CANADIAN WILDLIFE SERVICE

ANNUAL WATERFOWL REPORT
ALASKA, 1956

ANNUAL WATERFOWL REPORT

ALASKA, 1956

By

Henry A. Hansen
Supervisor, Waterfowl Investigations

ANNUAL WATERFOWL REPORT
ALASKA, 1956

INTRODUCTION

The purpose of this report, in type and scope, is to consolidate in a brief summary the history and background of Waterfowl Investigations in Alaska so that future annual reports can depart from this 1956 base and be made comparable year to succeeding year, inasmuch as comparability and cohesion is possible in the program. The physiography of Alaska and the inaccessibility of practically all of the waterfowl habitat is a major limiting factor in developing adequate continuity into a ground study program and an air-to-ground comparison study. Until problems of logistics and maneuverability on the ground can be mastered more readily in the Arctic regions, comparability of data from year to year and from area to area will have an inherent bias of unknown value.

Each phase of the program will be treated as a unit and each unit will be summarized and up-dated separately in this report so that, in the future, a general reference will not need to be retraced further back than 1956.

HISTORY OF PROGRAM

Prior to 1941, sporadic and cursory ornithological studies in Alaska had been conducted for about 150 years, usually the afterthought of a broader investigation of natural resources as a whole. Gabrielson and Lincoln (1956. The Birds of Alaska, Seventh Alaska Science Conference.) have compiled a detailed historical account of all the early work and mention briefly some of the findings of recent years. Probably the more important contributors to our general knowledge of waterfowl in Alaska between 1920 and the beginning of World War II were O. J. Murie, Frank Dufresne, Ira N. Gabrielson, H. W. Brandt and C. E. Gillham. Gillham initiated what was probably the first specific waterfowl study in 1941 on the Yukon Delta near Hooper Bay.

Intensive work under the present program, however, was begun in 1948. The program was financed largely through Federal Aid, but in every respect was a cooperative venture involving personnel and equipment from the Refuge, Game Management and River Basins Divisions, and the Cooperative Wildlife Research Unit of the University of Alaska, as well as Federal Aid. A Waterfowl Project, as such, was established under its own identity in 1955, but the close cooperation originally attained among the various Divisions, still a necessary and integral part of the field program, has been retained and functions to a high degree.

WINTER INVENTORY

Probably in no one season has a total coverage of Alaska's wintering areas been attained because of foul weather and other operating hazards during January.

Over a period of years, however, all of the wintering areas, with the exception of the Aleutian Islands, have been censused piecemeal by whatever personnel and equipment were available to do the job, weather permitting.

The physiography of the winter habitat in Alaska is unlike that of any other area in the Pacific Flyway excepting the coastal region of adjacent British Columbia. Most species of game ducks and geese utilize small, fresh water bays and sounds which are frequently long and narrow with steep walls rising into the perpetual winter overcast. Flying into the ends of these canyons to count birds is comparable in many respects to a bat flying into a dead-end culvert to catch insects. During mild wet winters, when more of these areas are ice-free and usable, a corresponding increase in the total number of ducks is found. Along the coast from a latitude of 54° and northward during January, a relatively minor drop in mean temperature from the long-time average can freeze out most of the habitat, forcing the birds farther down the coast.

In recent years some serious, and quite realistic, thought has been given to abandonment of the winter inventory entirely in Alaska. This line of reasoning is predicated upon the generally poor and unpredictable weather, hazardous terrain features and the low density of waterfowl scattered along more than 30,000 miles of coast line. Regardless of effort and planning, it is doubtful if a total coverage ever could be attained in any given year, nor, because few of the waterfowl which normally winter in Alaska would be subject to stateside hunting pressures under present conditions, is it necessarily important to attempt complete annual coverage. A compromise solution between attempted total coverage and outright abandonment of the winter inventory has been to establish a curtailed effort in three representative areas where comparable counts have been made for the past four consecutive years and in which an annual census appears feasible at the present time. It seems that a trend of the population wintering in Alaska can be ascertained by an adequate survey of the three areas listed in Table I, and this will constitute the minimum goal of future winter inventories unless, or until, there is a warranted reason to modify the scope of the survey.

BREEDING POPULATION SURVEY (AERIAL)

Objectives:

1. To delineate and stratify the intricate breeding habitat network in Alaska.

2. To supply the Waterfowl Regulations Committee with a population index from the Territory and a subsequent production forecast.

HISTORY OF AERIAL SURVEYS

The first aerial survey, a tentative probing but ambitious in scope, was conducted in 1949 in western Alaska along the Bering Sea and Arctic coasts. A comparable coverage was given these same areas in 1950, but in 1951 the survey was extended to do exploratory work in many of the major breeding areas of the Interior. Further change occurred in 1952 when the Arctic Slope north of the

TABLE I. A FOUR-YEAR SUMMARY OF THE ALASKAN WINTER WATERFOWL INVENTORY IN THREE REPRESENTATIVE AREAS - KODIAK, PETERSBURG, KETCHIKAN

AREA	Mallard	Gadwall	Baldpate	Teal	Pintail	Scaup	Goldeneye	Buffle-head	Unidenti-fied	Geese	Swan	TOTAL
1953												
Kodiak	2,980	120	60	560	1,860	2,060	2,340	75	6,570	20		16,645
Petersburg	4,200		250		925	550	1,125	110	5,800	1,150		14,110
Ketchikan	9,400					5,700	16,700	2,800	6,950	3,800	65	45,485
TOTAL	16,580	120	310	560	2,785	8,310	20,235	2,985	19,320	4,970	65	76,240
1954												
Kodiak	3,510	50	20	110	130	1,670	600	215	4,935	50		11,290
Petersburg	12,600		360		1,340	930	1,500	450	2,500	2,340	30	22,050
Ketchikan	6,000					3,450	12,600	900	8,550	2,715	175	34,390
TOTAL	22,110	50	380	110	1,470	6,050	14,700	1,565	15,985	5,105	205	67,730
1955												
Kodiak	1,280				120	1,925	1,070	160	4,500	350		9,405
Petersburg	10,500		70		2,050	1,370	1,780	330	3,160	1,650	5	20,915
Ketchikan	850					240	1,200	1,000	240	1,530	90	5,150
TOTAL	12,630		70		2,170	3,535	4,050	1,490	7,900	3,530	95	35,470
1956												
Kodiak	2,480	200			250	1,920	2,230	230	860	430		8,600
Petersburg	2,050		50		275	3,535	560	85	100	800		7,535
Ketchikan	705				75	250	1,460		300	425	15	3,230
TOTAL	5,235	200	50		600	5,705	4,250	315	1,260	1,735	15	19,365

Brooks Range and most of the small delta areas of the Seward Peninsula were deleted so that greater coverage could be extended to the more important areas of the Interior.

On a basis of previous surveys and reports and an accumulated knowledge of climatic and topographic features, in 1953 a preliminary stratification of the breeding areas was established based on population densities of ducks per square mile. Flight transects 16 miles long and 1/4 mile wide were laid out on a random basis, but a statistical analysis of the results revealed some basic inaccuracies in the stratification. Further modification, re-stratification and improvement of sampling techniques were worked out in the aerial surveys of 1954 and 1955 and incorporated into the basic habitat map re-designed for 1956 and subsequent years. A copy of this map has been submitted under separate cover.

The complete randomness of transect location as originally conceived has been modified to a certain extent in the interest of developing a more practical flight plan under the present system of stratification. In some instances transects have been relocated to conform to the new strata boundaries and to take advantage of terrain features for the purpose of more accurate navigation. Based upon the Yukon Delta survey by Spencer in 1949, we feel that validity of the statistical analysis will not suffer a great deal in spite of the abrogation of complete randomness in selection of transects as long as the stratification is adequate. Spencer's 1949 analysis is quoted as follows (Federal Aid Quarterly Report, September 30, 1949):

> The sampling pattern laid out for the area consisted of a combination of two types of transects which were computed independently. Flight routes were laid out to give coverage of the entire area (non-random) transects were made on these flight routes with the distance measured on the map. Random transects were also taken along these flight routes.
>
> Random transects were made in a "U" pattern consisting of one leg of 7-1/2 minutes either upwind or downwind, a one minute leg crosswind, and a 7-1/2 minute leg the reverse of the first. For practical purposes the pattern thus flown permits calculation from the true airspeed of the distance traveled. At a true airspeed of 104 mph these 16-minute transects had a computed length of 28 miles or an area of seven square miles. The 32 random transects were all based on this seven square mile unit. Time intervals along the flight routes at which these transects were made were selected by chance, as was the direction of the initial leg, either upwind or downwind. The direction of the wind added a third element of chance. These random transects were used in the analysis of the sampling error.
>
> The 32 random transects, totaling 234 square miles, ranged in waterfowl population from 3.6 to 44 per square mile. The arithmetic mean was 16.6. The range of the mean with a probability of .98 was 15.4 to 17.8, or a probable sampling error of 7.1 per cent.

The 17 flight route transects in the main delta area totaled 260 square miles. The average duck population on these 260 square miles of transect was 16.5.

