

DISTRIBUTION AND MORTALITY OF SASKATCHEWAN-BANDED WHITE-FRONTED GEESE<sup>-1</sup>

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At its annual spring meeting in 1959 the Technical Committee of the Central Flyway Council recognized a decreased population of the white-fronted goose (Anser albifrons). The recorded harvest in Canada and the United States had exceeded the estimated wintering population in some years. After summarizing records for the Central and Mississippi Flyways the Committee found them inadequate for management and to help fill this void, recommended banding on local concentration areas including Saskatchewan.

A cooperative project of the Canadian Wildlife Service, the U. S. Bureau of Sport Fisheries and Wildlife, and the Nebraska Game and Parks Commission was initiated in the Kindersley District of Saskatchewan in 1961. The objectives were: (1) to develop techniques for capturing white-fronted geese, (2) to annually band samples adequate to produce at least 100 first-year recoveries, (3) to determine from these recoveries, the distribution and population dynamics of whitefronts concentrating in the Kindersley area, and (4) to make recommendations for management as may be indicated by these analyses.

This paper summarizes the results of the banding program in regard to: (1) perfected techniques for mass capture of autumn migrating white-fronted geese, (2) geographical and temporal distribution patterns of band recoveries and to further delineate major harvest areas, (3) preliminary annual mortality estimates, and (4) management procedures which might lead to more stable or increasing population levels.

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## METHODS

### Banding Area

Banding was conducted on four lakes; Teo, Buffalo Coulee, Cut-bank, and Eyre, all within the degree-block 51° N latitude and 109° W longitude. The first two lakes are in inviolate game preserves while the last two have a 500-yard no-shooting zone around them.

The degree-block was situated near the northern edge of the mixed prairie region (Coupland, 1950), immediately south of the Fescue Prairie Association (Coupland, 1961), and the Aspen Parklands (Bird, 1961). Topography is gently to moderately rolling with numerous closed depressions which fill with runoff water from snow melt or heavy thunderstorms. Descriptions of soils, climate, and land use are found in Mitchell et al. (1944), Boughner and Thomas (1948), Chapman and Brown (1966), and Duffett (1957).

### Trapping Techniques

Initial attempts to trap whitefronts in 1961 were made with cannon-projected net traps (Dill and Thornsberry, 1950; Miller, 1957) and a drop-door trap (Addy, 1956). Traps were baited with mixed barley and wheat. Subsequent trapping was conducted without bait on shorelines where geese concentrated for loafing or resting. We used nets of 4-inch mesh measuring 40 by 80 feet, in batteries of one to six, set 15 to 30 feet back from and parallel to the water. If the shoreline was wet and muddy, pondweeds (Potamogeton spp.) were spread on the site in a thin mat to attract loafing geese. We found that geese could be "herded" to the trap sites by driving a vehicle onto the opposite shoreline.

Most geese were banded between 14 September and 15 October each year. This period was immediately prior to and during the hunting season in the Kindersley District.

Marking for sight identification to determine local movements and family behavior (Miller and Dzubin, 1965) was with jesse-knot neckbands (Craighead and Stockstad, 1956) and plumage dyes (Kozlik et al., 1959).

### Productivity Surveys

Age ratios were obtained by observing flocks using several lakes in the degree-block after methods described by Lynch and

Singleton (1964). Biases inherent in these methods are described by Dzubin and Miller (1966) and J. J. Lynch (unpublished reports, 1966 and 1967, Bureau of Sport Fisheries and Wildlife).

#### Analysis of Band Recoveries

Terminology and definitions (e.g., direct, indirect, recovery rate, etc.) used are the same as those utilized by the U. S. Bird Banding Laboratory, and defined in Vaught and Kirsch (1966) and in Moisan et al. (1967).

