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Title: POPULATION CHARACTERISTICS OF THE DUSKY CANADA GOOSE AS DETERMINED FROM BANDING DATA

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Banding data for the dusky Canada goose (*Branta canadensis occidentalis*) on file at the Bird Banding Laboratory, Laurel, Maryland were analysed to determine population characteristics of this goose.[1] Banding programs have been conducted on the nesting grounds of this subspecies in southcentral Alaska by the U. S. Fish and Wildlife Service and the Alaska Department of Fish and Game. Between 1952 and 1965, 5,758 geese were banded and 1,553 bands were recovered and reported to the Bird Banding Laboratory.

Analysis of band recovery locations indicated that the race has a well-defined migration route and restricted wintering areas. Exodus from the nesting grounds in Alaska begins about 15 September and the birds begin arriving in the central Willamette Valley of Oregon

[1]This study was supported by the Oregon Agricultural Experiment Station, the Bill Ornduff Natural Science Scholarship Trust, and the Wildlife Management Institute.

(major wintering area) about 5 November. The geese remain in the valley until approximately 10 April; they then return to the Copper River delta of Alaska to nest. Nesting begins about 1 May.

The size of the winter dusky Canada goose population in Washington and Oregon has averaged 18,078 for the last four years (1964-67). Sixty-five percent of the dusky Canada geese harvested are taken in Oregon; 16 percent in British Columbia, 11 percent in Washington, 8 percent in Alaska, and a trace in California. An average of 45.3 percent of the population is killed annually (1952-65). However, population mortality rates have been increasing; immature rates are now in excess of 60 percent. The annual mortality rates in the flyway are correlated with season lengths and bag limits in Oregon. This may be a result of two-thirds of the harvest occurring in that state. Hunting club members and their guests harvested as estimated 65 percent of the dusky Canada geese taken in Oregon in 1965. One large club accounted for 36 percent of the harvest.

Considering the average population mortality rates (1952-64), it was estimated that between 50 and 66 percent of the subadult females must attempt to nest with an 85 to 90 percent nest success just to maintain a stable population. This percentage is considerably higher than those recorded in the literature for other races of Canada geese.

In view of the population size, the present mortality rates, the

environmental changes on the breeding grounds, and the production rates necessary to maintain a stable population, it was concluded that more restrictive hunting regulations were necessary to maintain the population at the present level. Advantages and disadvantages of possible restrictive hunting regulations are discussed.

Population Characteristics of the Dusky Canada Goose as Determined from Banding Data

by

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POPULATION CHARACTERISTICS OF THE DUSKY CANADA GOOSE AS DETERMINED FROM BANDING DATA

I. INTRODUCTION

There has been a tendency to regulate waterfowl harvest by species or by populations in recent years, as the waterfowl supply declines, or becomes less stable. Therefore, it becomes increasingly important to learn and describe the population characteristics of each of the harvested species. Studies of this nature have led to the late summer special blue-winged teal (*Anas discors*) seasons, the bonus mallards (*Anas platyrhynchos*) in the San Luis Valley of Colorado, and the kill-quota system for Canada geese (*Branta canadensis*) in the vicinity of Horicon Marsh, Swan Lake, and Horseshoe Lake. Management of waterfowl by species or flocks may become more common in the future.

The present study was concerned with the distribution, migration, numbers killed, survival, and status of the dusky Canada goose (*Branta canadensis occidentalis*). The population of this subspecies is exceptionally small in comparison with other Canada goose populations. Winter inventory counts indicate the population size to be between 15,000 and 18,000 (Tables V and VI). The range of the subspecies includes the states of Alaska, Washington, Oregon, occasionally California, and the Canadian province of British Columbia

(Hansen, 1962). The dusky Canada goose is the principal goose hunted in western Washington and the Willamette Valley of Oregon.

A well-defined nesting area, a narrow migration route, and a restricted wintering area make the dusky Canada goose a unique subspecies to study. The breeding range of the race extends along the coast of Alaska from the vicinity of Bering Glacier on the southeast to Cook Inlet on the west, a distance of about 275 air miles (Hansen, 1962). The population may be considered a colonial nester with the highest nesting densities on the Copper River delta near Cordova, Alaska. This type of nesting is not commonly observed among other subspecies of Canada geese. Nesting densities of 108 nests per square mile have been found on study areas on the Copper River delta (Trainer, 1959).

In 1964 the Bureau of Sports Fisheries and Wildlife established the William L. Finley National Wildlife Refuge south of Corvallis, Oregon. The refuge was designed to give protection to the dusky Canada geese on their primary wintering ground (central Willamette Valley of Oregon) where, incidentally the major portion of the hunting kill occurs. The present mortality rates for this population are similar to those of the Horseshoe Lake flock before the kill-quota system was established (Hanson, 1967).

This study is principally based on banding data acquired since 1952. The study has advantages over other studies of the dusky

Canada goose because it reflects the characteristics of the entire population instead of localized study areas.

Data regarding population dynamics of the dusky Canada goose were gathered in hopes that it would be of value in determining management policies for the race. We have passed beyond the point in history where all Canada geese, whether large or small, or dark or light can be called Canada geese and can be managed as one unit.

Objectives of the Study

The main objectives of the study were as follows:

1. To define summer and winter population ranges and the associated migration routes.
2. To determine survival of the different sex and age groups in the population.
3. To determine the relative importance of the harvest in each state and province.
4. To determine the role of hunting and hunting regulations in the management of the species.
5. To make recommendations for management and point out research needs.

History of Banding

Systematic bird banding as a technique for studying migration

was first used by C. C. Mortenson in Denmark in 1900 (Fisher, 1951). He published maps showing points of banding and recovery of teal (*Anas crecca*) and pintail (*Anas acuta*). Maps of a similar type constituted the primary contribution of most banding analyses published during the next 45 years.

Much bird banding was accomplished in the United States in the 1930's and 1940's, and was mainly directed toward non-game species. Nice (1937) studied the life history of the song sparrow (*Melospiza melodia*) while Farner (1945 and 1949) discussed longevity and age groups of the American robin (*Turdus migratorius*). Leopold *et al.* (1943) used the banding technique to estimate turnover in pheasant (*Phasianus colchicus*) populations on a refuge in Wisconsin. These early studies indicated that there were still many problems that needed to be solved before the banding technique could be used to its fullest extent.

Many problems of interpreting the results of banding still have not been solved. Hickey (1951) discussed the effect of differential vulnerability between adults and young, of dates of banding in relation to the hunting season, and of unequal hunting pressures on the geographical distribution of band recoveries. Crissey (1955) outlined the problems of interpreting population movements because of variation in band reporting rates and crippling loss rates between areas. Atwood and Geis (1960) discussed biases associated with attempts to

increase the proportion of bands reported.

Bellrose (1955), Geis and Atwood (1961), Martinson (1966), and Martinson and McCann (1966) obtained information regarding the percentage of banded birds obtained that hunters actually report to the Bird Banding Laboratory. Bellrose (1955) compared numbers of bands recovered from mallards marked with reward and standard legbands. The remaining authors compared numbers of bands that hunters in the United States reported that they had recovered in answer to a mail questionnaire with the number actually reported to the U. S. Fish and Wildlife Service Bird Banding Laboratory.

Crippling loss is of major importance as a mortality factor in waterfowl and other game species. Crippling loss information is important for estimating hunting mortality. Crissey (1956, 1958, 1960) from answers provided by mail questionnaires estimated that 15 to 20 percent of the numbers killed for all duck species were crippled and not retrieved in the United States. Hansen (1964) compiled data obtained from observations of hunter blinds and found that 32 percent of the ducks shot were not retrieved. Sufficient data to assess losses due to crippling for several species were acquired by the U. S. Fish and Wildlife Service hunter performance program, usually referred to as "spyblind observations." In this program, biologists throughout the United States watched duck hunters and noted the numbers of birds knocked down and numbers retrieved.

These records are on file at the Migratory Bird Populations Station, Laurel, Maryland.

Addy (1953) published the first detailed analysis of the migration of a single species of duck based on all available bandings. This was accomplished when he described migration routes for the various subpopulations of the black duck (*Anas rubripes*). A more comprehensive paper dealing with population distribution and hunting kill of canvasbacks (*Aythya valisineria*) appeared in 1958 (Stewart, Geis, and Evans). The authors combined data from breeding and winter surveys with banding data, and gave quantitative estimates of population levels and numbers killed in various parts of the species' range. A similar report on redheads (*Aythya americana*) appeared later (Weller, 1964).

Banding as a technique for studying survival and mortality in birds has been reviewed by Hickey (1952), Farner (1955), and Geis and Taber (1963). Some Canada geese studied with banding techniques include Canada geese of the Mississippi Flyway (Hanson and Smith, 1950), the cackling goose (*Branta canadensis minima*) (Nelson and Hansen, 1959), the Canada geese of coastal Alaska (Hansen, 1962), behavior and survival of Canada geese in Utah (Martin, 1964), and the Canada geese of the eastern prairie population (Vaught and Kirsch, 1966).

II. METHODS

Definitions

Biologists studying bird populations from banding data utilize many technical terms. These terms facilitate brevity when writing because of their very precise meanings. Thus, a section on definitions of certain technical terms is included:

Adult: a goose at least three years old.

Adult mortality rate: percentage of the adult population presented at the beginning of the year that are estimated to have died that year.

Adult recovery: bird recovered as an adult (includes indirect recoveries of birds banded as locals or immatures).

Age Class I: downy young, no feathers visible (1 to 25 days old).

Age Class II: partly feathered, both down and feathers visible under field conditions (26 to 55 days old).

Age ratio: proportion of young to adult. Usually expressed as immatures per 100 adults.

Band-reporting rate: proportion of banded birds recovered by hunters that are actually reported to the Bird Banding Laboratory in Laurel, Maryland.

First-hunting-season recovery (direct recovery): a band recovered during the first hunting season after banding.

First-hunting-season recovery rate (direct recovery rate): percentage of the birds banded one year which are recovered the first hunting season after banding.

Harvest rate: the percent of the population that is harvested. This is the recovery rate divided by the reporting rate. (For example, if the recovery rate was 10 percent and half

the banded birds taken were reported, the harvest rate would be 20 percent.)

Immature: during the 1950's, young birds capable of flight were recorded as "immatures" and those not yet fledged were called "locals." In this study immatures and locals are referred to as immatures.

Immature mortality rate: percentage of the immature population estimated to have died between the beginning of the first and the beginning of the second hunting season after banding.

Immature recovery: bird banded and recovered as immature.

Index: a measure of a characteristic of a population which is determined from incomplete but representative data.

Indirect recovery: recovery occurring in the second or later hunting seasons after banding was accomplished during the summer months.

Kill rate: recovery rate adjusted for crippling loss and non-report of bands. The proportion of the population dying as a result of hunting.

Natural mortality: deaths due to causes other than hunting.

Population unit: a species collectively, or segment thereof, which because of significant differences from other segments in range, kill distribution, mortality rate, recovery rate or other characteristics is considered as a separate population for study and/or management purposes.

Relative recovery rate: a measure of the differential vulnerability of one age or sex group to the other. It is determined by comparing the direct recovery rates for each group.

Shooting pressure: the degree to which a population is subjected to shooting as measured by the proportion of the population which dies as a result of being hunted. An index to shooting pressure is the direct recovery rate.

Subadult: a goose two years old, and it becomes an adult at the end of its third summer of life.

Sources of Data

Banding Data

The main source of data was the records of dusky Canada geese banded on the Copper River delta and recovered in North America. These records were obtained from the files at the Migratory Bird Populations Station of the U. S. Fish and Wildlife Service at Laurel, Maryland. Data used pertained to wild birds banded and released in a normal manner. All sick or experimental birds were eliminated from the records. Only recoveries of birds reported shot during the hunting season were used in most cases; recoveries obtained otherwise, such as birds retrapped or found dead, were rejected in the recovery rate and mortality rate studies. There were 51 recoveries in this category including 26 retrapped birds.

Data on the dusky Canada goose banded during the years 1952 through 1966 were analysed. A summary of the summer bandings on the Copper River delta for that period is presented in Table I. An additional 66 geese were banded in the Willamette Valley of Oregon near Corvallis in the winters of 1953, 1955, and 1956. The sex and age were not determined for the geese banded in Oregon. A total of 5,758 dusky Canada geese were banded of which 1,553 were shot and reported to the Bird Banding Laboratory (26.97 percent). Recoveries received through January 1966 were used in this report.

Table I. Number of dusky Canada geese by sex and age class, banded by the U.S. Fish and Wildlife Service Alaska Department of Fish and Game in the summer on the Copper River delta of south-central Alaska, 1952 through 1966.

Year	Adult			Immature			Age and Sex Not Determined	Total
	Male	Female	Unknown	Male	Female	Unknown		
1952	4	3	9	26	27	79	--	148
1953	31	31	79	129	121	90	--	481
1954	26	32	14	335	296	53	--	756
1955	43	58	--	168	138	3	--	410
1956	34	31	1	169	169	3	--	407
1957	1	1	74	---	---	286	50	412
1958	18	30	--	24	27	257	--	356
1959	8	13	18	93	79	243	--	454
1960	--	--	75	---	---	360	65	500
1961	--	--	--	---	---	---	--	---
1962	--	--	172	---	---	323	--	495
1963	--	--	241	---	---	260	--	501
1964	--	--	---	---	---	---	--	---
1965	--	--	236	---	---	198	--	434
1966	--	--	94	---	---	244	--	338
Totals	165	199	1,013	944	857	2,399	115	5,692

All recoveries from the 1965-66 hunting season were included.

Agencies taking part in the banding operation were: the United States Fish and Wildlife Service, the Alaska Department of Fish and Game, and the Oregon State Game Commission.

Bands were reported to the Bird Banding Laboratory by three major sources: hunters, state or provincial game management personnel, and federal game management personnel. A few bands were reported by other means, e. g., plucking stations, bird banders, and U. S. Fish and Wildlife Service surveys.

Hunter Questionnaire Data

A questionnaire (Figure 1, Appendix) was mailed by the Department of Fisheries and Wildlife, Oregon State University, to 599 Oregon waterfowl hunters, on 8 October 1966 and a second mailing followed 10 days later. This questionnaire was answered by 477 hunters (79. 6 percent) after two mailings. All names and addresses were obtained from the Migratory Bird Populations Station. The questionnaire referred to activities during the 1965-66 hunting season.

One sample of 122 names was of persons that reported at least one dusky Canada goose band from Oregon during the 1962, 1963, or 1964 hunting seasons. This sample was probably biased because it only contained successful hunters. However, important information regarding methods of hunting, affiliation of hunters, and areas of

hunting pressure were determined from this sample.

The remaining 477 questionnaires were sent to a random sample of hunters that bought 1965 duck stamps in the Willamette Valley of Oregon. These names were the same as those used by the U. S. Fish and Wildlife Service Waterfowl Mail Survey in 1965. The sample was probably not biased toward successful hunters, hence, a realistic figure for hunter success in the Willamette Valley was obtained. However, this sample probably includes reports of an undetermined number of Canada geese other than the subspecies under investigation.

Other Data

Miscellaneous information relating to hunting regulations, sale of duck stamps, refuge censuses, and breeding ground studies were examined to help in the interpretation of recovery records from banded birds.

Banding Techniques

The sequence of events that provides banding information is long and arduous. It requires many people working cooperatively. Birds are caught on the nesting grounds, marked with individually numbered U. S. Fish and Wildlife Service legbands, released, retaken by hunters, and reported to the Bird Banding Laboratory. Banding is accomplished between the first week of July and the first week of

August, usually about the middle of July by personnel of the Alaska Department of Fish and Game and the U. S. Fish and Wildlife Service. Techniques used for capturing geese for the purpose of banding were aptly described by Trainer (1959). He stated that the banding method consisted of traveling through the deeper sloughs and along the grass-banks with skiff and outboard during high tide in search of geese. After the birds were sighted, and if not already ashore, they were herded from the water with the boat, and immediately pursued on foot. Although dip nets were valuable in securing birds at the edge of ponds and in gutters, it was usually more expedient at other times to grasp the geese by one foot as they were overtaken, and subsequently place them in the nets for temporary holding.

In more recent years, the geese were herded with an airplane into large "drive traps." This method facilitated banding large numbers in a relatively short time. All banding on the delta has been accomplished at the same site (Hilliker, 1967).

A basic assumption of the banding technique is that banded birds return to the population, become randomly distributed throughout the population and, when recovered are representative of the population. It is assumed in this project that this was true for young and adult Canada geese wearing one leg band.

The band size and the composition of the bands used were changed frequently. However, all geese were banded with the butt-end

type of band. In 1952 and 1953, both band sizes No. 7 and 8 were used. Only band size No. 7 was used in 1954 and 1955. From 1956 until present, all geese of this race have been banded with band size No. 8. All bands used were made of aluminum, except in 1965 when monel bands were used.

Statistical Tests

Statistical tests used in this report followed those outlined by Steel and Torrie (1960). Statistical significance was considered to be the 0.05 level unless otherwise stated.

Interpretation of Data

Mortality rates may be estimated by the dynamic or time-specific method. When using the dynamic method, the assumption is made that the number of recoveries occurring each year after marking reflects the total deaths that occurred during that year. In contrast, when using the time-specific method the number of recoveries during a given year is assumed to reflect the size of the population at the beginning of the year (Geis and Taber, 1963).

