Number and distribution of Mute Swans *Cygnus olor*, Bewick's Swans, *C. bewickii*, and Whooper Swans *C.Cygnus* in the West Siberian plain.

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Bird census data from the West Siberian plain, USSR, were analysed to give population estimates for three swan species. The Mute Swan only inhabits the steppe and forested steppe and numbers about 6,000 individuals. Bewick's Swans are only found in the forest-steppe during the spring migration, although they are also found in the arctic tundra which was not censused. The average number of Whooper Swans decreases from the forest-tundra northwards to the southern taiga, then increases towards the forest steppe and decreases again in the steppe. The population is mainly concentrated in the northern taiga. A total of 316,000 Whooper Swans were counted in the whole of the West Siberian plain during the first half of summer. The accuracy of this population estimate is discussed.

Bird censuses made throughout the West Siberian plain between 1959 and 1988 have been analysed in order to study the distribution of swan populations. There are considerable problems involved in estimating numbers of birds in such large areas, especially when funds are limited. Studies which aim to count all birds to an individual always result in underestimates whilst to extrapolate from selective data limits the accuracy. The reliability of any estimates depends on the amount of data analysed and it is desirable to use all available information, even if it has been collected for other purposes.

For this reason the population estimates presented in this paper relate to the secondary use of bird census data provided by the zoological monitoring laboratory of the Biological Institute and some published material (Pantelejev 1972a,b, Kucheruck *et al.* 1975, Bursky & Vakhrushev 1983, Danilov *et al.* 1984, Toropov *et al.* 1986, Stopalov 1986, Koslov 1988).

Study area and Methods

The whole of the West Siberian plain from the Ural Range in the west, eastwards to Yenisei and from Kazakhstan in the south to the Arctic Ocean has been censused. Only the arctic tundras were excluded. The whole territory covers 2,500,000 sq.km. of which 50% (up to 70-75% in some regions) comprises vast bogs. There are many large and small lakes. Woods are situated in areas drained by rivers but they are becoming poor and thinned-out in the northern taiga.

Nine zones have been censused, ranging from the subarctic tundra in the north to the steppe in the south (Fig.1.). Counts were repeated twice monthly. On the tundra counts were carried out four times during the summer, in the northern taiga six times and over the remaining area seven times. Counts were initiated on 15 June in the tundra, 1 June in the northern taiga and from 15 May in all southerly areas. They were continued to 31 August in all areas.

The majority of the counts were carried out in terrestial areas (forest, fields, river floodlands, marshes). Within aquatic ecosystems, 83 lakes and 81 rivers were surveyed seven times (included in this figure are areas cut off by large rivers which intersect a variety of terrestial areas). Birds were counted along constant but not strictly fixed routes of unlimited transect width covering 39,000 sq. km. In each half of each month not less than 5 km. of each habitat and about 10 km. of lake shoreline and rivers were censused. The distance from the observer to the birds at the observation time affects the accuracy of the visual estimates (Kendeigh 1944). All birds encountered were grouped by grade of observability according to the distance from the observer (up to 25m, 26-100m, 101-300m, 301-1,000m, and more than 1,000m away). The mean distance of bird-observation within each grade is approximately equal to half the distance from the observer to the outer

