AERIAL OBSERVATIONS OF WHISTLING SWANS ON THE YUKON DELTA, ALASKA [1]

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Whistling swans are the most conspicuous of wild residents of the Yukon-Kuskokwim Delta, the principal nesting grounds for swans of the Pacific Flyway. They are readily visible from low flying aircraft, and local pilots or their passengers frequently remark on their abundance, the occurrence of large flocks, or even of numbers of young in broods, or of eggs in nests.

The occurrence of a large population, and the ease with which swans are viewed from the air, permits detailed observations of many individuals with relatively small effort or cost. Because the various factors which may affect the welfare of whistling swans may affect other species similarly, much information on swans should be of significant value in understanding the ecology of species that are more difficult to study.

Many persons have contributed observations summarized in this report. James King, former Refuge Manager, initiated the study in 1962 and 1963. In addition, King has contributed observations made during annual surveys of breeding populations on the Delta and elsewhere in Alaska. All members of the refuge staff, but particularly Jerry Hout, and even visitors to the Wildlife Range, have participated by serving as observers.

Methods

Most observations are obtained during routine flights over the Delta for a variety of purposes, including hauling of freight and passengers from point to

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point, as well as systematic aerial census of waterfowl populations. Flights intended primarily for observing swans include only those conducted for censusing a series of random plots in 1968 and 1971, and occasional flights in late fall to insure adequate sampling of broods just prior to their migration.

Observations are normally recorded in the following categories -

Single or lone swans

Single swan with nest or brood

Pairs (does not include pairs in flocks)

Pairs with nest or brood

Flocks (three or more swans in close proximity)

Sizes of clutches or broods

General area of observations

These are then summarized for intervals of ten days to provide reasonable sample sizes and still permit detection of changes in the structure of population units that may occur over the summer (Tables 1 & 2). The consistency of recording observations, and the proportion of swans in the flight path, which are tallied, is variable, depending on the purpose and altitude of the flight, weather conditions, motivation and ability of observers and many other factors. Consistency has much improved in recent years of the study, as compared to years prior to 1967.

Most flights, whatever the purpose, are made at elevations of between 100 and 500 feet (30 and 150 meters). Elevations of 300 to 400 feet (90 to 120 meters) appear optimum, except for counting eggs or cygnets in newly hatched broods.

Results

Distribution and Behavior

First swans appear on the Yukon Delta in late April and most have arrived by mid-May. Pairs are soon dispersed widely across the Delta in all suitable habitat, with densities somewhat higher in areas near the coast between Nelson Island and

Cape Romanzof, an area which, incidentally, is the most productive for several species of geese and ducks as well as swans. Nonterritorial swans, presumably mostly subadults, gather in large flocks along coastal estuaries.

Nesting begins almost immediately in normal years, although late springs may delay nesting by ten days or more. Hatching has begun as early as June 20, or as late as July 6 - but, in either event, coincides with early growth of green vegetation and maximum activity of insects and other invertebrates.

During nesting and incubation paired swans are frequently separated from their mates and many enter our tally as singles. At hatching the population structure changes abruptly - members of pairs are less commonly separated and nonbreeding flocks begin dispersing over the Delta in small groups as they enter the molt.

Although we have not studied individual broods throughout the season, numerous observations suggest that they are relatively sedentary and that most may remain in the vicinity of their nesting site (100-400 meters) for a considerable period.

Nonbreeders remain in small flocks of three to fifteen individuals, but as flight is regained in late August they being congregating in larger premigrant flocks along the costs or in favorable foraging areas on large inland lakes. Pairs remain scattered until early September when pairs without broods join the larger flocks, causing a distortion in the apparent proportion of pairs with broods (Tables 1, 2, & 6). By late September most swans have left the Delta but some remain until freezeup in October. The number which linger is clearly the direct result of spring conditions - a late spring retarding all events throughout the summer.

