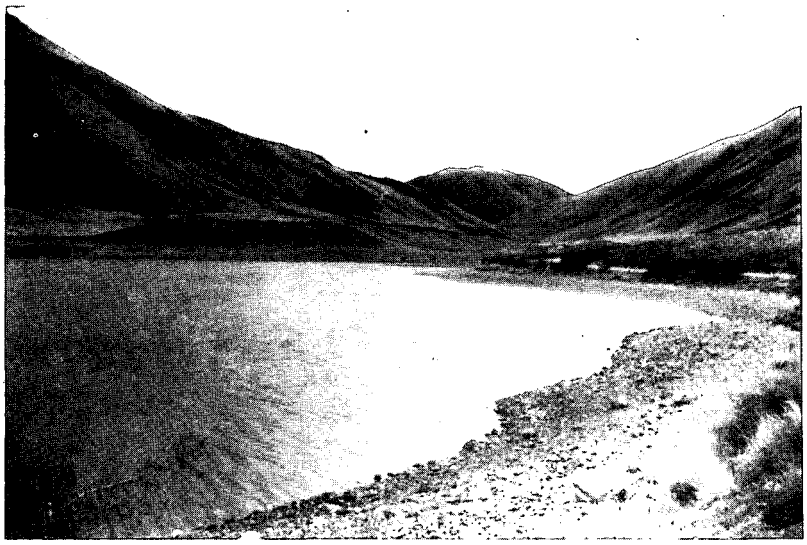

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FIGURE 6 — Lake Georgina photographed at low water-level with exposed stony shores. In such summers grebe nesting is entirely prevented.

not seen permanent Grebe on is Lake Georgina though this could have seasonal use." A pair was seen on 25 December 1961; this pair built a nest in the centre of lake (G. Chance, pers. comm.). A pair was seen on 10 January 1963 (G. Harrow, pers. comm.). A pair of grebes was seen on lake in November-December 1969 (M. R. Murchison, pers. comm.). On 26 January 1970 I saw to my surprise a pair of Crested Grebes on this unsuitable-looking lake; the water level was very low, exposing stony banks, and there were no bushes or trees at the lake edge, nor any raupo stands. At normal water level there are a few matagouris at the lake's edge to which a grebe nest may be anchored. This is one of the smallest lakes I have seen apparently capable of sustaining a pair of Crested Grebes.

Lake Lyndon (22) is a narrow high altitude lake (2,769 feet) without suitable raupo stands and set in tussock-covered hills; size 275 acres. Being next to the main highway to Arthur's Pass it is frequently visited and is used for winter sports as it freezes over most winters. An early record is that of Reischek (1952: 22) who on 20 December 1877 apparently saw Crested Grebes on this lake: " On the west side, at the foot of the Pass, lay a little lake, the Lyndon. Paradise duck, grey duck, little grebe, and other water dwellers were enjoying life on its surface." I have checked the original German text (Reischek, 1924: 43); Reischek uses the name *Steissfusse* which is an alternative (old) German name for the grebes; he precedes this with a descriptive *kleine* (meaning small) in lower case, not a capitalized adjectival part of the specific name. Reischek undoubtedly saw the Crested Grebe (for him to have seen the Dabchick — which is rare in the South Island, in particular east of the Southern Alps — would have been more sensational; Reischek knew both species of grebes as his writings show, and he was undoubtedly also familiar with the Crested Grebe from Europe before his coming to New Zealand). A specimen of Crested Grebe, a female, without date from this lake is in the Canterbury Museum (AV 2890). A pair was seen on the lake in January 1940 (B. J. Marples, pers. comm.). A pair was seen in December 1962, January 1963 and January 1968 (S. C. Sparrow, pers. comm.). Mr. D. R. Maindonald of the North Canterbury Acclimatisation Society has only seen grebes here on very few occasions. Personally I have passed and watched the lake for grebes on a number of occasions, both summer and winter, but have never seen any. I last passed the lake on 26 January 1970 when it was extremely low, exposing wide areas of stony banks. No grebes were seen. On the western side are found a few scattered matagouri bushes — during drought as just described high above the waterline. Ranger G. Webb of the North Canterbury Acclimatisation Society advises me that in summers when the lake is high and full of water, the waterline reaches matagouris and beeches, and he is of the opinion that a pair of grebes nest on the lake in such years when conditions are right.

Lake Heron (23) is a large lake (1,800 acres) east of Mt. Taylor and at an altitude of 2,276 feet. The shape of the lake is very uneven and there are large adjoining swamps and stands of raupo and patches of willows in many places along the lake edge. The lake has been known for its permanent Crested Grebe population for many years.

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FIGURE 7 — Home Bight at the northern end of Lake Heron with a Crested Grebe territory and where a nest was found anchored to trailing willow branches.