In this analysis, the dynamic method of mortality estimation was used. This method was used because hunting regulations for migratory waterfowl influence the portion of the population harvested as opposed to the size of the population. This fact has been shown by

band recovery rates. In studies conducted on the mallard (Hickey, 1952), canvasback (Geis, 1959), and black duck (Smith and Geis, 1962), there was a strong relationship between hunting regulations and band recovery rates.

It is evident from analyses of banding data that some bands recovered by hunters are not reported. Analyses of banding data are difficult if the proportion of bands reported each year changes. Several methods have been devised for estimating the proportion of recovered bands that are reported, so that the needed adjustments may be made. Bellrose (1955) compared rates of recovery of reward bands with those of standard U. S. Fish and Wildlife Service bands. Geis and Atwood (1961) and Martinson (1966) compared estimates of banded ducks bagged (based on a mail questionnaire survey) with numbers of bands reported to the Bird Banding Laboratory.

The method of computation used in this paper for estimating the band reporting rate is superior to previous methods used because only banding data and an estimate of crippling loss are necessary. The method compares two independent estimates of rates of hunting mortality, one of which is biased downward by a lack of complete band reporting by hunters and the other, using the same basic data but estimated with a different technique, is not biased by a reporting rate. The first of these, the one which is biased by a lack of complete report of bands, is the direct or first-year band recovery rate

adjusted for birds killed but not retrieved (crippling loss) by hunters. The second is a first-year mortality estimate derived from life table methods such as those described by Hickey (1952), Ricker (1958), and Geis and Taber (1963), minus the annual natural mortality rate. Henny (in press) explained the method in detail.

III. RESULTS

Nesting

Nesting Range in Relationship to Other Goose Populations

The dusky Canada goose nests in southcentral Alaska. The breeding range extends along the coast from the vicinity of Bering Glacier on the southeast to Cook Inlet on the west, a distance of about 275 air miles (Hansen, 1962).

The breeding population reaches its greatest abundance on the delta of the Copper River near Cordova, Alaska. In Prince William Sound and on the lower Susitna River at the head of Cook Inlet these geese breed only in small numbers and are much more solitary in their nesting habits. Many of the non-breeding birds spend the summer in this area. A few geese nest near the confluence of the Bremner River with the Copper River about 50 miles from the coast and a few isolated pairs are found about the same distance inland on the Susitna River drainage. How far their breeding range extends down the west coast of Cook Inlet and the Alaska Peninsula is problematical (Hansen, 1962).

The physiography of the country together with long distances between known nesting populations today indicate it is unlikely that the breeding range between this subspecies and any interior subspecies

overlaps. The breeding range of the Vancouver Canada goose (*Branta canadensis fulva*), the other large Alaska coastal subspecies, appears to terminate at Cross Sound near Glacier Bay on the northwest about 300 miles southeast of the breeding terminus of the race under study (Hansen, 1962).

Nesting Density

This subspecies has the highest nesting density reported for any race of Canada geese. The highest densities are found on the Copper River delta.

In 1959 Trainer established a 2.08 square-mile study plot in the vicinity of Copper Slough on the delta to determine clutch size, nesting success, and other production data. By taking advantage of the absence of rank plant growth early in the season and by repeatedly covering the plot on foot, Trainer located 224 goose nests for an average of 108 nests per square mile. The minimum separation of nest sites was 100 yards, although the majority were situated at least 200 yards apart (Trainer, 1959).

Brood Size

Because of the tendency of the broods to remain in the heavy sedge cover away from the ponds and sloughs, brood counts proved extremely difficult to obtain (Trainer, 1959). A summary of brood

sizes in 1953, 1954, 1955, and 1959 is presented in Table II, but the counts are only reliable for Class I broods. Young geese tend to flock at an early age making brood counts unreliable for Class II and above (Trainer, 1959). Therefore, the best available estimate of brood size is an average of the four year study for age Class I, which is 4.2 goslings (Table II).

Table II. Dusky Canada goose brood size on the Copper River delta (Trainer, 1959).

	Age Class I		Age Class II	
Year	No. Broods	Ave. Size	No. Broods	Ave. Size
1953	19	3.8	12	5.0
1954	21	4.4	6	6.3
1955	94	4.2	10	4.2
1959	30	4.3	4	5.5
Totals	164	4.2	32	5.1

Sex Ratios at Time of Banding

The sex was determined for immatures banded on the nesting grounds between 1952 and 1959. During the eight year period, 1,801 immatures were banded. This sample included 944 males and 857 females (110 males per 100 females) which is statistically different from a 1:1 ratio ($X^2 = 4.2$ d f = 1). Hanson and Smith (1950) also found a slight but statistically significant excess of males in the juvenile age class from trap data obtained at Horseshoe Lake, Illinois.

Their results were based on 3,512 Canada geese banded between 1940 and 1947.

Migration

Fall Migration

Short descriptions of the life history and migration of the dusky Canada goose are found in the works of Bent (1925), Gabrielson and Jewett (1940), and Kortright (1942). These authors described the species as being practically non-migratory, and occupying a decidedly local habitat from Vancouver Island north to Prince William Sound, but as only an occasional visitor along the Oregon coast. From these statements it is apparent that the present wintering population in the Willamette Valley of Oregon either has increased appreciably in recent years, or was mistaken for a different race previously. The American Ornithologists' Union (1957) stated that the dusky Canada goose winters (at least in part) south to Oregon and may be accidental in Nevada.

Band recoveries indicate that the dusky Canada goose occurs in Alaska, British Columbia, Washington, Oregon, and occasionally California during the hunting season.

Geese begin leaving the Copper River delta by late September and their exodus is complete by the end of October. Only one banded

goose from this race has been recovered in Alaska after 1 November. Six bands have been reported in Alaska south of the nesting area, four near Yakutat and two south of Juneau. It may be concluded that either the race does not migrate overland, makes a non-stop flight over Alaska, or rests in an area where little or no hunting pressure exists. Hansen (1962) suggested that the population migrates over water and makes its first stop at the Queen Charlotte Islands of British Columbia.

The arrival of dusky Canada geese begins the first week of October on Queen Charlotte and Vancouver Islands and a few bands continue to be reported until the hunting season ends in January. Most of the band recoveries in British Columbia occur from 11 October to 20 November, with only 15 percent occurring after 20 November (Appendix Table I). Because the hunting season in British Columbia extends into January (Table III), it may be assumed that most of the geese leave the province by 20 November to continue their migration south. Hansen (1962) believes that a few dusky Canada geese winter among these islands. The geese apparently by-pass the mainland of British Columbia in the same manner as they do Alaska. Only one band has been reported from the mainland of British Columbia in the last 14 years.

From Vancouver Island the geese fly directly to Gray's Harbor and Willapa Bay near the mouth of the Columbia River in southwestern

Table III. Alaska and British Columbia hunting regulations for Canada geese during the period 1952 to 1966.

Year	Season Dates	Daily Bag Limit	Season Bag
ALASKA			
1952	Sept. 1-Oct. 25	3	--[a]
1953	Sept. 1-Nov. 14	3	--
1954	Sept. 1-Nov. 14	3	--
1955	Sept. 1-Nov. 22	3	--
1956	Sept. 1-Nov. 22	3	--
1957	Sept. 1-Nov. 29	3	--
1958	Sept. 1-Dec. 3	3	--
1959	Sept. 1-Dec. 3	3	--
1960	Sept. 1-Dec. 3	3	--
1961	Sept. 1-Dec. 14	3	--
1962	Sept. 1-Dec. 14	3	--
1963	Sept. 1-Dec. 14	3	--
1964	Sept. 1-Dec. 14	3	--
1965	Sept. 1-Dec. 14	3	--
1966	Sept. 1-Dec. 14	3	--
BRITISH COLUMBIA			
1952	Sept. 15-Nov. 15	5	25
1953	Sept. 15-Dec. 3	5	25
1954	Sept. 15-Dec. 13	5	25
1955	Oct. 15-Jan. 18	5	25
1956	Oct. 13-Jan. 16	5	25
1957	Oct. 12-Jan. 15	5	25
1958	Oct. 11-Jan. 14	5	25
1959	Oct. 3-Jan. 6	5	25
1960	Oct. 15-Jan. 18	5	--[a]
1961	Oct. 14-Jan. 17	5	--
1962	Oct. 13-Jan. 16	5	--
1963	Oct. 12-Jan. 15	5	--
1964	Oct. 10-Jan. 13	5	--
1965	Oct. 9-Jan. 12	5	--
1966	Oct. 8-Jan. 8	5	--

[a]No season bag limit established.

Washington. Counts from Willapa Bay National Wildlife Refuge indicate that geese arrive in large numbers about the first week of November (Figure 1). Bands are reported from dusky Canada geese in the Willapa Bay area throughout the hunting season. U. S. Fish and Wildlife Service winter inventories show that as many as 2,000 large Canada geese have wintered in southwestern Washington (Table V).

Most of the birds immediately resume their migration inland by following the Columbia River east to the mouth of the Willamette River at Portland, Oregon. This is indicated by recoveries of banded geese along the river from the coast to Portland. Some geese remain at the Sauvies Island Game Management Area and in the vicinity of Portland, but again a majority of the birds continue their migration south to the central Willamette Valley, which includes Polk, Linn, and Benton Counties. B. c. occidentalis usually arrives in the central Willamette Valley in large numbers between 1 November and 10 November.

Occasionally a band from a dusky Canada goose is reported from northern California, however these birds are considered infrequent visitors to the state. Six bands have been reported from the state since 1952, a fraction of one percent of the total number of bands recovered in the flyway.

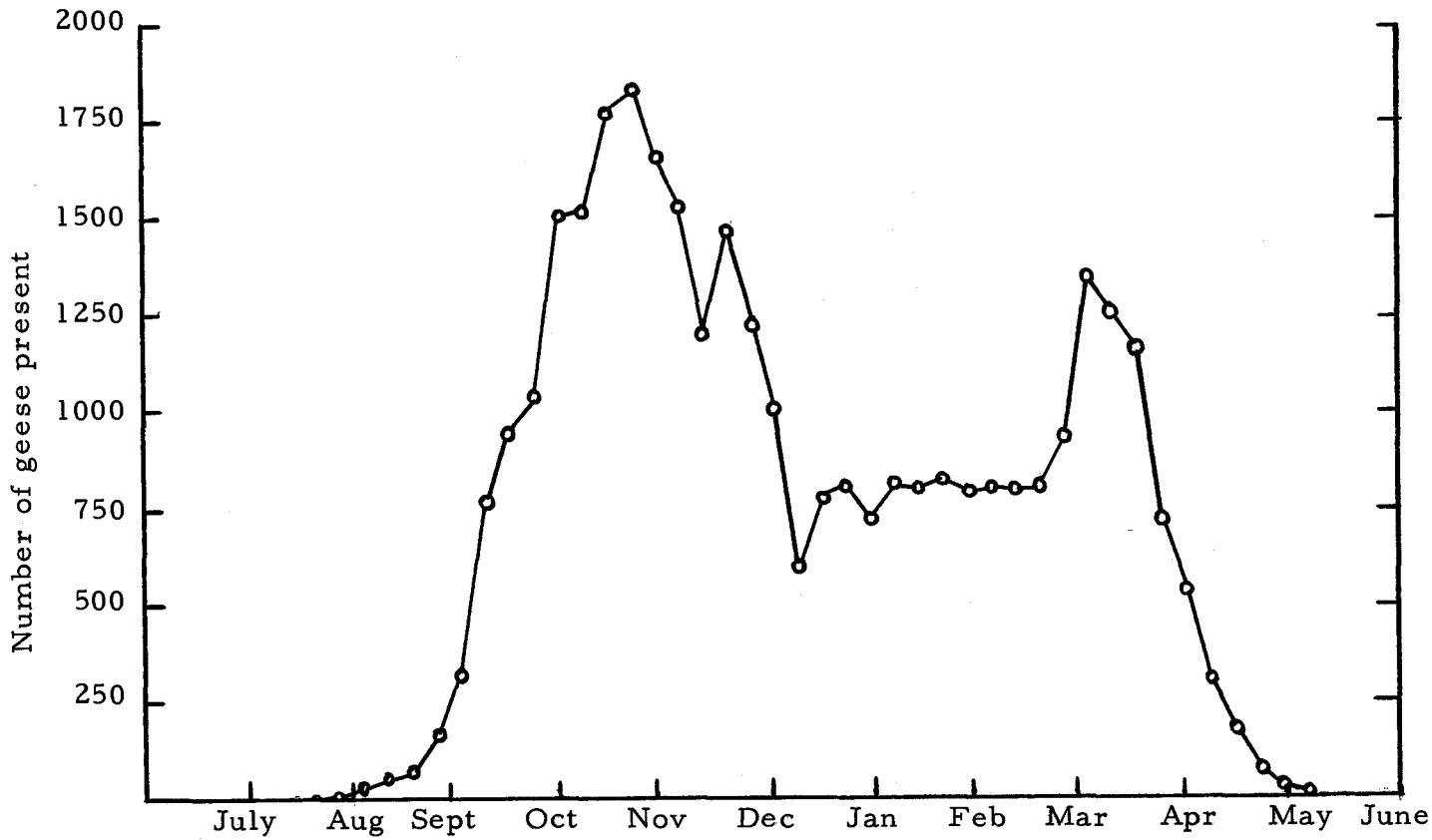


Figure 1. Weekly counts of dusky Canada geese at Willapa National Refuge in southwestern Washington, average for 1959 through 1966.

Table IV. Washington and Oregon hunting regulations for Canada geese during the period 1952 to 1966.

Year	Season Dates	Daily Bag Limit	Effective Season Length for Dusky Canada Geese[a]
WASHINGTON			
1952	Oct. 17-Dec. 25	2	51
1953	Oct. 17-Dec. 30	3	56
1954	Oct. 16-Jan. 3	3	60
1955	Oct. 15-Jan. 2	3	59
1956	Oct. 13-Dec. 31	3	57
1957	Oct. 15-Jan. 15	3	72
1958	Oct. 12-Jan. 14	3	71
1959	Oct. 7-Jan. 8	3	65
1960	Oct. 8-Jan. 5	3	62
1961	Oct. 14-Dec. 27	3	53
1962	Oct. 13-Dec. 26	3	52
1963	Oct. 12-Jan. 5	3	62
1964	Oct. 10-Jan. 7	3	64
1965	Oct. 16-Jan. 9	3	66
1966	Oct. 15-Jan. 8	3	65
OREGON			
1952	Oct. 24-Jan. 1	2	58
1953	Oct. 17-Dec. 30	3	56
1954	Oct. 16-Jan. 3	3	60
1955	Oct. 22-Jan. 9	2[b]	65
1956	Oct. 13-Dec. 15	2[b]	41
1957	Oct. 12-Jan. 14	2[b]	71
1958	Oct. 11-Jan. 13	3	70
1959	Oct. 7-Jan. 8	3	65
1960	Oct. 11-Jan. 8	3	65
1961	Oct. 21-Jan. 3	3	59
1962	Oct. 20-Jan. 2	3	59
1963	Oct. 8-Jan. 5	3	62
1964	Oct. 10-Jan. 7	3	64
1965	Oct. 9-Jan. 6	3	63
1966	Oct. 8-Jan. 5	3	62

[a]Season length from November 5, the usual time of dusky Canada goose arrival in the two states.

[b]Daily bag limit of 2 in Yamhill, Polk, Benton, Lane, and Linn Counties, Oregon. The remaining counties had a daily bag limit of 3 Canada geese.

Table V. Winter inventory counts of large[a] Canada geese in western Washington by county from 1960 to 1967.

County	1960	1961	1962	1963	1964	1965	1966	1967
Clallam	--[b]	200	--	400	--	--	745	15
Clark	75	235	470	632	499	755	201	1,300
Cowlitz	30	37	16	31	40	21	91	21
Grays Harbor	53	250	20	25	--	--	--	--
Pacific	1,725	900	1,520	900	560[c]	491[c]	590[c]	750
King	24	--	--	--	--	--	27	--
Pierce	--	11	--	--	1	--	22	--
Skagit	--	150	--	--	15	14	200[c]	--
Jefferson	--	50	--	--	--	--	--	--
Snohomish	70	--	75	150	--	--	45	80
Thurston	--	--	--	--	--	--	15	--
Wahkiakum	--	--	150	190	500	--	--	500
Total	1,977	1,833	2,251	2,328	1,615	1,281	1,936	2,666

[a]Large Canada geese (B. c. occidentalis and B. c. fulva) are distinguished from smaller Canada geese by size. Although B. c. occidentalis and B. c. fulva cannot be separated by size, very few fulva are included in these data (Hansen, 1962).

[b]No counts available.

[c]Listed as lesser Canada geese, but believed to be dusky Canada (Chattin., 1966).

Table VI. Winter inventory counts of large[a] Canada geese in western Oregon by county from 1960 to 1967.

County	1960	1961	1962	1963	1964	1965	1966	1967
Benton	5,143	1,548	220	2,389	1,974	9,141	7,950	11,050
Clatsop	--[b]	245	385	40	360	300	--	--
Clackamas	--	--	--	4	--	--	--	--
Columbia	4,725	825	585	1,180	25	335	1,330	--
Coos	--	--	--	25	--	3	--	--
Lane	3,000	2,600	1,132	1,000	1,100	43	300	700
Linn	9,500	7,940	10,082	1,800	2,796	1,390	300	3,350
Marion	--	11	--	--	--	41	550	--
Multnomah	--	800	615	945	1,420	300	590	2,018
Polk	2,700	1,629	270	4,985	5,535	2,000	6,000	650
Tillamook	35	--	--	--	--	--	--	--
Washington	--	--	--	31	--	--	22	69
Yamhill	--	575	540	370	1,839	532	800	--
Total	25,103	16,173	13,829	12,769	15,049	14,085	17,842	17,837

[a]Large Canada geese (B. c. occidentalis and B. c. fulva) are distinguished from smaller Canada geese by size. Although B. c. occidentalis and B. c. fulva cannot be separated by size, very few fulva are included in these data (Hansen, 1962).