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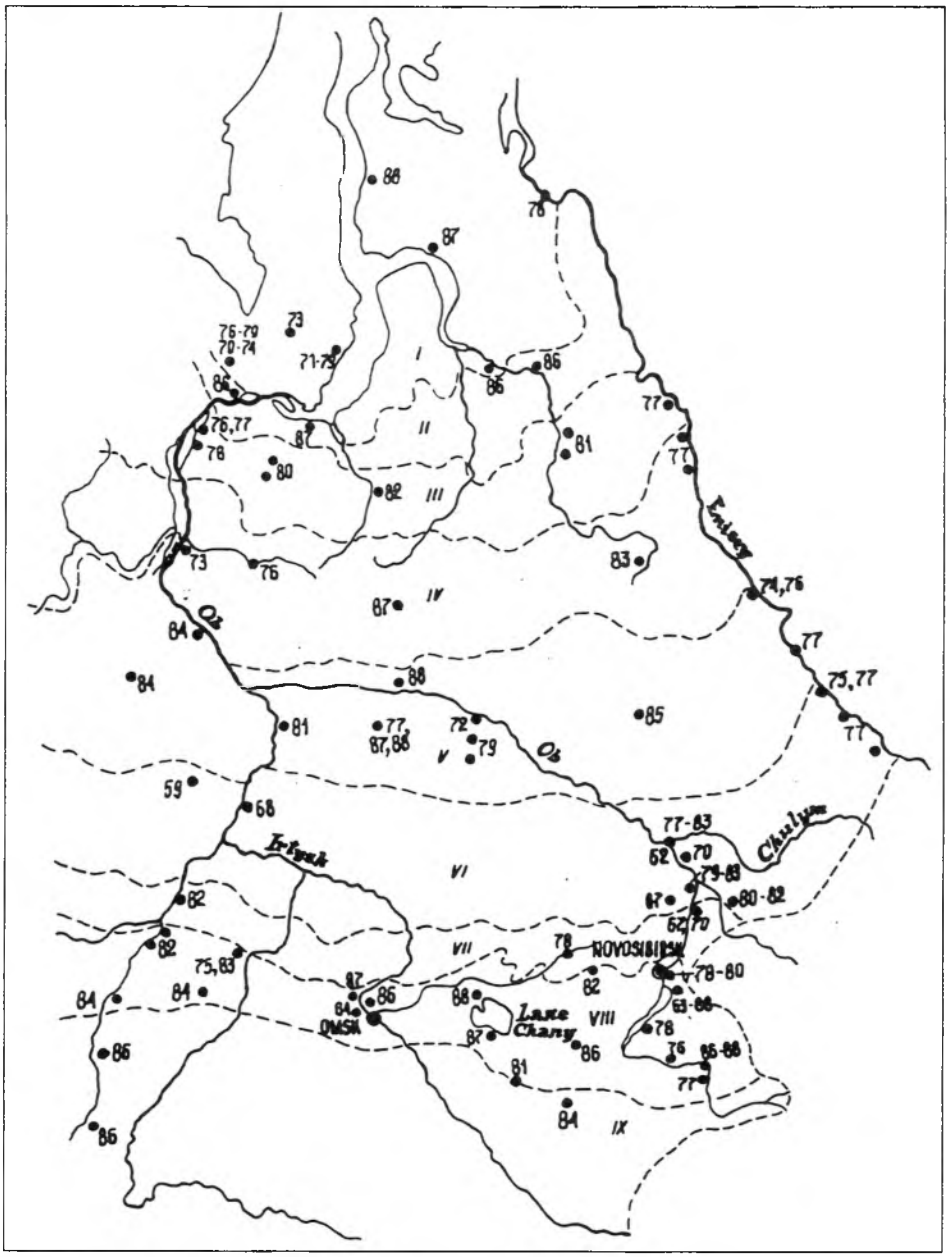

Fig. 1. Areas and years of bird counts. 59–88 — 1959–1988 years. I. Subarctic tundra, II. Forest tundra. III. North-taiga thin forest. IV. Typical northern taiga. V. Middle taiga. VI. Southern taiga. VII. Subtaiga forest. VIII. Forest-steppe. IX. Steppe.

boundary of the grade (corresponding to 12.5m, 50m, 150m, 500m and 1,000m). By these relative distances of observation the abundance of birds was calculated in each grade. The overall abundance of each species was the sum of these indices (Ravkin 1967). This method is a spatial variant of Hayne's (1949). For birds in flight, a correction was made for the speed of travel (Yapp, 1956). This assumes that the speed of leisurely-flying birds is 30 km/hour. The counts of birds in flight included both local birds and migrants stopping off to rest and feed, but did not include birds flying over high.

Along rivers the indices of bird abundance

Table 1. Number and distribution of Whooper Swans *Cygnus cygnus* in West Siberian Plain (16.05-15.07.1959-1988)

Zone, subzone	Average abundance individual/100 km²	Average number					
		thousands individuals	percentage, %				
			extraflooded unboggy landscape	extraflooded bogs	flood basins	large lakes	rivers
Subarctic tundra	0.7	2	2	2	?	96	0.2
Forest-tundra	40	48	50	38	2	0	10
Northern taiga	30	142	1	51	0.4	31	16
Middle taiga	20	108	0.9	6	6	86	2
Southern taiga	0.7	3	0	0	6	31	63
Subtaiga forest	0.9	1	3	97	0	0	0
Forest-steppe	4	10	50	20	+	30	0.1
Steppe	2	2	3	9	0	88	0
Total for West Siberian Plain	10	316	10	32	3	45	10

were counted along 10 km. of shoreline (5km. length of river).

Habitat area was measured on a 1:1,5000,000 map of 'vegetation of West Siberian plain' (1976). Image distortion was regarded as being negligible (+/- 2%) and was therefore not corrected. The total area of large lakes and river networks was taken from the monograph 'West Siberia' (1963). Small lakes and hollows were not distinguished as independant habitats but were included with adjacent habitat types.