All recoveries reported to the Bird Banding Laboratory by August 1967 were made available for this report. Only those recoveries listed as shot or killed were utilized to determine distributions and estimate preliminary mortality rates. We recognize that the analyses of recoveries from banding during migrations have certain limitations as discussed by Hickey (1951, 1952) and Crissey (1955). The biases involved in determining distributions from recoveries have been summarized by Gollop (1963). In an attempt to overcome these limitations, we have used only indirect recoveries to determine distributional patterns.

Methods used to calculate mortality and survival rate estimates have been discussed by a number of authors (Deevey, 1947; Bellrose and Chase, 1950; Hickey, 1952; Farner, 1955; Haldane, 1955; Lauckhart, 1956; Geis, 1959). It was obvious that neither the "dynamic" method, which assumes the entire life span has been represented by recoveries, nor the "time-specific" method, which assumes the same fraction of the total population was shot and reported each year, could be used in our analyses. Geis and Taber (1963) discussed a method proposed and later published by Williams (1967). A. D. Geis provided a refinement of this method (pers. comm., 1966) which he termed the "relative recovery rate" method. This procedure compares band recovery rates from the same hunting seasons for two samples of geese, one banded a year longer than the other. The difference in the two rates reflects the mortality during the year. For example, with perfect survival, both recovery rates should be the same. This method assumes that the same population is banded each year; therefore, all surviving banded birds are subject to the same shooting pressure regardless of the year in which they were banded. We submit our bandings and recoveries meet this assumption; therefore, we have used this method.

## RESULTS

### Trapping Techniques

Our initial attempts in 1961 to capture white-fronted geese with baited net and drop-door traps were largely unsuccessful; only 78 were taken. There were no indications the whitefronts were "spooked" by baits; rather, any quantity of bait offered was consumed by ducks before the geese, apparently satiated from their morning feeding flight to surrounding fields, were interested in feeding. Once we recognized the propensity of whitefronts to use shorelines for loafing and were successful in capturing an additional 695 on such sites in 1961, we adopted this technique for the remainder of the program. However, the technique failed us in 1965, when above-average precipitation resulted in numerous ponds and lakes in the grain fields. The geese then used the shallow portions of these ponds beyond the range of the projected net traps.

### Recoveries and Vulnerability

The whitefronts marked during the four successful years of the study totaled 7,678 of which 6,555 were leg-banded only, 940 banded and color-marked with plumage dyes, and 183 banded and marked with "neckties".

A summary by age and sex groups of the "normal" (leg-banded only) whitefronts banded each year and the recoveries from each group by hunting season, as reported prior to August, 1967, are presented in Table 1. This shows that higher proportions of immatures than adults were recovered the year of banding. The ratio of immature to adult recovery rates was 2.59:1 in 1961, 2.15:1 in 1962, 2.23:1 in 1963, and 2.55:1 in 1964. We assumed that the rate at which hunters reported banded birds was the same for immature and adult whitefronts; therefore, the weighted mean indicates that immatures were 2.31 times as vulnerable (likely to be shot) as were adults.

### Distribution of Banded Geese

The direct (first hunting season) recoveries of birds banded at Kindersley immediately prior to and during the open season in that locality, produced biased distribution patterns since the harvest occurring northward of the banding site and prior to banding was not represented. Therefore, indirect recoveries (May 1 following banding and later) of normal and dye-marked birds (these assumed a normal

appearance after the first molt) were used in the geographic distribution presented in Figure 1. The indirect recoveries of whitefronts banded at Lower Souris National Wildlife Refuge, North Dakota are also presented in Figure 1.

Table 1. Recoveries of white-fronted geese banded at Kindersley, Saskatchewan.