Size of Clutches and Broods

Sizes of clutches have varied annually from an average of 3.30 in 1964 to 4.95 in 1967 (Table 3). Modal size of clutches has varied from 3 to 5. Average size of broods varies directly with size of clutches (Table 4). Broods observed in the month following the hatch average only 75% of average clutch size (Table 5). During the remainder of the summer attrition to broods is relatively small, and at migration still average between 60 and 75% of clutch size. Both the initial loss of cygnets and attrition to broods during the summer appears to be independent of clutch size.

A second sharp reduction in brood size is indicated by censuses of family groups in California and Utah, where broods observed in December average only a little more than 50% of clutch size (Lynch, 1964-1971). Again, losses appear to be independent of original clutch or brood size.

Number of Productive Swans

Nesting is completed by late May or early June, when the proportion of swans observed with nests becomes stable (Table 6). This proportion may vary considerably from year to year, but remains relatively constant through August, suggesting that few pairs lose entire clutches or broods. An apparent increase in the proportion of pairs with broods in September results from desertion of territories by idle pairs. In the nine years of our study, the proportion of swans with broods in August ranged from 15.1 to 47.8% of estimated total pairs, and averaged 31.4%.

Estimates of the proportion of productive swans in the population are somewhat more tenuous than our analysis of productive pairs, because of the difficulty in sampling the nonbreeding flocks which are not randomly distributed. During July and August, however, flocks are smaller and more dispersed than in other months, and our samples seem reasonably consistent during this period (Table 7). For years in which our samples seem adequate (large), between 40 and 60 percent of swans appear to be paired and on territories (Table 8). Occasional pairs are observed in nonbreeding flocks, but these are not considered as potential breeders. The proportion of swans occurring in flocks appears relatively stable and does not seem much affected, if at all, by changes in the number of nesting pairs. We suspect variation not resulting from sampling error is caused by variation in productivity during preceding years, thus changing the relative sizes of subadult age classes. Observations in wintering areas indicate that the yearling class may vary between about 10 and 25% of the population (Lynch 1964-1971), hence, cannot much influence flock size.

If we assume that approximately 50% of swans are paired and on territories, estimates of the proportion of productive adults range from about 9% of the population in 1964 to 25% in 1968. The difference is proportionately much larger (1:2.78) than the difference in clutch size (1:1.48), hence, is a primary factor in determining annual productivity. As both clutch size and number of productive swans normally vary in the same direction, changes in productivity are larger than either. Thus, estimated production in 1964 was only .15 eggs per adult, but in 1968 was .62 eggs per adult, a difference ratio of 1:4.13.

Factors Affecting Productivity.

Weather conditions in spring are invariably the most important of factors which may affect the productivity of swans. Predators, disease, hunting, or other possible factors appear to have negligible effect. A late breakup of ice on rivers and ponds or lakes, caused by low temperatures in April or May, results in a reduction in both the size of clutches and the proportion of swans that nest (Table 9). Differences in survival of cygnets during the summer are comparatively small and seem also to be affected partly by spring conditions, as well as weather during summer months. However, our data is confusing and at present no conclusion can be drawn. With the exception of 1964, a year when the reliability of our data is doubtful, survival of cygnets during migration was highest in years with early springs. Examination of many cygnets indicates that a few may not be fledged and others are just fledging at the normal time for migration to begin. At this point in a cygnets growth they are without fat reserves and muscle development is poor, and it is apparent that many cygnets are unable to survive the excessive demands of long, migration flights. It seems more surprising that so many can.

The low productivity and subsequent hazards to survival of cygnets on the Yukon Delta in years with late springs, suggests that swans nesting in more northern areas of Alaska, where shorter seasons are characteristic, are occupying habitat that is marginal for their survival in even normal years. The relatively large population of swans on the Yukon Delta as compared to these areas, may be due entirely to a difference in length of the summer season.