The appraisal of these two independently computed series of sample transects becomes of significance in planning for future limited surveys. It is to be noted that the average population of a well distributed series of transects laid out between map landmarks did not vary appreciably from the mean of a series of well distributed random transects. In analyzing the random transect data, it was found that about 125 square miles of sample would produce a probable ten per cent sampling error. Therefore, if around 125-150 square miles, or 600 linear miles, were laid out in a representative fashion between landmarks on the map, an average waterfowl population figure might be obtained which would be sufficiently accurate for indicating any pronounced trend from year to year.

DESCRIPTION OF HABITAT AREAS

The waterfowl habitat in Alaska was classified in 1949 by Scott into five basic types. This original classification, both accurate and adequate, has been retained and is herein described.

a. Coastal tundra - Uniformily low, flat, wet tundra, interspersed with numerous channels and potholes and subject to tidal action.

b. Lowland tundra - Low, flat or rolling tundra, with occasional hillocks, many potholes, lakes, streams and sloughs. Not subject to the tidal action of coastal tundra.

c. Upland tundra - High, dry, hilly tundra interspersed with potholes, lakes and streams. (All tundra is devoid of tree growth and the three types are distinguished by location from line of tree growth toward the coast.)

d. Muskeg - The common upland habitat within the timbered areas of Alaska. Normally spruce-birch-aspen forest interspersed with lakes, rivers, sloughs, potholes and bog, in varying proportions.

e. Bottomland - The growth typical of the heavily timbered lower river valleys. Large hardwoods prominent among the many sloughs, river channels and stream scars.

For reference and working purposes, the numerous habitat units have been named and the stratum, size, type and location of each is listed in Table II. It should be emphasized that the areas listed do not constitute all of the waterfowl habitat in Alaska, but only the major units in strata II through V which have been adequately delimited and measured and are presently being censused. Many small deltas and bays of high waterfowl density along the northern shore of the Seward Peninsula, as well as several small, isolated areas of lower density in the Interior and the extensive, low density or marginal habitat of stratum I, have not been included. The extent in size and over-all contribution these areas lend to the total waterfowl population has not yet been determined; but, as a whole, their importance is known to be of considerable significance. Included in the unclassified areas is all of the Arctic Slope north of the Brooks Range.

TABLE II. A SUMMARY OF MEASURED WATERFOWL HABITAT IN STRATA II - V, 1956

Name of Area	General Location	Habitat Type	Stratum	Size of Area in square miles
Yukon-Kusko-kwim Delta	61° lat. 163° long.	Coastal-Lowland-Upland tundra	III IV	18,100 8,500
Innoko	63° lat. 159° long.	Muskeg-Bottomland	II III	850 2,550
Koyukuk	65° lat. 158° long.	Muskeg-Bottomland	III	4,100
Kotzebue Sound	67° lat. 160° long.	Lowland-Upland tundra	IV	6,300
Noatak	67° 30" lat. 163° long.	Muskeg	II	500
Norton Bay	65° lat. 161° long.	Coastal-Lowland tundra	IV	700
Bristol Bay	59° lat. 157° long.	Lowland-Upland tundra	III	9,900
Nelchina	63° lat. 147° long.	Muskeg	II III	2,100 1,800
Fort Yukon	67° lat. 145° long.	Muskeg-Bottomland	III IV	3,800 3,200
Tanana-Kuskokwim	65° lat. 152° long.	Muskeg-Bottomland	II	7,500
Minto	65° lat. 149° long.	Muskeg	V	950
Tetlin	63° lat. 142° long.	Muskeg	V	800
Copper River Delta	60° lat. 145° long.	Muskeg Coastal-Lowland tundra	V	400

STRATA REVISION

Practically all of the geographic habitat units in Alaska, e.g., Yukon Delta, Fort Yukon Flats, Nelchina, etc., are heterogeneous relative to density of waterfowl. This factor is undoubtedly related to basic carrying capacity of individual bodies of water. In other words, water, per se, of which there is a limitless supply in the permafrost regions of the Arctic, is not enough to attract and hold ducks through a breeding season. Based upon the distributional pattern of waterfowl in many areas, Buckley reasons that there may be a basic soil fertility pattern of comparable distribution. For instance, on a river delta the greatest density of ducks is usually found near the outer or coastal tundra, and the density decreases in a concentric pattern inland and upland even though there are enough seemingly adequate potholes and lakes to attract as many birds as near the outer shore. The Yukon-Kuskokwim Delta, Selawik, and Kobuk Deltas, Colville and Copper River Deltas, and the numerous small deltas around the Seward Peninsula are good examples of the concentric distributional pattern observed by various biologists for several years.

In a report on his aerial survey of the Yukon Delta in 1949, Spencer pointed out the above distribution of ducks by habitat type without probing its probable cause, but he did outline the system of stratification necessary to sample such heterogenous areas. Through 1954 whole geographic units were included in the same stratum where waterfowl densities sometimes varied more than 100 birds per 16-mile transect. Such diverse conditions on relatively small areas dictated a change in method of stratification, or at least a radical change in the boundaries of existing strata. The areas listed in Table II have now been re-stratified into units with enough homogeniety that population changes can be measured with a much lower sampling intensity than was possible prior to 1955. Although minor boundary changes between some strata may still be necessary, the pattern of stratification should be valid.

In the 1954 Status Report of Waterfowl (Alaska section), Table I listed a habitat area of 311,822 square miles which included 189,120 square miles of miscellaneous low density habitat now designated as stratum I. The latter area, censused with 48 standard 16-mile transects, showed a mean density of 1.8 game ducks per square mile in 1954. The outer limits of this extensive area, for the most part, however, were originally delineated by "educated guess" from topographic maps because of limited funds and manpower for adequate reconnaissance flights. The same was true to a lesser extent for some of the presently designated strata II-V. The physical size of most of the units now incorporated into strata II-V has been materially reduced from the original estimate to conform more closely to the actual waterfowl density pattern. Most of the area deleted from these strata is low density in character and will be added to stratum I which is largely a strip of varying depth surrounding most of the higher density strata. Considerably more reconnaissance is necessary to determine the extent and character of all the low density habitat which is widely dispersed throughout the Territory.

In many cases major changes in waterfowl density are quite abrupt, corresponding to changes in habitat type. For instance, scarified river flood plains are poorer production areas in general than the adjacent muskeg. The line of demarkation between these two types can be easily and quite accurately mapped, e.g., strata II and III on the Innoko area. A marked decrease in production is frequently found where the level spruce muskeg changes to rolling terrain with an aspen-birch climax. This line has been fairly well delineated in many areas, giving an inner boundary to stratum I (low density) which is largely associated with the aspen-birch climax.

When an entire heterogeneous area was lumped into one stratum, prior to the system of stratification adopted in 1956, transects were randomized for the gross area disregarding changing densities within the area. To compensate for the variability between transects and bring the sampling error within acceptable limits for each individual area, it was necessary to fly more transects than a homogeneous area of like size would have required. In an operation as widespread geographically and as telescoped in time as an Alaska survey dictates, a minimum of flying in any one area compatible with statistically adequate coverage is mandatory. Even if unlimited funds were available so that each area could be combed, a duck is not inclined to pace his courtship to the manipulation of a biologist's slide rule. A period of about 15 days is the maximum during which an optimum breeding population survey can be conducted south of the Brooks Range, although that span of time can vary from year to year between May 15th and June 15th, depending upon onset and progression of the spring break-up.

Scott recognized the practical limitations of sampling small, heterogeneous, widely dispersed areas and questioned the reliability of a population index derived from them following the 1951 aerial survey as follows (Quarterly Progress Report, Federal Aid, June 30, 1951, pp 12-13.):

"The theoretical indication of accuracy in this method of inventory is the sampling error as computed statistically. An analysis of this factor raises questions regarding the suitability of certain areas for annual sampling, and the actual importance of statistical processing of results. Although the same transect coverage has been used in certain areas for the past 3 years (1949-1951), the indicated sampling error has sometimes varied tremendously and sometimes remained about the same. The indicated error is magnified when certain transects tally substantially more or less birds than the majority of transects in the sample.

Theoretically, the error should be decreased by increasing the transect coverage. In the Noatak area which is roughly rectangular in shape, the transects are now spaced a minimum distance apart. Computation by formula indicates that, in order to decrease the error to 10 per cent, almost three times as large a sample would have to be taken. This would mean a greatly increased density of transects which seems impractical.

The question is: Does annual sampling of areas such as these reveal significant population trends in spite of theoretical sampling error, or should they be abandoned and effort confined to larger areas where numerous transects will produce a smaller error?"

Although the following analysis is not strictly comparable because of modification in sampling area and changing personnel, and several intervening years without continuous coverage, the example as cited may partially answer Scott's question above. If properly delineated and combined with other areas of like character and waterfowl densities and treated as one unit (stratum), regardless of their geographic relationship to each other, most areas should be sampleable with a practicable amount of effort. In 1951, Scott sampled six areas in northwest Alaska, totaling 7,550 square miles with 61 standard 16-mile transects, one area being the Noatak quoted above. At that time, the survey result was run through the statistical mill for each diverse area as a separate entity (stratum) with a sampling error ranging from 9 per cent to 32 per cent. Of the 61 transects, 10 were run in the Noatak Valley which was measured as 450 square miles at the time, or 7.6 per cent of the Noatak area actually being counted. Obviously, such sampling intensity cannot be considered as operationally feasible. In 1956 Hansen sampled the same six areas, but reconnaissance subsequent to 1951 extended the total area to 12,850 square miles compared to 7,550 in Scott's initial effort. Under the present system of stratification, the entire area of the six habitat units has been divided among strata II, III, and IV and combined with areas of comparable density elsewhere in Alaska. The number of transects run in the six enlarged areas was 45 (compared to 61 in the reduced area in 1951) with an over-all sampling intensity of 1.4 per cent in 1956 compared with 3.2 per cent in 1951. The sampling error between the two years is not directly comparable because of dissimilar sampling units, but the error for strata II, III, and IV, of which the above six habitat areas were partial components, was 15 per cent, 10 per cent and 17 per cent respectively in 1956.

