A REVIEW OF FACTORS AFFECTING THE POPULATION SIZE OF THE DUSKY CANADA GOOSE

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INTRODUCTION

Population status and management of the dusky Canada goose has received considerable attention during the past few years as the population declined from a mid winter index of 26,500 in 1975 to 7,500 in 1985. In response to this decline, Canada goose hunting seasons have been reduced on the nesting grounds and, with the exception of a limited experimental hunt on several small areas in Oregon and Washington, closed on the wintering grounds. As a result, the population decline has slowed, or, at best, stabilized at a level far below the objective of 20,000 birds, measured by the mid-winter index, established in the Pacific Flyway Management Plan.

In light of the population's limited response to harvest restrictions plus new information on factors limiting production on the nesting grounds, the Pacific Flyway Council has directed its technical committee to reevaluate the population objective for the dusky goose. Such reevaluation will also require that management procedures recommended by the Dusky Management Plan to achieve and maintain the population objective be reevaluated. This paper summarizes information pertinent to reevaluation of the population objective and management procedures with emphasis on conditions leading to and sustaining the population decline.

Dusky Canada geese are known to nest only on the Copper River Delta of Alaska and winter primarily in the Willamette Valley of Oregon and southwestern Washington. Until about the 1970s, population size, which has ranged from a mid winter index of 7,500-8,000 in 1953 to 28,000 in 1960 (Table 1), was apparently limited by hunting on the wintering grounds. Based on estimates from 1953-63, hunting was responsible for virtually all (95%) of the 45% annual population mortality. Production was typically good with spring weather responsible for nearly 80% of the annual fluctuation. In the mid 1970s, the population increased to about 25,000. Around 1979, production dropped off considerably and the population began to decline. Failure of the population to respond to harvest restrictions during 1983-85 suggests that conditions influencing production are now the limiting factor. The following is a synopsis of conditions influencing production.

HABITAT AVAILABILITY AND USE

Nesting habitat on the Copper River Delta is in a tectonic triggered state of flux. Based on information from nesting study plots habitat has evolved from a predominately tidal influenced salt marsh with stringers of mixed forbs and low shrubs on elevated terrain to a fresh water marsh of which over 23% is covered by shrubs (Table 2). Shrub habitat, which is composed of tall alder and willow (14% cover) and low shrubs such as sweetgale (9% cover), now covers much of the elevated terrain.

In conjunction with changes in habitat availability, the dusky has apparently changed its preference of habitats for nesting. Prior to the earthquake, geese preferred the mixed forb/low shrub habitat which was protected from tidal flooding. Today, shrub habitats are preferred for nesting (Table 2).

SPRING PHENOLOGY

The simple linear relationship between spring phenology and production has apparently broken down. As previously mentioned, about 80% of the annual variation in production was directly related to spring weather during the early-mid 1970s (Fig. 1). During this period, the portion of the fall population composed of young geese was greater during years with "early" springs. However, only about 7% of the annual variation was related to spring weather between 1979-86. A more sophisticated three-dimensional ordinal logit model suggests that, while weather is still important, some other factor (predation?) that is peculiar to each year significantly affects production (Fig. 2).

AGE COMPOSITION OF BREEDING POPULATION

It is well accepted that the average age of a breeding population has a bearing on production with older, more experienced nesters typically being more productive. Age composition of the dusky goose population should be ideal for maximum production. Over 85% of the birds should be of breeding age with about 70% of the population theoretically between 6-14 years of age or prime breeders (Table 3).

NEST DENSITY

Calculated nest densities for the dusky goose have been some of the highest recorded for noncolonial nesting geese. Densities averaged around 160/mi^2 during the early 1970s, but declined to an average of 108/mi^2 between 1979-87 (Table 4). This decline was not at the same rate or in proportion to the population decline, suggesting that either data are being collected from a core nesting area where the number of nests is relatively stable compared to marginal nesting areas or that the dusky population is larger than the mid-winter index indicates. The apparent increase in the number of geese nesting on the far western and eastern portions of the west Copper River Delta during the mid 1970s-1980s, a time when the population was supposedly declining, plus nesting ground population indices that have been occasionally 90% larger than mid-winter indices (1985) support the latter.