Year	Age-Sex	Number banded	Recoveries by hunting season opening in					
			1961	1962	1963	1964	1965	1966
1961	AM	158	16	5	5	5	1	3
	AF	129	7	7	4	1	1	1
	IM	40	7	0	1	0	1	0
	IF	37	9	1	1	0	0	0
1962	AM	460		33	20	7	11	8
	AF	427		30	15	8	6	3
	IM	255		37	10	7	3	0
	IF	262		42	11	12	4	9
1963	AM	712			43	26	19	8
	AF	665			44	29	18	15
	IM	607			90	24	17	13
	IF	580			77	24	13	7
1964	AM	807				46	23	20
	AF	726				41	20	21
	IM	363				52	8	6
	IF	327				48	13	9
Total		6,555						

Distributions of recoveries from these two banding sites were distinctly different. A strong western orientation was shown by 603 recoveries of Kindersley bandings, 11 per cent of which were reported from Alberta, 29 per cent from Saskatchewan, 31 per cent from Texas, 14 per cent from Mexico, 3 per cent from Louisiana, and none from Manitoba. An eastern orientation was indicated by 56 recoveries of Lower Souris bandings as 20 per cent were reported from Manitoba, 16 per cent from Saskatchewan, 39 per cent from Louisiana, and only 9 per cent from Texas.

Nineteen whitefronts we banded were subsequently trapped and released at other banding sites; five in the MacKenzie District, NWT; five in Nebraska; four in Mexico; two in Texas; and one each in the Yukon Territories, Illinois, and Louisiana. We trapped and released 32 whitefronts we had banded previously and 31 which had been banded at other locations including 12 banded in the MacKenzie District, 7 in Nebraska, 6 in Alaska, 3 in South Dakota, and 1 each in North Dakota, Kansas, and Texas. This information complements the recovery patterns determined from shot birds (Figure 1) since whitefronts migrating through western Saskatchewan in autumn were associated with spring migration areas in Nebraska and South Dakota. They were also associated with molting areas in the Northwest Territories and northwestern Alaska in July and early August.

#### Distribution of Yearling Cohort

Field counts prior to 15 September indicated that early migrant flocks were composed primarily of unsuccessful or non breeding adults or of yearlings. Differential migration of population components has been substantiated for Canada geese of the Eastern Prairie Population (Vaught and Kirsch, 1966) and for the Tall Grass Prairie Canada Goose Population (MacInnis, 1966). The former authors also suggest that yearlings show somewhat wider distribution patterns because they are more apt to stray and also show higher band recovery rates than adults. In England, Boyd (1955) noted young banded pink-footed geese (A. fabalis brachyrhynchus) were less likely to be subsequently taken in the banding area than were adult birds.

Although samples were small, the distribution pattern of 93 yearling whitefront recoveries did not vary significantly from that of adults in the second year after banding or from the direct recoveries of immatures. Yearlings were recovered in the same major harvest areas as the adults and immatures (Figure 1). The similarity of yearling band distribution patterns with adult and immature patterns may reflect (1) an anomaly due to small samples, (2) strong post-molt familial ties of yearlings or, (3) fidelity of post-molt yearlings to former natal areas where they rejoin flocks which consistently utilize the same migratory routes.

#### Temporal Distribution of Recoveries

The distribution by 10-day intervals of indirect recoveries of all normal and dye-marked whitefronts banded at Kindersley is presented in Figure 2. This distribution reflects hunting season dates

and may be biased by hunter activity and other factors (Crissey, 1955; Gollop, 1963). However, in Saskatchewan, the temporal distribution of recoveries (Figure 2) closely paralleled the temporal distribution of birds as determined by weekly surveys, and furthermore, closely paralleled the temporal distribution of the harvest as indicated by the Saskatchewan Hunter Surveys, 1961-1966. These data suggest that, although three-quarters of the harvest in Saskatchewan occurred in late September and early October (a 20-day interval), the harvest on the wintering grounds was spread from late October through January (approximately 80 days in Texas and 100 days in Mexico).

The annual distribution patterns were similar for all years except 1966 when there was a noticeable shift of recoveries to the later part of the hunting seasons, e.g., one recovery from interior Alaska on 23 September and no recoveries in Mexico prior to 1 December. T. W. Barry (in. litt.) reported flocks of migrating whitefronts near the delta of the MacKenzie River as late as 7 October, 1966. The retarded migration was associated with above-average September temperatures throughout the MacKenzie River Basin.