[b]No counts available.

Spring Migration

The spring migration from the Willamette Valley wintering grounds usually begins the first week of April. The exodus began 8 April in 1966 (Lehenbauer, 1967). Figure 1 shows an increase in geese on Willapa National Wildlife Refuge the first week of April as the population stops temporarily in Southwestern Washington. A steady decline occurs on the refuge after the middle of April (Figure 1).

The population arrives on the Cooper River delta about 1 May (Hilliker, 1967). The earliest egg laying began on 6 May in 1959 (Trainer, 1959).

Hunting Kill

Kill Distribution by State and Province

Assuming that all states had an equal hunter band reporting rate for the period 1952 to 1965, the distribution of the kill may be determined by finding the percentage of recoveries occurring in each state and province. However, the distribution of the kill may be biased by state or federal personnel collecting or checking bands and reporting them (Atwood and Geis, 1960). Hunters were responsible for reporting 83 percent of those reported from Oregon, 80 percent from Washington, 77 percent from British Columbia, and 44 percent

from Alaska; (the remainder of the bands were reported by game officials, duck club operators, and other agencies (Appendix Table II). There were no significant differences in the percentages of bands reported by hunters for Oregon, Washington, or British Columbia (X^2 = 2.98, d f = 2), but Alaska was significantly different from the other three (X^2 = 52.31, d f = 1). However, Shepherd (1966) stated that the hunter band reporting rate was comparable to those of the other states and that no adjustment in kill distribution was necessary. He emphasized that Alaska hunters believed they had fulfilled their obligation to report the bands when they gave them to state or federal personnel, and as a result the bands were reported by game management personnel instead of hunters.

A lower band reporting rate was suspected for Oregon in more recent years. A large proportion of the dusky Canada geese are killed on large hunting clubs in Oregon. Because hunters have learned that practically all bands that they have reported came from geese banded on the Copper River delta, they have lost interest in reporting bands. When the author was making bag checks in 1964, 1965, and 1966, the hunting club members talked about where the geese were banded (evidently based on past band reports), and showed lack of interest in reporting bands. Hence, the Oregon portion of the kill probably was underestimated in recent years because Alaska, Washington, and British Columbia do not have large hunting

clubs. Table VII shows that the portion of the kill in Oregon between 1958 and 1964 declined slightly from the period 1952 to 1957.

The kill in Oregon averaged 64.9 percent of the total kill for the period 1952 to 1964. The kill in British Columbia was 16.2 percent, Washington 11.4 percent, and Alaska 7.5 percent of the total kill in the flyway, (Table VII).

The Location of Kill in Alaska. The distribution of the kill in Alaska has shown only slight fluctuations. Between 1952 and 1964 an average of 94.3 percent of the estimated kill in Alaska occurred on or near the Copper River delta. The remainder of the kill in Alaska occurred near Yakutat (3.8 percent) and south of Juneau (1.9 percent).

Apparently very few geese are available to the hunter south of their nesting area in Alaska. As mentioned earlier, Hansen (1962) suggested that the geese migrate over water from the delta to the Queen Charlotte and Vancouver Islands of British Columbia. Surely the race would be hunted along the Alaska coast if it were available. Evidence that there are hunters along the Alaska coastline is available since over 80 percent of the recoveries of the Vancouver Canada goose occur there (Hansen, 1962).

The Location of Kill in British Columbia. With the exception of one band reported from the mainland in 1962, all recoveries

Table VII. The distribution of the kill by state or province of immature, subadult, and adult dusky Canada geese banded on the Copper River delta.

Area of Recovery	Immature Kill[a]	Subadult Kill[b]	Adult Kill[c]	Total Kill
1952-57				
Alaska	7.5	7.8	7.4	7.5
British Columbia	16.1	11.3	15.3	15.1
Washington	12.7	6.1	10.8	11.1
Oregon	63.6	74.8	66.5	66.3
Sample Size	385	115	203	703
1958-64				
Alaska	8.8	4.7	6.8	7.4
British Columbia	16.9	17.2	17.8	17.4
Washington	10.7	10.9	12.5	11.6
Oregon	63.6	67.2	62.9	63.6
Sample Size	272	64	353	689
1952-64				
Alaska	8.1	6.7	7.0	7.5
British Columbia	16.4	13.4	16.9	16.2
Washington	11.9	7.8	11.9	11.4
Oregon	63.6	72.1	64.2	64.9
Sample Size	657	179	556	1,392

[a]Direct recoveries of geese banded as immatures.

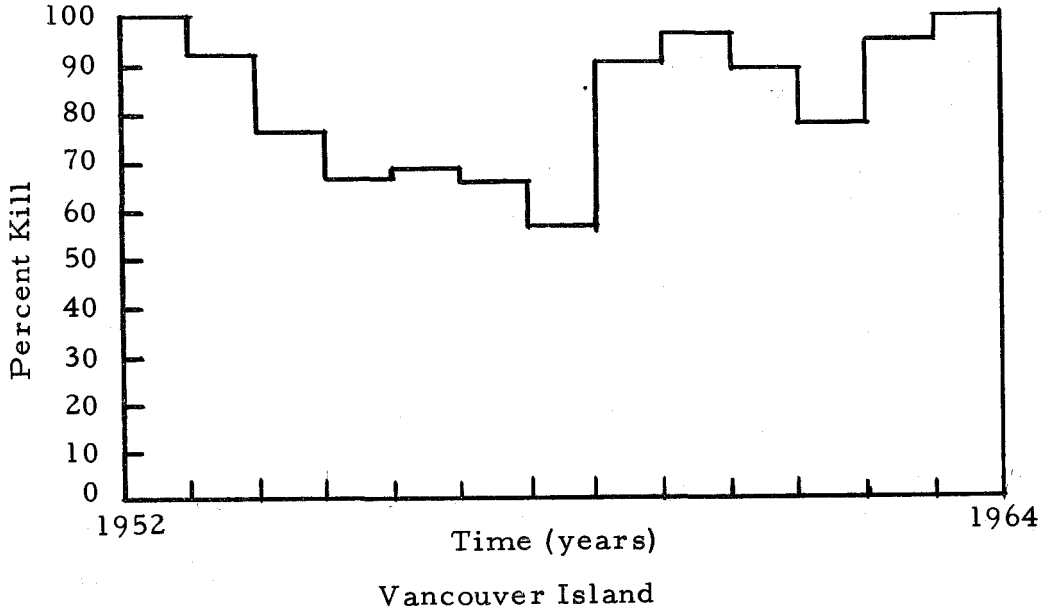
[b]Second-hunting-season recoveries of geese banded as immatures.

[c]Third-hunting-season and later recoveries of geese banded as immatures, plus all recoveries of geese banded as adults.

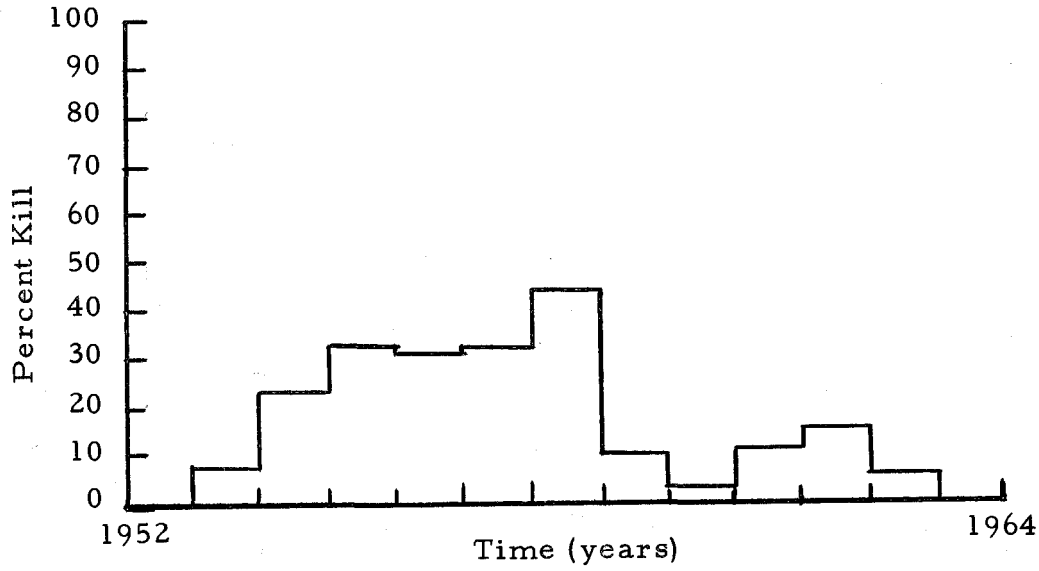
of dusky Canada geese have been confined to the offshore islands. Vancouver Island seems to be the major harvest area, accounting for 81.6 percent of shot recoveries between 1952 and 1964. The remaining 18 percent for the same time period came from the Queen Charlotte Islands. The distribution of the kill has fluctuated in the province. The proportion of the kill on the Queen Charlotte Islands declined from 35.0 percent during the period 1955 through 1958 to 7.6 percent for the period 1959 through 1964 (Figure 2). Dusky Canada geese may be present in other areas of the province where no hunting pressure exists.

The Location of Kill in Washington. Bands from two dusky Canada geese have been reported from east of the Cascade Mountain Range in Washington, one near Ellensburg on the Yakima River, and one near Pasco on the Columbia River. All remaining recoveries occurred west of the Cascade Mountain Range in Washington. Western Washington has been divided into four harvest areas for the purpose of determining changes in the distribution of the kill. The harvest areas are: the SOUTHWEST COASTAL AREA (Grays Harbor to Longview), the VANCOUVER AREA (inland Columbia River), the PUGET SOUND AREA (interior western Washington), and the NORTHWEST COASTAL AREA (Hoquiam to Port Angeles) (Figure 3).

Between 1952-64 an average of 72.4 percent of the dusky Canada



Vancouver Island



Queen Charlotte Islands

Figure 2. Changes in the distribution of dusky Canada goose kill in British Columbia between 1952 and 1964.

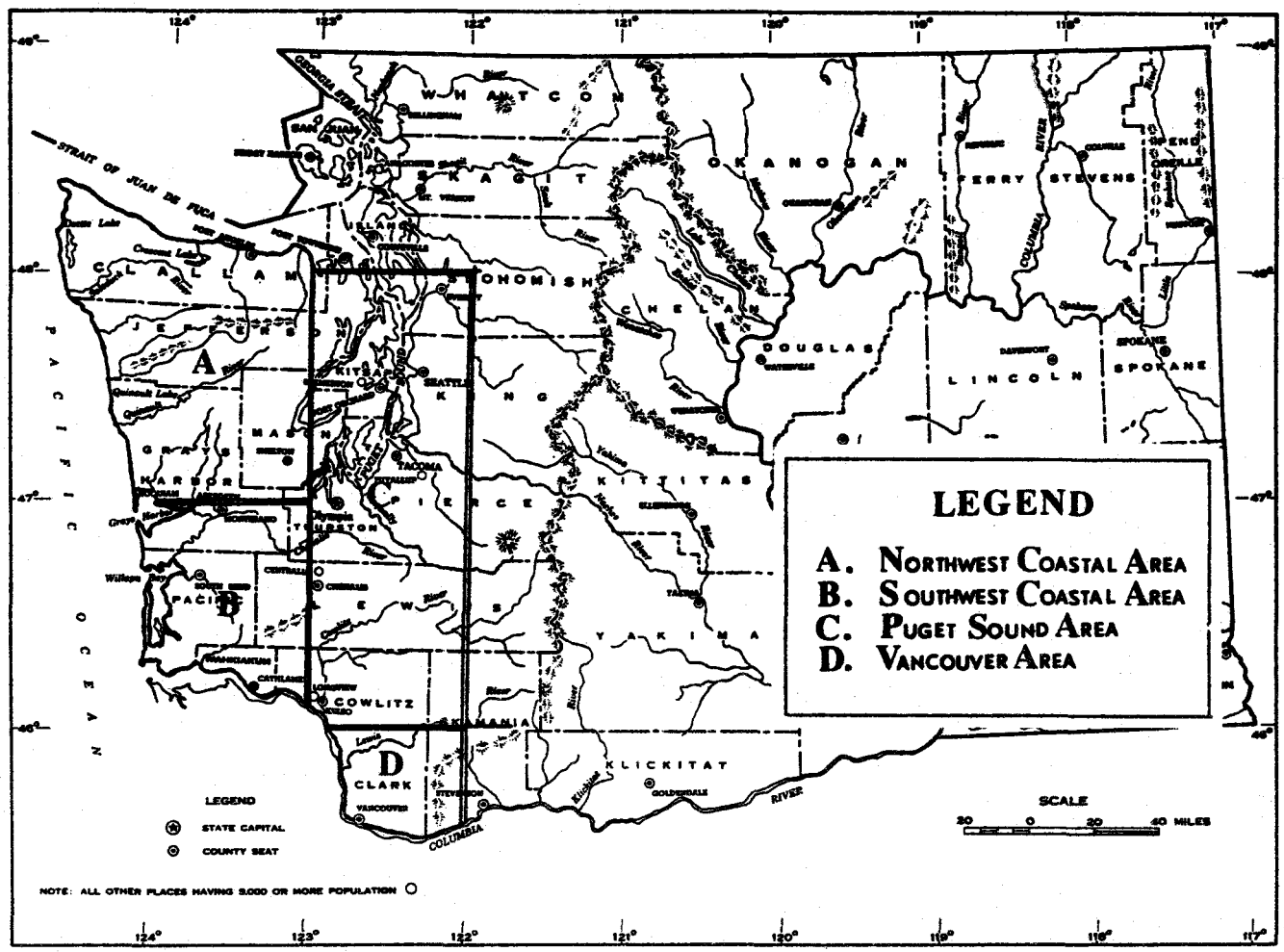


Figure 3. Map showing dusky Canada goose harvest areas in Washington.

geese killed in Washington were taken in the SOUTHWEST COASTAL AREA. The kill in the NORTHWEST COASTAL AREA amounted to 14.1 percent, in the VANCOUVER AREA 6.4 percent, and the PUGET SOUND AREA 5.8 percent for the same time period.

No appreciable changes in the distribution of the kill in Washington were noted since the initiation of the banding program (Figure 4). It is interesting that no bands were recovered at Port Townsend, Washington in the last 14 years. Port Townsend is the type locality for the dusky Canada goose.

The Location of Kill in Oregon. The kill of the dusky Canada goose in Oregon is confined largely to the Willamette Valley of western Oregon, i.e., the area between the Coast Range on the west and the Cascade Mountain Range on the east, and from Eugene on the south to the Columbia River on the north. Some geese of this race were taken east of the Cascade Mountain Range and a few were taken along the Pacific coast as far south as Newport.

Six bands recovered east of the Cascade Range included three from the Deschutes Valley near Madras, one from Summer Lake, one from the Snake River near Vale, and one from the Columbia River near Arlington. Five of the geese were immatures and the other a subadult.

Nine banded dusky Canada geese (five immatures, two subadults, and two adults) were reported from the Oregon coast south of

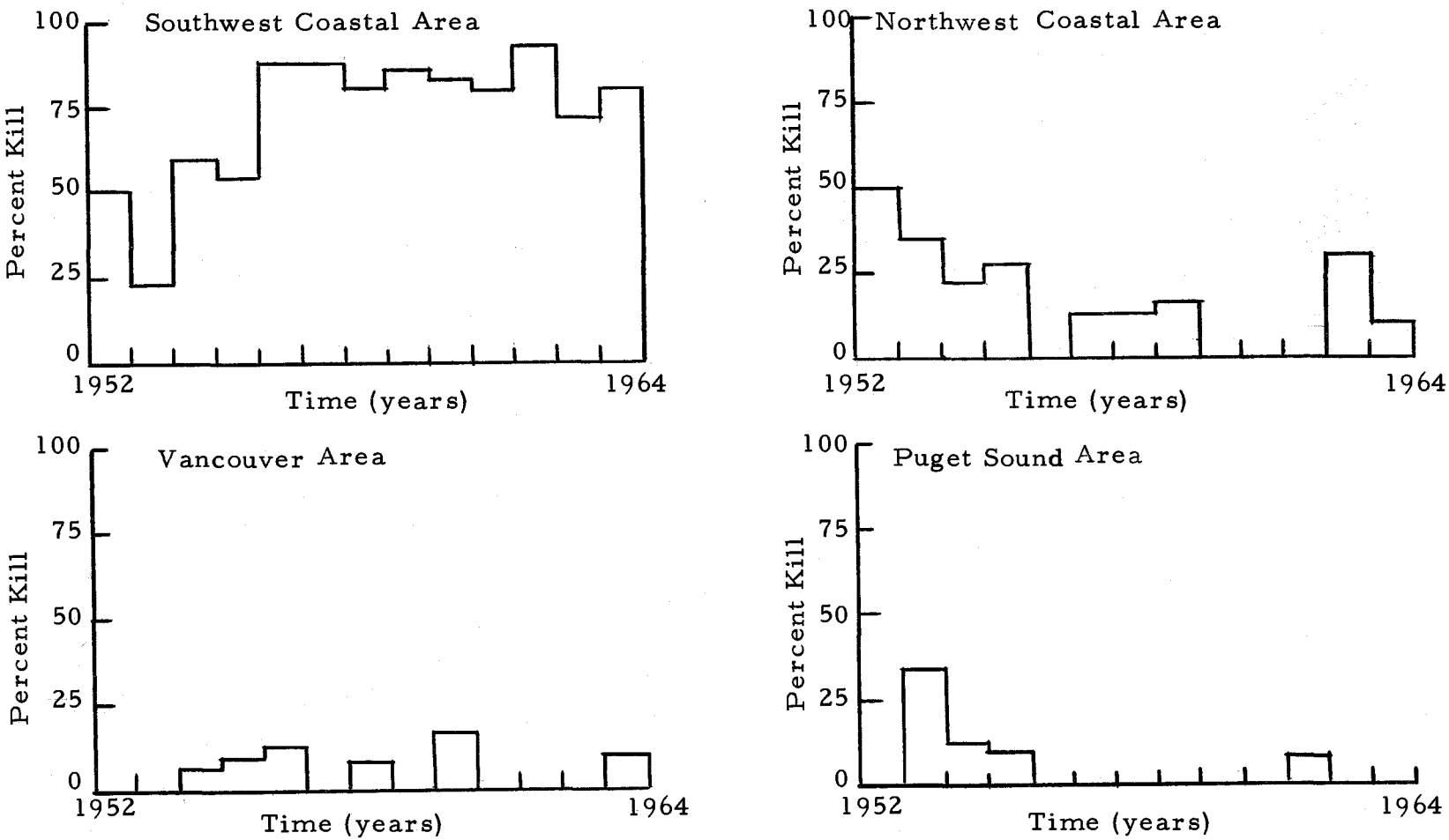


Figure 4. Changes in kill distribution of Washington, considering the four major kill areas.