NEST FATE

Nest success has also declined. Around 80% of the nests were successful during the 1970s, but success dropped off to an average of only 37% between 1979-87 (Table 4). A model, built on 1979-86 data, using nest density and success to predict the percent young in the late summer population has been developed (Fig. 3). Production was predicted within 0.9% with this model in 1987.

Nest fates other than success were not consistently measured until 1982. Between 1982-86, nest fate has averaged about 40% successful, 54% destroyed and 5% abandoned (Table 5). The primary cause of nest failure has been predation. In 1985 and 1986, nest destruction by predators was very high at about 87% and 76%, respectively. Nest predation apparently is not associated with habitat as destruction has been similar in all habitats during recent years (Table 6).

Brown bears are the major predator followed by coyotes and avian predators. The magnitude and distribution of nest destruction by these predators is apparently determined by several independent factors. Predation by brown bears is in proportion to nest availability in all habitats with magnitude determined by spring weather, timing of leaf emergence, and number of bears active on the Delta. Coyotes do not take nests in proportion to availability, but distribution of predation between habitat types changes annually and shows no discernible pattern. Apparently, coyote predation on geese and nests is related to prey base availability. Avian predators, primarily Parasitic Jaegers and Glacous-wing gulls, seem to prefer to forage for goose nests in shrub habitats. Factors determining the degree of nest predation by these predators are not well defined, but are likely related to spring weather and the energy demands and nest attentiveness of nesting geese.

The results of an experimental reduction in the brown bear population in 1987 suggested that nest predation is compensatory. Nest predation by avian predators was much greater than in previous years, offsetting the reduction in nest predation by bears (Table 5). Predation by brown bears was also higher than expected. Even with a 40-60% reduction in bear numbers, about 30% of the nest destruction was by bears, much closer to the 1982-86 average of 48% than anticipated (Table 5).

BROOD SURVIVAL

Little is known about the ecology of dusky goose broods. Various factors such as habitat availability, habitat preference, and predation undoubtedly affect survival of young geese. A comparison of nest success and young in the fall populations during the 1970s to the 1980s (Fig. 4) indicates that gosling survival has declined. In the 1970s, high nest success resulted in a high ratio of young to adult geese in the fall population, but during the 1980s, this has not been the case. For example, in 1974 and 1977, nest success was 82.7% and 79.0%, respectively. The portion of the fall population comprised of young was 51.4% and 44.3% or 18,900 and 18,500 young, respectively. In 1984, nest success was similar at about 80.4%, but only 18.3% of the population or 2,200 geese were young. Adjusting for the 54% reduction in population size and based on the 1974 and 1977 production rates, from 7,900-10,000 young should have occurred in the 1984 fall population. Since environmental factors were favorable for brood survival in 1984, predation was suspected to be the primary cause of poor gosling survival.

POPULATION TRENDS AND OBJECTIVES

Based on the preceding information it is obvious that poor production is limiting the size of the dusky goose population. Production has declined as a result of natural phenomena on the Copper River Delta and will remain low for the foreseeable future. Assuming that production continues at the 1983-87 average of 11.5±5.5% young, hunting restrictions remain in effect, and the annual survival rates of 75% for first year birds and 90% for geese older than one year (Campbell and Griese 1987, unpubl. ADF&G rep., Juneau) are appropriate, the population will continue to decline (Fig. 5).

Conditions on the nesting grounds indicate that the population objective of 20,000 is unrealistic and would be difficult to accomplish and maintain even with intensive management. It is likely that this objective, which was established during a period when the dusky population was at an all time high due to temporarily favorable conditions on the nesting grounds, was set too high to begin with. Between 1953-64, the population index averaged about 15,000. After production was stimulated by the elimination of tidal flooding and an increase in availability of preferred nesting habitat in 1964, the population increased. This increase was reflected in a population index average over 21,000 between 1965-81. Starting in about 1979, as conditions affecting production became less favorable the population begain to decline. The population index has averaged only 12,750 between 1982-87.

RECOMMENDATIONS

If the population objective is to be a realistic target for management of the dusky goose, then it should be revised downward. Such a revision would not solve the problem of a declining population, a problem that will still have to be addressed by managers, but would establish an accomplishable and maintainable population objective.

