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POPULATION STRUCTURE AND PRODUCTIVITY OF *CYGNUS COLUMBIANUS COLUMBIANUS* ON THE YUKON DELTA, ALASKA

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Introduction

The broad, flat delta between the Yukon and Kuskokwim Rivers covers an area of approximately 67 340 km^2 in southwestern Alaska. Here *Cygnus columbianus columbianus* is an abundant nesting species occurring in higher densities than elsewhere in its breeding range (King 1973). The swans nest throughout the Yukon-Kuskokwim Delta, which extends approximately 376 km north to south at the coast and 320 km east to west. The mid-portion of the delta lies at about 61°30'N.

Variations in population characteristics, have been demonstrated by standardized survey methods, exploratory searches and on-site nesting studies along the coastal fringe (King 1973; Clarence Rhode National Wildlife Range unpubl data). These evaluations have shown that areas within 32 km of the coastline usually support the greatest nesting densities.

Lensink (1973) analysed the population structure and productivity of *C. c. columbianus* on the delta between 1963 and 1971. Since 1971 several studies have expanded knowledge of nesting waterfowl on the Yukon-Kuskokwim Delta (Boise 1977; Dau 1974; Dau and Mickelson 1979; Eisenhauer and Kirkpatrick 1977; Eisenhauer 1977; Mickelson 1975; Scott 1977). These and continuing field investigations performed by the refuge staff have provided data expanding knowledge of the nesting biology of *C. c. columbianus* in selected habitats along the coastal fringe (Clarence Rhode National Wildlife Range unpubl data).

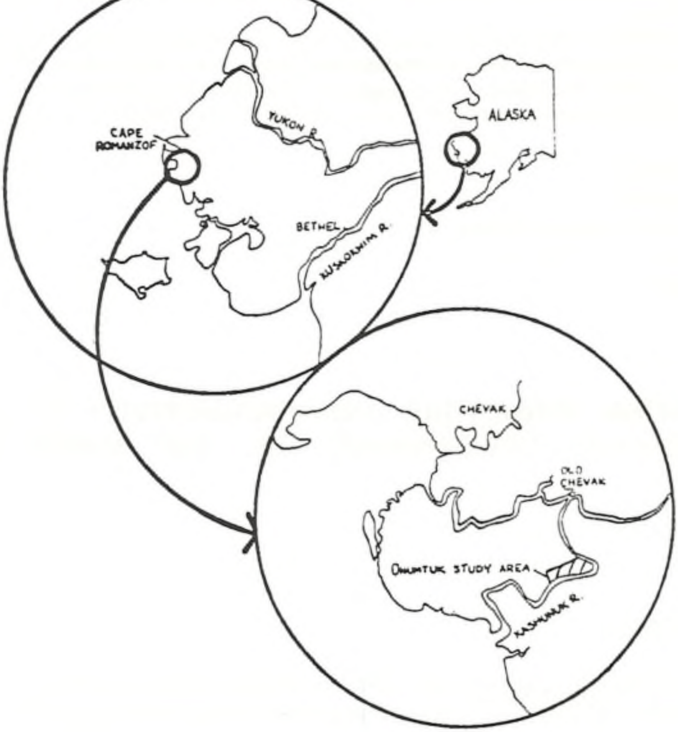

Fig 1. Location of the Onumtuk study area on the Yukon-Kuskokwim Delta, Alaska.

The present paper is an up-date of data on population structure and productivity for 1972 to 1979. An evaluation is provided of the phenology of weather patterns during the spring/early summer period and the resulting effects on the nesting distribution, densities and production of swans on the 10.4 km^2 Onumtuk study area situated 11.2 km from the Bering Sea coast (Fig 1).

Results

Distribution and productivity

The Onumtuk study area is dominated by low, wet sedge/grass meadow with numerous small, irregularly shaped ponds, typical of this habitat type within the coastal fringe of the delta. In some climatically early years *C. c. columbianus* nests in such areas in densities averaging over 0.4 nests per km^2. Areas of upland, ericaceous tundra interspersed with areas of wet meadow along the coastal fringe seem to be preferred areas for nesting and may support densities up to 1.5 nests per km^2, probably averaging nearly 0.8 nests per km^2.