Two clutches of grebe eggs in the Canterbury Museum are from this lake, both from Stead's collection, one of three eggs from 17 January 1932 (AV 4737), and one of four eggs from 21 January 1933 (AV 4735). Because of Lake Heron's high altitude and nearness to high mountain ranges, parts of the lake frequently freeze over in winter, and seasonal as well as unseasonal snow-falls occur in the area. Much information has been provided by Mrs. Lane of Ashburton and Mrs. Shona Mulligan of Barford; both frequently visit Lake Heron. They have found that the number of resident grebe pairs varies somewhat, but in the areas visited by them there appear to be five permanent pairs holding territories, one pair in the south-western end of the lake, one pair about half-way up the western shore, two pairs in the northern end, and one (or possibly more) pair at the swamps half-way up the eastern shore. Two grebes were seen on 28 May 1960 (E. W. Crack, Notornis 9: 237). Two pairs seen on 23 November 1960 (G. Chance, pers. comm.). R. Boud (pers. comm.) saw a breeding pair in December 1962; the nest was in a willow growing in the water, about 30 feet from the shore, south-western end of lake. Seven grebes were seen on 10 January 1963 (W. T. Poppelwell, pers. comm.). On 2 November 1963 Mrs. S. Mulligan (pers. comm.) saw five pairs displaying during the day; they were in the southern end of the lake. A pair was observed in May 1965 (E. B. Green, pers. comm.), and a pair seen in August 1966 (M. J. W. Douglas, pers. comm.); a single grebe was seen on 5 June 1966 (G. Harrow, pers. comm.). A pair was seen on 25 July 1967 (S. N. Adams, pers. comm.).

Two grebes seen in Harrison's Bight on 18 November 1967, have been noticed here for last three years; they keep to the shallow weedy parts (N. Etheridge, pers. comm.). Observations in 1968 (Mrs. M. Lane, pers. comm.): One grebe seen on 30 October, four on 1 December, two on 26 December, and four on 29 December; on last mentioned day two pairs were seen displaying in the more secluded upper lake area. The disastrous floods in November 1967 were thought to have affected their numbers. In 1969 the following observations were made: on 20 and 27 April and on 3 May, seven adult grebes and three young were seen (one pair with two young and one pair with one young); on 21 July a total of nine grebes was seen. On 17 May 1969 I visited the lake with Mrs. Mulligan, but in spite of watching for grebes using both binoculars and telescope in the lower and upper ends of the lake as well as from various points along the western side of the lake, only one Crested Grebe was seen, feeding near the middle of the lake and nearer the far shore. I visited Lake Heron again 15-17 January 1970 and covered the lake by car, walking and dinghy (northern end); I located 7 pairs of Crested Grebes: 2 pairs in the south-western corner where a willow-sheltered bay and a tree-framed lagoon at the stream outlet provide shelter and numerous nesting possibilities; the holiday season brings many visitors, and nesting success appears low: a pair another mile up the western shore where there is another bay: a pair in Home Bight at the northernmost end of the lake, where I found a grebe nest with one lukewarm (incubated) egg; the nest was anchored to trailing willow branches in a willow thicket: two pairs further down from Home Bight, one of these pairs had a half-grown still striped young: and finally a pair outside the eastern bay, surprisingly not in the long narrow bay itself although it appeared to be promising grebe nesting habitat. From my talks with Mr. A. T. Urquhart and sons of Lake Heron Station, Mr. and Mrs. J. J. Rouse of Upper Lake Heron Station and a number of anglers and visitors who have visited the lake for a number of years, it appears that the Crested Grebe population has been declining (and fluctuating somewhat) and that formerly some 10-12 pairs nested at the lake.

Maori Lakes (24) are two small lakes about three miles north of the Lake Heron-Erewhon turn-off; the lakes are surrounded by swamp and there is a large swampy area between them; altitude 2,044 feet. Crested Grebes were never seen on these lakes over many years of regular visits (M. Orton, pers. comm.). No grebes seen during several visits in 1969 (Mrs. M. Lane, pers. comm.). I saw no grebes when watching the lower (eastern) lake on 17 May 1969. On 17 January 1970 I again carefully scanned the eastern lake with binoculars from a hill, but no grebes were seen. I then went to the western Maori Lake (size 52 acres) where I saw a pair of Crested Grebes in the western end of the lake, diving and fishing. The pair gradually moved further eastward (which also was away from me); one of the grebes eventually swam and disappeared in the large reed-bed at the southern side of lake (to their nest?). This lake is not readily accessible for man owing to marshy surrounds and large reed-beds, and would appear a lake in which grebes can successfully nest for years to come (if access is not improved).

Lake Clearwater (25), also called Lake Tripp, is a fair-sized lake (488 acres) at 2,188 feet altitude and with a swamp at its western end and scattered willows lining the lake edge. A large camp of anglers' and holiday-makers' cribs brings large numbers of people to the lake, especially during the holiday period, but fortunately motor boats are not allowed on the lake. A pair of Crested Grebes nests annually (M. Orton, pers. comm.). Three grebes were seen on 28 May 1960 (E. W. Crack, Notornis 9: 237). No grebes were seen on 26 December 1967 (J. McIlroy, pers. comm.); no grebes were seen on 20 July and 28 August 1969 (Mrs. M. Lane, pers. comm.), and I saw no grebes during a visit on 17 May 1969. On 15 January 1970 when visiting the lake again, I saw a pair of grebes in the bay with willows at the south-western side of the small island in the middle of the lake towards the northern shore; there was also an adult grebe in the bay at the eastern end of the lake, so possibly two pairs nested at Lake Clearwater during the 1969-70 breeding season.