Astoria. Five of these birds were reported from Tillamook Bay, two from Nehalem Bay, and one from Yaquina Bay at Newport.

The Willamette Valley was divided into six harvest areas for the purpose of showing fluctuations in the distribution of the kill in the valley (Figure 5). The harvest areas and their definitions are as follows: the MCMINNVILLE-FOREST GROVE AREA, from McMinnville north to Forest Grove and east to Newberg including the Tualatin Valley; the RICKREALL-AMITY AREA, from McMinnville on the north to Independence on the south including Salem, St. Paul, and Dallas; the CORVALLIS-ALBANY AREA, from 5 miles south of Corvallis to 2 miles north of Albany (includes the Oak Knoll Hunt Club); the MCFADDEN'S AREA, from 5 miles south of Corvallis to 3 miles south of Monroe including the William L. Finley National Wildlife Refuge; the JUNCTION CITY-EUGENE AREA, south of the McFadden's area including Fern Ridge Reservoir and south to Eugene; and the SAUVIES ISLAND-COLUMBIA RIVER AREA, between Portland and Astoria along the Columbia River including the Sauvies Island Game Management Area. Changes in the distribution of kill from 1952 to 1964 are presented graphically in Figure 6.

Only 1.5 percent of the total kill in Oregon occurred in the MCMINNVILLE-FOREST GROVE AREA between 1952 and 1964, hence, the area was considered to be of minor importance. Kill on the area increased to 3.2 and 6.1 percent in 1962 and 1963 respectively.

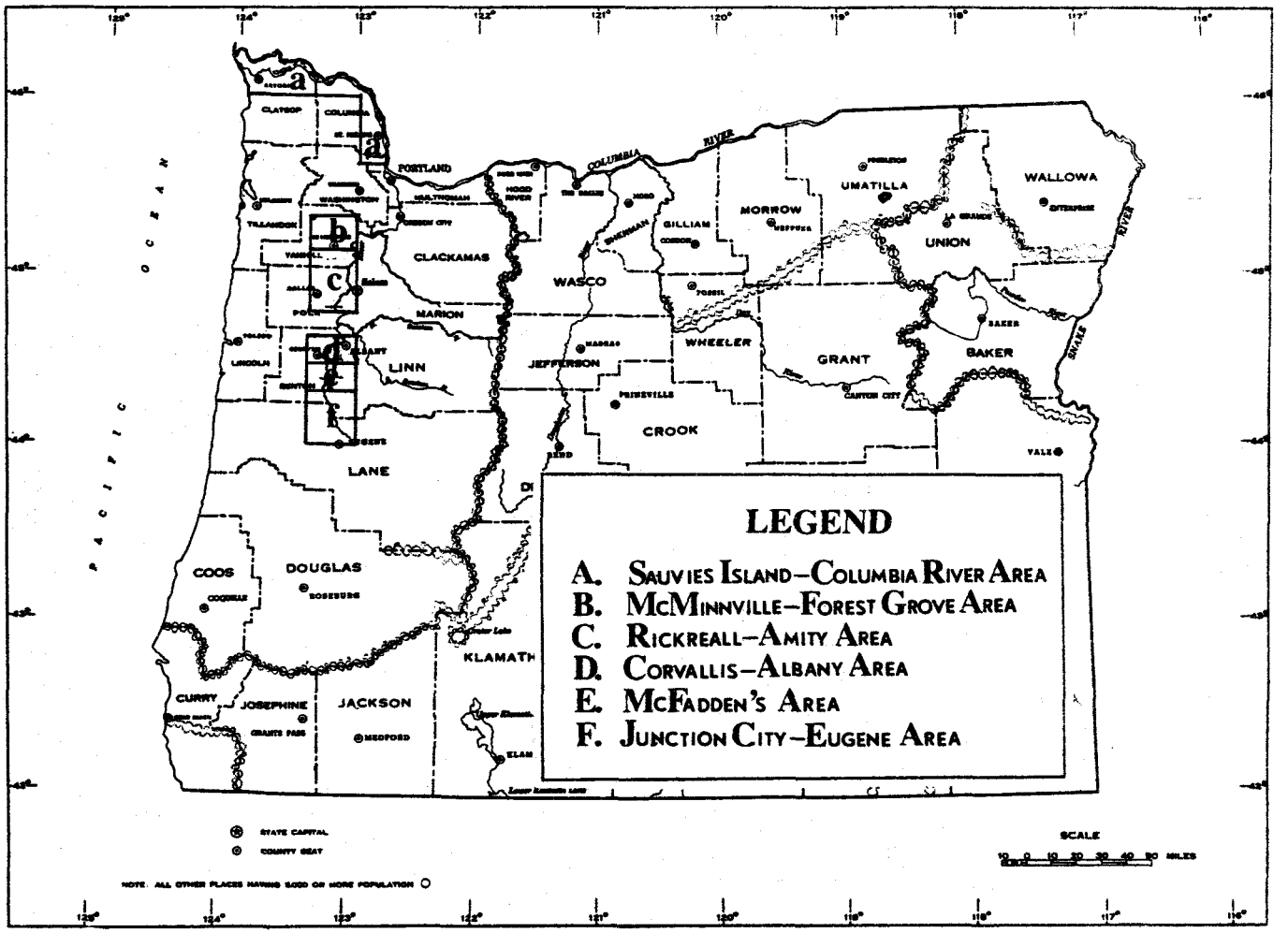


Figure 5. Map showing dusky Canada goose harvest areas in Oregon.

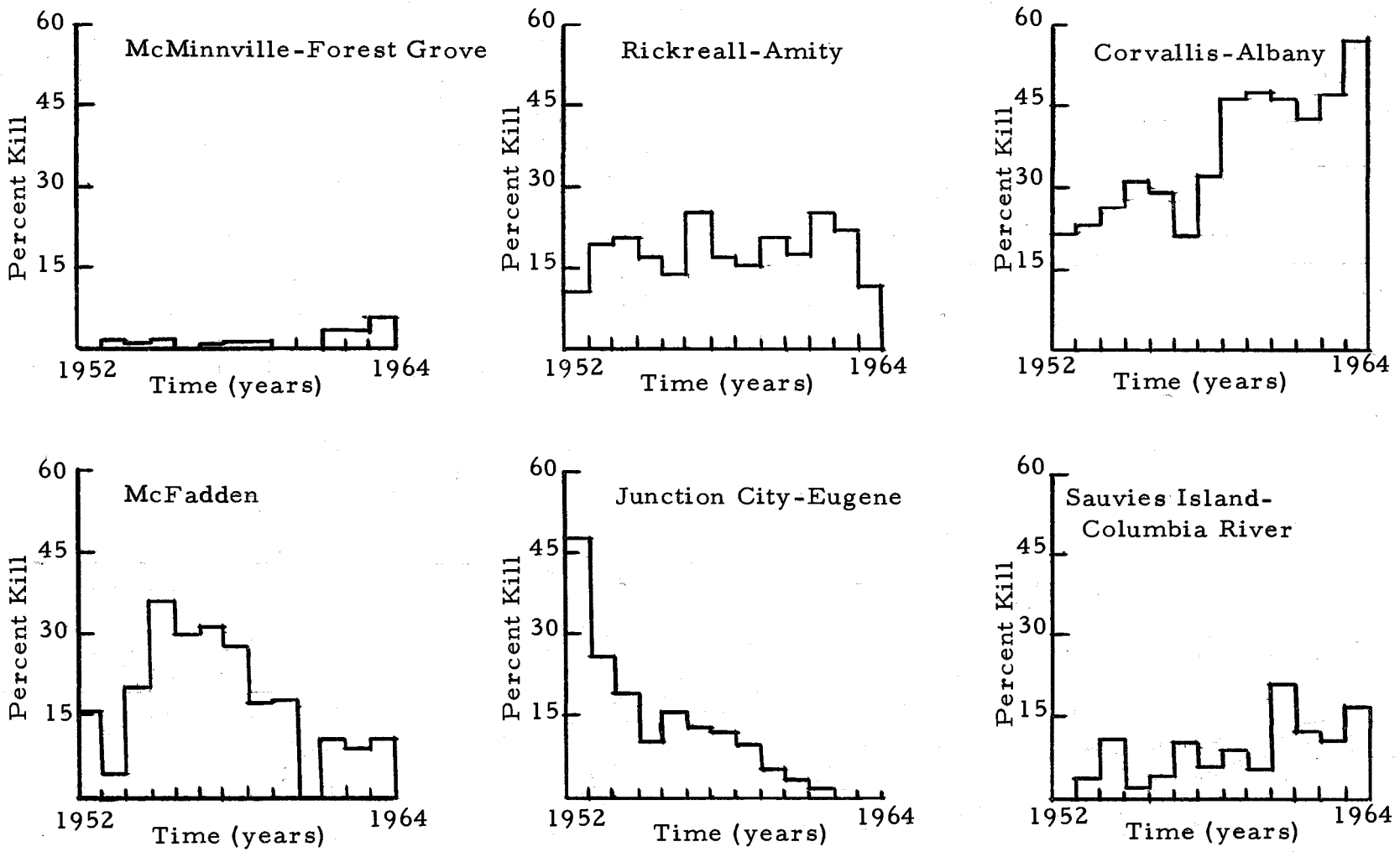


Figure 6. Changes in kill distribution of Oregon, considering the six major kill units.

Between 1952 and 1964 an average of 8.2 percent of the band recoveries in Oregon occurred on the SAUVIES ISLAND-COLUMBIA RIVER AREA. A large percentage of the recoveries from this area was taken at the Sauvies Island Game Management Area operated by the Oregon State Game Commission. However, bands were reported all along the Columbia River from Portland to Astoria. Band recoveries indicate a slight increase in kill on the area during the last few years (Figure 6).

During the banding period an average of 11.6 percent of the recoveries in Oregon occurred on the JUNCTION CITY-EUGENE AREA. In the early 1950's, the area was considered the major harvest area in the state. However, in recent years the geese have not wintered in the area. The percentage of band recoveries from this area showed a steady decline since banding began. In 1952, 47.4 percent of the band recoveries in the state occurred there. Only two bands were reported from the area since 1960. The development of the Oak Knoll Hunt Club for goose hunting in 1959 by Mr. John Glaser in the CORVALLIS-ALBANY AREA was probably the reason for the change in the distribution of the kill. An inverse relationship can be seen between the yearly kill percentages on the JUNCTION CITY-EUGENE AREA and the CORVALLIS-ALBANY AREA. Some geese have been sighted in the JUNCTION CITY-EUGENE AREA near Fern Ridge Reservoir in recent years, but

apparently they sustain little hunting pressure.

Between 1952 and 1964 19.7 percent of the recoveries in the state occurred on the MCFADDEN'S AREA. Approximately 30 percent of the dusky Canada goose kill in Oregon was taken in this area between 1955 and 1958, before the advent of the Oak Knoll Hunt Club. Since 1958, the kill has shown a steady downward trend in the area, similar to the JUNCTION CITY-EUGENE AREA. Only about 10 percent of the kill in the state since 1960 has occurred on the MCFADDEN'S AREA (Figure 6). The development of the William L. Finley National Wildlife Refuge in 1964 may enhance future goose hunting on the MCFADDEN'S AREA. The refuge is closed to waterfowl hunting at the present time.

The second largest kill area in Oregon at the present time is the RICKREALL-AMITY AREA. Since 1952 an average of 19.4 percent of the states kill has occurred on the area and the area seems to be showing an increase in recent years (Figure 6). A satellite section of the William L. Finley National Wildlife Refuge was developed in the area at Baskett Slough near Rickreall in 1965 to offer the geese some protection from the heavy hunting pressure.

The CORVALLIS-ALBANY AREA is the major kill area in Oregon at the present time. The area has averaged 35.0 percent of the kill between 1952 and 1964. The percentage of the Oregon kill occurring on the area has continually increased since 1952. I

believe the increase in kill on the area was a result of the establishment of the Oak Knoll Hunt Club five miles east of Corvallis. The kill in the area increased from 21.1 percent of the kill in the state in 1952 to 57.1 percent in 1964 (Figure 6).

Between 1952 and 1958, 27.8 percent of the adult kill and 24.8 percent of the immature kill occurred in the CORVALLIS-ALBANY AREA. The kill on the area increased between 1959 and 1964 to 42.7 percent of the adult kill and 54.4 percent of the immature kill. Thus, the increase in kill on the area after 1958 was primarily of immatures i.e., adult kill increased 14.9 percent while immature kill increased 29.6 percent. Kill in the CORVALLIS-ALBANY AREA does not all occur at the Oak Knoll Hunt Club. However, an estimated 76.1 percent of the 1965 kill in the area was produced at the club (Table IX). Much of the remaining 23.9 percent of the kill in the area in 1965 was taken near the boundaries of the Oak Knoll Hunt Club by members of smaller clubs.

The Location of the Kill in California. Dusky Canada goose kill in California amounted to less than 1.0 percent of the flyway kill. Six banded geese (one immature, one subadult, and four adults) have been reported from California. All recoveries occurred in the northern portion of the state, one from Sacramento, two from Crescent City, and three from Tule Lake National Wildlife Refuge.

Two of the birds reported from Tule Lake in 1963, were banded 10 years earlier as an immature male and an immature female. All birds shot in California were recovered late in the hunting season, either December or January.

Average Kill Distribution by Time

The distribution of the kill by time and place was determined from band recoveries (1952-64). The kill distribution for each subdivision was determined by using the number of recoveries in each state and province as a base, and by using the number of recoveries in the total flyway as a base (Figure 7). More detail can be seen in the state and province kill distribution by using the number of recoveries in each political subdivision as a base, however, the magnitude of the kill by time in each subdivision can best be seen by using all flyway recoveries as the base.

The Alaska goose hunting season opens 1 September (Table III). The kill in Alaska peaks during the first 10-day period in September. By approximately the middle of September, half of the Alaska kill has occurred (Table VIII). Only one band recovery has been reported in Alaska after 1 November.