Discussion

Weather conditions of early spring clearly effect productivity of other waterfowl in Alaska as well as that of whistling swans. The deleterious effect of late springs was conclusively demonstrated for ducks of several species during my studies on the Yukon Flats between 1961 and 1964, but on the Yukon Delta our data for most species is too meager to permit adequate comparison with that of swans. Studies now in progress should meet necessary data requirements if continued for a sufficient period.

Because of the dominating effect of spring conditions, we can predict production by swans with reasonable accuracy before the first egg is laid. Subsequent observations during the summer essentially confirm and increase the accuracy of earlier predictions. We are satisfied that we can also predict trends in productivity for other species, but can not at the present time accurately estimate the magnitude of change that may occur - even after the fact.

Productivity of geese on the Yukon Delta (black brant, cackling, emperor, and white-fronted) appears generally to be much more stable than that of swans. Perhaps adaptation of these species to changing conditions may not have to be nearly as great as for swans which require a significantly longer period of time between nesting and fledging of young. Among ducks, productivity of late nesting species such as scaup and most sea ducks seems less effected by late springs than that of earlier nesting dabbling ducks, particularly mallards and pintails, our earliest migrants and nesters.

Maximum changes in productivity that we have noted for any species occurs among snow geese, which we can observe only during their migration. The population we see nests primarilly on Wrangel Island in the Soviet Arctic, and its productivity as indicated by percent of immatures in the population has ranged from near 0 to 54%. As Wrangel Island has a much shorter season than the Yukon Delta, productivity of snow geese there may be analogous to that of swans in northern Alaska. Given the low production we observed among snow geese this fall (14%), we suspect that spring on Wrangel Island was rather chill.

Table 1. Aerial Observations of Swans, 1968 Summary

Period	Adults				Est. Tot.[2]	Nests or broods w/			% Prs/
	Sing	Pair	Flocks	Total	Pairs	Sing	Pair	Total	Broods
May									
26 only	18	32	261	343	41.0	1	7	8	19.5
June									
1-10	115	82	124	403	139.5	35	29	64	45.9
11-20	129	85	100	399	149.5	47	29	76	50.8
21-30	48	115	312	590	139.0	7	70	77	55.3
Total	292	282	536	1392	428.0	89	128	217	50.7
July									
1-10	47	114	430	705	137.5	5	56	61	44.4
11-20	39	117	82	355	136.5	7	63	70	51.3
21-31	16	97	335	545	105.0	4	77	81	73.4
Total	102	328	847	1605	379.0	16	196	212	55.9
August									
1-10	13	74	251	411	81.5	1	53	54	66.2
11-20	37	146	366	685	164.5	9	67	77	46.7
21-31	97	298	919	1616	348.5	9	144	153	43.9
Total	147	518	1536	2712	594.5	19	264	284	47.8
September									
1-10	56	360	1145	1921	388.0	10	212	222	57.2
11-20	17	143	491	794	151.5	6	101	107	70.6
21-31	6	70	251	397	73.0	1	44	45	61.6
Total	79	573	1887	3112	612.5	17	357	374	61.1
Observations on Census Plots[1]									
June	34	53	3/1	143	70.0	13	31	44	62.9
July	24	73	134/7	304	85.0	2	41	43	50.6
August	44	138	374/21	660	160.0	1	66	67	41.9

1 Number of plots censused included 11 in June, 18 in July, and 20 in August. Indicated populations were 1.44/mi.^{2} in June, 1.88/mi.^{2} in July, and 3.67/mi.^{2} in August.