Lake Camp (26), also called Lake Howard, is a small rain-fed tarn (121 acres), a few hundred yards south of Lake Clearwater and at the same altitude. There is no raupo vegetation around the lake, nor nearby swamp, willows or matagouri bushes along the lake edge which is a stony beach, and it appears an entirely unsuitable grebe lake. Furthermore, it is heavily fished and is also used for water-skiing, and there is a large anglers' camp immediately to the north-west of it as mentioned under Lake Clearwater above. A Crested Grebe was seen on 28 May 1960 (E. W. Crack, Notornis 9: 237), showing that the lake has been and may be used occasionally as a feeding water for grebes from nearby lakes. No grebes were seen on 26 December 1967 (J. McIlroy, pers. comm.), nor on 17 May 1969 when I visited the lake; Mrs. M. Lane (pers. comm.) has not seen any grebes on this lake during various visits, including on 20 July and 28 August 1969. I saw no grebes on 15 January 1970 when again visiting the lake.

Lake Roundabout (27) is a small (32 acres) and shallow lake in gently rolling tussock country, about 600 yards south of the Erewhon Station road and east of Lake Camp; its altitude is 2,159 feet. No grebes were seen on 26 December 1967 (J. McIlroy, pers. comm.). On 15 January 1970 I visited the lake, and while there were a great many waterfowl, no grebes were present. I did hear, however, from anglers that Crested Grebes have been seen feeding on the lake, probably non-breeding birds flying between Lakes Clearwater and Emma.

Lake Emma (28), also called Lake Acland, is a fair-sized lake (384 acres) at 2,151 feet altitude; it is partly surrounded by large swamps, particularly to the west and with reed stands and scattered groups of willows. No grebes have been seen during several visits to the lake over a number of years (M. Orton, pers. comm.). I watched the lake for grebes on 17 May 1969 but failed to see any; as it looked a suitable grebe lake with extensive reed beds and willows, I asked if Mrs. M. Lane of Ashburton could have a closer look which she did: on 20 July and 28 August 1969 she looked carefully for grebes on the lake without, however, seeing any. I visited the

lake on 15 January 1970 and from a vantage point spotted a Crested Grebe fishing and diving in the northern part of the lake; later this bird swam away and eventually settled down on a nest. I walked around the north-western end of the lake and came to within 50 feet of the nest, wading out from a willow tree on the marshy shore; the lake bottom was so soft that I unfortunately could not get to the nest. This nest was quite in the open, an oblong pile of lake-weeds, about 4-5 ins. above water level; the eggs had been covered over with nest material when the bird left, and not till I was several hundred yards away from the nest on my way back, did one of the grebes (the mate had joined in the meantime) return to the nest, uncover the eggs and settle down to incubate.

Lake Denny (29) is a very small lake (approximately 30 acres), about two miles south of Lake Emma and at an altitude of 2,208 feet. While M. Orton (pers. comm.) has never seen Crested Grebes on this lake during several visits over a number of years, N. Etheridge (pers. comm.) reports that he saw a pair of grebes on 9 December 1967 and that he has seen a pair on this lake each year for three years.

Lake Ellesmere (30) is one of New Zealand's largest and best bird lakes, the water area covering approximately 68,800 acres. It is a coastal lagoon, protected from the sea by a narrow gravel spit which is opened up two or three times a year; at such times the water level is lowered, water running into the sea, and salinity increases with incoming tidal water from the sea. Crested Grebes probably nested at this lake in fromer times and maybe till comparatively recently. Stead (1927: 214), writing about the birds of Canterbury, thus stated that while the two New Zealand species of grebes were at one time common on the lakes of Canterbury, the Crested Grebe: " though gone from Lake Ellesmere, may still be seen in pairs on most of the suitable lakes in the back country." Stead seems to have possessed information about former occurrence and breeding of this species on Lake Ellesmere, but I have not been able to find any verification in print or otherwise; it would appear, however, that the lake has been a suitable nesting lake for this grebe. In the Canterbury Museum is a Crested Grebe specimen from Upper Riccarton (31), 14 miles from Lake Ellesmere; this bird, a female (AV 371), was collected on 21 April 1929 and was originally in the Edgar Stead collection. Another specimen in the Canterbury Museum was collected even closer to the lake: a female (AV 1222), collected on 28 August 1922 at Leeston (32), only three miles from the lake. A Crested Grebe was watched on 30 October 1947 in Heathcote Estuary (G. Guy, N.Z.B.N. 2, 154). A more recent observation, showing that Crested Grebes may still occur far outside their present somewhat contracted breeding grounds, is that of Field Officer C. Hughes, North Canterbury Acclimatisation Society, who on several occasions in October 1966 observed two Crested Grebes in the western end of Lake Ellesmere; grebes have not been seen there since (D. R. Maindonald, pers. comm.).