It remains to be seen, however, whether or not the revised system can withstand the rigors of statistical scrutiny in the future. If the stratification breaks down, will it be because it is illogical to lump coastal tundra and interior muskeg into one stratum, even though their densities coincide at the present waterfowl level? Will the two types of habitat exert the same attractiveness to extremely high or extremely low waterfowl populations that they do to the present "normal" population? Does the majority of scaup nesting at Fort Yukon, for instance, tread the same flyway as the scaup nesting on the Yukon Delta? If not, then a major decline of that species in one flyway could affect stratification in Alaska as it is now constituted, temporarily, at least.

POPULATION INDEX

One of the toughest imponderables to date has to do with a satisfactory waterfowl population index for Alaska, both by individual species and total of all species. An annual turnover of aerial observers has introduced a recurring bias of unknown proportions, and there is no prospect at present for permanency of crews. In lieu of permanent crews, then, an effort has been made to standardize the several observers used against a common denominator. A comparison of some of the differences among six of the observers participating in the 1956 Alaska breeding population survey is contained in Tables III and IIIa.

The waterfowl supervisor was one of the observers, or pilot-observer, on every transect with the exception of the Minto area and is designated as observer "X". The five other observers with whom the supervisor flew are listed as A, B, C. D, and E. In comparing the five observers, A through E, with each other, it must be assumed that the common denominator (observer X) was a constant throughout. Such a basic assumption, however, must surely be tempered with the knowledge that the common denominator was a humanly flexible constant revolving around the immeasurable factors of changing visibility, advancing phenology, various fatigue levels, etc. Under any circumstances, however, the variability of the norm certainly should have been less than the wide variations shown for the other five observers listed in Table IIIa. Observer X has been established as the common denominator, or "norm" at par

TABLE III. A COMPARISON OF POPULATION INDICES AS COMPUTED FOR SIX OBSERVERS PARTICIPATING IN THE 1956 AERIAL SURVEY

Observer	No. of X-Sects & Total Area	Sq. mi. Sampled	Identified Ducks Lone M.	Identified Ducks Pair	Identified Ducks Flocked	Unidentified Ducks Single	Unidentified Ducks Pair	Unidentified Ducks Flocked	Total Ducks All spp.	Total Ducks % Ident.	Population Index Numerical	Population Index % Diff.
X	88	176	341	679	598	46	101	112	2,657	87	589,650	
A	44,400	176	245	463	467	131	187	230	2,373	69	516,750	- 13%
A + X	sq. mi.	352	586	1,142	1,065	177	288	342	5,030	78	550,175	
X	20	40	14	87	113	3	17	57	395	76	55,370	
B	9,200	40	33	106	99	4	3	28	382	90	65,550	+ 15%
B + X	sq. mi.	80	47	193	212	7	20	85	777	87	61,295	
X	28	56	65	203	342	20	26	96	981	83	51,850	
C	4,700	56	42	313	293	10	81	131	1,264	76	74,920	+31%
C + X	sq. mi.	112	107	516	635	30	107	227	2,245	79	63,550	
X	34	68	143	277	512	27	97	103	1,533	79	94,340	
D	5,800	68	90	284	538	56	93	135	1,574	76	87,260	- 8%
D + X	sq. mi.	136	233	561	1,050	83	190	238	3,107	77	88,780	
X	12	24	38	53	267	2	16	83	528	78	45,000	
E	4,800	24	34	58	276	4	9	-	448	95	42,200	- 4%
E + X	sq. mi.	48	72	111	543	6	25	83	977	86	43,600	
TOTAL X	182	364	601	1,299	1,832	98	257	451	6,094	83	877,150	
TOTAL A to E	68,900 sq. mi.	364	444	1,224	1,673	205	373	524	6,041	76	838,600	- 5%
GRAND TOTAL ALL OBSERVERS	182 68,900 sq. mi.	728	1,045	2,523	3,505	303	630	975	12,135	79	843,870	

TABLE IIIa. A COMPARISON OF THE VISION FACTOR FOR SIX OBSERVERS PARTICIPATING IN THE 1956 AERIAL SURVEY

Observer	% of Lone Drakes	Ratio of Lone Ducks: Ident. Drakes	Ratio of Lone Ducks: Total Singles	Ratio of Pairs: Ident. Pairs	Ratio of Pairs: Total Pairs	Ratio of Flocked Ducks	Ratio of Total Ducks Counted
X	33						
A	35						
A : X		72 : 100	97 : 100	68 : 100	83 : 100	84 : 100	89 : 100
X	14						
B	24						
B : X		236 : 100	218 : 100	122 : 100	105 : 100	75 : 100	97 : 100
X	24						
C	12						
C : X		65 : 100	61: 100	154 : 100	172 : 100	95 : 100	129 : 100
X	34						
D	24						
D : X		103 : 100	86 : 100	103 : 100	101 : 100	109 : 100	103 : 100
X	42						
E	37						
E : X		85 : 100	95 : 100	109 : 100	113 : 100	79 : 100	85 : 100
Total A to E : X	29	74 : 100	93 : 100	94 : 100	103 : 100	96 : 100	99 : 100

value of 100, and observers A through E are compared to the norm. All population indices have been derived by the formula in the memorandum of instructions to Robert Smith, dated March 5, 1956, and are not based upon habitat stratification as was the index submitted at the end of the summer operations. The duck populations shown in Table III reflect differences in observers rather than differences in habitat carrying capacity and are not directly comparable to the indices as derived for individual strata. It is interesting to note, however, that the population index for all observers combined, when based upon a stratified sample as submitted in the earlier Breeding Population report, was within 12,000 ducks of the 843,870 listed in Table III.

A few questions for consideration relative to a population index follow: (1) What specific ingredients actually should be used in the recipe for building a "population index"; (2) Which observer's count should be the basis for such an index when there is a substantial difference between observers in the total number of ducks counted, and species identification, especially where there is little correlation in the above differences; (3) How should flocks of early deserting male puddle ducks in a rapidly advancing season enter into the computation when lone drakes and pairs are the basis for establishing a population index? In 1956, for example, in the Kotzebue Sound area the pintail has been relegated to a position of lesser importance than scoters in the population index. There is little question, however, that pintails were at least four times more abundant there than scoters in 1956. When the breeding pair survey was flown on June 11 and 12, only 7 pair and 25 lone pintail drakes were recorded as compared to 32 pair and 6 single scoters. On the transect strips, however, only 14 flocked scoters were counted in comparison to 343 pintail, practically all "pure stands" of male deserters, in flocks of 3 to 30 except for one larger aggregation. A concurrent ground count on part of the Kotzebue area corroborated the 4:1 breeding pair ratio of pintails to scoters.

Disregarding the visibility factor, there are other variables inherent in a diversified complement of observers which can distort the index and render it unreliable. Crissey has referred to one of these variables as the difference in observers and their ability to see and record birds, and has asked for a standardization of crews to counteract it. The differences in observers' sight mechanism might be called "vision factor" as opposed to "visibility factor". The first has to do with different men's ability to see and the latter with various species' inability to keep from being seen. In a memo of December 11, 1956 a generalization was made that pairs are less conspicuous than lone drakes and are, therefore, less visible. Their degree of visibility is not consistent among various observers, however, and could be a factor in distorting a population index based upon a count of lone drakes and pairs. For instance, only observers A and B tallied a smaller ratio of total paired ducks than they did of singles. The other three observers recorded pairs in much greater abundance, which would seem to refute the thinking that pairs are less conspicuous in general.