Predation is obviously a major problem on the nesting grounds. Habitat manipulation may reduce predation, but because such actions are experimental, a complete and thorough evaluation of thier affect on production should be completed prior to large scale application. Because the major predators on the Delta are known for their ability to capitalize on food resource availability, habitat manipulations that are beneficial to reproducing geese may also attract predators. Also, because predation is apparently heavy throughout the reproductive cycle, habitat manipulation that addresses only a portion of the cycle, such as nesting, likely will not improve production significantly. Predator management will probably be necessary along with habitat manipulation.

The dusky goose management plan recommends continued marking of birds and annual analysis of band recoveries and collar observations. Current harvest restrictions limit the amount of data available from band recoveries, making collar observations the primary source of information on survival rates and the age structure of the population. If the population objective is revised downward, the margin for error in management will decrease, making knowledge of these population

parameters critical to management of the dusky goose. Because of this, the marking and intensive collar observation program should be extended and expanded to provide the necessary population parameters. Perhaps this could be done as a jointly funded student project.

Table 1. Mid winter population index for the dusky Canada goose, 1953-1986.

Year	Population Index	Year	Population Index
1953 [a]	8,080	1970	---
1954 [a]	10,570	1971	19,800
1955 [a]	9,960	1972	17,900
1956 [a]	11,370	1973	15,800
1957 [a]	15,220	1974	18,600
1958 [a]	17,450	1975	26,500
1959 [a]	10,580	1976	23,000
1960 [a]	28,100	1977	24,100
1961 [a]	19,200	1978	24,000
1962 [a]	16,780	1979	25,500
1963 [a]	16,800	1980	22,000
1964 [a]	15,800	1981	23,000
1965 [a]	18,000	1982	17,740
1966 [a]	17,100	1983	17,000
1967 [a]	20,800	1984	10,100
1968	---	1985 [b]	7,500
1969	---	1986	12,200
		1987	-- [c]

[a] From: Hansen, H. S. 1968. Dembar Educational Research Services, Madison, Wisconsin.

[b] Accuracy of mid winter population questionable, calculated breeding grounds estimate was 13,150.

[c] No index developed due to incomplete survey on wintering grounds.

Table 2. Pre- and post-earthquake habitat availability, nest distribution, and Chi square goodness of fit test to determine habitat preference for dusky Canada geese nesting on the West Copper River Delta, Alaska.

Cover Type	1959			1975 [c]			1982-86 [d]		
	% of area [a]	% of nests [b]	X^2 cell contribution	% of area	% of nests	X^2 cell contribution	% of area	% of nests	X^2 cell contribution
Low shrub	10-15 [e]	97	+1707.2*	3	23	+312.2*	9	26	+265.7*
Levee				49	36	-8.1	20	14	-16.0
Tall shrub	0	0	0	0	0	0	14	20	+19.8*
Meadow	85-90	3	-177.2	49	50	-1.9	44	40	-2.5

[a] Calculated from Potyondy et al. 1975. Univ. of Minn., St. Paul.

[b] Trainer, C. 1959. Annual Waterfowl Rpt., U. S. Fish and Wildl. Ser. Juneau.

[c] Bromley, R. G. H. 1976. MS Thesis, Univ. of Alaska, Fairbanks.

[d] Alaska Dep. Fish and Game. Unpubl. data.

[e] Habitat composition was considerably different prior to 1964 and is poorly represented by this classification scheme. Elevated areas or levess were covered by a mixed forb/low shrub community.

* Preferred habitat.

Table 3. Theoretical age composition of the dusky Canada goose population in 1987. [a/]

Age class	% of population	Number of geese [b/]
0-1	6.8	850
1-2	6.0	741
2-3	1.9	240
3-4	7.4	925
4-5	9.2	1,140
5-6	13.0	1,623
6-7	9.2	1,144
7-8	9.7	1,207
8-9	5.3	665
9-10	6.8	841
>10	24.7	3,074

[a/] Based on the following assumptions.

1. The productive life span of a Canada goose is 12-14 years.

2. Annual survival rates between 1974-83 are best depicted by ESTIMATE model 0 (Brownie et al. 1985, USFWS. Res. Publ. 156, Washington, D. C.). This model indicates that, due to heavy harvest, annual survival rates are independent of age, are year specific, and average 77.49%.