2 Total pairs are estimated by considering single swans as 1/2 pair.

Table 2. Aerial Observations of Swans, 1971 Summary

Period	Adults				Est. Tot.[1]	Nests or broods w/			% Prs/
	Sing	Pair	Flocks	Total	Pairs	Sing	Pair	Total	Broods
June									
6-10	127	167	709/13	1170	230.5			70	30.3
16-20	63	60	231/9	414	91.5	11	14	25	27.3
21-30	203	187	931/22	1508	288.5	51	24	75	26.0
Total	393	414	1871/44	3092	609.5			170	27.9
July									
1-10	78	102	385/32	667	141.0	11	16	27	19.1
11-20	66	111	432/39	720	144.0	7	21	28	19.4
21-31	35	97	199/39	428	114.5	9	33	42	36.8
Total	179	310	1016/120	1815	399.5	27	70	97	24.3
August									
1-10	55	98	339/60	587	125.5	8	27	35	27.9
11-20	51	146	172/34	515	171.5	3	25	28	16.3
21-31	137	384	710/94	1615	452.5	4	77	81	17.9
Total	243	628	1221/188	2717	749.5	15	129	144	19.2
September									
1-10	62	253	521/44	1089	284.0	7	58	65	22.3
11-20	23	111	254/15	499	122.5	2	24	26	21.2
21-30	8	71	430/13	580	75.0	0	22	22	26.7
Total	93	435	1305/72	2168	481.5	9	104	113	23.5
October *	3	48	653/17	752	49.5	0	19	19	38.4

*Cygnets and pairs in flocks not tallied separately in October

[1] Total pairs are estimated by considering single swans as 1/2 pair.

Table 3. Frequency Distributions of Clutch Size

Year	Frequency by Size [1]							Total	Average
	1	2	3	4	5	6	7		
1963	1	2	5	12	27*			47	4.32
1964	1	5	23*	23*				52	3.30
1965	2	4	9	17*	10	2		44	4.34
1966		1	5	8*	5	1		21	4.14
1967	1		2	7	20*	11	1	42	4.95
1968	1	7	10	29*	9	3		59	4.80
1969	3	2	6	14*	8			33	4.67
1970	1	0	3	4	9*	3		20	4.45
1971	2	4	17*	11	3	1		36	3.34

[1] Modal size indicated with asterisk (*).

Table 4. Average sizes of clutches and broods.

Year	Clutches	Broods [1] June	July	August	September	October	Winter [2]
1963	4.32		(3.39)	(2.85)	2.86	2.55	
1964	3.30		(2.59)	(2.38)			1.88*
1965	4.34		(1.94)	(3.27)	2.67*		2.18*
1966	4.14		(3.03)	(2.37)	(2.51)	(2.44)	2.09*
1967	4.95	(3.63)	(4.12)	2.98	3.04*	2.91	2.5+*
1968	4.80	(4.08)	3.71	3.64*	3.63*		2.57*
1969	4.67		3.52	3.54*	3.51*		2.71*
1970	4.45		(3.43)	3.45	3.34*		2.36*
1971	3.34		(2.66)	2.61*	2.52*	2.89	

1 Samples of less than 50 broods are enclosed in parentheses (); those with more than 200 are indicated with an asterisk (*).

2 Observations in California, Utah, during December or January summarized in various reports by John J. Lynch (1964-1971).

Table 5. Survival of Cygnets as Indicated by Changes in Size of Broods [1]

Year	Average Clutch	Percent Survival [2]					
		June	July	August	September	October	Winter
1963	4.32		(78.6)	(66.1)	66.4	59.1	
1964	3.30		(78.5)	(72.1)			57.0
1965	4.34		(44.7)	(75.3)	61.5*		50.2
1966	4.14		(73.2)	(57.2)	60.6*	58.9	50.5
1967	4.95	(73.3)	(83.2)	60.2	61.4*	58.8	50.5
1968	4.80	(85.0)	77.3	75.8*	75.6*		53.5
1969	4.67		75.4	75.8*	75.1*		58.0
1970	4.45		(77.1)	77.5	75.0*		53.0
1971	3.34		(79.6)	78.1*	75.4*	86.5	

[1] See Table 4 for basic data

[2] Average clutch equals 100%

Table 6. Percent of Pairs With Nest or Brood.