The vision factor also operates in a way other than the mere ability to see a bird or pair of birds. The plumage pattern and size of the birds must appear sufficiently different to otherwise competent observers so that species identification is not always within acceptable limits. Of the six men compared in the survey, B, D, E and X should be experienced enough to have been consistent in their species identification regardless of total ducks tallied. Yet there is too wide a discrepancy between scaup and scoters in each case. Table IV summarizes and compares the

TABLE IV. A COMPARISON OF SPECIES COMPOSITION BETWEEN OBSERVERS B AND X IN THE BRISTOL BAY AREA

Observer	B	X	B	X	B	X	B	X	B	X	B	X	B	X	B	X	B	X	B	X	B	X
	Scaup		Scoter		Pintail		Mallard		Baldpate		Goldeneye		Old Squaw		Eider		Gadwall		Total Ident.		Unidentified	
Lone Males	8	3	7		13	7		2	1				3		1			1	33	14	4	3
Pairs	38	22	48	50	7	7	1	2				1	12	2				3	106	87	3	17
Flocked	21	35	72	47	3					3	3	20		8					99	113	28	57
Relative Abundance(%)	33.1	24.8	39.5	49.5	14.4	13.9	0.7	4.0	0.7			1.0	10.8	2.0	0.7			4.0				
Pop. Index B	21,700		25,900		9,450		450		450				6,990		450				TOTAL 65,550			
Pop. Index X	13,800		27,600		7,800		2,260				550		1,100				2,260		55,370			
Pop. Index B + X	18,130		26,850		8,700		1,290		250		250		4,530		250		1,050		61,300			

TABLE IVa. A COMPARISON OF SPECIES COMPOSITION BETWEEN OBSERVERS D AND X IN THE FT. YUKON AREA

Observer	Scaup D	Scaup X	Scoter D	Scoter X	Pintail D	Pintail X	Mallard D	Mallard X	Baldpate D	Baldpate X	Shoveller D	Shoveller X	G.W.Teal D	G.W.Teal X	Canvasback D	Canvasback X	Goldeneye D	Goldeneye X	Buffle-head D	Buffle-head X	Old Squaw D	Old Squaw X	Total Ident. D	Total Ident. X	Unident. D	Unident. X
Lone Males	10	23	1	1	22	32	28	37	19	35			2	2	3	4	2	7	2	2	4	3	93	146	56	27
Pairs	124	99	75	96	21	28	16	16	16	19	2	4	6	1	13	3	3	6	1	5	6		283	277	94	97
Flocked	64	73	236	332	23	234	16	12	21	35	3		3		38							15	404	701	135	105
Relative Abundance(%)	35.6	28.8	20.2	22.9	11.4	14.1	11.7	12.5	9.3	12.8	0.5	0.9	2.1	0.7	4.2	1.7	1.3	3.1	0.8	1.7	2.6	0.7				
Pop. Index D	31,065		17,625		9,950		10,200		8,015		435		1,830		3,765		1,135		700		2,270		Total 87,260			
Pop. Index X	27,170		21,575		13,300		11,800		12,075		850		660		1,600		2,900		1,600		660		94,340			
Pop. Index D + X	28,400		19,265		11,450		10,710		9,985		710		1,240		2,575		2,040		1,150		1,425		88,780			

TABLE IVb. A COMPARISON OF SPECIES COMPOSITION BETWEEN OBSERVERS X AND E IN THE KOTZEBUE SOUND AREA

Observer	Scaup X	Scaup E	Scoter X	Scoter E	Pintail X	Pintail E	Mallard X	Mallard E	Baldpate X	Baldpate E	Shoveller X	Shoveller E	Old Squaw X	Old Squaw E	Total Ident. X	Total Ident. E	Unidentified X	Unidentified E
Lone Males	12	17	3	3	15	10	1		7	4	1				38	34	2	4
Pairs	37	27	12	20	2	5				1			2	5	53	58	16	9
Flocked	134	22	11	3	92	251			30						267	276	83	
Relative Abundance(%)	53.7	47.8	16.5	25	18.6	16.4	1.1		5.4	5.4	1.1		2.2	5.4				
Pop. Index X	24,000		7,400		8,300		450		3,500		450		900		Total 45,000			
Pop. Index E	20,170		10,550		6,920				2,280				2,280		42,200			
Pop. Index X + E	22,105		9,025		7,540		220		2,835		220		1,655		43,600			

species composition for observers X and B in the Bristol Bay area, Table IVa compares X and D in the Fort Yukon area and Table IVb compares X and E in the Kotzebue area. Agreement in identification of puddle ducks is probably adequate. A concurrent ground census at Selawik in the Kotzebue Sound area indicated that observer X was relatively close in his tally of scaup vs. scoters, but whether his ratio of scaup vs. scoters was as accurate in the Bristol Bay area while flying with observer B is an unknown factor. Under the assumption that the norm is a constant, such would be the case. At Fort Yukon the discrepancy between scaup and scoters is evident, though not as great as in the other two instances, but there is less agreement among most of the other species. Although this was his first attempt at an aerial census, observer D appeared to be competent in the ground study he conducted at Fort Yukon for the remainder of the summer.

It should be pointed out in Table III that the total population index as computed for observer X was only about five percent greater than the combined index for the other five observers. In other words, the individual differences from the low of observer A to the high of observer C tended to strike a balance. If such a close figure is not merely a coincidence of 1956, but the "law of averages" at work, perhaps it is a desirable feature to have a large and diversified number of observers covering the several areas simultaneously before the male pintails have gathered in deserter flocks. The other alternative would be to have one or two crews of men with comparable vision factors complete the census over a longer span of time and develop some means of utilizing the flocks of male puddle ducks in deriving a more realistic population index. For instance, the population index of 843,870 ducks would have been increased by about 185,000 game ducks, mostly pintails, if the 950 flocked and identified male deserters had been included in the population index for the survey sample.

In reference to question (2) on page 12 and the above paragraph, by the simple expedient of using the vision factor of observer C only, a population index of 33 percent more ducks could be obtained than the index based on the vision factor of observer A. If such a degree of variation exists among six observers, how is it possible to predict with any degree of accuracy a waterfowl trend based upon a 20 percent sampling error unless the highs and lows strike a balance year in and year out as they did in 1956? If an adjustment is made to the common denominator for each observer, which of the six ratios listed in Table IIa should be adjusted to arrive at a realistic population index comparable from year to year? For the present a figure of 865,350 total ducks will be used as the base from which to depart for strata II, III, IV, and V in 1957. This index is based upon the final measurement of the four strata involved. Stratum I cannot be delineated and evaluated under the present budget without sacrificing most of the banding effort and ground studies.

Prior to 1955, seldom had all the same transects been flown in any given area in two successive years. There were two major reasons, perhaps, for this seeming lack of continuity. First, the pilots and observers were changed from year to year, and it would be virtually impossible for one pilot to retrace accurately a random course flown by another man in the previous year across tundra and muskeg devoid of charted landmarks. Second, changes in transect location were often purposeful in an effort to delineate habitat boundaries more accurately or to delete unproductive effort of a previous year. Sometimes the sampling intensity was increased or decreased, thus, altering transect locations. In any event, it is now apparent that even if the identical transects had been censused in successive years by different personnel the counts would not necessarily have been comparable because of basic differences in the vision factor. Such was the case in 1956 when most of the transects of 1955 were retraced, but by different crews so that a paired sample at this time would be meaningless even though counts were made on the same transect routes. Tallies were kept separate for all observers in 1956, however, and the transects have been stabilized and numbered as indicated to lend cohesion and continuity to the aerial survey.

PRODUCTION STUDIES (GROUND)

HISTORY OF GROUND STUDIES

Ground studies have been an integral part of the waterfowl program some place in Alaska each summer, sometimes detailed and intensive and other times only cursory in nature, and usually in conjunction with a banding program. Scott explored a part of the Innoko-Iditarod area in 1948 as an initial effort in the present program, although Gillham had spent some time in 1940 and 1941 near Hooper Bay on the Yukon Delta, gathering data on species composition, predation and nesting success. In 1949 Nelson worked on the Colville River from Umiat to the Arctic coast, Scott ran preliminary studies in the Kotzebue Sound area, and Spencer and Chatelain followed their aerial survey of the Yukon Delta with a rather intensive ground reconnaissance in the Hooper Bay area. Chatelain also continued the Innoko banding. Most of the ground studies in 1949, apart from the banding effort, were basically reconnaissance in nature to determine the feasibility of establishing future intensive and extensive banding and production study areas. In 1950 ground crews again worked at Hooper Bay and the Innoko, and Hosley explored part of the Minto area near Fairbanks as a possible study site for students from the University of Alaska.

In 1951 work was continued on the Innoko by Lensink, Yukon Delta by Olson and Chatelain, and at Minto Lakes by Hooper. In addition to the above, a project was initiated on the Copper River Delta by Nelson and a one-year intensive study was concluded on the Serpentine River along the north coast of the Seward Peninsula. Although a banding crew returned to the Yukon Delta in 1952, 1953 and 1954, there was no attempt made to conduct a nesting and production study as intensive as the one by Olson which is well reported in the Federal Aid Quarterly Progress Report for September 30, 1951. Nelson continued the Copper River project in 1952, primarily banding, as was the accomplishment at Minto Lakes by Buckley and Lensink. After the relatively small scale program of 1952, intensive ground studies were increased to three field stations in 1953. Stepped-up programs at Minto Lakes and on the Copper River Delta were conducted, and a new study area near Fort Yukon was established by Lensink. In addition, a limited banding program was conducted again on the Yukon Delta. In 1954, five previous banding and production study areas were used: Minto Lakes, Fort Yukon, Yukon Delta, Innoko, and Copper River Delta. In addition, limited banding was accomplished in the Tangle Lakes area immediately south of the Alaska Range and west of the Richardson Highway. Production studies were confined to Fort Yukon in 1955 and to a newly established area at Selawik near Kotzebue Sound. Banding was continued on the Copper River Delta and a new banding station was activated at Tetlin on the Alaska Highway where it crosses the border from the Yukon Territory. In 1956, the same four field stations were operated and Minto Lakes was re-activated after having been flooded out in 1955. A new Canada goose banding operation was also undertaken with considerable success in Southeastern Alaska near Gustavus.