The Canada goose season in British Columbia begins approximately 10 October (Table III). Approximately 15 percent of the kill in British Columbia occurs in October, 70 percent in November, and

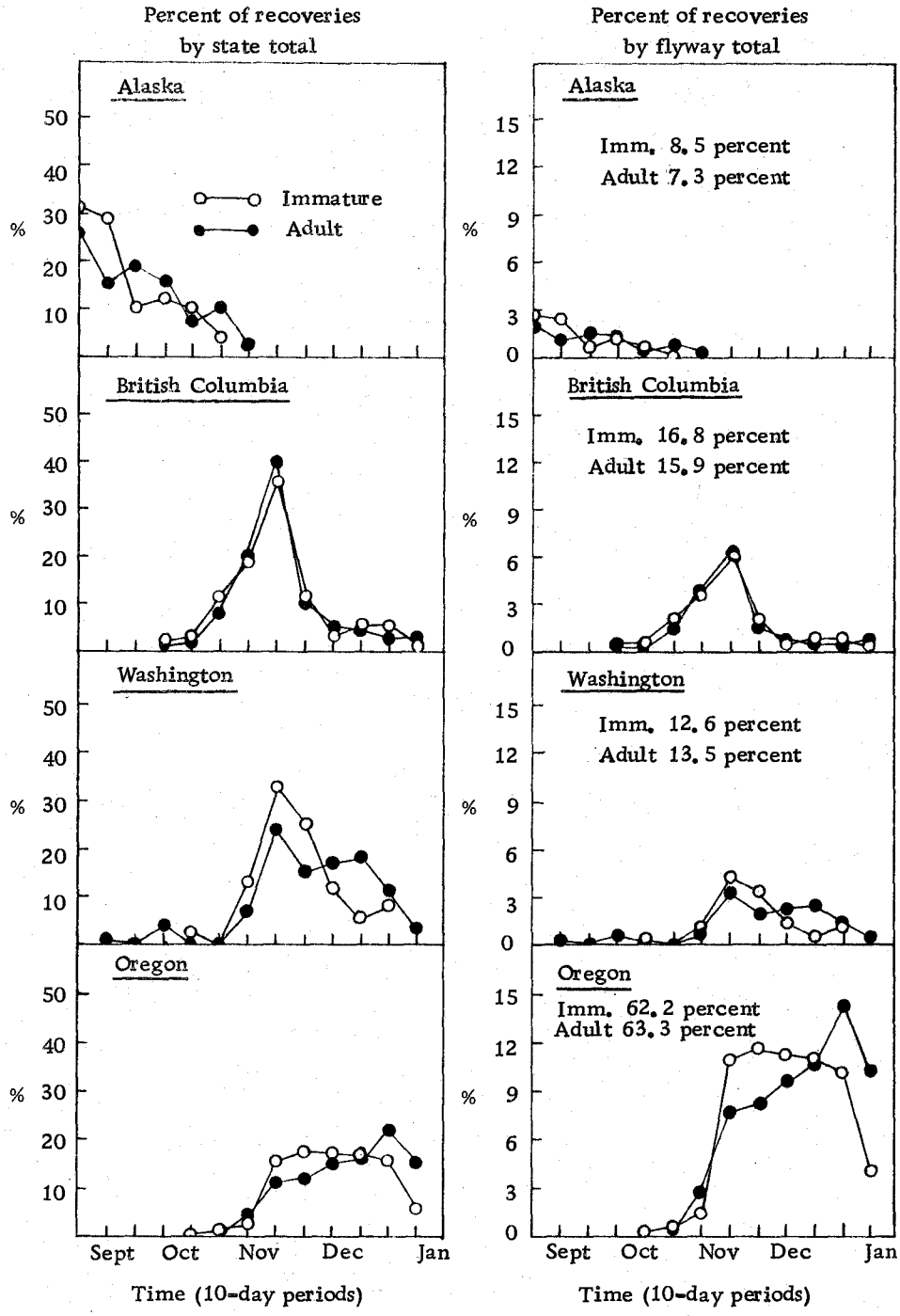


Figure 7. The average percentage of recoveries occurring by 10-day periods (1952-64). Data are presented independently for each state and province (left) and as a percentage of the flyway total (right).

Table VIII. The mid-point in kill date and peak kill date for the dusky Canada goose in each political subdivision.

State or Province	Mid-Point Date		Peak Kill Date	
	Immatures	Adults	Immatures	Adults
Alaska	16 Sept.	24 Sept.	1-10 Sept.	1-10 Sept.
British Columbia	14 Nov.	14 Nov.	11-20 Nov.	11-20 Nov.
Washington	21 Nov.	30 Nov.	11-20 Nov.	11-20 Nov.
Oregon	5 Dec.	14 Dec.	21-30 Nov.	21-31 Nov.

15 percent in December (Figure 7). Evidently most of the geese have left the province by December.

The Canada goose hunting season in Washington begins approximately 15 October, however, essentially no kill occurs until the first week of November (Table IV and Figure 7). The kill in Washington peaks at the same time the British Columbia kill peaks (between 11 and 20 November), however the Washington mid-point in kill was one to two weeks later (Table VIII). The Washington mid-point evidently occurs later because more geese remain in the state throughout the season. Approximately 35 percent of the Washington kill occurs in December as compared with 15 percent in British Columbia.

Dusky Canada goose harvest in Oregon begins between 5 and 15 November, approximately the same time that the peak kill occurs in British Columbia and Washington (Figure 7). The kill of immatures and adults in Oregon reached the mid-point exactly two weeks later than Washington (Table VIII). This is evidence that geese

continue to leave Washington throughout the hunting season. Approximately 65 percent of the kill in Oregon occurs in December and January. The kill later in the hunting season is predominately adults. More than 38 percent of the adult geese killed in Oregon were taken after 20 December, whereas only 22.9 percent of the immatures were killed after that date (Table I, Appendix).

Magnitude and Distribution of Kill in 1965

Band recovery information and hunter bag checks at the Oak Knoll Hunt Club by J. A. Chapman permit estimation of the magnitude and distribution of the kill in 1965.

Sex and age of almost all geese shot at the Oak Knoll Hunt Club east of Corvallis, Oregon were determined in 1965. In addition all band numbers seen were noted. A total of 1,572 geese was checked and an estimated 5.0 percent of the geese killed at the club were not checked (Chapman, 1967). Chapman noted 28 bands and estimated that he probably missed about five, which included bands removed in the field by hunters. It was not known until 1966 that one member of the club was collecting but not reporting bands. He also was soliciting bands from other hunters before their geese were being checked by Chapman. In 1965 he collected 21 bands in the field and did not report them to Chapman or to the Bird Banding Laboratory. His band collection, 90 in all over a 4 year period, was obtained in

January 1967. The bands could be sorted according to the year the geese were shot because the bands were made into a "chain" in chronological sequence (Table III, Appendix).

Fifty-four bands (28 checked, 5 estimated missed, and 21 collected) represented 1,656 geese in the bag. I assumed the 54 bands represented 100 percent of the bands taken at the Oak Knoll Hunt Club in 1965. Therefore, one of 30.7 birds bagged was banded. If in the flyway a 100 percent band reporting rate existed, each band reported in 1965 would represent 30.7 birds in the hunter bag, and thus the magnitude of the kill could be determined. Unfortunately no bandings in 1964 made it impossible to estimate band reporting rate for 1964, and insufficient data were available for the 1965 estimate. However, the band reporting rate for this population was determined to be 34.9 percent in 1963 (Table XV).

Of the 28 bands noted by Chapman plus the five estimated to be missed (total 33) excluding those held by the band collector, 13 were reported to the Bird Banding Laboratory, a 39.4 percent reporting rate. The reporting rate for the Oak Knoll Hunt Club however, was not 39.4 percent because the 13 reported bands actually represented 54 bands. Because 21 bands were not reported (held by the collectors) the band reporting rate for Oak Knoll Hunt Club was 13/54 (24.1 percent).

Because the estimated reporting rate for Oak Knoll Hunt Club

was 24.1 percent and the estimated overall reporting rate for the flyway was 34.9 percent, a proportion was used to find the reporting rate for the remaining portion of the flyway.

Oak Knoll Hunt Club	+	rest of flyway	=	total flyway
24.1 (54 bands)	+	X (82 bands)	=	34.9 (136 bands)

$$X = 42.0 \text{ percent}$$

The reporting rate for the remaining portion of the flyway was estimated to be 42.0 percent. The reporting rate of the Oak Knoll Hunt Club was very similar (39.4 percent) when bands collected by the solicitor were disregarded.

Assuming a 100 percent reporting rate, an average of 30.7 geese must be shot for one band to be reported. However, with a calculated 42.0 percent reporting rate another proportion was used to determine the number of birds that must be shot for one band to be reported, 30.7/.420 = 72.9.

In the flyway other than the Oak Knoll Hunt Club, an average of 72.90 birds must be shot to obtain one band report from a hunter. For purposes of determining the magnitude of the kill in the flyway, it was assumed that the reporting rate was the same for all areas other than the Oak Knoll Hunt Club.

The kill in Oregon in 1965 was sub-divided into seven harvest areas (Table IX). The Oak Knoll Hunt Club accounted for the largest

proportion of the kill in Oregon.

Table IX. Distribution and magnitude of the dusky Canada goose kill in Oregon in 1965.

Harvest Area	Number of Bands	Harvest Estimate	
		Numbers	Percent
Oak Knoll Hunt Club	a	1,656[a]	36.2
Oak Knoll Fringe[b]	5	365	8.0
Rickreall-Amith Area	19	1,385	30.3
McFadden's Area	5	365	8.0
Sauvies Island-Columbia River Area	4	292	6.4
McMinnville-Forest Grove Area	3	219	4.8
Coastal Oregon	3	219	4.8
Unknown Oregon	1	73	1.6
Total		4,574	100.1

[a]Oak Knoll Hunt Club Kill obtained by actual count (Chapman, 1967), number of bands not applicable.

[b]The Corvallis-Albany Area consists of the Oak Knoll Hunt Club plus the Oak Knoll Fringe.

The total harvest of dusky Canada geese for 1965 in the Pacific Flyway was estimated to be 7,635 (Table X). Over half of the kill occurred in Oregon with the remaining kill occurring in Washington, British Columbia, Alaska, and California. The distribution of the kill in Table X is in close agreement with the 1952-64 average (Table VII).

Hanson and Smith (1950), Craighead and Stockstad (1956), Hunt, Bell, and Jahn (1962), and Green, Nelson, and Lemke (1963) estimated crippling losses of Canada geese to range between 20 and 40

Table X. Distribution and magnitude of the dusky Canada goose kill in 1965 by state and province.

State or Province	Number of Bands	Harvest Estimate	
		Numbers	Percent
Alaska	7	510	6.7
British Columbia	16	1,166	15.3
Washington	18	1,312	17.2
Oregon	a	4,574[a]	59.9
California	1	73	1.0
Total		7,635	100.1

[a]Oregon kill determined partially by actual count and partially by band recoveries, refer to Table IX.

percent. The average of these estimates was approximately 25 percent. Using a 25 percent crippling loss, the kill for the entire dusky Canada goose population was estimated to be 10,180 in 1965.

The winter inventory indicated a postseason population of 19,778 in January 1966 for Washington and Oregon (Tables V and VI). Assuming that the winter inventory counts consisted only of dusky Canada geese, the estimated hunting kill accounted for 34 percent of the population. The annual mortality rate in 1965 was estimated to be 39.6 percent when a 5.6 percent average natural mortality (Figure 10) was added to the hunter kill rate. The estimated annual mortality rate was less than the 45.3 percent average annual mortality rate determined from the composite dynamic life table (Table XVI). The mortality rate would be higher if other subspecies of Canada geese were included in the winter inventory counts. It seems very likely

that some geese of other subspecies were included in the winter inventories.

Methods of Hunting

Questionnaires were mailed to 122 hunters who had reported at least one band from a dusky Canada goose to the Bird Banding Laboratory from the Willamette Valley during the 1962, 1963, or 1964 hunting seasons. The hunters were asked to record the number of geese shot in 1965 and their methods of hunting. The results of this survey are shown in Table XI.

Table XI. Methods of hunting Canada geese in the Willamette Valley of Oregon in 1965, as determined by a questionnaire mailed to 122 hunters.[a]

Category	Decoy and Blind	Pass Shooting	Sneak Shooting	Other
Number of successful hunters in 1965	36	14	3	1
Number of geese killed in 1965	631	188	11	3
Percent of geese killed in 1965 by:	76%	23%	1%	Trace

[a]Sample included only hunters that reported at least one dusky Canada goose band from the Willamette Valley during the 1962, 1963, or 1964 hunting season.

Hunter Attitude

Hunters were asked if they would be in favor of doubling or

tripling the Willamette Valley Canada goose population by modest hunting restrictions for a few years. Although this question may have been highly biased, I believe some trends in attitude were shown. The random sample of duck stamp buyers indicated that 87.9 percent of the hunters were in favor of modest hunting restrictions while only 63.9 percent of hunters reporting bands were in favor of restrictions (Table XII). I believe the difference was attributable to the fact that the band reporting sample included more hunting club members and, therefore, hunters that were more successful. The latter hunters know they can usually kill geese and do not want to reduce their daily or yearly bag.

Table XII. Hunter attitude toward modest hunting restrictions in the Willamette Valley for a few years based on a mail survey sent to 599 valley hunters.

Category	Yes	No	Question Mark	Unanswered
Random sample of duck stamp buyers	305	29	13	43
	87.9%	8.4%	3.7%	--[a]
Sample reporting dusky Canada goose bands in either 1962, 1963, or 1964.	46	22	4	15
	63.9%	30.6%	5.5%	--

[a]A large portion of the questionnaires were left blank by unsuccessful hunters. Thus, they did not leave the question unanswered because they were undecided, hence unanswered questionnaires were not used to figure percentages (see Appendix Figure 1).

When asked to comment on goose hunting in the Willamette Valley, an overwhelming number of the hunters said they were disgusted with hunting clubs that accounted for such a large percentage of the geese killed. Many were hopeful that the new William L. Finley National Wildlife Refuge would alleviate the problem by giving non-club hunters a place to hunt. Many asked when the new refuge would be open to waterfowl hunting. Some hunters reported that they were going to quit hunting waterfowl because they did not have a place to hunt. A decline in sales of waterfowl stamps in Oregon is evidence that interest in waterfowl hunting has declined in recent years (Figure 2, Appendix).

Hunter Affiliation

Hunter affiliation in the Willamette Valley was estimated from 390 replies (81.8 percent) to the 477 questionnaires sent at random to 1965 duck stamp buyers in the valley. Of the 390 hunters that answered the questionnaire, 280 (71.8 percent) hunted in the Willamette Valley.

One hundred and twenty-one (35.2 percent) of the 344 geese reported shot were killed by non-club members (Table XIII). Applying the reciprocal of this percent (64.8) to the total kill in Oregon (Table IX) an estimated 2,962 geese were killed by members and guests of goose hunting clubs in 1965. Chapman (1967) estimated that 1,656

Table XIII. Hunter affiliation in the Willamette Valley of Oregon in 1965 as determined from a mail questionnaire sent to 477 hunters that bought duck stamps in 1965.

Category	Hunting Club Member	Hunting Club Guest	Non-Club Hunter
A. Number of hunters	38	34	208
B. Percentage of total hunters	13.6	12.1	74.3
C. Number of days hunted (total)	604	265	1,934
D. Average number of days hunted	15.9	7.8	9.3
E. Total number of geese shot	172	51	121
F. Percentage of total goose kill	50.0%	14.8%	35.2%
G. Number of successful hunters[a]	16	12	43
H. Percentage of successful hunters (G ÷ A)	42%	35%	21%
I. Number of days hunted per goose killed (C ÷ E)	3.7	5.2	16.0
J. Average Number geese per successful hunter (E ÷ G)	10.8	4.3	2.8
K. Average Number geese per hunter (E ÷ A)	4.53	1.50	.58
L. Percentage of hunters killing all of the geese by affiliation (B x H)	5.7%	4.2%	15.6%

[a]Hunters that shot at least one goose.

geese were killed at the Oak Knoll Hunt Club, therefore, other clubs must have been responsible for killing 1,306 geese in 1965. Hence, non-club hunters harvested only 1,612 dusky Canada geese in Oregon in 1965.

Successful hunting club members killed almost five times as many geese as the successful non-club sportsman, while the non-club sportsman hunted more than four times longer to kill a goose

(Table XIII). An estimated 64.8 percent of the geese were killed by 9.9 percent of the hunters, and these hunters were all members or guests of private gun clubs (Table XIII). It is estimated that all of the geese were killed by 25.5 percent of the hunters.

Recovery Rates or Hunter Vulnerability

Moffitt (1935) apparently first suggested that young birds were more vulnerable than adults on the basis of recovery rates of Canada geese banded in California. Bellrose *et al.* (1961) suggested that comparative hunting recovery rates of different ages or sexes yielded data on differential vulnerability.

Direct Recovery Rates Associated with Age

An average direct recovery rate of 8.2 percent was calculated for adult dusky Canada geese banded between 1952 and 1959, and 17.9 percent for immatures (Table XIV). Hence, the relative recovery rate was 2.19, indicating that immatures were more than twice as vulnerable to the hunter as adults.

Direct Recovery Rates Associated with Sex

The sex was determined for geese banded on the Copper River delta between 1952 and 1959. The average direct recovery rate for immature males was slightly higher than for immature females

Table XIV. Direct recovery rates and total recovery rates for each sex and age group of dusky Canada geese banded in the summer on the Copper River delta, 1952-59.

Category	Adult Male	Adult Female	Adult Total	Im. Male	Im. Female	Im. Total
Number banded	169	199	368	944	857	1,801
Number of direct recoveries	13	17	30	177	145	322
Total recoveries[a]	60	71	131	300	271	571
Direct recovery rate (percent)	7.7	8.5	8.2	18.8	16.9	17.9
Total recovery rate (percent)	35.5	35.6	35.6	31.8	31.6	31.7

[a]Indirect recoveries include the 1964-65 hunting season.

(Table XIV). The overall recovery rate was essentially identical for males and females (Table XIV). The similar total recovery rates tended to suggest that the natural mortality was the same for each sex group. Low natural mortality on the nesting grounds may be a possible explanation of the phenomenon.

Relative Recovery Rates Associated with Harvest Areas

Locations within the flyway have noticeably higher or lower relative recovery rates than the average for the flyway. The relative recovery rate (immatures to adults) on the Oak Knoll Hunt Club for 1965 and 1966 was found to be 3.81 (Chapman, 1967). Almost half of the kill in Oregon occurred on the Oak Knoll Hunt Club. The

relative recovery rate for Oregon excluding the Oak Knoll Hunt Club based on 26 band recoveries in 1965 was 1.19. The relative recovery rate in 1965 for Alaska, British Columbia, and Washington was 1.38 (based on 28 band recoveries).