Lake Tekapo (33) is formed in the lower end of a glaciated valley and, through the building of a 115 feet high dam (completed in 1954), the formerly much smaller lake has been lengthened and widened to become a large (20,480 acres) hydroelectric storage dam.

The water is not clear, with much sediment in suspension, being fed by the Godley and many other glaciers. There is hardly any shore-vegetation, such as reed-beds and willow thickets anywhere; most of the artificial lake shore is barren with water levels artificially varied between 2,310 and 2,330 feet above sea level. In spite of diligent search of the lake through binoculars and telescope from vantage points at both southern, central and northern parts of the lake in both summer and winter on a number of visits, I have never seen any Crested Grebes on this lake, neither have local residents and boating people asked. There are no likely nesting places, but grebes from nearby Lakes McGregor and Alexandrina could easily move to central Lake Tekapo for feeding during autumn and winter; the murky glacier-fed water, however, is unsuitable for grebes to fish (see) in, and it is likely that their usual animal food cannot exist there either. The only record I have of Crested Grebes on Lake Tekapo is from Mr. George Chance (pers. comm.) who in January 1961 saw a pair in the small bay at the outlet of the stream from Lake McGregor, obviously a pair from this lake. Mr. Chance also advised that he was told by the late owner of Glenmore Station, that he had on occasion seen grebes on the small tarn near the road between Lake Tekapo and Lake Alexandrina and just under a mile from the north-east corner of Lake Alexandrina.

Lake Alexandrina (34) is a large (1,645 acres), long (4.3 miles) and narrow lake, running north-south, surrounded by tussocky hills and with willows along the shore, bays with reed-beds, a swamp at the northern end and a small island; altitude 2,350 feet. Sheltered bays and parts of the lake freeze over during winter. There are

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FIGURE 8 — Willows along the shore of Lake Alexandrina provide in places anchor-sites for Crested Grebe nests; safer nesting is provided at the small tree-covered island in the northern part of the lake.

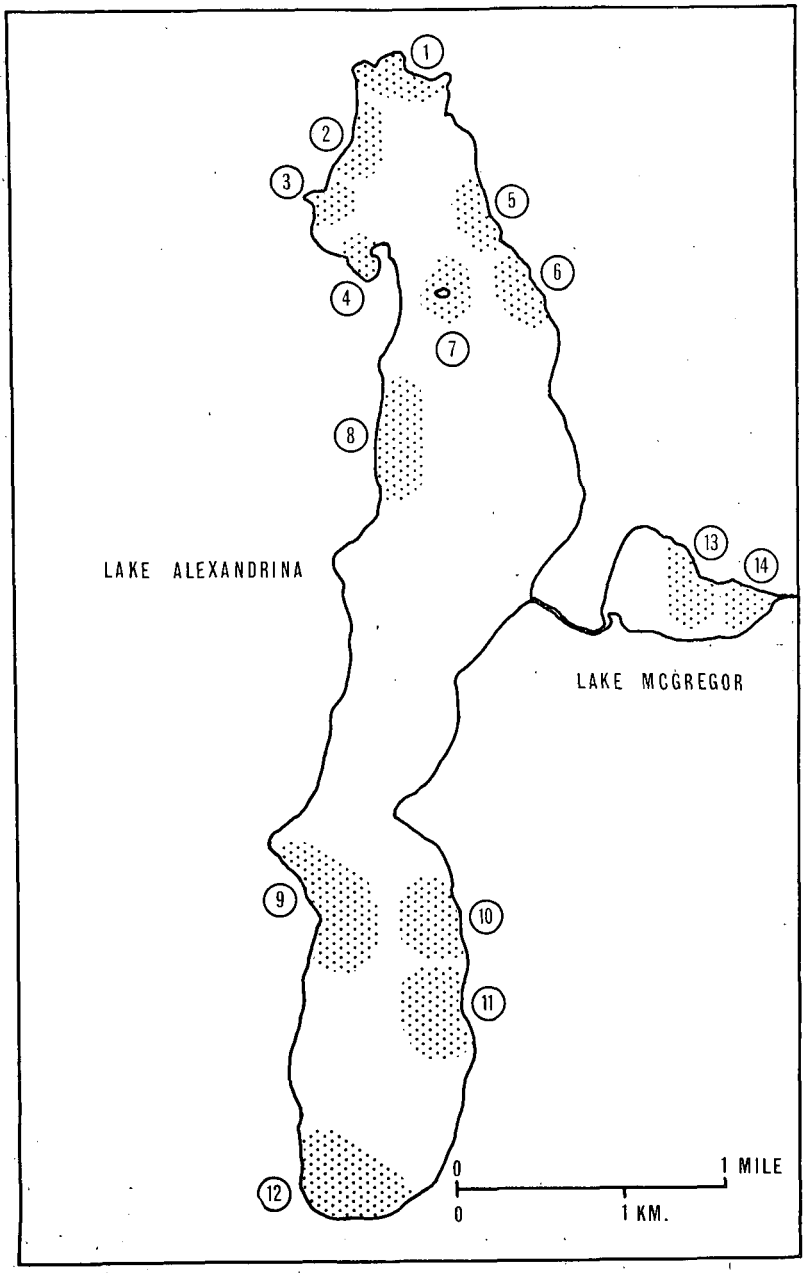

FIGURE 9 — Distribution of 12 pairs on Lake Alexandrina and 2 pairs on Lake McGregor as encountered and mapped on 17 - 18 January, 1970.