3. Annual survival rates change after 1984 due to reduced seasons and bag limits and are 90% for birds older than one year and 75% for first year birds (Campbell and Griese 1987, ADF&G unpubl. rpt., Juneau).

[b/] Based on 1987 breeding grounds population index of 12,450.

Table 4. Dusky Canada goose nest density, nesting success, and young production on the west Copper River Delta, Alaska.

Year	Nest/mi^2	% nest success	% young
1959	105	89.2	-
1964	-	82.4	-
1965	-	62.9	-
1966	-	97.0	-
1967	111	-	-
1968	-	86.8	-
1970	-	88.2	-
1971	-	76.0	16.2
1972	-	81.0	10.6
1973	-	-	36.0
1974	-	82.7	51.4
1975	179	31.6	17.9
1976	156	-	24.2
1977	175	79.0	44.3
1978	183	56.2	24.8
1979	133	18.2	16.0
1980	108	-	23.7
1981	-	-	17.9
1982	102	52.3 1/	23.7
1983	91	57.9 1/	15.0
1984	95	80.4 1/	18.3
1985	97	9.8 1/	3.7
1986	119	14.0 1/	10.6
1987	116	23.8 1/	9.8

1/ Based on nests with known fate, i.e. no unknowns, between 1982-87.

Table 5. Fate of dusky Canada goose nests on the west Copper River Delta, Alaska, 1979-86 and 1987 after experimental reduction of brown bear numbers.

Year	No. nests w/known fate	% successful	% destroyed	% abandoned	Types of nest predation					
					N	Flooded (%)	Brown bear (%)	Canid (%)	Unknown mammal (%)	Avian (%)
1979	409	18.2 [a/]	-	-	-	-	-	-	-	-
1982	151	52.3	46.4	1.3	55	0	36.4	14.5	1.8	47.3
1983	145	57.9	37.9	4.1	41	0	61.0	17.1	12.2	9.8
1984	153	80.4	16.4	3.3	23	0	30.4	21.7	8.7	39.1
1985	153	9.8	86.9	3.3	133	0	46.6	26.3	12.8	15.0
1986	178	14.0	76.4	9.6	118	0	52.5	16.9	22.9	7.6
1982-86 $\bar{x}$		41.8	53.7	4.5	370	0	47.6	20.3	14.1	18.4
1987	193	23.8	58.5	17.6	115	7.8	28.7	12.2	4.3	47.0

[a/] Bromley, R. G. H. Unpubl. data.

Table 6. Chi-square goodness of fit test of the distribution of dusky Canada goose nests and destruction by habitat type on the Copper River Delta study plots, 1982-86

Habitat type	Nests available		Nests destroyed		X^2 cell contribution
	No.	%	No.	%	
Tall shrub	157	20.0	81	20.6	0.018
Low shrub	204	26.0	120	30.5	0.779
Levee	107	13.6	56	14.2	0.026
Meadow	314	40.0	137	34.8	0.676
X^2 (df = 3, P>0.05)					1.499