The records for the first and second half of summer were averaged (ie. records from before and after 1 August for the tundra and before and after 15 July for all other areas). Total swan numbers were estimated as the mean density within each habitat multiplied by the area of that habitat and summed over all habitat types. Estimates for numbers on rivers were calculated on the basis of total river network length and within the whole area.

Results

Three species of swans inhabit West Siberia: the Mute Swan *Cygnus olor*, Bewick's Swan *C. bewickii* and the Whooper Swan *C. cygnus*. Mute Swans only inhabit the southern forest-steppe and steppe and number about 6,000 individuals in the first half of summer.Bewick's Swans inhabit the tundra in the north and have only been recorded in the steppe during spring migration. Only 200 individuals were counted but Bewick's Swans also nest in the arctic tundra where they were not censused.

Whooper Swans are widely distributed throughout West Siberia. In the first half of summer an average of 10 Whooper Swans per 100 sq. km. were counted throughout the whole study area. The highest density was recorded in the forest-tundra (Table 1) with slightly lower densities in northern and especially middle taiga. Considerably lower densities were recorded in the remaining habitats.

The largest numbers were counted in the northern taiga mainly on large lakes (2/km²), with smaller numbers on rivers (0.2/ 5km of river). They are much less common in waterlogged bogs (0.2/km²) and most rare in flood basins and marshes (0.1 and 0.003/ km² respectively). A total of 316,000 Whooper Swans was estimated in the whole of the West Siberian plain during the first half of summer and 67,000 in the second half. However, the overall degree of error is large due to sampling and extrapolation; the 95% confidence limits amount to 151,000 - 662,000 birds (calculated by the method of Ravkin & Chelintsev (1990)).

Discussion

Many Soviet ornithologists consider our total population estimate for Whooper Swans to be too high. The only previous estimate for the West Siberian plain was 52,000, recorded during late summer 1971-86 (Krivenko 1989). This agrees with the current estimate for the second half of summer. It is possible that the counts reported by Krivenko were underestimates. Swans are very wary during nesting and cygnet

rearing periods and prefer to inhabit thick vegetation. During the moult they occupy inaccessible lakes free from disturbance. Our observations commenced towards the end of the spring migration. From mid-May to June the swans were very active and were easily observed whilst migrating or calling. There was a sharp decrease in numbers later. Some birds probably fly to Kazakhstan to moult but most non-breeders move to remote lakes which are almost inaccessible and were not censused.

Our counts for the first half of summer are also considered to be over-estimates relative to the lower population numbers counted in winter. However no-one has published total winter counts of Whooper Swans. Previously only swans on large lakes have been counted, but they also winter on small lakes, unfrozen rivers and even in polynias (unfrozen patches of water in icebound rivers). In addition, dispersed groups of swans wintering in East Europe up to Tataria and Bashkiria have not been censused.

Our population estimates of other waterfowl and *Grus grus* have also been higher than previous counts made on large lakes, rivers and, in the case of *Grus grus*, bogs. The discrepancies may largely be due to the birds' sparse distribution throughout large areas of suboptimal habitat, which are not censused by conventional waterfowl counts. Our counts are more detailed and cover small waterbodies and hollows and include counts of swans in flight.

In Europe there may be no such discrepancies in waterfowl censuses due to the high human population density and widespread road network. However the lack of both cause problems in West Siberia and Kazakhstan. Motor boats and helicopter censuses do not provide accurate counts either. Motor noise has been seen to cause broods to hide in the shoreline vegetation.

There are a number of possible reasons why the population abundance has been overestimated. These include mis-calculation of the number per area as a result of incorrect detectability indexes. However, the differences between the estimates and the absolute distance to the individual bird for every bird detected are not large enough to explain the discrepancies in population counts. The recount (by the method of Hayne 1949) gives counts 28% lower for the first half of summer but somewhat higher for the second half.

Our estimates include birds counted on the way to the census area and back, as well as on the main routes. If swans were not seen on these additional transects the additional distances were not included in the calculations. If all these additional transects are excluded the estimate for the first half of summer drops by 14% and by 4% for the second half. When estimating the abundance of flying swans, they were considered to be flying at a rate of 30 km/hour. If this rate is twice as much the population estimate is increased by 3%. This correction was not used for birds counted on rivers but if it were, the result would be increased by 0.6%.

If all these reasons for the possible overestimation are valid then the total should be lowered by 45% to 173,800 individuals (95% confidence limits 83,000-364,000 birds). However, it is also possible that our counts are underestimates, since swan activity drops during the second half of June as non-breeding swans (comprising about 75% of the population) fly to remote lakes which were not censued. Unfortunately the degree of underestimation is unknown at present.

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