anglers' camps with cribs at northern, mid-eastern shore and southern end of the lake, but fortunately no motor boats are allowed. One of the most valuable Crested Grebe lakes in New Zealand and for its size probably still has — although local residents and anglers who have fished here for many years claim a decrease — the largest concentration and breeding population of the species in present-day New Zealand. On 21 November 1960 Mr. George Chance (pers. comm.) saw nine grebes, seven in the northern (Glenmore) end and two at the middle camp; a nest with seven eggs was found at lake on 14 January 1961. A total of 14 grebes was counted on 20 October 1962 (W. T. Poppelwell, pers. comm.). Three pairs seen on 18 October 1966 (A. Wright, pers. comm.). On 25-26 December 1966 M. F. M. Wright (O.S.N.Z. Rec. Scheme) counted a total of 18 Crested Grebes on this lake: one pair in the north-eastern end, five pairs below the middle camp on the eastern side, one pair in the south-eastern part, one pair in the south-western end, and a pair in the Bay of Wales, a mile-and-a-half from the bottom end on the western side. On 5 March 1967 Mrs. H. Oliver (pers. comm.) saw three Crested Grebes near middle camp. I have studied grebes at this lake since 1964 with visits in spring, summer, autumn and winter, and have over this period observed a fairly constant population of some 10 - 12 pairs, mainly present in the upper and lower thirds of the lake; the middle third with the large and ever growing anglers' and holiday camp is less often frequented by grebes. On 17-18 January 1970 I made a careful count and mapping of Crested Grebes on Lakes Alexandrina and McGregor, delineating their approximate territories, and located 12 pairs on Lake Alexandrina: three pairs obviously had nests, one pair had two-quarter-grown young, and one pair had a half-grown young (cf. Fig. 9).

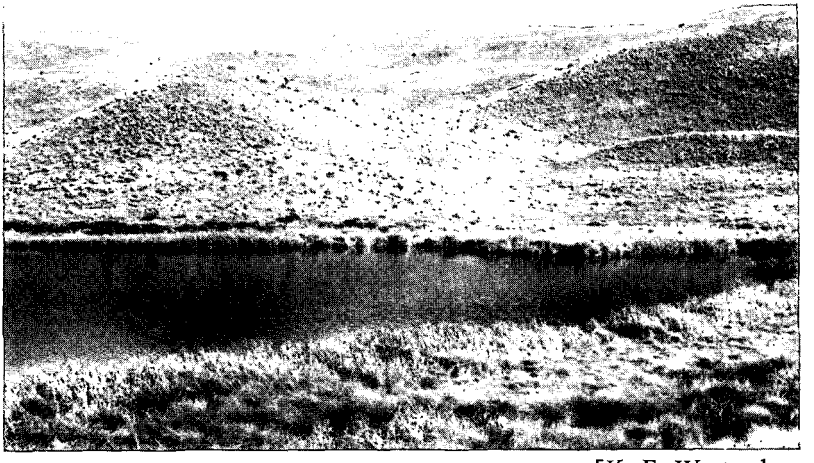

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FIGURE 10 — A sheltered bay, fringed with reed-beds, offers optional nesting sites for Crested Grebes in a bay at Lake Alexandrina; such dense reed-beds are the exception on New Zealand grebe waters.

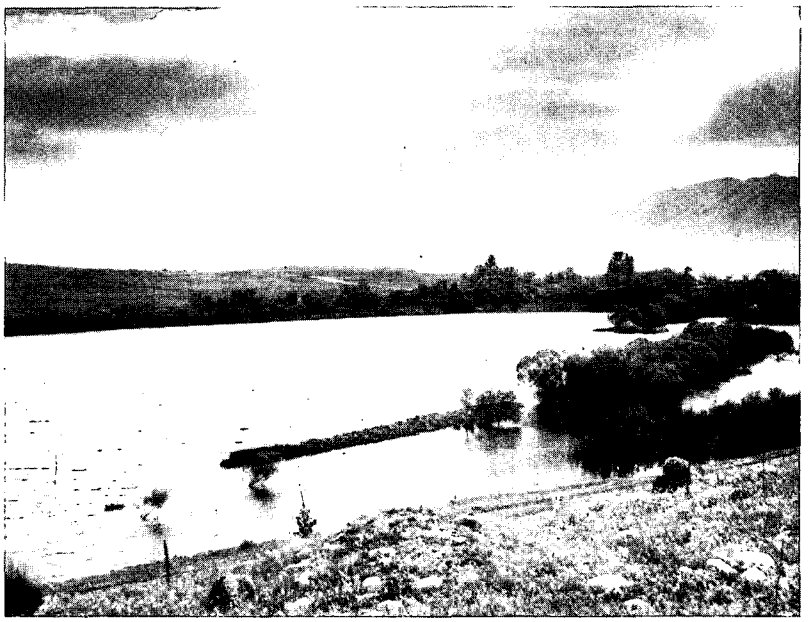

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FIGURE 11 — The eastern end of Lake McGregor during a period of high water levels. Two pairs nested here during the 1969-70 breeding season, in reed-beds and willow thickets.