Lensink stated that most *C. c. columbianus* arrive on the Yukon-Kuskokwim Delta by mid-May. On the Onumtuk study area it is one of the first species to arrive. First arrivals and peak influxes seem to relate to fluctuations in the timing of the snow-melt period and the subsequent availability of nest sites (Table 1). The years of 1974, 1978 and 1979 were climatically early and the first arrival and peak influxes of swans were also advanced. In the late years of 1972 and 1977 the timing of spring migration and ice break-up were delayed.

Table 1. Phenology of habitat availability and *Cygnus columbianus columbianus* nesting on the coastal fringe of the Yukon Delta.

A = April, M = May, Jn = June

Year	Snow cover 100%	Snow cover 10%	Nest sites available	First arrival	Peak arrival	Onset laying (n)
	meadow	meadow	meadow			
1972	10M	28M	6Jn	8M	–	–
1973	16M	23M	29M	6M	13M	1Jn (1)
1974	26A	4M	12M	26A	2M	–
1975	–	–	–	2M	–	15M– 1Jn (8)
1976	16M	23M	24M	2M	9M	28M (1)
1977	19M	1Jn	3Jn	7M	11M	24M (1)
1978	2M	13M	14M	24A	30A	14–17M (2)
1979 pre	28A	10M	11M	28A	2M	13–21M (8)
Av	10M	17M	23M	1M	3M	24M

Weather conditions from late March to mid-May dictate to a large extent the timing and duration of the snow-melt and runoff period in May. This affects the nesting distribution of swans in areas dominated by wet meadow. Dau and Mickelson (1979) have described some relationships of spring weather to the nesting of *Branta canadensis minima* on the Onumtuk study area. Weather data presented by Searby *et al* (1977), shown in Fig 2, closely approximate to that recorded on the Onumtuk study area. Cloud conditions in late March are not as extensive, falling in the 50% cloud cover bracket (Searby *et al* 1977). Comparative figures for early versus late years on the Onumtuk study area suggest that temperatures and cloud cover in April and May are the primary factors determining the phenology of the season (Table 2).

Climatically late years prevent swans from nesting in some wet meadow areas and hence have an obvious effect on nesting distribution and potentially overall nesting density. Productivity may also be affected if predation rates differ among habitat types.