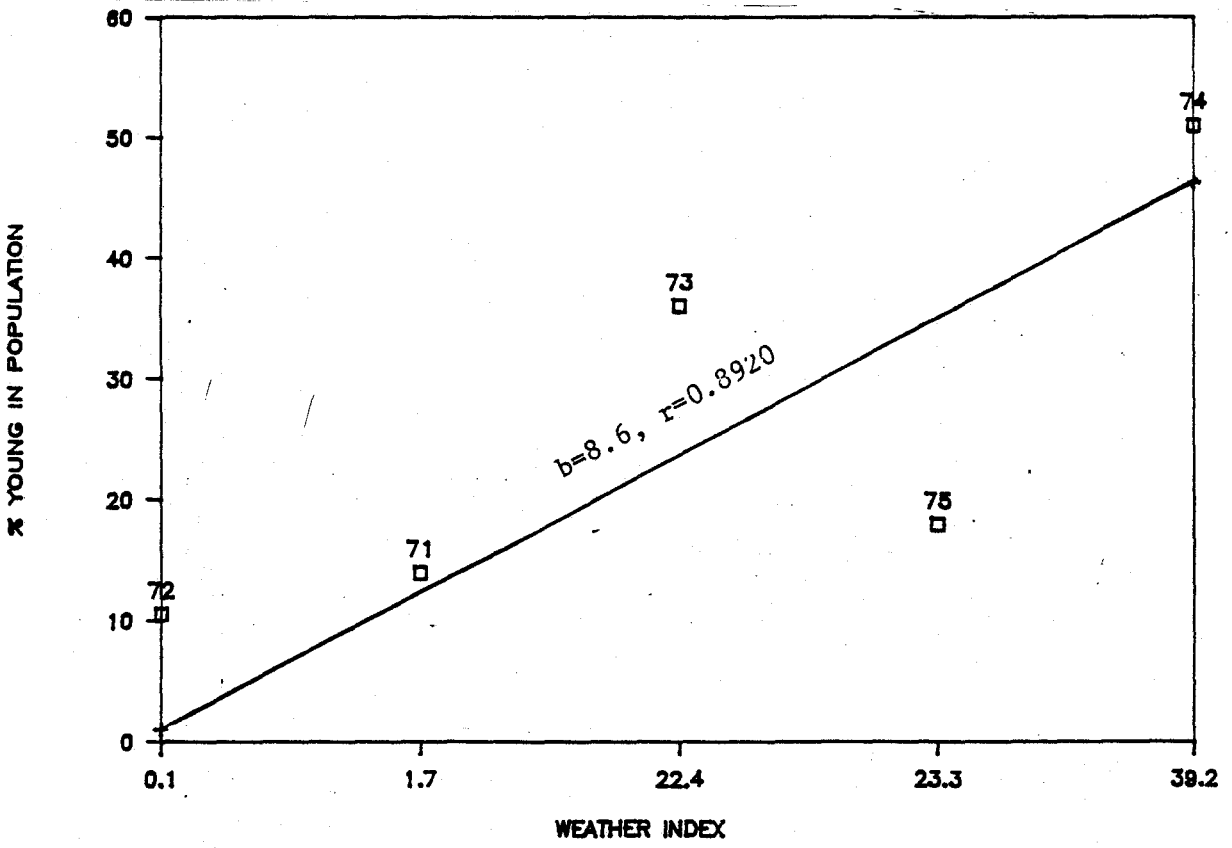

Figure 1. Linear relationship between production and spring pheneology bet-
1971-75 (Bromley, R. G. H., 1976, MS Thesis, Univ. of Alaska, Fairbanks).