Lake McGregor (35) is a small lake (102 acres) at the same altitude as Lake Alexandrina and connecting the latter with Lake Tekapo via streams at both ends. Extensive reed beds at the northern shore and willow and reed thickets in the eastern parts provide suitable water fowl nesting areas. On 20 November 1960 Mr. G. Chance (pers. comm.) counted 14 Crested Grebes in this lake and on 21 November 1960 found a nest with 4 eggs; the group of 14 grebes was assembled near the outlet. Over this period 20-27 November 1960 7 pairs were located, holding territory; each pair patrolled a roughly triangular area consisting of a piece of shore-line and a less frequented area of water out towards the centre of the lake. When the 14 birds were holding their " community gathering " one evening, much courtship display, fighting, chasing and defending of territory was seen. On 18 October 1962 a total of 23 Crested Grebes was counted on this lake (W. T. Poppelwell, pers. comm.). On 24 February 1963 five adults: one pair and three single grebes were seen; no young; a total of 12 grebes was observed on 22 November 1965; all were in pairs; one seemed to have a nest which could not be found; no young (H. R. McKenzie, pers. comm.). Over the period 30 October - 2 November 1966 three pairs were located and their territories defined (G. Chance, pers. comm.). A pair and a single grebe were seen on 27 December 1966 (P. M. Sagar, pers. comm.). On 11 January 1967 2 pairs of grebes were seen; courtship display was observed (W. T. Poppelwell, pers. comm.). During my own visits I have observed

two or three pairs; while surveying grebes and mapping territories on 18 January 1970, I observed two pairs, one in the eastern end with two half-grown young, and a second pair more towards centre of lake but also in narrower eastern half. An angler told me that he in early January 1969 (the holiday period when the middle camp has a large population of anglers and their families and other holiday makers) had found a dead Crested Grebe with a .22 bullet in its head, and washed ashore on the lake edge, the result of vandalism. Crested Grebes are fully protected by law.

Hartley Tarn (36) is a small high country tarn a couple of miles north of Lake Alexandrina. Mr. G. G. Murray of Glenmore Station told me that he had seen a pair on this lake in December 1969 when working in the area; when I visited this barren tarn in its forbidding hills on 18 January 1970 I did not see any grebes and as the tarn can easily be covered, I am sure there were no grebes then. Maybe the pair seen had been looking for a suitable nesting habitat as part of the spring exodus to breeding grounds.

Lake Pukaki at 1,588 feet altitude and of a size at present of some 31 sq. miles is a large lake with a hydroelectric power station at its southern end. This lake is fed by the Tasman River which drains the alpine valleys to the west; it is as uninviting and unsuitable as a waterbird area as is Lake Tekapo and mainly for the same reasons; furthermore, present planning envisages a raising of this lake when the future development of the hydroelectric development of the Waitaki River is carried out. I have visited this lake on a number of occasions at different times of the year (the road to the Hermitage skirts the western shore of the lake at its full length) but I have never seen any Crested Grebes on this lake, nor have any of the local people I have talked to ever seen or heard of grebes being seen there. Mr. G. Seymour of Ferintosh Station (pers. comm.) has advised me that he has never seen or heard of Crested Grebes on this lake.

Lake Ohau (37) is another large (approximately 14,720 acres) high country lake in impressive but barren surroundings; elevation 1,720 feet. I have visited this lake on various occasions but never seen any Crested Grebes, but two grebes were seen in the northern end of lake during the second week of October 1966 (R. Smith, O.S.N.Z. Rec. Scheme). Mr. S. H. Weatherall of Lake Ohau Station advises (pers. comm.) that two pairs of Crested Grebes were permanent residents on the pond at the northern end of the lake from 1954-1959; from 1960-68 there was only one pair left but on 9/10/70 I saw two pairs in full breeding plumage, one pair at the top end and the other off the western shore about half way along.

In addition to the above mentioned lakes where Crested Grebes are or have been found as breeding birds or visitors, there are a few more records of accidental occurrences of grebes in Canterbury. In the Canterbury Museum collections there are two Crested Grebe specimens: a female (AV 1224) shot on a small lake in Rangitata Gorge (38) on 8 May 1917; this bird was with a male when shot, but the male is not now in the Canterbury collection: and a young male (AV 2888), with no date, collected at Temuka (39).

NUMBERS AND POPULATION DENSITY

Accepting the inevitable shortcomings and errors in a field project of this nature and magnitude, the results of this study show that about 50 pairs of Crested Grebes have been found on Canterbury lakes about 1965 - 70.