Direct Recovery Rates Associated With Band Reporting Rates

The direct recovery rate is an expression of hunting pressure, however, it may be altered by changes in band reporting rates. It is necessary to determine if annual band reporting rates are similar before comparing direct recovery rates and estimating changes in hunting pressure. Henny (in press) described the method for estimating band reporting rates that was used in making these analyses.

To calculate the rate of band reporting by this method, four components are necessary: estimates of crippling loss, direct recovery rates, first year mortality rates, and natural mortality rates. Using these four components, an estimate of the rate of reporting bands can be calculated by the use of the following formula:

$$\text{Reporting Rate} = \frac{(1 + \text{estimate of crippling loss factor}) \times \text{direct recovery rate}}{\text{Est. first year annual mort. rate} - \text{est. ann. nat. mort. rate}}$$

(Estimated first year hunting mortality rate)

The band reporting rates derived by the above formula are listed in Table XV and graphically compared with the direct recovery rates in Figure 8. A high band reporting rate was noticed the first year of

Table XV. Band reporting rates, immature direct recovery rates, and first year immature annual mortality rates for the dusky Canada goose from 1952 to 1963.

Year	Band Reporting Rate	Immature Direct Recovery Rate	Immature Mortality Rate[a]
1952	78.5	24.2	48.8
1953	58.6	21.8	57.3
1954	48.7	21.3	65.9
1955	51.1	12.3	39.9
1956	57.8	11.7	34.8
1957	57.6	20.3	54.7
1958	54.6	16.9	49.0
1959	44.5	15.7	54.8
1960	55.6	20.8	57.6
1961[b]			
1962	32.9	13.3	61.6
1963	34.9	14.3	60.3

[a]Derived from formula, page 68.

[b]No banding.

banding (1952). Similarly, a high direct recovery rate was also noticed the first year. Evidently the high rate of reporting bands the first year was due to hunters being exceptionally curious about the origin of the bands. The band reporting rate from 1953 to 1960 remained fairly constant. A major decline in the band reporting rate occurred in 1962 and continued through 1963 (Table XV). The band solicitor at the Oak Knoll Hunt Club began his collection of 90 goose bands (Table II, Appendix) at this time and was probably one of the major reasons for decline in the band reporting rate.

Martinson (1966) listed other possibilities as reasons for the decline in band reporting rates: 1) a higher proportion of successful

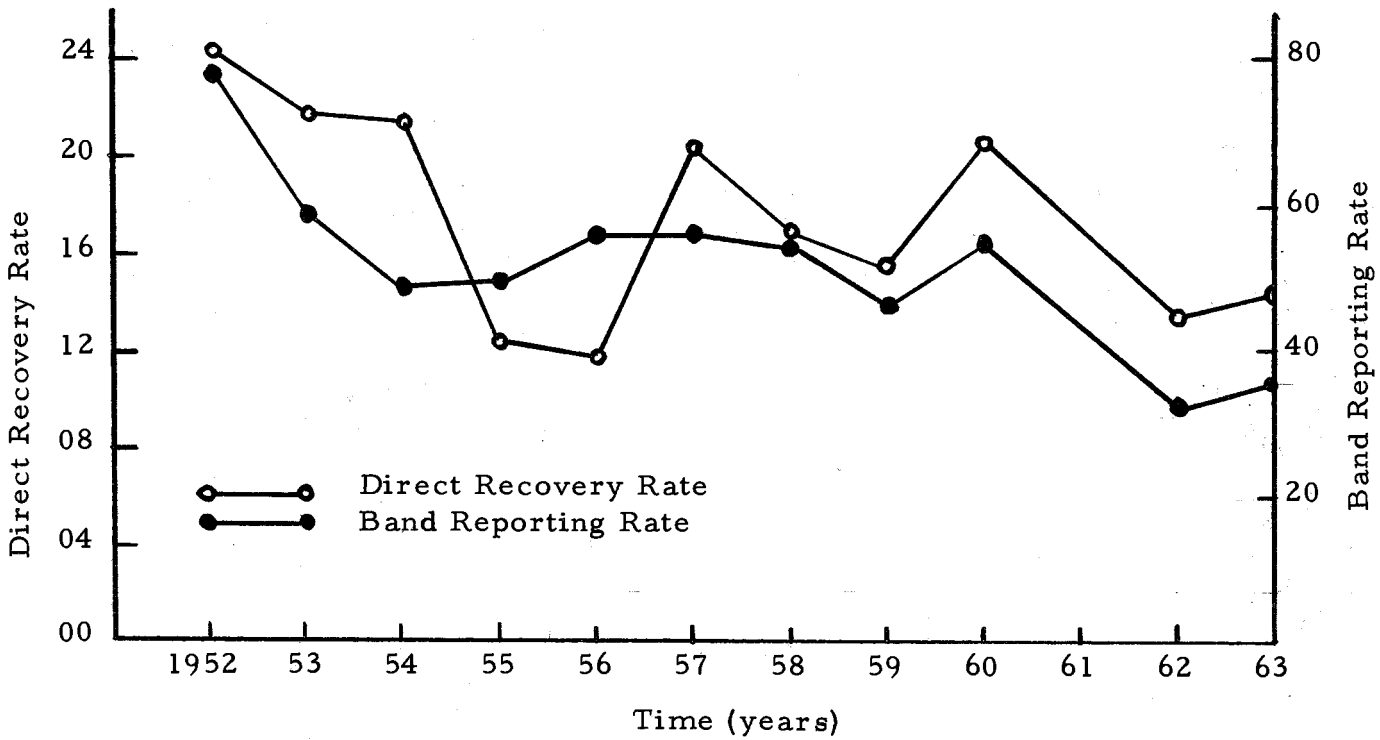


Figure 8. A comparison of direct recovery rates with band reporting rates of dusky Canada geese banded on the Copper River delta, 1952 to 1963.

and experienced hunters than in earlier years who have shot banded birds and may be less apt to report bands than inexperienced hunters, 2) more banded birds in the population and the hunters conceivably lost interest, 3) also, the method of sending information to the hunter was altered in 1961. Before 1961, a detailed form (flimsy) showing the species, age, sex, location and date of banding, as well as the name and title of the bander was sent to the person who reported the band. In 1961, this information was sent to the hunter on an IBM card with the banding and recovery location given in coordinates of latitude and longitude rather than place name, and without the age and sex of the bird. Both the hunters and banders disliked the use of coordinates and were vociferous in their displeasure with the IBM cards in general. Negative reaction to the radical change in the report form in 1961 and the subsequent use of a modified, but still somewhat impersonal IBM card could have reduced the interest of some hunters in reporting waterfowl bands (Martinson, 1966). The lower direct recovery rates in 1955 and 1956 can be attributed to lower hunting pressure, since essentially no change in reporting rates existed (Figure 8).

Population Survival

One of the objectives of this research was to determine through banding analyses the annual mortality rate and the average longevity

of the dusky Canada goose. These mortality data were compared with similar data derived for other populations of geese.

Mortality Rates Associated with Age

The average first year annual mortality rate for immature dusky Canada geese calculated by the composite dynamic method was 57.0 percent (Table XVI). Subadult geese (yearlings in second year of life) had a 37.2 percent mortality rate. Adults had a mortality rate (after the second season) of 34.7 percent (Table XVI). The average annual mortality rate between 1952 and 1965 calculated by the same method for adults banded as adults was 32.3 percent, about 2.0 percent less than for adults banded as immatures (Tables XVI and XVII).

Mortality Rates Associated with Sex

Mortality rate estimates for males and females were based on birds banded as immatures, because the sample size for adults was too small. An estimated 58.8 percent of the males and 53.5 percent of the females died between the beginning of the first hunting season and the beginning of their second season after banding (Tables XVIII and XIX). The same data indicated that the subadult mortality rates were higher for females (43.7 percent) than males (40.3 percent). In the adult segment of the population (3 years old and older), males were estimated to have higher mortality (38.8 percent to 32.1

Table XVI. Composite dynamic mortality rate estimations from shot recoveries of immature and local dusky Canada geese banded in the summer on the Copper River delta of southcentral Alaska.

Year Banded	Number Banded	Hunting Seasons Survived											First Hunting Season Recovery Rate
		1	2	3	4	5	6	7	8	9	10	11	
1952	132	32	10	8	2	1	2	0	0	1	0	0	.2424
1953	340	74	22	6	4	4	6	1	1	1	2	1	.2176
1954	684	146	24	10	12	9	6	3	0	2	6	1	.2134
1955	309	38	14	17	10	2	0	1	1	0	0	0	.1230
1956	341	40	30	11	13	2	0	1	1	1	0		.1173
1957	286	58	17	8	4	6	1	2	2	1			.2028
1958	308	52	19	10	4	7	2	2	3				.1688
1959	415	65	19	9	7	2	6	1					.1566
1960	360	75	13	15	4	1							.2083
1961[a]													
1962	323	43	7	6	5								.1331
1963	260	37	8	5									.1431
1964[a]													
1965	198	27											.1364
Totals	3956	687	183	105	69	37	24	11	7	6	8	2	.1737
Banded birds available		3956	3758	3758	3498	3175	3175	2815	2400	2092	1806	1465	
Rec. /1000 banded		173.7	48.7	27.9	19.7	11.7	7.6	3.9	2.9	2.9	4.4	1.3	$\frac{82.3}{236.9} = .347$[d]
Alive going into period		304.7	131.0	82.3	54.4	34.7	23.0	15.4	11.5	8.6	5.7	1.3	$\frac{304.7}{672.6} = .453$[e]
Mortality rates		.570[b]	.372[c]										

[a]No banding. [b]Immature annual mortality rate. [c]Subadult annual mortality rate.
[d]Adult annual mortality rate, third through eleventh year. [e]Average annual mortality rate for population.

Table XVII. Composite dynamic mortality rate estimations from shot recoveries of adult dusky Canada geese banded in the summer on the Copper River delta of southcentral Alaska.

Year Banded	Number Banded	Hunting Seasons Survived 1	2	3	4	5	6	7	8	9	10	11	1st Hunting Season Recovery Rate
1952	16	1	1	2	1	1	0	0	0	0	0	0	.0625
1953	141	20	16	8	3	2	2	0	1	1	0	0	.1418
1954	72	8	2	2	3	1	0	1	0	0	0	0	.1111
1955	101	8	6	8	5	4	5	0	2	0	0	1	.0792
1956	66	4	11	6	5	4	0	1	0	0	0		.0606
1957	76	10	4	5	1	4	0	0	3	3			.1315
1958	48	4	5	3	0	1	1	2	1				.1833
1959	39	1	2	1	2	3	1	0					.0256
1960	75	12	3	6	0	0	0						.1600
1961[a]													
1962	172	12	13	6	3								.0726
1963	241	34	13	12									.1411
1964[a]													
1965	236	26											.1102
Totals	1283	140	76	59	23	20	9	4	9	4	0	1	.1091
Banded birds available		1283	1047	1047	806	634	634	559	520	472	396	330	
Rec. /1000 banded		109.1	72.6	56.4	28.5	31.5	14.2	7.2	17.3	8.5	0.0	3.0	
Alive going into period		348.3	239.2	166.6	110.2	81.7	50.2	36.0	28.8	11.5	3.0	3.0	
Mortality rate													$\frac{348.3}{1078.5} = .323$[b]

[a]No banding.

[b]Adult annual mortality rate, first through eleventh year.

Table XVIII. Composite dynamic mortality rate estimations from shot recoveries of male dusky Canada geese banded as immatures and locals in the summer on the Copper River delta of southcentral Alaska.

Year Banded	Number Banded	Hunting Seasons Survived 1	2	3	4	5	6	7	8	9	10	11	1st Hunting Season Recovery Rate
1952	26	5	3	2	0	0	1	0	0	0	0	0	.1923
1953	129	29	10	2	1	1	1	0	0	0	1	1	.2248
1954	335	76	12	4	7	4	2	2	0	0	2	0	.2269
1955	168	17	4	10	6	1	0	1	0	0	0	0	.1012
1956	169	25	13	6	6	2	0	1	0	1	0		.1479
1957[a]													
1958	24	7	0	0	1	1	0	0	0				.2917
1959	93	18	8	4	0	1	0	1					.1935
Totals	944	177	50	28	21	10	4	5	0	1	3	1	.1875
Banded birds available		944	944	944	944	944	944	944	851	827	827	568	
Rec. /1000 banded		187.5	53.0	29.7	22.2	10.6	4.2	5.3	0.0	1.2	3.6	1.8	
Alive going into period		319.1	131.6	78.6	48.9	26.7	16.1	11.9	6.6	6.6	5.4	1.8	
Mortality rates		.588[b]	.403[c]										$\frac{78.6}{202.6}$=.388[d]

[a]Sex was not determined in 1957 or after 1959.
[b]Immature annual mortality rate.
[c]Subadult annual mortality rate.
[d]Adult annual mortality rate, third through eleventh year.

Table XIX. Composite dynamic mortality rate estimations from shot recoveries of female dusky Canada geese banded as immatures in the summer on the Copper River delta of south-central Alaska.

Year Banded	Number Banded	Hunting Seasons Survived 1	2	3	4	5	6	7	8	9	10	11	1st Hunting Season Recovery Rate
1952	27	8	4	1	0	0	1	0	0	1	0	0	.2963
1953	121	27	8	2	2	0	1	0	1	1	1	0	.2231
1954	296	64	13	4	5	3	3	1	0	2	4	1	.2162
1955	138	21	10	6	4	1	0	0	0	0	0	0	.1522
1956	169	15	17	5	7	0	0	0	1	0	0		.0888
1957[a]													
1958	27	5	2	1	0	1	2	0	0				.1852
1959	79	7	2	2	4	1	1	0					.0886
Totals	857	147	56	21	22	6	8	1	2	4	5	1	.1715
Banded birds available		857	857	857	857	857	857	857	778	751	751	582	
Rec. /1000 banded		171.5	65.3	24.5	25.7	7.0	9.3	1.2	2.6	5.3	6.7	1.7	
Alive going into period		320.8	149.3	84.0	59.5	33.8	26.8	17.5	16.3	13.7	8.4	1.7	
Mortality rates		.535[b]	.437[c]										$\frac{84.0}{261.7} = .321$[d]

[a]Sex was not determined in 1957 or after 1959.
[b]Immature annual mortality rate.
[c]Subadult annual mortality rate.
[d]Adult annual mortality rate, third through eleventh year.

percent) rates.

Mortality Rates Associated with Time and Hunting Regulations

Definite changes occurred in hunting regulations during the last fifteen years (Tables III and IV). The major change occurred during the middle 1950's in Oregon, when the effective season length and the daily bag limits were reduced. Some minor yearly fluctuations in effective season length occurred throughout the study period. Because approximately two-thirds of the annual harvest between 1952 and 1965 in the flyway occurred in Oregon, and because the greatest changes in hunting regulations also occurred in Oregon, I believe that changes in mortality rates were most affected by the harvest in Oregon.

There was a significant correlation ($r = +0.67$, $df = 9$) between the annual mortality rates between 1952 and 1963 (excluding 1961) and an index of hunting opportunity derived by multiplying the effective season length (5 November to end of season) by the daily bag limit (Figure 9).

The index to hunting opportunity did not take into consideration the number of goose hunters. There was a considerable variation in numbers of waterfowl stamps sold (hence, numbers of hunters) between 1952 and 1963 (Figure 2, Appendix). Only a small portion of the waterfowl hunters killed geese (Table XIII), therefore it was

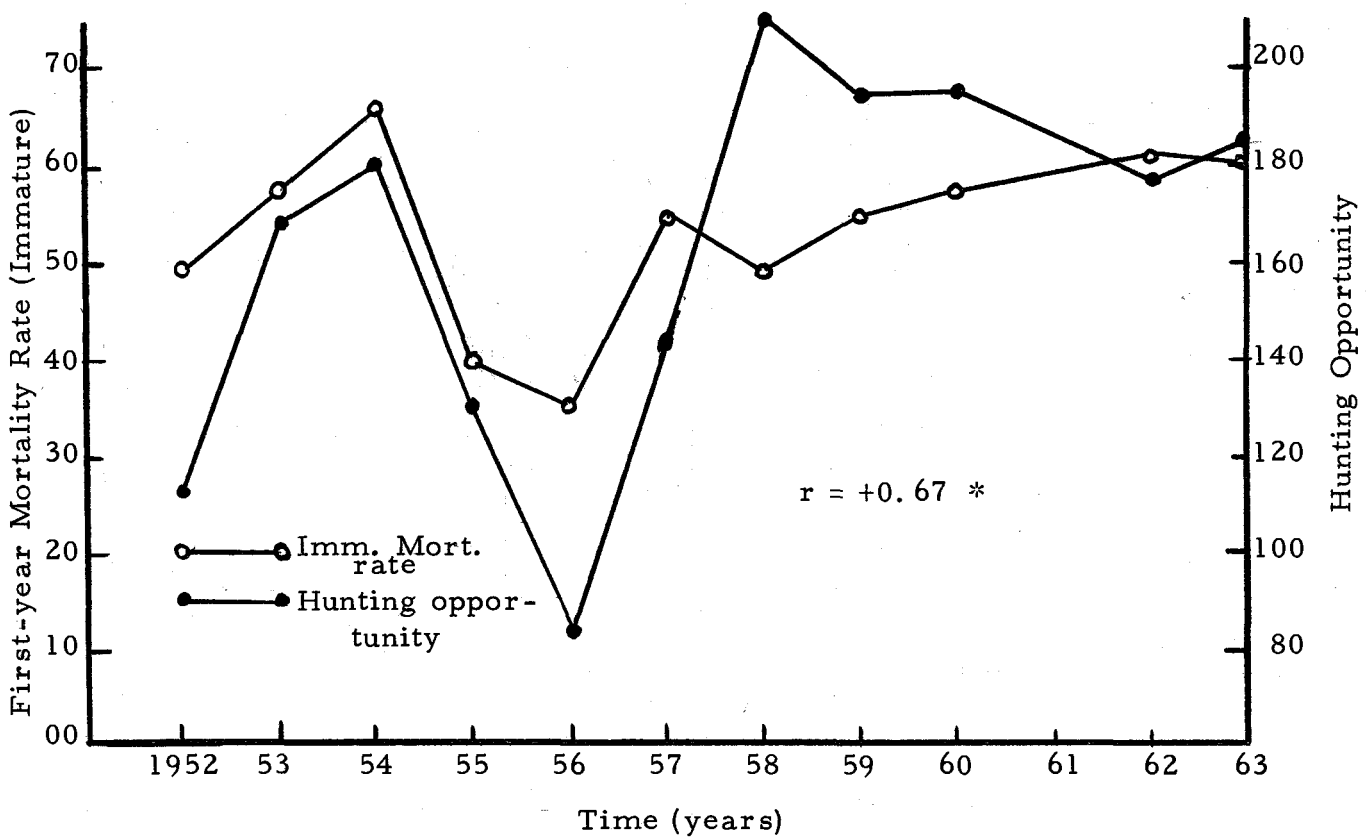


Figure 9. A comparison of first-year mortality rates with hunting opportunity in Oregon of geese banded on the Copper River delta, 1952 to 1963.

assumed that the small segment of successful hunters continued to hunt but unsuccessful hunters gave up the sport. Therefore, the total number of hunters was not believed to influence the hunting kill greatly.