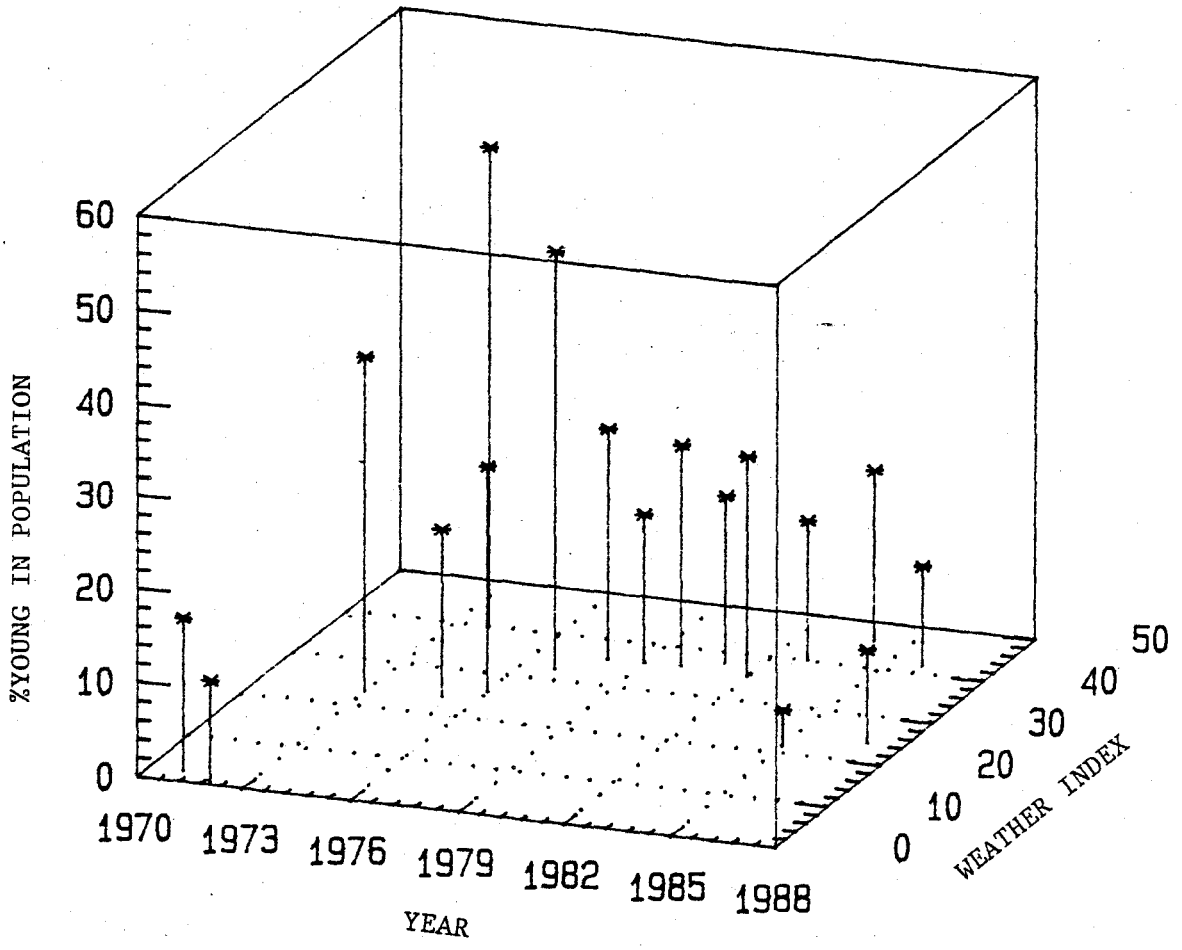

Figure 2. Logistic regression model of the influence of spring phenology (weather) and an undefined year specific factor (predation ?) on dusky Canada goose production, 1971-87.