A comparison of the time of indirect band recoveries within the hunting seasons suggested that whitefronts banded in September each year showed consistently earlier recovery patterns than did those banded in October. That is, early migrating segments in one year continued to show a tendency to migrate early in the following years.

#### Survival and Mortality Estimates

The survival and mortality rates, as estimated by the relative recovery rate method, for all normal adult white-fronted geese banded at Kindersley are presented in Table 2. The survival rate for any year (to the beginning of the next hunting season) is the recovery rate for the next and subsequent seasons divided by the recovery rate for all recoveries from the following banding year. For example, the 1962 survival rate for adult whitefronts banded in 1962 is the recovery rate determined by the number of bands recovered during 1963-66 ( $78 \div 887 = 0.088$ ) divided by the recovery rate for adult whitefronts banded in 1963 and recovered during 1963-66 ( $202 \div 1377 = 0.147$ ) or 0.60. The average survival rate is the sum of the recovery rates for the second and later hunting seasons ( $HS_2$  through  $HS_j$ ) divided by the sum of recovery rates for all hunting seasons ( $HS_1$  through  $HS_j$ ) of birds banded in subsequent

years. Note that the analyses considered only those hunting seasons yielding both second through later ( $HS_2$  through  $HS_j$ ) and first through later ( $HS_1$  through  $HS_j$ ) recoveries, during the same hunting season, to assure that the same shooting pressures were applied to both samples. To do this, recoveries during the periods  $HS_1$  to  $HS_2$  were omitted for 1961 and  $HS_2$  through  $HS_j$  for 1964. Thus, we can determine survival rates of only those whitefronts banded in 1961, 1962, and 1963. The mortality rate, in all cases, is the difference between a complete survival rate (1.00) and the observed survival rate.

The average first-year mortality rates for adult males was 0.293, for adult females 0.337, and for all adults combined 0.313. The average mortality rates, based upon recovery rates corrected for differential vulnerability rates, was 0.452 for immature males, 0.437 for immature females, and 0.441 for all immatures. Note that these first-year estimates are based primarily upon birds banded during the hunting season. Banded birds were then exposed to less total hunting days, and presumably less hunting pressure, during the first season than during the second and later hunting seasons; therefore, these mortality rates would be depressed. We submit that these mortality rates are conservative.

Table 2. Estimates of survival and mortality rates by the relative recovery rate method for adult white-fronted geese banded at Kindersley, Saskatchewan.

Year banded	Number banded	Number of recoveries		Recovery rates	
		$HS_1^1 \text{---} HS_j$	$HS_2 \text{---} HS_j$	$HS_1 \text{---} HS_j$	$HS_2 \text{---} HS_j$
1961	287	56	33		0.115
1962	887	141	78	0.159	0.088
1963	1,377	202	115	0.147	0.084
1964	1,533	171	84	0.112	
Totals				0.418	0.287

Average survival rate:--  $0.287/0.418 = 0.687$

Average mortality rate:--  $1.000-0.687 = 0.313$

<sup>1</sup> HS = hunting season of recovery;  $HS_1$  = first hunting season,  $HS_2$  = second hunting season ...  $HS_j$  = last hunting season for which recoveries are available.



The number of second hunting season recoveries of whitefronts banded as immatures was 91 (3.7 per cent) versus 145 (3.6 per cent) banded as adults. The estimated mortality rate for yearlings (immatures in their second year) was 0.39 which was higher than the 0.27 rate for adults in their second year after banding.

Dye-marked whitefronts were analyzed separately in view of the possibility that their recovery rates were biased by differential reporting rates. In 1962, the only year in which the dye-marked sample was adequate for analyses, the first-year recovery rate for 455 dye-marked adults was 0.057 compared to 0.071 for normal adults and for 263 dye-marked immatures was 0.129 compared to 0.153 for normal immatures. Although the first-year recovery rate was lower for all dye-marked (0.079) than normal whitefronts (0.101), a chi-square test of independence indicated the difference was not significant ( $p > 0.05$ ). The first-year mortality rates from 1962 bandings were 0.39 for dye-marked compared to 0.40 for normal adults and 0.24 for dye-marked compared to 0.26 for normal immatures (corrected for differential vulnerability).