Immature first year mortality rate indices were estimated by dividing the number of bands recovered during the first hunting season by the total number of bands recovered during the first four seasons. Geese banded as immatures were used because the sample was larger. Mortality rate indices for the first year calculated by this method were obviously overestimated because some bands were recovered after the fourth year. Therefore, the indices had to be adjusted (lowered). This was accomplished by comparing data of years which no further band recoveries were expected. In my example (Table XX), bandings in 1952, 1953, and 1954 were used to compare mortality indices based on the first four years of recoveries with mortality indices using all recoveries during the life of the cohort.

Table XX. Dusky Canada goose shot recovery information for the first three years of banding, 1952, 1953, and 1954.[a]

Year of Banding	Hunting Seasons Survived										
	1	2	3	4	5	6	7	8	9	10	11
1952	32	10	8	2	1	2	0	0	1	0	0
1953	74	22	6	4	4	6	1	1	1	2	1
1954	146	24	10	12	9	6	3	0	2	6	1
Combined	252	56	24	18	14	14	4	1	4	8	2
Cumulative Totals	252			350							397

[a]Taken from Table XVI.

$$A = \frac{\text{Number of bands recovered the first year}}{\text{Number of bands recovered during the first 4 years}} = \frac{252}{350} = 0.720$$

$$B = \frac{\text{Number of bands recovered the first year}}{\text{Number of bands recovered during the life of the cohort}} = \frac{252}{397} =$$

$$0.635$$

The average amount that (A) overestimated the rates of mortality for immature birds was calculated by subtracting (B) from (A) to provide an adjustment factor (C):

$$\begin{array}{ccccc} A & - & B & = & C \\ 0.720 & - & 0.635 & = & 0.085 \end{array}$$

The adjustment figure (C) was subtracted from all estimates of mortality rates of immature birds. This adjustment seems to provide satisfactory estimates of first year mortality rate, however, it has a weak theoretical foundation. The immature mortality rate index is shown in Table XV.

The decline in mortality rates in 1955 and 1956 indicated that restrictive regulations were effective.

Natural Mortality

Mortality was separated into two major groups, hunting mortality and natural mortality. An estimate of the rate of natural mortality was made from the linear regression between the direct recovery

rate and the rate of mortality during the first year (Hickey 1952). The intercept of the regression line with the mortality axis is an estimate of the natural mortality rate (Figure 10). At this point, the rate of direct recovery reaches zero indicating that no further mortality due to hunting is occurring.

In my example, data acquired during the first year (1952) and, the last two years (1962 and 1963) were omitted in making estimates of the rate of natural mortality because of unequal band reporting rates. The inflated rate of reporting during 1952 probably reflected a high degree of interest generated by the first appearance of bands on this race of geese. Reduced rates of reporting bands from ducks were noted beginning in 1962 (Martinson, 1966), and for geese and brant beginning the same year (Martinson and McCann, 1966). My data show that the reporting rate declined sharply in 1962 and 1963 to an average of 0.332 (Table XV). This was in close agreement with the 0.361 shown by Martinson and McCann (1966) for geese during the same time period. Therefore, the last two years of data were not used. Only data with similar band reporting rates should be used for estimating natural mortality rates by this method.

A natural mortality rate of 5.6 percent was estimated for the dusky Canada goose population (Figure 10). The only previous estimate of natural mortality in geese that I found was by Rienecker (1965) who estimated the natural mortality rate for immature snow

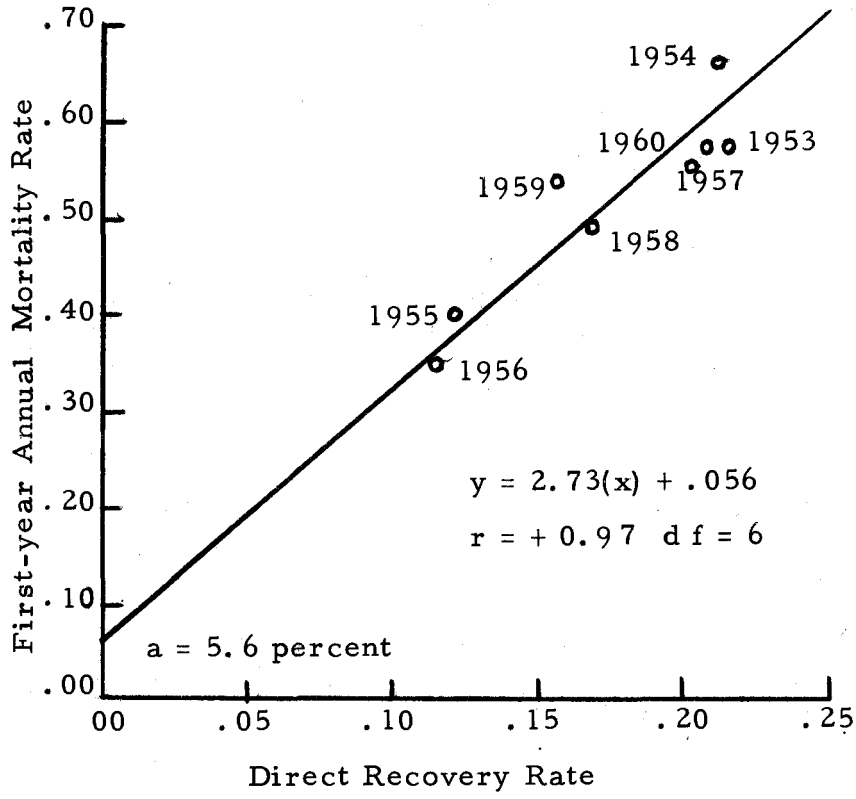


Figure 10. Estimated natural mortality rate of the dusky Canada goose population using a regression analysis.

geese (Chen hyperborea) to be 8.2 percent.

Life Expectancy

The life expectancy of the dusky Canada goose was determined by using the life table approach of Deevey (1947). The expectation of life, or mean life time remaining for each age interval is shown in Table XXI. Immatures have a lower life expectancy than either subadults or adults, which is caused by the high hunting vulnerability of immatures. The life expectancy of subadults was slightly greater

Table XXI. Estimated life expectancy from the time of banding of dusky Canada geese banded as immatures on the Copper River delta between 1952 and 1965 using the life table method (Deevey, 1947).

x Age Years	d_x Number Dying in Age Interval out of 1,000 Banded	l_x Number Surviving at Beginning of Age Interval out of 1,000 Banded	$1000q_x$ Mortality Rate Per Thousand Alive at Beginning of Age Interval	e_x Expectation of Life, or Mean Life Time Remaining to those Attaining Age Intervals
0-1	570	1000	570	1.73
1-2	155	430	360	2.56
2-3	94	275	342	2.39
3-4	65	181	359	2.37
4-5	39	116	336	2.42
5-6	26	77	338	2.40
6-7	13	51	255	2.36
7-8	6	38	158	2.00
8-9	10	32	313	1.28
9-10	16	22	727	0.64
10-11	6	6	1000	0.50

than adults. Adults in the third through seventh year had essentially the same life expectancy. This is to be expected since the adults had similar mortality rates during these years. After the seventh year, data was insufficient for calculating life expectancy with accuracy.

Because the banding program for dusky Canada geese began in 1952, no banded geese older than 14 years were in the population. No geese of the maximum age were reported. Two geese were reported that were at least 12 years old and two more were reported shot 11 years after banding.

The greatest age reached for a wild Canada goose was 23 years old (Dornville and Friley, 1957). This bird was banded at the Jack Miner Bird Sanctuary, Kingsville, Ontario in the fall of 1932 and recovered in southwestern Michigan during the 1955 waterfowl hunting season. Other geese banded at the same site have lived to be 12, 12, 13, 15, and 18 years (Dornville and Friley, 1957). An immature female giant Canada goose (B. c. maxima) banded at Horseshoe Lake, Illinois on 1 March 1942 was found dead 22 years later near Rantoul, Illinois (Hanson, 1965). Hanson and Smith (1950) stated, "It is of little importance biologically speaking how long members of a species live providing their life span is long enough for a generation to reach and maintain sexual maturity in order to duplicate the achievement of its predecessor."

Comparisons of Mortality Rate Estimations with Other Goose Populations

Dusky Canada goose mortality rate estimates were compared with those of the interior Canada goose (*B. c. interior*), the western Canada goose (*B. c. moffitti*), the cackling Canada goose (*B. c. minima*), the Vancouver Canada goose (*B. c. fulva*), the lesser snow goose (*Chen hyperborea*), and the black brant (*Branta bernicla nigricans*) (Table XXII). All mortality rates were estimated by the composite dynamic method; some of the rates were recalculated so they would be comparable.

Few populations experience higher annual mortality rates on immatures than the dusky Canada goose. Adult mortality rates were similar for all Canada goose populations. The goose populations in Missouri and Utah had immature mortality rates similar to the dusky Canada goose (Table XXII). However, restrictive regulations in the form of a kill quota system in Missouri and season bag limits in Utah have undoubtedly lowered the mortality of these populations since these data were compiled. The dusky Canada goose population has not yet been subjected to similar restrictions.

Population size must be considered when evaluating mortality rates. Large populations are less affected by a catastrophe because more breeding birds remain available to rebuild the population. The annual wintering population of the dusky Canada goose is about

Table XXII. Comparison of mortality estimations of other goose populations with the dusky Canada goose data from this study.

Species and Area of Banding	Method of Mortality Determination	Years of Study	Mortality Rates					
			Imm.	Imm. Male	Imm. Female	Adult	Adult Male	Adult Female
B. c. occidentalis (this study) Alaska	Comp. dynamic	1952-59		58.8	53.5		38.8[a]	32.1[a]
		1952-65	57.0			34.7[a] 32.3[b]		
B. c. occidentalis (Hansen, 1962) Alaska	Comp. dynamic	1951-60	56.9			35.5[a*] 28.9[b*]		
B. c. interior (Vaught-Kirsch, 1966) Missouri	Comp. dynamic	1950-60		62.6	53.1		40.9[a*]	29.8[a*]
B. c. minima (Nelson-Hansen, 1959) Alaska	Comp. dynamic	1949-54	46.0			35.9[a*] 31.9[b*]		
B. c. fulva (Henny, unpublished) Alaska	Comp. dynamic	1956-65				33.5[b]		
B. c. moffitti (Martin, 1964) Utah	Comp. dynamic	1937-41[c]	53.3*			39.6[a*] 37.7[b*]		
		1946-49[c]	47.0	46.9*	47.1*	41.1[a*] 34.6[b*]	42.1[a*] 33.8[b*]	40.3[a*] 35.3[b*]
		1952-58[c]	56.2*			49.7[a*] 44.7[b*]		
		1952-58[d]	63.8*	62.6*	65.3*	49.8[a*] 37.0[b*]	45.9[a*]	56.6[a*]

Table XXII. (cont.)

Species and Area of Banding	Method of Mortality Determination	Years of Study	Mortality Rates					
			Imm.	Imm. Male	Imm. Female	Adult	Adult Male	Adult Female
B. c. moffitti (Craighead-Stockstad, 1964) Montana	Comp. dynamic	1953	66.1					
Chen hyperborea (Rienecker, 1965) California	Comp. dynamic	1953-63	49.1			26.5[a*]	23.8[b*]	27.0[b*]
Branta bernicla nigricans (Hansen-Nelson, 1957) Alaska	Comp. dynamic	1949-54	45.4			32.2[b] 25.5[a*]		

[a]Banded as immature, average mortality rate after second year.

[b]Banded as adult, average mortality rate for all years.

[*]Mortality rate recalculated.

[c]Banded at Bear River, Utah.

[d]Banded at Ogden Bay, Utah.

17,000 (Tables V and VI), which is considerably smaller than other Canada goose populations. A nesting failure during any one year with the existing mortality rates and the small population could possibly lead to a large decline in total population size or ultimately to a remnant population. Current studies on the nesting grounds indicate marked changes in the nesting habitat as a result of the 1964 earthquake. Shepherd (1965) questioned whether or not there will be sufficient suitable nesting cover to produce a huntable population of dusky Canada geese in the future.

Maintenance of the Population (Production vs. Mortality)

Assuming a stable population i. e. production equals mortality, the fall population of dusky Canada geese between 1952 and 1965 has averaged 45. 3 percent immatures (Table XVI). It would be reasonable to assume that a high percentage of immatures (50 to 60 percent) in a goose flock in the autumn necessarily would indicate a thriving and secure population. Hanson (1965) stated that more than likely it may point out a population whose age structure was out of balance as a result of heavy losses from hunting or from one or more preceding years of extremely low productivity, or a combination of both.

I believe that the population has remained fairly stable in recent years. What factors or combinations of factors have led to this stability? Do subadult females in this population nest, and if so what

percentage of them do? I have approached the problem by asking the question, "What percentage of the subadults of the dusky Canada geese must nest to maintain a stable population?" The average brood size or young hatched per clutch for the dusky Canada goose was 4.20 (Table II). Data regarding gosling loss from the time of hatching until the end of the rearing season has not been determined for this population. Geis (1956) reported a 19 percent mortality among 1,396 goslings observed over a 2-year period on western Canada geese in Montana. Her calculations were based on the number of goslings hatched and the number counted at the end of the rearing season. Gosling mortality ranged from 20 to 36 percent annually, and averaged 32 percent for a 3-year period on the giant Canada goose in Missouri (Brakhage, 1965).

Applying the smaller value, 19 percent gosling mortality, to the 4.20 average brood size of the dusky Canada goose indicates an average production per successful nesting female of 3.40.

A theoretical population of female dusky Canada geese was calculated to aid in estimating the percent of subadults that attempt to nest (Table XXIII). It was obtained by subjecting 100 immature females to the average population mortality rates which results in a theoretical population with an average age structure approximating that of the actual population. The theoretical population of females consists of 224 birds of which 100 are immature, 43 are one-year

Table XXIII. A theoretical population beginning with 100 immature female dusky Canada geese, that are subjected to the average mortality rates for the dusky Canada goose population.

Hunting Seasons Survived	Alive at Beginning of Period		Mortality Rate[b]	Number of Deaths Occurring
0	100		570	57
1	43		360	15
2	28[a]		342	10
3	18		359	6
4	12		336	4
5	8	53	338	3
6	5		255	1
7	4		158	1
8	3		313	1
9	2		727	1
10	1		1000	1
Totals	224			100

[a]Subadult segment of population.

[b]Taken from Table XXI.

olds, 28 are subadults, and 53 are adults. This theoretical population has an annual loss of 100 birds when subjected to the average mortality rates. Assuming the population remains stable and each sex class has similar mortality rates, 100 immature females and 100 immature males must be produced annually to keep the population stable.

To obtain estimates of the percent of subadults that must nest to maintain a stable population, it is assumed that all adult females (53) attempt to nest, that the brood size is 4.20, that gosling loss is 19 percent, and that average mortality rates exist. The average

number of young per successful female after gosling loss is 3.40. Combinations of nest success estimates and estimates of percentages of subadult females nesting are computed in Table XXIV. Any combination that yielded a fall production higher than 3.40 young per

Table XXIV. Percentage of subadults nesting and nest success that are necessary to maintain a stable population, considering average brood sizes and mortality rates for the theoretical population in Table XXIII.