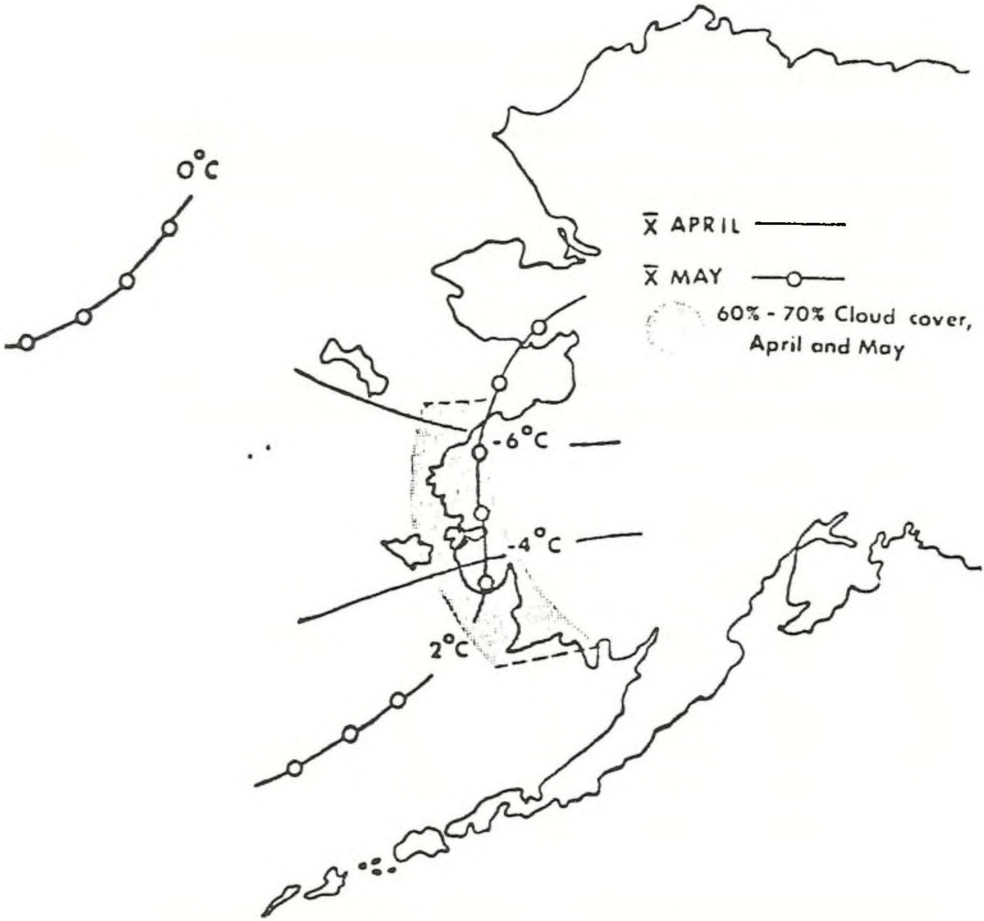

Fig 2. Average air temperatures and percent cloud cover for April and May on the Yukon-Kuskokwim Delta, Alaska (after Searby *et al* 1977).

Table 2. Comparative climatological data for a late year (1977) and early year (1978) recorded at Cape Romanzof and average percent cloud cover for the Onumtuk Study Area

Year	Month	Temperatures (°C)			Precipitation		Av %
		Av min	Av max	Average	No. days ≥2.5mm	Total (in mm)	cloud cover
1977	April	−13.3	−6.9	−10.0	4	33.8	—
	May	− 3.3	+0.9	− 1.3	4	22.1	77
1978	April	− 4.6	−0.1	− 2.4	4	32.3	—
	May	+ 0.8	+6.4	+ 3.6	3	29.2	62

Analysis of aerial survey data over two coastal transects dominated by wet, sedge/grass meadows and two other transects over mixed upland/wet meadow habitat for two climatically late years versus three climatically early years showed two-fold increases in nests observed in early years for both strata (Table 3; Fig 3). Observations of pairs, singles or flocks for these years did not show an obvious response in habitat selection in relation to spring climate.

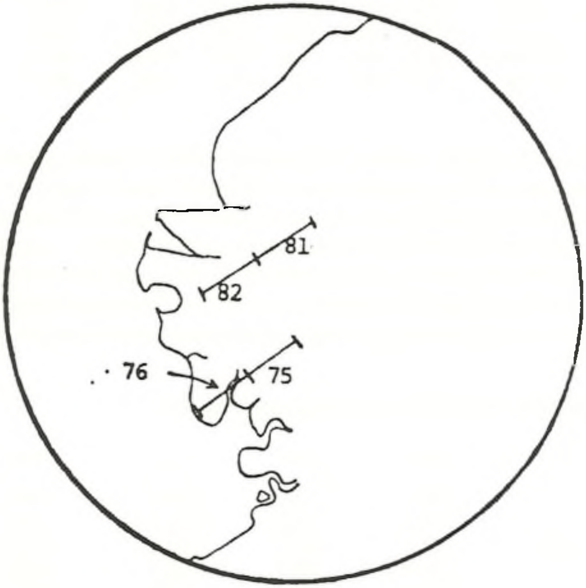

Fig 3. Four 25 km spring aerial transects utilized to assess response of *Cygnus columbianus columbianus* to climatically late versus early years (segments 76 and 82 predominately wet sedge-grass meadow; segments 75 and 81 mixed upland-wet meadow).