## DISCUSSION AND CONCLUSIONS

### Delineation of Populations

The majority of banded white-fronted geese recovered are shot by hunters. Therefore, recoveries reflect the distribution of hunting activity in addition to the distribution of banded whitefronts. A comparison of the distribution of recoveries from several banding sites enabled a reasonable inference of the distribution of birds represented by any one banding site. If Kindersley-banded whitefronts were not recovered in areas where whitefronts banded at other sites were recovered, we assumed Kindersley-banded birds did not occur in those areas.

The geographic distribution of recoveries indicated that the Kindersley bandings represented white-fronted geese harvested primarily in Alberta and Saskatchewan, the eastern half of the Central Flyway, and in Mexico. Only 3 of 1,308 recoveries of all Kindersley-banded whitefronts were reported from the Pacific Flyway, the only other area in North America where whitefronts are common migrants. To 1966, the State of California banded 4,827 whitefronts and of 1,035 recoveries

reported through the 1966 hunting season, only two were from the Central Flyway.

Recovery information from whitefronts banded in Alaska between 1 June and 31 August 1948-1960, as provided by Mr. H. A. Hansen (Annual Waterfowl Report, Alaska-1960, Unpubl. mimeo. report, 14 pp. w/appendix), demonstrated orientation to one or the other of the two western flyways. All recoveries (29) from 119 birds banded on the Yukon-Kuskokwim Delta were in the Pacific Flyway. Conversely, none of 420 banded at Selawik, approximately 300 miles further north on the west coast, were recovered in the Pacific Flyway; the distribution pattern of the 50 recoveries was similar to that of Kindersley bandings. Approximately 12 per cent of 157 recoveries from 639 banded on Innoko River sites were from Pacific Flyway states and 78 per cent were from Alberta, Saskatchewan and Central Flyway states. The remaining 10 per cent were from Mexico. The Innoko River sites were approximately 120 miles south of the Selawik site and 80 miles inland. The distribution of recoveries indicated an overlapping of breeding or molting ranges within this area. Three recoveries of 22 whitefronts banded at Minto Lakes, near Fairbanks, were from Saskatchewan and two were from central Mexico.

We conclude that there are two distinct, major populations of North American white-fronted geese. We have termed the one harvested in the Prairie Provinces, Central and Mississippi Flyways, and Mexico the "Mid-continent Population" and the other the Pacific Flyway Population.

We compared the distribution of Recoveries from banding stations within the range of the Mid-continent Population of whitefronts. Figure 1 presents the geographic distribution of indirect recoveries from whitefronts banded during the fall migration in the Kindersley district.

The Kindersley bandings are referable to whitefronts which breed in Alaska and Arctic Canada generally north of  $64^{\circ}$  N latitude and west of  $125^{\circ}$  W longitude. They migrate southeast and south into east-central Alberta and west-central Saskatchewan, southeastward into western North Dakota, south into Texas and then southward into Mexico. They apparently winter on the coastal plains of Texas and in eastern and central Mexico as far south as Mexico City. One extra-limital recovery was received from the State of Campeche.

The recoveries of Alaska-banded whitefronts in the mid-continent range showed a distribution similar to that of the Kindersley bandings.

Recoveries of white-fronted geese banded in South Dakota and Nebraska in spring show close affinities with the pattern of recoveries from Kindersley. Twedt (1964) in recording South Dakota retraps of foreign-banded white-fronted geese noted that they originated near Holy Cross and Selawik, Alaska; MacKenzie and Anderson Rivers, N.W.T., and Kindersley, Saskatchewan. Hunting returns of birds banded in South Dakota and Nebraska were received from Kindersley, eastern Alberta, east-central Texas, and Mexico.