Nesting takes place every year on 23 waters, namely Lakes Guyon, Sumner, Sheppard, Taylor, Sarah, Grasmere, Pearson, Marymere, Letitia, Lilian, Catherine, Ida, Selfe, Evelyn, Coleridge, Georgina, Heron, Western Maori Lake, Clearwater, Emma, Denny, Alexandrina, and McGregor.

Nesting birds may (occasionally) be present on Lake Hawdon and Vagabonds Inn.

Formerly occupied nesting lakes are Lakes Katherine, Mason, Lyndon, Ohau (where they may possibly still nest some years when conditions are favourable), and Ellesmere.

Crested Grebes occur as visitors on Lakes Marion (possibly nesting?), Camp, Roundabout, Tekapo and Hartley Tarn.

There are no records of Crested Grebes present now or formerly at Lakes Tennyson, Pukaki and Waitaki or in the coastal lagoons, Washdyke and Wainono Lagoons.

Grebe waters in Canterbury vary enormously from small lakes like Lake Ida (24 acres), Lake Denny (30 acres), Lake Evelyn (36 acres), Western Maori Lake (52 acres) and Lake Sarah (50 acres) to such large lakes as Lake Coleridge (11,520 acres), Heron (1,800 acres) and Alexandrina (1,645 acres).

The mean water area per nesting pair for all occupied Canterbury lakes is 430 acres; excluding the two large lakes (Sumner and Coleridge) — for which grebe numbers correspond to a breeding pair per 2,149 acres — the average water area per pair is 150 acres. Comparatively the highest populations are found on the smaller suitable lakes, where the lake margin with nest sites is comparatively larger per unit of water area, and where maximum populations are a pair per 25 - 50 acres compared with a mean of 137 acres per pair in for example the larger Lake Alexandrina; which is, for New Zealand conditions, one of the most densely populated larger grebe lakes. If Lake Ida, which in fact consists of two lakes which usually freeze over in winter so Crested Grebes are summer residents only, is considered somewhat anomalous compared with the usual all-year lake occupancy of New Zealand grebes, indications are that minimum lake size to sustain permanently a pair of breeding grebes (and the offspring eventually leaving to nest elsewhere) in Canterbury is in the order of 40 - 50 acres. The highest verified populations are Mr. George Chance's record of 15 acres per pair on Lake McGregor in 1960; on this same lake Mr. W. T. Poppelwell counted 23 Crested Grebes in October 1962. The number of grebes on Lake McGregor has decreased appreciably but even earlier, numbers fluctuated somewhat from year to year, possibly mainly as a result of fluctuations in lake level (the lake connects Lake Alexandrina and the controlled hydro-lake, Lake Tekapo).

In ideal circumstances and in the best years, Canterbury grebe populations have thus reached maximum populations of up to one nesting pair per 15 acres of water surface. Compared with high densities of this species in Europe, New Zealand populations look poor indeed. In Czechoslovakia, Hanzak (1952: 10) mentions for example the Slavnic Pond which on its 27 acres has as many as 7 pairs of nesting grebes, or approximately one pair per 4 acres. Hanzak also found that smaller lakes, provided they are otherwise suitable, have comparatively higher grebe populations: On lakes exceeding 247 acres (100 ha.) there are 4 pairs per 100 ha. (or 1.6 pair per 100 acres), while on lakes of smaller size there are on the average 10 pairs per 100 ha. (or 4 pairs per 100 acres).

In Britain Simmons (1955: 12) found that Crested Grebe waters must be at least 5 acres in extent " though locally a couple of small pits of some two acres each have been colonized recently (one pair of grebes on each) and young successfully reared there." Harrison and Hollom (1932: 175) during their famous Crested Grebe Inquiry 1931 found that under special conditions even very small lakes may be colonized in southern England, with a pair of grebes per 3.5 acres (Blackpit in Bucks.), 3 acres (Latimer in Bucks.), 3 acres (Lindridge, Warwick) and 4 acres (Island Pool in Worcs.).

Whether comparing maximum or over-all numbers of Crested Grebes on European and New Zealand waters, the much higher population densities in Europe stand out clearly. Higher European grebe densities may partly be a result of more suitable ecological conditions: better food supply, more abundant nesting sites, less violent hydrological situations (less marked changes in lake levels); all of which needs further study. Another difference which has a possible bearing on the pronounced differences in population densities is the fact that New Zealand grebes with rare exceptions are permanent residents on their breeding waters; in this way, feeding opportunities at the most unfavourable part of the yearly cycle, i.e. winter, become the deciding factor in determining populations. In Europe grebes are migratory and thus only occur on their breeding grounds during the spring-summer-autumn period when food production is highest. Hanzak (1955: 35) showed that in Czechoslovakia grebes arrive on their breeding grounds late March and leave again in October, thus spending only some six months on their breeding waters; during the remainder of the year these grebes live in their winter quarters, sustained by other food sources.

POPULATION DECLINE

As will appear from the detailed discussion of individual lake populations of Crested Grebe, the present population on Canterbury lakes is approximately 50 pairs while an enumeration of former population estimates show a population earlier this century in the order of some 80 pairs (minimum). Utilising these figures, the decrease in the grebe population appears to be some 35-40 per cent, a depressing state of affairs when the limited distribution and the current habitat deterioration is considered.