Since 1948, in all types of habitat, 12 different waterfowl field stations have been manned with production study and banding crews, some stations remaining in use for several years. Many types of transportation and equipment have been tested and used in an effort to beat the logistics problems in isolated areas, and also to develop living and working techniques under conditions of extreme adversity. A great deal of sound basic information has been accumulated concerning waterfowl populations, production potential, predator-prey relationships, migratory patterns and habitat conditions. All the ground studies enumerated above have been well recorded in the respective Federal Aid Quarterly Reports from 1948 through 1955. Only the four-year production study conducted near Fort Yukon will be summarized as a unit in this report, primarily because the Fort Yukon Flats is a muskeg habitat somewhat typical of conditions elsewhere in the far northern breeding areas and this study may show more cohesion from year to year than the others.

FORT YUKON PRODUCTION STUDY

Description of Area

The Yukon Flats is an area of about 10,500 square miles located on the northernmost bend of the Yukon River astride the Arctic Circle in east-central Alaska. The area is typical Arctic muskeg dotted by countless lakes and potholes formed by glaciation and dissected by numerous sloughs which were formed by the meandering of the Yukon River and several of its tributaries. From the north out of the Brooks Range the Chandalar, Christian and Sheenjek Rivers empty into the Yukon, and from the east out of Yukon Territory the Porcupine and Black Rivers converge with the main stem at Fort Yukon. Birch, Preacher and Beaver Creeks drain the White Mountains across the flats from the south.

Three strata of approximately equal size are encompassed in the entire area forming, roughly, a concentric density pattern as described in the section under Strata Revision on page 7. Stratum IV, of 3200 square miles, is located in the center of the flats straddling the Yukon River. Stratum III, 3800 square miles of a lower waterfowl density, surrounds and extends eastward from the upper end of stratum IV. Stratum I is 3500 square miles of low density habitat surrounding the other two strata and extending into the rolling foothills.

The lakes, potholes and sloughs vary greatly in size and shape, but most of them are relatively shallow or have extensive shallow areas supporting a luxuriant growth of aquatic vegetation. Most of the standing water is bog-brown and on the acid side of the pH scale. Shorelines of many lakes during periods of high water are bordered by willows, but at normal levels they are surrounded by wide meadows of *Calamagrostis*, *Carex* and *Equisetum*. The latter two frequently grow out into shallow water forming excellent brood cover in which it is practically impossible to count birds from the air. Climax vegetation on the flats consists of white and black spruce except where numerous fires have reduced large areas to a stage of willow growth, which may actually be of more benefit to waterfowl than the climax spruce.

The area is underlaid with permafrost so that there is no loss of water through percolation from the average precipitation of 6.93 inches annually. There is a considerable loss of surface water, however, through transpiration and evaporation during the short, hot summers. The temperature range at Fort Yukon has been recorded from -76°F to 100°F.

The original study area, selected and operated for the first time in 1953, was bounded on the south and east by the Yukon and Porcupine Rivers and on the west by the Christian River. The total size was left indeterminate at that time depending upon the mobility of the ground crew and a reconnaissance to delineate a definite area for the future. The selection of the general site was made because of a high waterfowl population as determined from the first breeding population survey and also because it could be reached readily from the village of Fort Yukon for supply purposes. At the end of the first summer, an area of 75 square miles was selected but this eventually proved to be much larger than a two-man crew could cover adequately so the area was reduced to 45 square miles in 1954 and further reduced to 32 square miles in 1955. Even the latter size was too large for thorough, repeated coverage in 1956, and it was recommended to reduce the intensive study area to 25 square miles divided into three units as illustrated in figure 1, if the project were continued. In 1956, 68 individual ponds were classified according to vegetative cover as outlined in Table V. The percentage breakdown is probably adequate for much of the interior muskeg habitat.

TABLE V. CLASSIFICATION OF PONDS ON FT. YUKON STUDY AREA, 1956

Emergent Vegetation	Shoreline Vegetation	No. of Ponds	% of Total
Open	Open	5	7.4
Open	Half Closed	5	7.4
Open	Closed	13	19.1
Half Closed	Open	17	25.0
Half Closed	Half Closed	5	7.4
Half Closed	Closed	7	10.2
Closed	Open	13	19.1
Closed	Half Closed		
Closed	Closed	3	4.4
Total		68	100.0

Objectives:

As originally conceived, the objectives of the study were:

1. To identify and evaluate all factors which may operate to affect waterfowl production, and to determine indicators of production success.

2. To establish quantitative means of evaluating annual production.

3. To band a representative sample of resident waterfowl.

Methods and Personnel

The ground study at Fort Yukon has been conducted by students from the University of Alaska on a summer employment basis. A two-man crew has worked on an overlapping basis, each man for a period of two years in an effort to build continuity into the program. Calvin Lensink initiated the study in 1953 employing an Indian from Fort Yukon as guide and helper. Lensink returned as project leader in 1954, assisted by a student, Eugene Reuter, who in turn inherited the leadership in 1955 with assistant Kenneth Hughes. In 1956, Hughes became co-leader, with graduate student George Cornwell, whose assignment was to develop a visibility factor index over a two-year period for his thesis research. Unfortunately, Cornwell returned to the states at the end of his first summer in the bush, and Hughes has graduated so that there is no experienced man to continue the Fort Yukon project. For that reason, and even more important, because the study area has not maintained the stability necessary in an intensive air-ground problem, ground studies will be discontinued there.

Each year, concurrent with the first breeding pair count on the ground, an aerial survey was conducted. The observers in 1953 were Scott and Elkins, in 1954 Scott and Lensink, in 1955 Olson and Libby, and in 1956 Hansen and Cornwell. The aerial census was randomized for the Yukon Flats, in toto, and it was more or less coincidental that two of the aerial transects dissected the ground study plot which, in its reduced size of 32 square miles, is largely encompassed within the presently designated stratum IV.

Photographs obtained from the U. S. Geological Survey were used by crew members to locate all the bodies of water on the study area and to navigate from one to the other through the dense willows and rank grass, carrying camera, binoculars, mosquito repellent (pint size) and native canoe. For reference purposes, the ponds have all been numbered and the study area divided into working units (figure 1).

An itemized phenological progression has been accumulated and is presented in Table VI. The rule-of-thumb generalization that an early season tends to be a good production year and a late season may be a poor production year seems to be particularly appropriate in the far north. And there may be more than a shred of evidence that the chronological difference between "early" and "late" can be as short as a ten to fifteen day period.

Waterfowl Density and Species Composition

Population densities per square mile have been tabulated both by aerial census and ground census as listed in Table VII. When the study was started in 1953, a quantitative ground census was not made, but comparisons are shown for the three subsequent years. Although conclusions might be of doubtful validity, the following observations are offered to explain the data. Because of annually changing crews of personnel with diverse experience and abilities, little comparability can be read into the aerial census column. On the other hand, there should be reasonable credance in the population density as derived from the ground census because of the continuity of crews. It was evident that there was a decreased production of ducks each year on the study area and the reason was as evident as the fact: a lowering

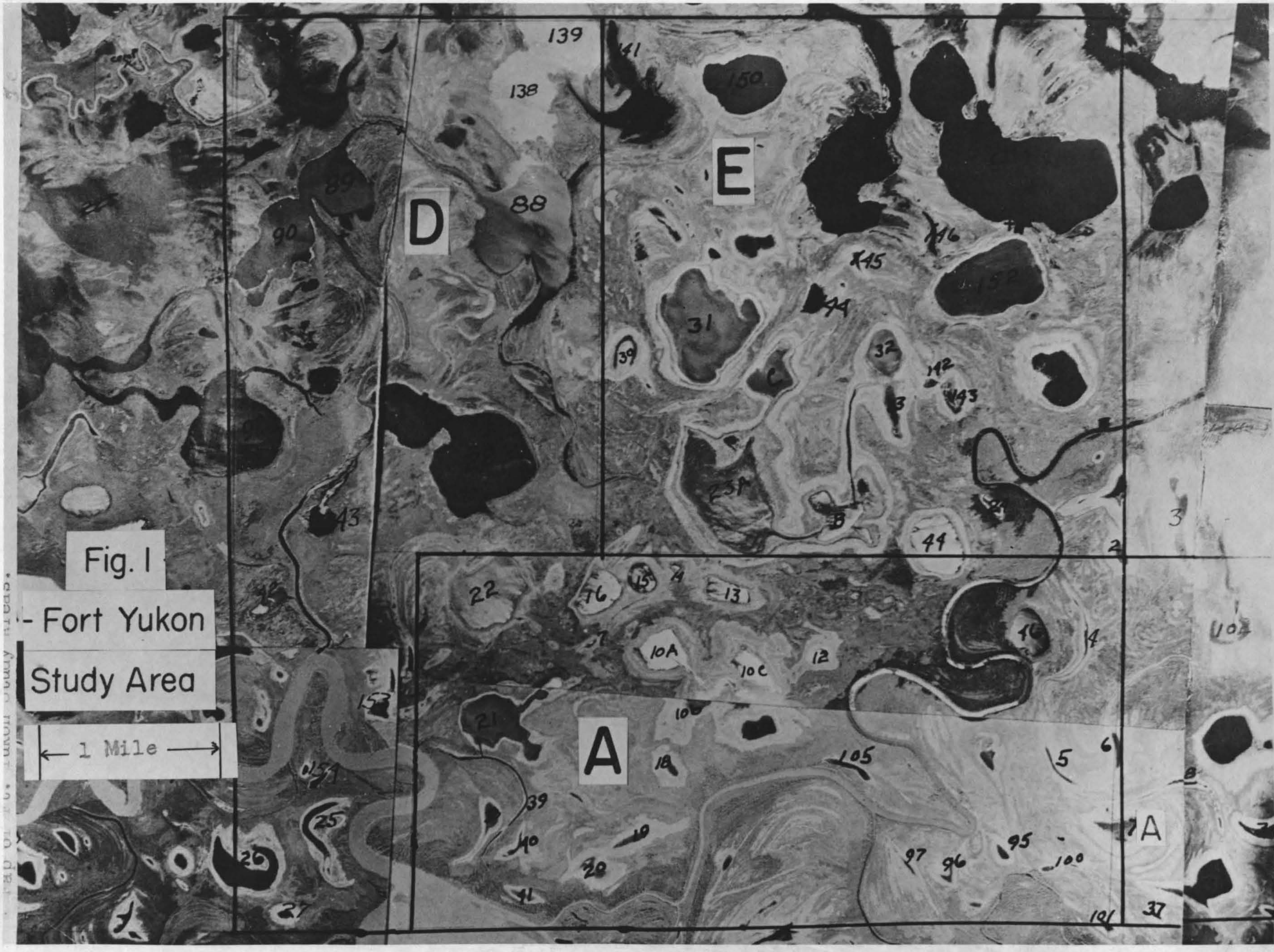
Fig. I
- Fort Yukon
Study Area
1 Mile
A
D
E
139
138
88
89
90
150
31
32
44
22
10A
10C
12
13
21
105