The whitefronts banded on the Anderson River during the molting period migrated southward to the vicinity of the Kindersley banding site. An association between these points was further illustrated by five Kindersley-banded geese trapped on the Anderson River and 12 Anderson River birds trapped at Kindersley. The next major harvest areas are in the Katy-Lissie Prairie area of Texas and in southwestern Louisiana.

Figure 1 also presents the geographic distribution of recoveries from whitefronts banded at the Lower Souris (now J. Clark Salyer) National Wildlife Refuge, North Dakota. These bandings produced only one recovery within the known breeding range (Godfrey, 1966); that was made at Chesterfield Inlet on the west coast of the Hudson Bay in the Keewatin District, N.W.T. Whitefronts assumed to have bred in Keewatin, migrate southward through west-central Manitoba into southwest Manitoba and southeast Saskatchewan, the east Central Flyway, states and into the Mississippi Flyway in Louisiana.

Tom Sterling of Ducks Unlimited banded 146 molting adults between Aberdeen and Beverley Lakes (lat. 64°33' N, long. 100°13' W) on the Thelon River drainage in July 1964 and 1965. This region of Keewatin is part of the eastern breeding grounds of the white-fronted goose (Snyder, 1957; Godfrey, 1966). Of 24 direct and indirect recoveries received, 3 were in eastern Saskatchewan, 1 in Manitoba, 2 in eastern North Dakota, 15 in Louisiana, and 3 in eastern Mexico.

The percentage ratio of all recoveries in Texas and Louisiana was 92 in Texas:8 in Louisiana for Kindersley-banded whitefronts, 82:18 for Anderson River bandings and 18:82 for Lower Souris bandings.

Therefore, we conclude that there are at least two sub-populations within the Mid-continent Population of white-fronted geese which, for management purposes, are separate and distinct. We will consider for the purposes of this discussion that the Kindersley bandings are representative of the "western" sub-population and that the Lower Souris bandings are representative of the "eastern" sub-population.

#### Status of Mid-Continent Population

The status of the Mid-continent Population of whitefronts is appraised during both the wintering and spring migration periods. The mid-winter surveys of all waterfowl are conducted by the Bureau of Sport Fisheries and Wildlife, state conservation agencies, and other cooperators and included in Waterfowl Status Reports (Crissey, 1961; Glover and Smith, 1963; Hansen, 1964, 1967; Hansen and Hudgins, 1965). The spring surveys were initiated in Nebraska in 1961 and were expanded to include Iowa and Missouri in 1962. Since 1963, these late March surveys have been coordinated by the Bureau of Sport Fisheries and Wildlife and have included cooperators in Oklahoma, Kansas, North and South Dakota, and Minnesota. The population estimates from these surveys (L. J. Bonde, pers. comm.) are presented in Figure 3.

The mid-winter surveys are designed primarily to measure trends in waterfowl populations. How well whitefront trends are measured and their relationship to actual populations is unknown at this time. J. J. Lynch (pers. comm.) reported whitefronts were difficult to locate on the wintering grounds as they had usually dispersed into small flocks or even family groups by mid-January. A. R. Brazda (pers. comm.) reported those that wintered in Mexico were usually in small flocks scattered on small lakes or, especially in the Central Highlands, on small streams where it was only by chance they were observed. The portion of the wintering area surveyed in Mexico was less than in Texas; therefore, the counts probably were less complete in those years when drought-depleted habitat in Texas forced more whitefronts to winter in Mexico.

The coordinated spring surveys have, since 1963, included all states where whitefronts are known to be present in mid-March and presumably, included the entire Mid-continent Population. This was strongly indicated when, in 1964 and 1965, the combined estimates of the Mississippi and Central Flyway populations from the mid-winter surveys were similar to the estimates from the spring surveys.