Table 3. Analysis of swan numbers on two coastal transects during climatically late versus early years

	Late years [1]				Early years [2]			
Transect	82	81	76	75	82	81	76	75
No. nests	1	0	2	5	4	3	5	12
No. single birds	5	7	13	9	22	12	16	23
No. pairs	6	5	27	5	8	3	11	21
Est. total pairs [3]	9.5	8.5	33.5	9.5	19.0	9.0	19.0	32.5
Birds in flocks	0	0	386	25	10	0	307	23

1) 1972 and 1977. 2) 1974, 1978 and 1979. 3) Pairs plus half the number of singles.

Table 4. Comparison of climatic factors and productivity

Year	Ice breakup		Mean temp (°C Bethel)				Av	Pairs with	Survival	
	Bethel	Chevak	April	May	June	July	Clutch	broods (%)	Sept.	Winter
1972	24 May	6 Jun	–9.8	2.9	9.2	14.3	3.50	21.9	91.1	60.6
1973	13 May	1 Jun	–3.8	4.3	9.9	11.8	4.18	34.2	75.6	62.2
1974	5 May	18 May	–1.8	7.4	10.8	12.6	4.33	46.7	68.6	53.4
1975	17 May	8 Jun	–6.4	4.3	9.7	13.6	3.38	25.2	87.9	73.1
1976	19 May	10 Jun	–8.3	3.1	9.7	12.7	5.00	13.8	66.0	52.2
1977	22 May	6 Jun	–10.1	1.9	11.4	13.4	4.50	12.6	62.2	52.9
1978	11 May	17 May	–0.9	6.6	7.3	12.2	5.20	35.1	51.7	43.5
1979	27 Apr	14 May	–0.3	6.8	8.8	12.0	4.60	48.9	60.7	–

The comparison of climatic factors and productivity of swans presented in Table 4 shows that decreases in the proportion of successful pairs occur in late years. This relationship is further exemplified in a temporal analysis of the proportion of pairs with nests or broods (Table 5). These data provide further support of the supposition by Lensink that there is a stabilization of the number of pairs with nests or broods from June to August. Variables such as human disturbance and predation have adverse effects on the survival of eggs and young but to an unknown degree.

Table 5. Percent of pairs with nest or brood

Year	May	June	July	Aug	Sept	Oct
1972	–	26.4	18.9	20.9	35.7	–
1973	–	27.6	40.8	32.8	29.2	–
1974	34.8	43.1	54.0	50.0	50.3	–
1975	–	30.0	38.3	45.5	45.5	(74.4)
1976	–	50.7	27.5	43.5	(43.5)	70.6
1977	–	20.7	38.0	45.7	(31.9)	(70.0)
1978	(40.9)	38.9	36.5	12.5	40.2	–
1979	39.6	64.4	34.4	(48.5)	52.3	(30.8)

Samples less than 100 pairs bracketed.

Lensink suggests that swan pairs with young remain near their nesting site until fledging. This seems to be the case in upland or mixed upland/wet meadow locations and is supported by the observations of Scott (1977) who maintained surveillance of several pairs and their young. However, pairs nesting in open meadow situations can move considerable distances with broods to large lake networks in meadows or, more preferably, in mixed upland/wet meadow situations.

Table 6 depicts survival throughout the brood rearing period, fall migration and into the winter. Lensink showed that most losses occur within the month after the hatch, with relatively constant rates of survival persisting throughout the remainder of the summer. This pattern is reinforced by the present analysis, as is his supposition that losses throughout the brood rearing period appear independent of the

Table 6. Survival of cygnets as indicated by changes in size of broods expressed as percentage of the average clutch size for year