TABLE VI. A COMPARISON OF WATERFOWL PHENOLOGY AT FT. YUKON, 1953 - 1956

Species	Year	First Arrival	Est. First Nest Hatch*	Computed Peak of Hatch	First Brood Observed	Last Observed Ia Young	First Fledged Young	First Obs. of Flightless Adult	First Fledged Adult Molters	Breakup Date at Ft. Yukon Year	Day
Baldpate	1953	May 11	June 15	July 1	June 25	July 9	August 6	--------	--------	1948	5/15
	1954	May 13	June 14	July 1	June 24	August 4	August 8	--------	--------	1949	5/19
	1955	------	June 20	July 1	June 28	August 11	August 11	--------	--------	1950	5/13
	1956	May 7	June 2	June 27	June 23	July 24	July 26	June 23	July 20	1951	5/8
Canvasback	1953	------	June 14	June 28	June 25	July 13	August 20	--------	--------	1952	5/22
	1954	May 15	June 19	--------	July 1	July 14	--------	--------	--------	1953	5/11
	1955	------	June 24	--------	July 5	July 18	--------	--------	--------	1954	5/18
	1956	------	June 13	June 24	July 11	July 12	--------	--------	--------	1955	5/19
G.W.Teal	1953	May 19	June 10	June 23	June 19	July 10	July 12	--------	--------	1956	5/9
	1954	------	June 14	--------	June 23	July 22	July 20	--------	--------		
	1955	------	June 21	--------	June 30	June 30	August 3	--------	--------		
	1956	------	June 16	June 30	June 22	July 24	July 24	June 27	July 24		
Mallard	1953	April 21	May 28	June 18	June 6	July 9	August 3	--------	--------		
	1954	------	June 9	June 24	June 21	July 21	August 2	--------	--------		
	1955	------	June 9	June 28	June 21	July 7	August 3	--------	--------		
	1956	April 27	May 25	June 20	June 24	July 10	--------	June 23	July 15		
Pintail	1953	April 21	May 30	June 18	June 9	July 10	August 3	--------	--------		
	1954	------	June 7	June 24	June 21	June 16	July 22	--------	--------		
	1955	------	June 7	June 28	June 21	June 30	August 3	--------	--------		
	1956	April 29	June 3	June 18	June 12	July 5	July 14	June 15	July 26		
Shoveler	1953	May 18	June 7	June 26	June 19	July 2	August 3	--------	--------		
	1954	------	June 14	July 11	June 24	July 15	August 2	--------	--------		
	1955	------	June 17	--------	July 5	July 31	August 4	--------	--------		
	1956	------	June 2	June 25	June 28	June 28	--------	June 26	--------		
Scaup	1953	May 18	June 25	July 12	July 8	August 5	--------	--------	--------		
	1954	------	July 5	July 25	July 13	August 15	--------	--------	--------		
	1955	------	July 7	--------	July 14	August 14	--------	--------	--------		
	1956	------	June 30	July 13	July 11	--------	--------	--------	--------		

* Calculated from first broods censused and growth rates.

TABLE VII. AN AIR TO GROUND COMPARISON OF THE WATERFOWL DENSITY ON THE YUKON FLATS (DUCKS PER SQ. MILE)

Year	Aerial Census (7,000 Sq. Mi.)	Ground Census (33 Sq. Mi.)
1953	16.8	Not Conducted
1954	20.0	100.0
1955	11.0	72.0
1956	17.3	34.4
1956	14.9*	34.4

*Density as computed from 8 special transects run on an east-west and north-south grid pattern across the study area and into adjacent habitat (256 sq. mi.).

TABLE VIII. A COMPARISON OF SPECIES COMPOSITION OF GAME DUCKS - AERIAL VS. GROUND COUNTS (IN PERCENTAGES)* AT FT. YUKON

	1953		1954		1955		1956	
Species	Air	Ground	Air	Ground	Air	Ground	Air	Ground
Scaup	64	23	47	26	43	26	41	53
Pintail	23	22	27	28	7	17	17	19
Mallard	7	12	9	7	11	17	16	6
Baldpate	3	34	9	27	12	17	15	14
Shoveler	tr.	2	tr.	4	2	11	1	2
G.W.Teal	tr.	6	1	2	3	2	2	1
Canvasback	2	1	4	3	7	4	3	4
Goldeneye			tr.	1	1	2	3	tr.
Bufflehead			2	2	14	4	2	1
Total	99+	100	99+	100	100	100	100	100

*1953 - 47% identified from air
1954 - 51% identified from air
1955 - 47% identified from air
1956 - 74% identified from air

water table and consequent loss of effective ponds. In 1953, Lensink reported that the water level was as low as natives of the area could remember, but that the condition caused no shortage of habitat nor did it appear that, at even lower levels, an adverse effect would be felt. In 1954, he further reported that the water table had continued to drop but that, on a ground census of 29 ponds selected at random (figure 1), each had a minimum population of two breeding pair. Habitat on the study area continued to deteriorate and Cornwell reported that, in 1956, 25 percent of all the ponds shown on areas A, D, and E (figure 1) supported no waterfowl. Thus, the decrease in waterfowl density as indicated by the ground censuses could be quite accurate for the study area. On the other hand, habitat conditions elsewhere on the Yukon Flats appeared to remain excellent. Many lakes adjacent to major rivers are dependent largely upon annual overflow from the river where ice jams cause local floods during the spring break-up. In recent years where this flooding condition could threaten a village, e.g. Fort Yukon, the Air Force hastens the break-up and run-off with aerial bombing, thus depriving lakes in the area of their natural replenishment. In 1953, selection of the study site near Fort Yukon appeared to be a good choice, but, in retrospect, the data may not be amenable to the over-all area because of unforeseen local influences unnatural to the Yukon Flats as a whole. The original estimate of Lensink, and other biologists elsewhere in Alaska, probably is valid in spite of a seemingly adverse "drought" on the Fort Yukon study area, viz. "observations indicate that there always will be satisfactory habitat on the Yukon Flats...for under present conditions, it seems that the flats are capable of supporting a much larger population. Although nearly all lakes, even those that are very small, produce one or more broods, others, often of considerable size, produce unexpectedly few broods. Thus, an insufficient amount of habitat cannot be considered a limiting factor of production."

There is no logical way to compare population densities from the aerial census in 1954 and 1955 with the concurrent ground censuses because of the diverse size and heterogeneity of the two samples. From the aerial census in 1956, however, a density of 17.3 ducks per square mile was obtained for all of strata III and IV on the Yukon Flats compared to a density of 14.9 ducks for eight special transects plotted on and adjacent to the study area about 15 percent fewer ducks per unit area on the eight special transects, which were 50-50 stratum III and IV, than on the flats as a whole. The ground census indicated a decrease in population of 48 percent on the study area from the 1955 population, but the aerial census showed an increase of 35 percent for the entire flats. Although the latter comparison is not entirely valid because there is no means of standardizing the vision factor of the two observers in 1955, it does not seem likely that there could be a 35 percent disparity between the two crews where all four observers were trained biologists, three of whom had extensive waterfowl experience. In no instance was a 35 percent difference noted between the five observers and the norm in 1956 where experience and training ranged from practically zero to 15 years or more. It seems fairly obvious then, that there was an increase in over-all breeding population density despite the downward trend on the study area which would indicate otherwise.

A comparison of species composition as derived from aerial vs. ground counts is given in Table VIII. Species composition was somewhat uniform throughout the Yukon Flats as analyzed from transect data in 1956. That is, any given species was in about the same relative abundance to the other species at Stevens Village toward the western end of the flats, for instance, as it was at Fort Yukon near the eastern end. It was assumed each year that identification in the ground census was one hundred percent correct and that practically all of the ducks observed were identified. Of the four major species at the head of Table VIII, scaup appeared to be least affected by the habitat deterioration on the study area and mallard and baldpate the most sensitive to habitat change. Because the Fort Yukon study area is so restricted and not typical of the flats as a whole, it would not seem logical to derive visibility factors from the two dissimilar samples. The comparisons are tabulated for the record only at this point. Figuratively speaking, however, further mental fingering of the facts and figures might indicate a tentative beginning for establishing visibility factors for the major species.