Crested Grebes have disappeared as breeding birds from some lakes, such as Lakes Katrine, Mason, Lyndon, Ellesmere and Ohau, and have decreased in numbers of breeding pairs on other lakes, such as Lakes Guyon, Sumner, Sarah, Grasmere, Pearson, Selfe, Heron and McGregor.

Indications are that the species is decreasing in a north-south direction with populations stronger in the southern sector. The Crested Grebe has in this century disappeared as a breeding bird in Nelson-Marlborough; the northernmost breeding lake, Lake Guyon, which formerly held a good population according to Travers (1870), has now only one pair left; the next group to the south is the Sumner Lake group where a population decline from some 16 to about 6 pairs has taken place over the last 20 - 30 years.

A certain minimum of nesting pairs (not known) is undoubtedly necessary on isolated lakes or associated lake groups in order to ensure breeding, stimulate courtship displays, facilitate exchange of individuals, replacements, prevention of inbreeding due to isolation as well as new recruitment in case of climatically caused disasters.

The string of grebe lake groups down the Canterbury high country slopes appears in danger of disintegration if or when in each cluster of lakes the population reaches below the safe minimum for this particular species.

New Zealand's Crested Grebes are vulnerable; they belong to an ancient and undoubtedly primitive bird order which has shown little ecological plasticity, little adaptability to environmental changes, in particular those caused by man (in which respect, incidentally, our New Zealand birds have proved inferior to Crested Grebes in north-western Europe), and their reproductive rate is extremely low.

Major factors in the decline of Crested Grebes in Canterbury are (not necessarily in the order of importance): illegal shooting (the Crested Grebe has had complete protection by law since 1907); disturbance from nests (by boaters, anglers, holiday makers); power-boating and water-skiing; dislodging nests and frightening birds; naturally occurring floods and associated disruption of nests; fluctuating water-levels (and nest disturbance) as a result of hydro-lake manipulations; eutrophication of lakes and resultant changes in invertebrate and fish populations as well as the murky water hindering or making difficult the under-water hunt for prey; opening up of lakes for holiday activities removing reed-beds, bushes and trees along shore (for nest attachment); tourists and anglers wandering along and fishing from the shore, keeping the grebes from their nests for hours and thus destroying the eggs. The above is a brief outline of some of the main factors responsible for the grebe decline; this subject will be dealt with in more detail in another paper.

DISTRIBUTION AND ALTITUDE

In Canterbury the Crested Grebe now nests in high country lakes only. On five lakes at from 2,275 - 2,600 feet altitude breed 46 per cent of the population, on 16 lakes between 1,900 and 2,200 feet breed 38 per cent, and below 1,900 feet (1,600 - 1,900 feet) altitude are found 16 per cent of the breeding population.

The mean lake level is about 2,202 feet altitude, or approximately at the level of Lake Catherine.

Freezing over of the breeding lakes takes place only at the upper level (2,600 feet), Lakes Ida and Lilian; and Lake Lyndon (2,769 feet), sometimes used as a breeding lake; partial freezing of lakes, in some bays and in some years also take place at 2,350 feet, Lakes Alexandrina and McGregor, while occasional freezing over of some bays takes place at 2,276 feet: Lake Heron.

The Canterbury Crested Grebe lakes lie between 42° and 44° S. latitude. This corresponds to northernmost Spain, central Italy, Bulgaria, and Turkey in the southern part of the European range of the nominate subspecies of this form; where it occurs in these parts, it is also a bird of high country and mountain lakes (cf. Harrison and Hollom, 1932: 103; Wadley, 1951: 63) but also at lower levels (cf. for example Bannerman, 1959: 204), although detailed recent studies are lacking. The whole question of the southern breeding range of the Crested Grebe in Europe in relation to altitudes of breeding lakes and with due consideration to appearance of accidental visitors and migrants is in need of attention.

The relationship between altitude and latitude in terms of climate and thus faunal and floral distribution patterns are of such a nature that it can be converted into a usable sliderule bio-climatic law. This rule, based on work by Humboldt and Chapman (Allee *et al.* 1949: 461), incorporates the facts that temperature increases about 1 degree Fahrenheit for each degree of latitude from either pole towards the equator and that 1 degree Fahrenheit is equivalent to 300 feet altitude in the mountains. Utilising this principle, the Canterbury Crested Grebe range corresponds bio-climatically to sea-level latitudes of approximately 49° - 52° N. latitudes, encompassing southern England Belgium, parts of Germany and Poland, all areas known for good grebe populations.

The comparative nearness of Canterbury grebe populations to the equator is thus offset by altitude, bringing the environmental conditions more into line with conditions prevailing in the main range of the nominate subspecies. Similar situations are found in the distribution of the African subspecies *(Podiceps cristatus infuscatus)* which according to Benson and Irwin (1963: 213) is found discontinuously on high country lakes, and in the eastern asiatic range of the nominate subspecies which breeds, for example, on Tso Kar Lake in Ladakh in the Himalayan Highlands at 14,900 feet altitude (Meinertzhagen, 1927: 617).

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