Year	May	June	July	August	September	October
1963			35.4	(16.1)	52.1	(64.5)
1964		29.4		15.1		
1965		(53.3)	(34.0)	36.6	(62.0)	
1966	-	(25.4)	(39.5)	34.1	44.7	(60.0)
1967	16.8	47.0	(48.1)	30.1	46.3	(18.3)
1968	(19.5)	50.7	55.9	47.8	61.1	
1969	(39.2)	48.3	51.6	45.4	71.7	
1970	(25.4)	36.1	36.2	38.6	65.2	
1971		27.9	24.3	19.2	23.5	(38.4)

Samples of less than 100 pairs are enclosed with parentheses.

Table 7. Average Size of Flocks

Year	Average Flock Size/Number of Flocks					
	May	June	July	August	September	October
1963			24.1/7	35.0/12	114.6/17	84.2/5
1964			11.5/2	28.3/6		
1965			3.0/2	6.7/9	14.4/10	
1966	-	32.5/8		21.2/12	41.9/19	15.3/3
1967	30.7/23	81.3/7	3.0/2	3.8/5	78.3/7	
1968	43.5/6	45.8/9	9.9/85	13.4/114	42.2/27	
1969	68.8/8	31.7/31	9.4/137	7.4/139	141.9/36	
1970	67.4/14	34.2/69	9.5/115	10.9/50	69.8/67	
1971		42.5/44	8.5/120	6.5/188	18.1/72	38.4/17
Average	48.2	38.4	9.5	9.8	61.4	44.8

Table 8. Percent of Adult or Subadult Swans Identified as Singles or Pairs. [1]

Year	May	June	July	August	September	October
1963			(57.2)	[22.1]	13.7*	[24.2]
1964		(85.6)		64.7		
1965		(29.8)	(94.0)	(61.6)	(41.0)	
1966		(59.5)		(25.8)	44.7	
1967	[24.2]	56.3		(94.6)	49.4	
1968	(23.9)	61.1	47.1	43.8*	39.2**	
1969	[25.5]	50.8*	41.7*	52.6*	8.9**	
1970	12.1	37.4**	62.6	[39.5]	16.2**	
1971		39.1**	44.0	55.2*	44.4*	[13.2]

1 Samples of less than 500 swans are enclosed in parentheses (), and of less than 1000 swans in brackets []; those larger than 2000 are indicated by one asterisk (*), and larger than 3000 are indicated by two asterisks (**).

Table 9. Comparison of Climatic Factors and Productivity.

Year	Ice Breakup [1]		Mean Temp.(°F at Bethel)				Aver. Clutch	% Pairs/ Broods [2]	Survival [3]	
	Bethel	Chevak	April	May	June	July			September	Winter
1963	5/19		19.4	40.6	47.1	54.2	4.32	33.7	66.4	
1964	6/3	6/16	19.5	31.0	52.5	56.6	3.30	18.3*	72.1	57.0
1965	5/19	6/15	26.5	32.6	48.6	51.6	4.34	39.5	61.5	50.2
1966	5/23	6/15	23.0	33.2	51.8	53.2	4.14	31.5	60.6	50.5
1967	5/11	6/2	30.9	42.5	54.0	53.6	4.95	42.4*	61.4	50.5
1968	5/14	6/5	23.1	41.6	52.3	57.9	4.80	50.9**	75.6	53.5
1969	5/11	5/30	27.1	45.5	52.4	53.7	4.67	48.2**	75.1	58.0
1970	5/14	6/3	22.3	43.3	51.9	51.6	4.45	36.5**	75.0	53.0
1971	5/27	6/15	17.0	35.2	50.0	52.8	3.34	23.4**	75.4	
Norm.	5/14	?	25.5	40.3	52.1	54.6				

1 Breakup of Kuskokwim River at Bethel and the Kashunuk River at Chevak.

2 Total of all observations June through August. Ratio changes abruptly in September when idle pairs join premigrant flocks. Sample exceeding 500 pairs (*), and exceeding 1000 (**).

3 Brood size in September as % of clutch size.