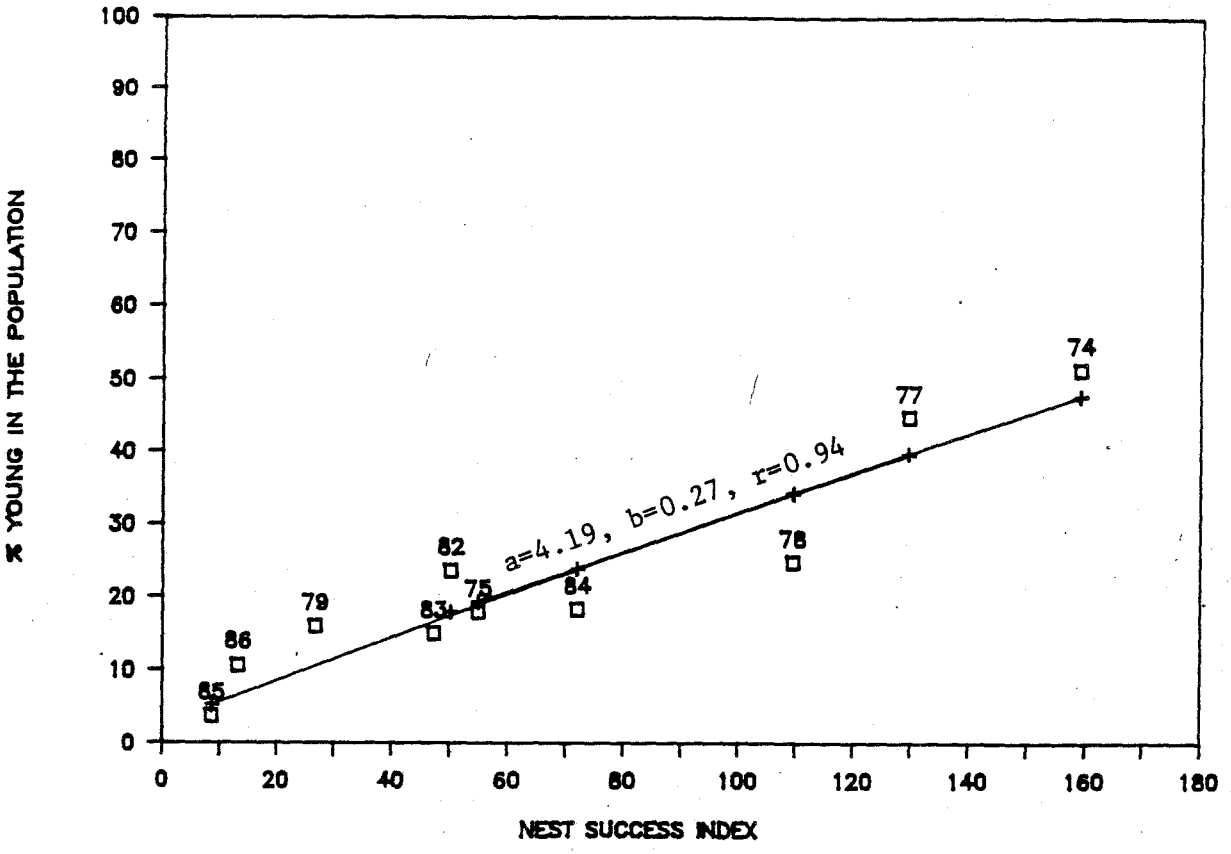

Figure 3. A linear regression of nesting success index (calculated nest density X nest success) on the percent young in the fall population of geese on the Copper River Delta, 1974-86.