Brood Surveys

The opinion has been expressed by several biologists assigned to ground studies in Alaska that perhaps brood surveys are the best indicator of production success. In 1954, Lensink pointed out two important items relative to the success of the breeding season obtained from brood censuses: (1) the number of broods per unit area, and (2) the average number of young per brood. Those two criteria alone, however, would not have indicated the trend of production in 1956 compared with 1955 for the entire Yukon Flats as judged from the Fort Yukon study area, nor for any other comparable area, for that matter. If item (1), above, read "the ratio of broods to breeding pairs per unit area," rather than an absolute number of broods, then abnormal and atypical conditions on small areas, such as the local habitat deterioration on the Fort Yukon study plot, would not be projected to the larger, normal area. The ratio of broods to breeding pairs should be a function of the season and operate in the same manner on the study area as elsewhere on the flats. With that approach, relative changes from year to year on small areas might logically be applied to strata or geographical units where the aerial population index is used as the base, and study plots would then be practical and justifiable from an operational point of view.

The statement relative to "early" and "late" seasons in a preceding paragraph on page 20 dealing with phenology is illustrated in Tables IX, IXa and IXb, showing brood sizes for three areas in interior and coastal Alaska. The years 1951, 1953 and 1956 were early and the intervening years were later, but only by 7 to 14 days. There was no quantitative measure of hatching success to show whether or not a higher percentage of the nesting ducks were successful during the early years, but certainly the total average brood size was larger in each of the three early years. The Selawik project has been in operation only the last two years, but the brood size pattern during 1955 and 1956 at Selawik correlates with the other areas. In 1955, the Minto project was inoperative due to a season-long flood, but there is brood data from Minto extending from 1951, showing the influence of another early season in larger broods. The 1955 total of 11 broods given for Minto was taken from an aerial brood survey made by Buckley on July 29, and the brood size probably is inaccurate on the low side.

Nesting Studies

Searching for nests and attempting to assess production from hatching success has been attempted in Alaska at several locations, but with discouraging results in each case except with the colonial nesting or gregarious species such as brant and Western Canada geese. A random selection of some of the intensive nest searches shows the following results. In 1951, on the Serpentine River, 29 duck nests and 32 geese and brant nests were located during a season's study. During the same year on the Innoko, one nest was found on several selected plots totaling

TABLE IX. SIZE OF BROODS ON FT. YUKON STUDY AREA, 1953 - 1956 (ONLY COMPLETE BROODS, ALL AGE CLASSES COMBINED)

Species	1953 No. of Broods	1953 Av. Size	1954 No. of Broods	1954 Av. Size	1955 No. Of Broods	1955 Av. Size	1956 No. of Broods	1956 Av. Size
Scaup	24	8.1	108	6.4	49	6.4	9	6.2
Scoter	4	11.2						
Pintail	31	6.6	89	5.3	38	6.2	20	7.9
Mallard	11	7.4	50	5.6	40	6.3	6	6.0
Baldpate	51	7.2	130	6.1	217	6.3	65	6.8
Shoveler	7	8.3					5	8.6
G.W.Teal	8	8.2					10	7.6
Canvasback	7	5.3					7	5.0
Goldeneye							2	9.0
Bufflehead	3	6.0					5	6.0
Total	146	7.3	377	5.9	344	6.3	129	6.9

TABLE IXa. SIZE OF BROODS ON SELAWIK STUDY AREA, 1955 - 1956

Species	1955 No. of Broods	1955 Av. Size	1956 No. of Broods	1956 Av. Size
Scaup	41	7.3	63	7.3
Scoter	1	6.0	3	10.3
Pintail	39	4.5	27	5.7
Mallard	2	4.0	1	7.0
Baldpate	30	6.4	30	6.9
Shoveler			3	6.7
G. W. Teal	10	7.2	10	8.2
Old Squaw	3	4.0		
Total	126	6.1	137	7.0

TABLE IX b. SIZE OF BROODS ON MINTO STUDY AREA, 1951 - 1956

Species	1951 No. of Broods	1951 Av. Size	1952 No. of Broods	1952 Av. Size	1953 No. of Broods	1953 Av. Size	1954 No. of Broods	1954 Av. Size	1955 No. of Broods	1955 Av. Size	1956 No. of Broods	1956 Av. Size
Scaup	8	7.7	46	6.6	106	7.6	80	6.6			18	
Scoter			5	7.6	5	7.8	2	7.0				
Pintail	72	6.2	8	5.8	35	5.6	109	4.6			18	
Mallard	11	7.7			8	5.5	25	5.6			3	
Baldpate	7	7.0	8	5.9	38	7.3	75	6.2			25	
Shoveler	11	7.4	7	7.3	12	7.5	35	7.2			1	
Gr. W.Teal	9	7.2	7	7.7	18	7.2	16	5.5			5	
Canvasback	6	5.2	9	5.0	2	6.6	19	6.0			5	
Goldeneye	5	6.8	1	5.0	6	6.2	4	7.5			6	
Total	129	6.7	91	6.5	230	7.1	365	6.0	11	5.6	81	7.2

seventy acres. On an intensive study of the brant nesting grounds in 1951, however, Olson found 259 brant and goose nests, but only 47 duck nests. In 1953 and 1954 at Fort Yukon, an intensive nesting study was attempted on the 32 square mile study area, but Lensink found only 45 nests in 1953 and 68 nests in 1954. Once having initially located nests, it is almost impossible to follow the fate of enough of them to determine nesting success, and even so, the ultimate production of a large population is predicated upon a pitifully small sample of nests.

In lieu of the time consuming, and too frequently unsuccessful, search for nests, a record has been kept for the past two summers at Fort Yukon and at Selawik of the sex ratio of ducks in flocks of deserters. We will continue to collect deserter sex ratio counts and correlate them with phenology and brood size to see if such a scheme can be developed into an indicator of nesting success. If renesting in the far north is of minor consideration in comparison with the southern breeding grounds, then females counted in flocks of deserter males might logically be assumed to be non-productive. If large enough numbers can be accumulated for the three or four most important species from small flocks in widely dispersed ponds, the indicated trend might be within acceptable limits. Instructions have been for the biologists to make counts primarily on scaup, baldpate, pintail and mallards, but perhaps the technique can be applied only to baldpate and pintail practicably. As among all the divers, scaup arrive in an unbalanced sex ratio of varying proportions heavy to males, so that deserter sex ratio counts may not be applicable unless adequate arrival sex ratios can be made for comparison. In most places in Alaska the mallard breeds in too limited numbers to accumulate the depth of information necessary to interpret nesting success.

As an indication of how the deserter sex ratio might be used, a comparison of the count made at Selawik in 1955 and 1956, correlated with average brood size and phenology, follows. In 1955, the break-up at Selawik occurred on June 1st, followed by about two weeks of inclement weather and retarded plant growth, compared to a May 20th break-up in 1956 immediately followed by good weather and rapid plant growth. The average size of 126 broods in 1955 was 6.1 and the average size of 137 broods in 1956 was 7.0 made by the same competent observer both years. Of approximately 1200 deserter pintails sexed each year in small flocks during and after the peak of incubation, 31 percent were females in "late" 1955 and only 13 percent were females in "early" 1956. Concurrently each year about 400 baldpates were sexed with 12 percent females in 1955 and six percent females in 1956, roughly the same decrease in females (increase in nesting success) in both species. The 1956 deserter count at Fort Yukon correlates very closely with the Selawik figures. Of 500 pintails sexed at Fort Yukon in 1956, only 11 percent were females (13 percent at Selawik), and of 630 baldpate sexed, 5 percent were females (6 percent at Selawik). The figures are presented here at face value and nothing of a quantitative value will be read into them until and unless another year or two of data indicates some logic in this line of reasoning.