	Clutches		Percent survival/average brood size					
Year	No.	Average	June	July	Aug	Sept	Oct	Winter
1972	14	3.50	(102.0)/3.57	88.3 /3.09	92.2 /3.25	91.1 /3.19	–/–	60.0/2.4
1973	22	4.18	(79.7)/3.33	(80.9)/3.38	(74.7)/3.12	75.6 /3.16	(60.3)/2.52	62.2/2.6
1974	21	4.33	100.9 /4.37	78.5 /3.40	74.8 /3.24	(68.6)/2.97	–/–	53.4/2.3
1975	8	3.38	(59.2)/2.00	(92.3)/3.12	(87.9)/2.97	(87.9)/2.97	(97.0)/3.28	73.1/2.4
1976	1	5.00	–/–	(70.0)/3.50	(60.0)/3.00	(66.0)/3.30	(63.4)/3.17	52.2/2.6
1977	2	4.50	(88.9)/4.00	67.3 /3.03	79.6 /3.58	(62.2)/2.80	74.4 /3.35	52.9/2.5
1978	13	5.20	(67.3)/3.50	65.0 /3.38	(54.0)/2.81	(51.7)/2.69	–/–	43.5/2.4
1979	12	4.60	–/–	(60.9)/2.80	(48.9)/2.25	60.7 /2.97	81.5 /3.75	–/–

Samples of less than 50 broods are bracketed; samples with more than 200 observations in California and Utah during December or January are summarized in various reports by J J Lynch or J Voelzer.

original clutch or brood size. Attrition of young swans during fall migration from 1963 to 1979 ranged from 8.3% to 31.1% (16.9% average) reductions in brood size from September/October to December.

Lensink suggests that determining the proportion of single and paired swans in May, June and September is hampered by the non-random distribution of flocks of non-breeders. This problem exists to a variable extent throughout the summer and increasingly so in mid- to late August (Table 7). Losses of nests or young may induce failed breeders to join existing flocks of non-breeders.

Table 7. Percent of adult or subadult swans identified as singles or pairs

Year	May	June	July	Aug	Sept	Oct
1972	–	62.1	65.2	83.1	16.8**	–
1973	–	43.2	55.6	(62.9)	(49.8)	–
1974	37.7	51.8*	43.0	35.0*	(17.6)	–
1975	–	(80.0)	60.1	(66.2)	(80.1)	44.3
1976	–	12.5	46.7	(79.2)	10.9	(15.9)
1977	–	12.0	52.4	(77.2)	(34.5)	4.4*
1978	(86.3)	(95.1)	(83.3)	(71.6)	(24.0)	–
1979	66.3	35.7	(72.1)	14.0*	12.1**	(50.9)

Samples of less than 1000 swans are bracketed; * samples larger than 2000; ** samples larger than 3000.

Conclusions

Timing of snow-melt and runoff in spring determines the utilization of low, wet meadow areas in the coastal fringe of the Yukon-Kuskokwim Delta by swans.

Climatic conditions, primarily temperature and cloud cover, dictate the phenology of spring break-up and, as was pointed out by Lensink, these factors can affect productivity via clutch size. Nesting distribution and density is also affected by snow-melt patterns, especially in late years. The relationship between spring climate and length of the nesting season on productivity of *C. c. columbianus* at other coastal locations in Alaska was presented by Lensink and recent data do not suggest a different appraisal (J G King pers comm).

There is no obvious relationship between timing of nesting and clutch size versus family group size and percentage of young in the winter population (Norman 1977, 1978; Voelzer and Wade 1979). This suggests that variability in the annual winter estimates of productivity probably reflects differential mortality during migration or on the winter grounds.

Summary

Observations on the population dynamics of the Yukon-Kuskokwim Delta *Cygnus columbianus*

columbianus population were reported for the nine-year period 1963 to 1971 (Lensink 1973). The present paper presents continuing data on this population for the eight-year period 1972 to 1979.

The high visibility of this species has permitted the collection of data relating to population status by aerial survey techniques. Clutch and brood sizes as well as flock size and composition are collected in this manner and relate productivity to the phenology of the spring snow-melt. Data relating to spring climate were collected on study areas within 30 km of the Bering Sea coast where nesting densities are approximately 0.4 nests per km^2.

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