Percent of Subadult Females Nesting				Nest Success	Number of Successful Nests	Young in Fall Population Prod. per Successful Nesting Female	Replacement for a Stable Population
33%	50%	66%	100%				
			x	.90	72.9	2.74	200
			x	.85	68.9	2.90	200
			x	.80	64.8	3.08	200
		x		.90	64.3	3.11	200
		x		.85	60.8	3.29	200
			x	.75	60.8	3.29	200
	x			.90	60.3	3.31	200
		x		.80	57.2	3.50	200
	x			.85	57.0	3.50	200
x				.90	56.7	3.53	200
			x	.70	56.7	3.53	200
		x		.75	53.6	3.73	200
	x			.80	53.6	3.73	200
x				.85	53.6	3.73	200
			x	.65	52.7	3.80	200
x				.80	50.4	3.96	200
	x			.75	50.3	3.98	200
		x		.70	50.1	3.99	200
x				.75	47.3	4.23	200
	x			.70	46.9	4.26	200
		x		.65	46.5	4.30	200
x				.70	44.1	4.54	200
	x			.65	43.6	4.59	200
x				.65	41.0	4.88	200

successful female was rejected as being above the expected productivity of the population. Hence, combinations below the dotted line (Table XXIV) seem improbable.

Assuming an 85 to 90 percent nest success, it is estimated that between 50 and 66 percent of the subadult females in the population must attempt to nest to maintain a stable population (Table XXIV). However, Craighead and Stockstad (1964) working with the western Canada goose in Montana reported that only 27 to 36 percent of the 2-year-old wild geese nested, and that all of the 3-year-old wild birds nested. Hanson (1965) stated, "It has long been my belief, however, that the Mississippi Valley Flyway population of interior could not have sustained the degree of harvest as well as it has in certain past years unless a significant number of the 2-year-old females in the population nested." Lynch and Singleton (1964) have recently reached similar conclusions in regard to the blue goose (*Chen caerulescens*) populations.

IV. DISCUSSION AND MANAGEMENT RECOMMENDATIONS

It is not within the scope of this paper to prepare management plans. However, one basic objective that appears to be needed is a statement of the optimum population level which will serve as a goal for the dusky Canada goose population in the future. Information currently available in this paper and others should prove useful in preparing guidelines for the achievements of these goals. I assume that a goal to increase the size of the population, within limits, is desirable and will be established.

Data presented in this paper indicate a need for a management program designed specifically for the dusky Canada goose. The well-defined migration route and restricted wintering range allow a management program of this type to be used to the fullest extent.

My study indicates that mortality rates for the population have been increasing. The immature mortality rate is now near 60 percent. This rate appears excessive. How can this be true of a population that has demonstrated increasing winter inventory counts? I believe we can safely say that winter inventory counts are becoming more complete each year. Part of the increase in the winter inventory counts may be attributed to more efficient ennumeration of the birds. Aerial counts were first used in 1960. This resulted in counts that were appreciably greater than counts of previous years. The

population mortality rates are closely correlated with hunting regulations in the Willamette Valley or Oregon, since approximately two-thirds of the kill occurs in the valley, predominately on private goose clubs.

Assuming that all of the adult geese attempt to nest, I have estimated that between 50 and 66 percent of the subadult females must attempt to nest just to maintain a stable population. This percentage is considerably higher than any records in the Canada goose literature, and may be a result of a population striving to remain stable. However, Geis (1963) stated there is little evidence to suggest that increased hunting mortality is compensated for by either a reduction in non-hunting mortality or by increased production. A decrease in nesting success during a single year with the existing mortality rates would cause a substantial decline in the size of the population, since the population is composed of an average of 45.3 percent immatures. A theoretical population of 20,000 dusky Canada geese subjected to average mortality rates and brood sizes is used as an example to show the effects of decreased nesting success. If the nesting success declined from the normal 85 percent to 60 percent (similar to the 1964 decline) the population size would decrease approximately 13 percent (2,600 geese). The population would decline at least 25 percent if the lower nesting success persisted for two years. This decline could be considerably greater if the regulations remained the

same, since the kill on the Oak Knoll Hunt Club (and probably other goose clubs) is not dependent on the total number of birds available in the population (Chapman, 1967).

An earthquake on the Alaska nesting grounds in 1964 has raised the Copper River delta approximately six feet. This is resulting in an ecological change in the plant communities on the delta. Shepherd (1965) questions whether there will be sufficient suitable nesting grounds to produce a huntable population of dusky Canada geese in the future because of these changes. The population at the present time has responded favorably to the environmental change. However, the long-term effect of the earthquake remains uncertain.

The dusky Canada goose is an important and unique natural resource and I believe that it is sustaining a maximum harvest at the present time. Agencies that establish the optimum population level goal should consider some type of management that will reduce the mortality rate in order that the population may achieve this goal.

Two alternatives are available to reduce the mortality rate; restrictive hunting regulations which have been shown to effectively reduce mortality, and refuge management which has the effect of making the population unavailable to gun pressure during at least part of the hunting season. In the future, as the William L. Finley refuge is further developed, the refuge management effect on the goose mortality may be significant. To date however, the kill of

geese has remained high in spite of increased goose use of refuge lands during the hunting season. For this reason, it would appear desirable to consider the alternative of restrictive hunting regulations to provide a reduction in the mortality rates that the geese are currently withstanding. The restrictive regulations chosen, of course, depend on the population goal decided by the management agencies. Hunting restrictions for the population could be in the form of: a kill-quota system, a season bag limit, a earlier closure of the hunting season, or a reduction in the daily bag limit. These methods have all been used on Canada goose populations with success in other states.

The population is adaptable to a kill quota system, but it would mean additional effort in the form of more complete inventories and nesting ground studies. The population inventories together with the nesting data would enable predictions of numbers of birds in the fall flight to be made. The season could then be closed when the desired harvest had occurred. This method, however, would not tend to make the kill more equitable among club and non-club hunters. But, by using this method the harvest would occur early in the season, hence a higher proportion of adult breeding birds would be saved. I believe the Oregon harvest should be approximately 3,000 dusky Canada geese instead of 4,500. This would reduce the population mortality rate from the present 45 percent to approximately 35

percent. The harvest would still be considerably higher than systems used in other states. The kill-quota systems in Missouri, Illinois, and Wisconsin are based on a 20 percent harvest by the hunters.

The season bag limit would distribute the kill among more hunters. It could be enforced by using punchcards or tags, similar to those now used for steelhead, salmon, and big game in Oregon. The method has been used successfully with geese in Utah and Wyoming, however it entails some additional costs. Tags must be printed and distributed. Ten thousand tags were printed at a cost of $62.00 in Wyoming for the 1960 hunting season. These tags were distributed to bona fide holders of bird hunting licenses and Federal duck stamps at no charge to the hunters (Nelson, 1962). Regulations required that the tag holder sign his name and affix the tag to the goose as soon as the bird was killed. Wakestraw (1961) indicated that the Wyoming Game and Fish Commission was well satisfied with the initial attempt at spreading out the goose kill among more hunters. The season bag limit also may offer the adult breeding stock some protection late in the season when they are more vulnerable. A major disadvantage of the season limit proposal is that the season bag limit would force some of the large hunting clubs to disband or to change their practices from a yearly fee with fewer hunters to a daily fee with many hunters. Both of these changes could result in a detrimental effect on the goose population. If the clubs go out of

business, much prime goose habitat will be lost, and if clubs change to a moderate daily fee, more hunters may cause a higher percent of the population to be harvested. At the present time, the major goose hunting club in the Willamette Valley (Oak Knoll Hunt Club) is operating at only a small percentage of its possible harvest efficiency. With a season bag, the operators might choose to greatly increase the profit by substantially increasing the numbers of hunters accommodated each day.

An early closure of the hunting season, would not distribute the kill among more hunters. This method is similar to a quota system but is based on past records rather than the kill of the particular year involved. These records are available for immediate use and would require no further studies. Since more adults are killed later in the season, an early closure will protect a portion of the adult breeding stock from the hunter. However, the method does not have the preciseness of the quota system.

A reduction of the daily bag limit from three geese to two would definitely lower the mortality rate of the population. The low mortality rates in 1955 and 1956 can be attributed to the reduction in the daily bag limit from three to two birds in five Oregon counties. At the same time, this method may distribute the kill among more hunters. Chapman (1967) further discussed the effect of reducing the daily bag limit from three birds to two, and concluded that the

principle age class that such a regulation would benefit is the immatures.

This study has demonstrated that the dusky Canada goose is currently sustaining a maximum harvest with high mortality rates as compared with other well managed populations. If the annual production on the breeding grounds is reduced, we may expect marked reductions in the wintering populations. At present harvest rates there is little opportunity for the population to increase. Management to reduce the mortality rates can be expected to result in population increases. At the present time, restrictions in the hunting regulations on dusky Canada geese holds greater promise for immediate mortality rate reduction than does refuge management. The latter will play an increasingly important role in the fate of the dusky Canada goose as development and acceptance of the refuges by the geese increases.

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APPENDIX

Appendix Table I. Average cumulative dusky Canada goose kill by time, age, and political subdivision, (1952-65).

		Alaska		British Columbia		Washington		Oregon	
		Imm.	Adult	Imm.	Adult	Imm.	Adult	Imm.	Adult
Sept.	1-10	.319	.273	---	---	---	---	---	---
	11-20	.617	.424	---	---	---	.016	---	---
	21-30	.723	.606	---	---	---	.016	---	---
Oct.	1-10	.850	.757	.021	.014	---	.065	---	---
	11-20	.956	.848	.053	.042	.029	.065	.006	---
	21-31	1.000	.969	.171	.125	.029	.065	.020	.007
Nov.	1-10	---	1.000	.365	.333	.157	.131	.046	.045
	11-20	---	---	.730	.736	.485	.361	.222	.167
	21-30	---	---	.848	.847	.742	.508	.407	.292
Dec.	1-10	---	---	.880	.902	.856	.672	.590	.442
	11-20	---	---	.933	.944	.913	.852	.769	.613
	21-31	---	---	.986	.972	1.000	.966	.931	.837
Jan.	1-16	---	---	1.000	1.000	---	1.000	1.000	1.000

Appendix Table II. Distribution of who reported dusky Canada goose band recoveries by state or province of recovery, 1957 to 1964.

State or Province of Recovery	Who Reported			
	Hunter	State/Province	Federal	Other[a]
Number of Recoveries				
Oregon	479	59	21	19
Washington	77	6	13	--
British Columbia	124	5	31	1
Alaska	27	17	17	--
Percentage of Recoveries				
Oregon	.83	.10	.04	.03
Washington	.80	.06	.14	--
British Columbia	.77	.03	.19	.01
Alaska	.44	.28	.28	--

[a]Other reports includes duck clubs, plucking station, bird bander, U. S. Fish and Wildlife Service Survey, or undetermined source.

Appendix Table III. List of band numbers that were collected by a band solicitor at the Oak Knoll Hunt Club. The numbers are in chronological order.

527-33964	558-10365	528-08825	498-55886	528-52577	528-79739
527-98486	558-10376	528-09195	528-79126	528-24599	528-79807
528-09076	528-52543	508-59966	508-59958	528-24503	528-79719
527-34404	558-10442	528-08832	528-79383	528-24323	528-79697
528-52296	498-55769	498-32299	528-79142	528-24432	528-79604
527-34611	528-08686	528-09173	528-79357	528-79268	528-79654
508-59851	558-10304	528-09113	528-79102	508-59818	528-79524
528-79290	558-10439	528-09068	528-09031	528-24380	528-79657
528-79108	528-79134	498-55768	528-79093	528-08697	528-24262
508-17836	558-10519	528-08904	528-08942	528-08644	528-24291
528-79476	528-52623	528-79307	528-79233	528-24267	528-24371
528-09122	528-52593	528-08803	528-79005	528-79551	528-24288
528-09003	528-79353	528-09039	528-09198	518-91452	528-24641
528-09096	528-79006	518-91591	498-32281	528-79665	528-79717
528-52531	508-59771	528-79478	528-52310	528-79570	528-79593

Willamette Valley Canada Goose Survey

Dear Oregon Sportsman:

The Department of Fisheries and Wildlife at Oregon State University is studying the Canada geese of the Willamette Valley. As you may know, a new federal refuge has been established south of Corvallis especially for these geese.

We are concerned with evaluating waterfowl hunter activity in the Willamette Valley. You have been selected to help in our evaluation. Your part in this job will take only a few minutes of your time, but the knowledge we will gain from this project could benefit waterfowl hunting for years to come.

Please answer this questionnaire even if you DID NOT HUNT or DID NOT SHOOT any geese. All reports are equally important.

Note: Include only information about hunting done in the Willamette Valley, Oregon, during the 1965 hunting season.

1. Did you hunt ducks or geese in the Willamette Valley in 1965? Yes ☐ No ☐

2. How many days did you hunt ducks or geese in the Willamette Valley during the 1965 hunting season? _____

3. Were you a member of a hunting club which owns or leases land to hunt waterfowl? Yes ☐ No ☐

4. Were you a guest at a hunting club (defined above)? Yes ☐ No ☐

5. Did you hunt and/or kill geese in the valley in 1965? Yes ☐ No ☐

6. Main type of goose hunting (mark only one).
   Decoy and blind ☐ Pass shooting fence rows, etc. ☐ Sneak shooting ☐ Other ☐

7. How many Canada geese did you get while hunting specifically for geese? _____

8. How many Canada geese did you get while hunting for ducks? _____

9. How many Canada geese in 1965 did you knock down within sight but could not find or retrieve? _____

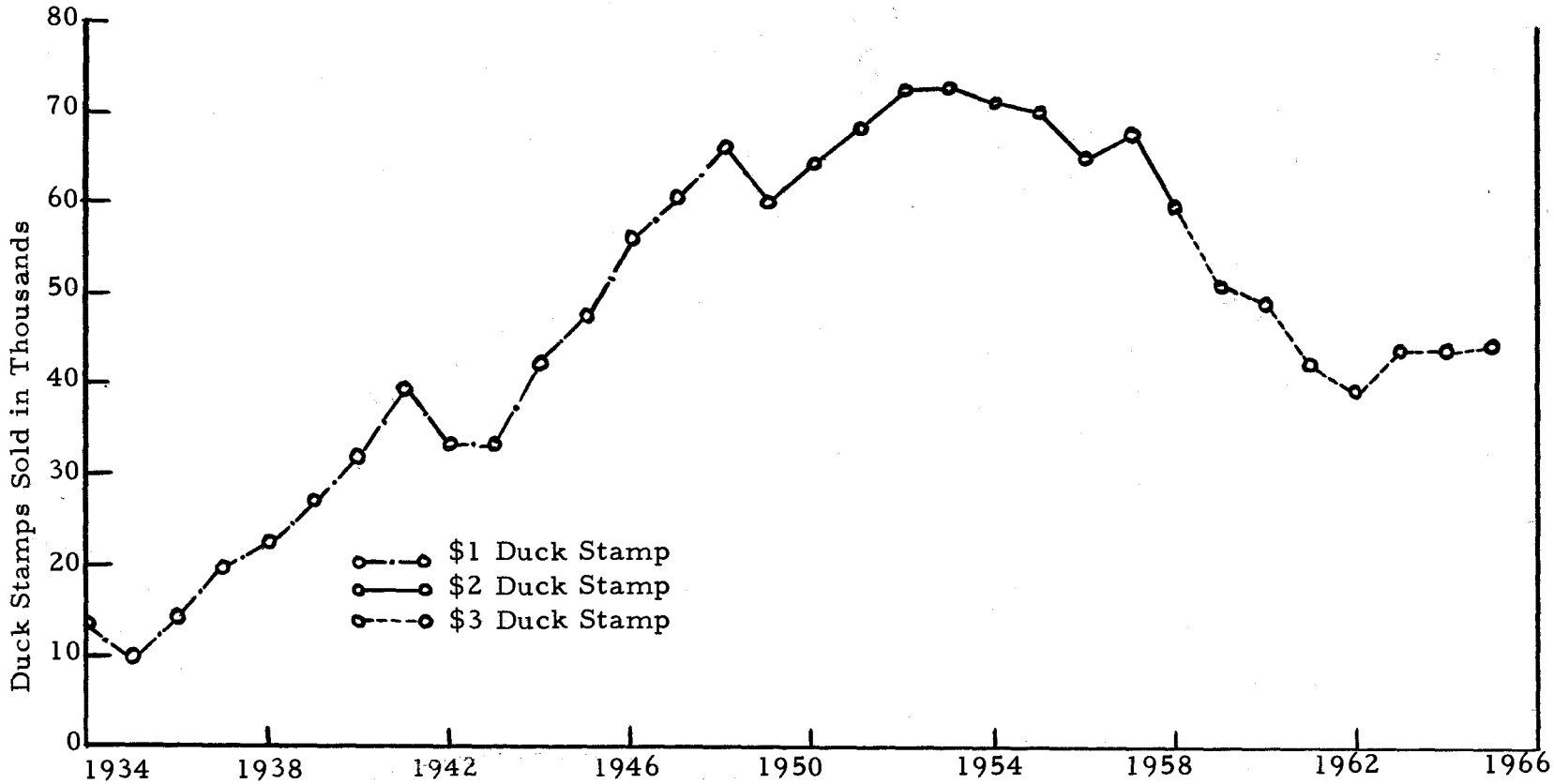
10. Where did you do most of your goose hunting (hunting club name, farmers name, distance and direction from nearest town, etc.) _____

11. How many banded geese did you shoot? _____

12. Would you be in favor of doubling or tripling the Willamette Valley Canada goose population by modest hunting restrictions for a few years? Yes ☐ No ☐

13. Do you have any comments on goose hunting in the Willamette Valley? _____

Appendix Figure 1. Copy of questionnaire sent to Willamette Valley waterfowl hunters in October of 1966.



Appendix Figure 2. Oregon duck stamp sales for the period 1934 to 1966.