AERIAL BROOD SURVEYS

Cursory aerial brood surveys have been attempted experimentally in various areas for several years and intensively at Minto since 1953, but there is no financial means yet of extending them on an operational basis even to one larger geographical unit such as the Yukon Flats. Results of the brood censuses have not been particularly satisfactory with the possible exception of Buckley's intensive work at Minto, but the coverage he has given 450 square miles there could not be considered as operationally feasible. Eight random transects eight miles long and 1/8 mile wide, censused in 1953, were increased to 10 in 1954 and 1955, and further increased to 31 in 1956. The result of these brood counts is summarized in Table X, and the data indicate a few facts of practical import to any aerial brood survey in the far north, the first of which is that an optimum sampling intensity should be developed on an experimental basis before an operational survey is extended to large areas. The brood density was calculated separately for the original eight transects in each of the four years (line "1 thru 8"), for the original eight, plus nine and ten, in the last three years and for all 31 in 1956. It is obvious that transects nine and ten either bisected pockets of extremely high density or ponds with unusually high visibility characteristics in order to offset the average of the first eight transects to the degree listed. The low density in 1955 was due entirely to abnormally high flood water remaining throughout the nesting and brooding season which cut production as indicated. Even in 1955, however, the influence of transects nine and ten are evidenced. In 1954, if a brood index were based on 10 transects instead of the original eight, the population would have been 33 percent greater; in 1955 on the same basis it would have been 40 percent greater; and in 1956 it would have been 31 percent greater. In 1956, however, with the sampling intensity increased to 31 transects, the brood index is within four percent of the index for the original eight transects. The original eight transects constituted a sample of 1.8 percent of the 450 square miles; 10 transects a sample of 2.2 percent; and 31 transects a sample of 6.9 percent. Based on the disparity between the eight-transect sample and the

TABLE X. AERIAL BROOD CENSUS AT MINTO LAKES,
1953 - 1956, FOR A 450 SQUARE MILE AREA

Transect Numbers Censused	1953 No. of Broods	1953 Av. Per Sq. Mi.	1954 No. of Broods	1954 Av. Per Sq. Mi.	1955 No. of Broods	1955 Av. Per Sq. Mi.	1956 No. of Broods	1956 Av. Per Sq. Mi.
1 thru 8	25	3.1	34	4.2	5	0.6	20	2.5
1 thru 10			63	6.3	10	1.0	36	3.6
1 thru 31							74	2.4

Brood Index Based on	1953	1954	1955	1956
1 thru 8	1,395	1,890	270	1,125
1 thru 10		2,835	450	1,620
1 thru 31				1,080

ten-transect sample, a greater sampling intensity is indicated. How much short of the 31 transects has not been determined. Yet, if the experimental brood census conducted at Minto were extended to Strata III and IV on the Yukon Flats, for instance, coverage comparable to the 8 transects at Minto would require 62 sixteen mile transects 1/8 mile wide, or roughly twice the amount of flying now required for the breeding pair census. Coverage comparable to the 31 transects extended to Minto in 1956, however, would require 240 sixteen-mile transects at Fort Yukon to accomplish a seven percent sampling intensity.

Perhaps more important than the size of the sample required operationally to secure data amenable to statistical scrutiny is the role phenology plays in securing brood data reflecting an honest production trend. For example, in early years when production is good, broods may be relatively more difficult to see, because rapidly growing emergents hide them better than in late years of slow plant development. Yet, in the phenologically later, poorer production year when vegetation is retarded and visibility factors are better, a higher brood density per unit area might actually be tallied, giving the false impression of better production than in an early season. On 10 brood transects across the Fort Yukon study area on July 12, 1956, for instance, the most broods Hansen counted on any one coverage under ideal conditions (early morning, no wind, good visibility in all direction) was six, an average of 1.0 per square mile. Only one brood was identified and the number of young was determined in three broods. It was possible, however, to age all the broods with reasonable accuracy. The emergent vegetation was extremely rank and dense and the broods usually rested and fed in the outer fringe of vegetation rather than in open water. Of the broods spotted only part of the ducks were normally seen scurrying for denser cover and the hen was almost always hid, hence, the inability to identify species. On one pond known to contain 13 broods by ground count, only two or three hours earlier, only one brood of pintails was counted from the air. A later check from the ground indicated that most of the broods were still in residence.

Aerial brood surveys in the far north are probably feasible, but they will be expensive on an operational basis and should have a conjunctive ground study to lend them stability at least until a backlog of data has given them maturity.

INDICATORS OF PRODUCTION

The ultimate goal of the coordinated aerial and ground breeding population surveys is to device some formula whereby a reliable quantitative and qualitative forecast of annual production can be made in time for consideration by the Regulations Committee. At the present time it looks as if there will be fewer components in a formula applicable to the far northern breeding grounds than in the system devised by Lynch for Saskatchewan. If so, the formula itself should be simpler, but it will be more difficult to collect adequate data with which to weight the factors involved. Two of the more important factors in the prairie provinces relative to good production, (1) number of water areas and (2) strength of renesting, are of minor import in Alaska. First, it does not appear that a lack of water in Alaska could possibly be a limiting factor in production. If localized spots, e.g., the Fort Yukon study area, are temporarily droughted there is no shortage of suitable habitat nearby to absorb all the returning brood stock. Secondly, effective renesting on an appreciable scale is almost precluded by the length of the season between break-up and freeze-out. This is especially true of the late nesting scaup and baldpate. It would be impossible for scaup in an average year to put a brood from a second nesting attempt on the wing. As it is, young scaup are frequently found flightless during an early freeze-up. Among the earlier nesting and faster developing pintail it would be possible for effective renesting in an early season, but present evidence points toward high initial nesting success in early seasons so that relatively few disturbed hens would be involved. In a late season when initial success is lower, the renesting effort is minimized by lack of time.

As a premise with which to start, then, the following two indicators of annual production are offered in order of importance: (1) Size of breeding population and (2) Phenology of the season. Two important functions of phenology that are measurable and directly comparable from year to year as determined from ground studies are the "deserter ratio", females to males in post-nuptial flocks, and brood size. An early season contributes to rapid growth of vegetation offering better protection for incubating hens and, hence, fewer females in the deserter flocks as well as better protection for broods and, consequently, larger average brood size, particularly among the early nesting species. The role of predation, both avian and mammalian, as a population depressant on Alaska's waterfowl breeding grounds has been studied intensively and is well recorded in Federal Aid reports. An aerial survey to measure the basic brood stock coordinated with ground study projects in selected geographical areas to measure the strength of phenological influences will constitute the basic approach in assessing production trends. However, assignment of values to the various factors has not been attained yet, nor have all the factors necessarily been identified. Certainly, more understanding is necessary to place each factor in its proper perspective to the others.

BANDING

Since 1948, 26,485 waterfowl representing 25 species and sub-species have been banded in Alaska as summarized in Table XI. Generalized patterns of migration from band returns can be interpreted for several species, and for a few species detailed and conclusive migratory data are available. No attempt will be made in this report to analyze band returns nor migrational patterns, but Nelson and Hansen will prepare a detailed account of the black brant data for publication prior to the 1957 field season. A summary of all the banding accomplished in 1956 is presented in Tables XII and XIIa.

TABLE XI. TOTAL WATERFOWL BANDED IN ALASKA, 1948 - 1956

Species	1948	1949	1950	1951	1952	1953	1954	1955	1956	Total
Wh. Fronted Goose	65	128	158	157	44		228	113	94	987
Lesser Can. Goose	104	153	111	79		5	446	20	72	990
Cackling Goose		698	1,101	492	1,011	6	218	1		3,527
Western Can. Goose			2	17	148	482	756	413	573	2,391
Black Brant		382	2,454	2,543	2,362	197	935			8,873
Emperor Goose		54	241	74	53		48			470
Snow Goose				14			1			15
Pintail	368	1,032	470	787	83	272	917	127	60	4,116
Baldpate	72	34	20	375	6	254	364	131	98	1,354
Mallard	27	26	16	70	11	90	126	63	18	447
Gadwall					1	10	5	14		30
G.W.Teal	51	95	20	222	4	20	141	55	18	626
Shoveller	3	4	5	73	7	56	146	23	7	324
Greater Scaup	2	3		8	17	47	20		86	183
Lesser Scaup				30	103	192	128			453
Scaup spp.				78	9	26	352	215	15	695
Goldeneye spp.				1	2		10	166	202	381
American Scoter					1				1	2
Wh. W. Scoter			1				37	2	1	41
Pac.&Spec. Eider		20	67	2	15		8			112
Canvasback			8	2	4	25	36	10	26	111
Old Squaw				1	1				4	6
Bufflehead					12	7	39	27	248	333
Whist. Swan			8		5			3	2	18
Total	692	2,629	4,682	5,025	3,899	1,689	4,961	1,383	1,525	26,485

TABLE XII. SUMMARY OF WATERFOWL BANDED IN ALASKA, 1956

Species	Glacier Bay Adult			Copper River Delta Adult		Copper River Delta Local		Selawik Adult			Selawik Local			Tetlin Adult		Tetlin Local		Ft. Yukon Adult		Ft. Yukon Local		Total
	M	F	?	M	F	M	F	M	F	?	M	F	?	M	F	M	F	M	F	M	F	
Mallard	13	3																1			1	18
Pintail				8	2	3	1	1	2		7	11	5	1				1		8	10	60
Baldpate											9	5		34						29	21	98
Gr. W. Teal											2	6						4		2	4	18
Shoveller																				2	5	7
Gr. Scaup						1			2		40	42	1									86
Scaup spp.														11	2		1				1	15
Canvasback															1	10	11			2	2	26
Goldeneye spp.														97	105							202
Bufflehead														204	44							248
Old Squaw															4							4
Amer. Scoter									1													1
W. W. Scoter																	1					1
West. C. Goose	26	32	110	35	24	182	164															573
Lesser C. Goose								10	19	1	25	16	1									72
Wh. F. Goose								13	15	40	4	11	11									94
Whist. Swan				1	1																	2
Total	39	35	110	44	27	186	165	24	39	41	87	91	18	347	156	10	13	6		43	44	1,525

TABLE XIIa. SUMMARY OF MISCELLANEOUS SPECIES BANDED IN ALASKA, 1956

Species	Tetlin Ad.	Tetlin Local	Ft. Yukon Ad.	Ft. Yukon Local	Selawik Ad.	Selawik Local	Total
Holboell's Grebe		5	1	1			7
Horned Grebe	105	3					108
Little Brown Crane				1			1
Wilson's Snipe						2	2
Semi-Palmated Plover				1			1
Artic Tern				2			2
Short-Billed Gull				1			1
Total	105	8	1	6		2	122