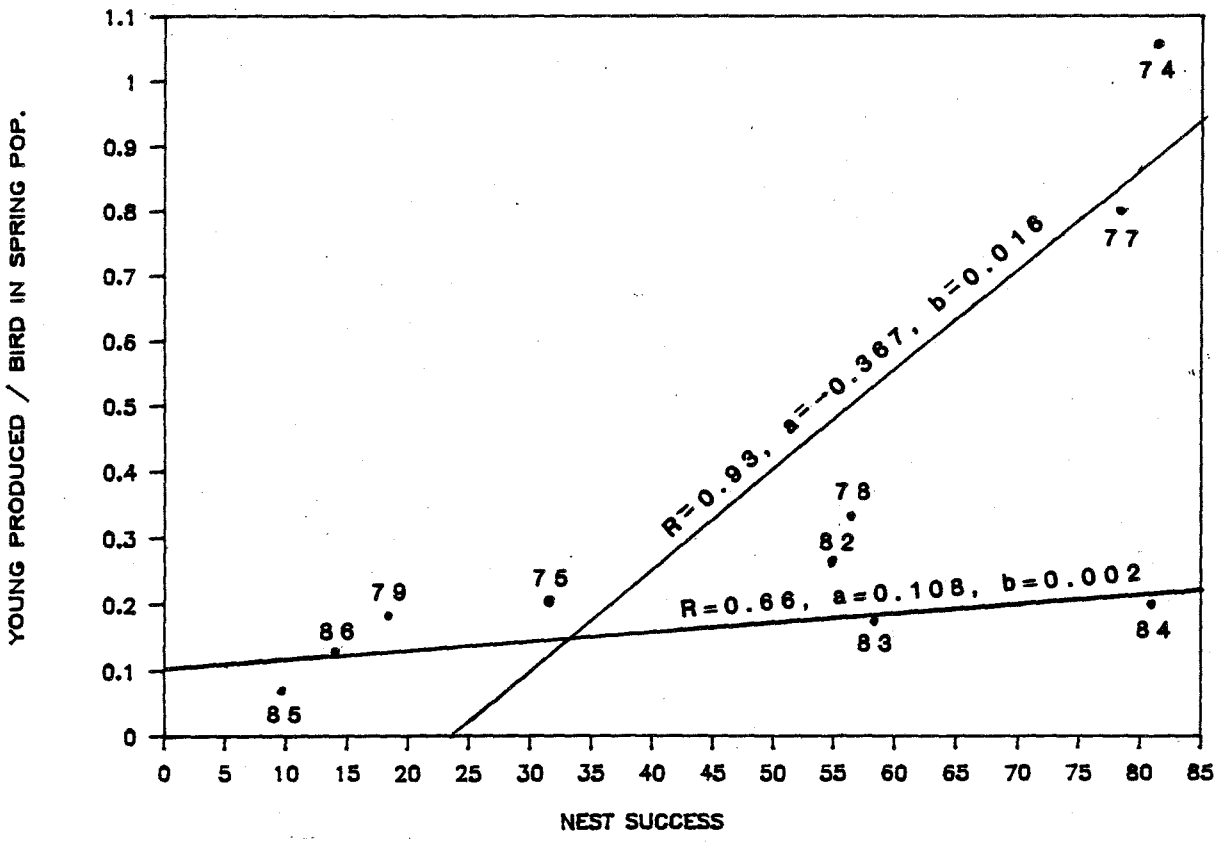

Fig. 4. Comparison of the linear relationships of nest success and young produced per adult goose on the Copper River Delta during the 1970's to the 1980's.

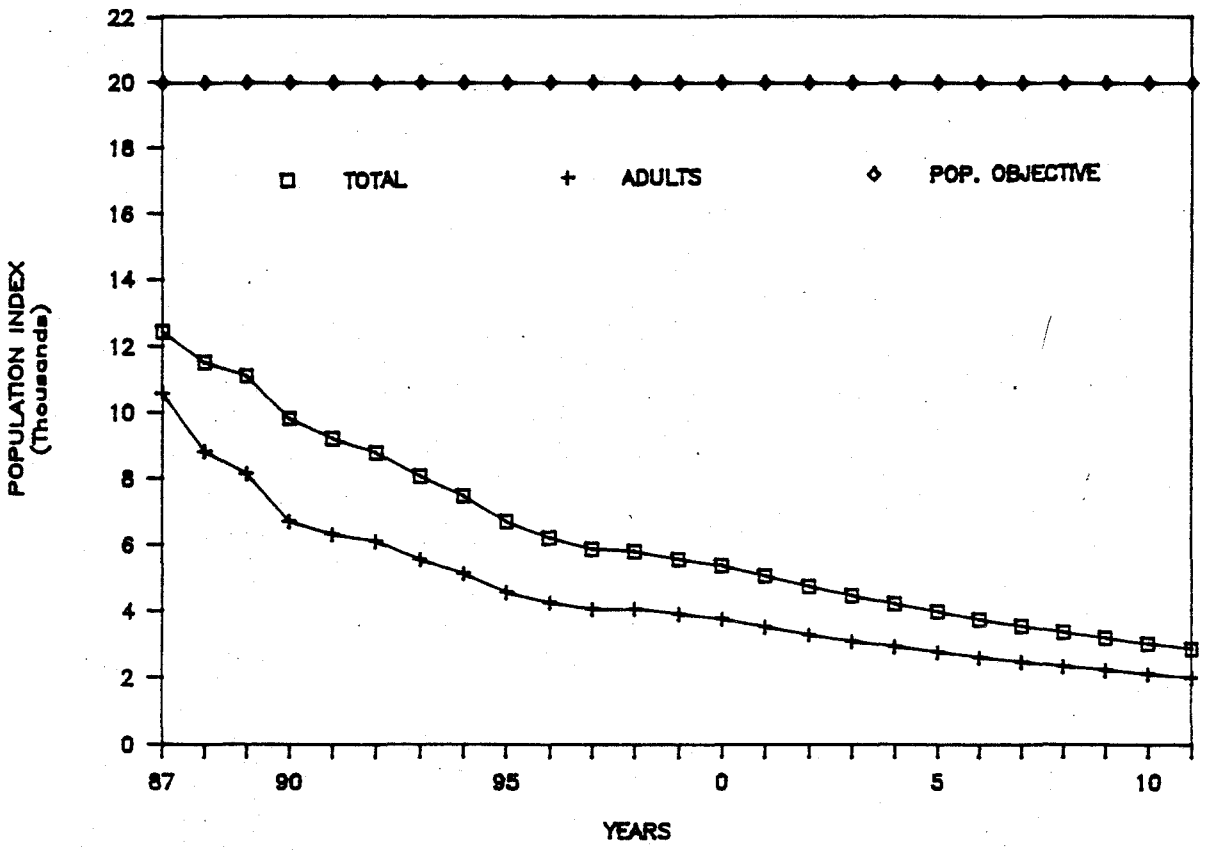

Figure 5. Model of the dusky Canada goose population trend assuming an annual production rate of 11 percent.