We interpret information in Figure 3 to indicate a considerable increase in whitefronts wintering in the Mississippi Flyway between 1961 and 1967. Parallel to this was a general increase in the number of breeding pairs and broods observed along the Thelon River since 1960 (Kuyt, 1962). Our band recovery information showed no evidence the harvest shifted from Texas to Louisiana during that period; therefore, we submit it unlikely the population shifted wintering areas.

There is no evidence to suggest that the Mid-continent Population, as estimated during the mid-winter or spring surveys, responded in proportion to the increase in the eastern sub-population (in Louisiana). Therefore, we concluded the western sub-population, wintering in Texas and Mexico and associated with our banding area, at best merely maintained itself and at worst decreased.

Other data supported this conclusion. The productivity of the western sub-population as determined from field counts in the Kindersley District, ranged from 11 per cent immatures in 1965 to 38 per cent in 1966 and averaged only 23 per cent during the 1960-66 period. For the 1962-64 period, the productivity can be estimated from the Kindersley banding data and information compiled by G. L. Smart from the nation-wide Goose Tail Collection Survey initiated in 1962 by the Bureau of Sport Fisheries and Wildlife (unpublished Administrative Report 112, Migratory Bird Populations Station, Laurel, Maryland). Texas was the only major harvest area in the Central Flyway where collections of whitefront tails were adequate to provide age ratios. The average immature to adult ratio in 1962, 1963, and 1964 was 77:100. A comparison of first-year recovery rates of Kindersley-banded immatures and adults recovered in Texas showed a differential vulnerability of 2.40 during the 1962-64 period. The observed age ratio in the Texas harvest corrected for the differential vulnerability in Texas ( $77 \div 2.40$ ) indicated an average age ratio of 32:100 (24 per cent immatures) in the banded population at time of banding. This was the same as the average of 24 per cent immatures observed those three years during the productivity surveys.

The average age ratio during the period for which mortality rates were calculated, (1961-63), as determined by the field productivity surveys, was 25 per cent immatures:75 per cent adults. The average annual mortality rates for immatures and

adults, weighted for this age ratio, indicated an average annual mortality rate of 0.34 for all cohorts of the banded population.

## RECOMMENDATIONS

### Management Recommendations

We suggest that there has been a decrease in the western sub-population of white-fronted geese. Furthermore, we see no evidence to indicate this decline has been halted prior to 1967. It should be noted that in Alberta and Saskatchewan, the bag and possession limits, which had been three and six during 1962-1966, were reduced in 1967 to two whitefronts daily and four in possession. The 1967 regulations permitted only one Canada or one white-fronted goose in eastern Texas; earlier regulations had permitted one Canada and one white-fronted goose. There were no data available to evaluate the effects of these more restrictive regulations.

We recommend consideration be given to increasing the western sub-population of whitefronts and the establishment of population goals geared to their extensive breeding and wintering ranges. This would require a considerable reduction in the total harvest. We urge that the Bureau of Sport Fisheries and Wildlife and the State of Texas together with the Canadian Wildlife Service and the Provinces of Alberta and Saskatchewan actively cooperate through the Central Flyway Council in all future management endeavors.

## SUMMARY

A review of all available recovery information on white-fronted geese in North America established two identifiable populations. One, breeding in southwestern Alaska, is oriented to the Pacific Flyway. The other which breeds in northern Alaska and Canada generally north of 64° N latitude, is oriented to the Prairie Provinces and the Central and Mississippi Flyways. The latter has been termed the "Mid-continent Population".

The distribution of recoveries of whitefronts from banding sites within the range of the Mid-continent Population indicated at least two sub-populations. For management purposes, these

can be separated into one referable to the Mississippi Flyway, the "eastern" sub-population, and another referable to the Central Flyway, the "western" sub-population.

Mid-winter surveys indicated the eastern sub-population of whitefronts increased considerably from 1961 to 1967. Conversely, there was no suggestion of an increase in the western sub-population in this overall period. Spring surveys indicated the Mid-continent Population fluctuated but did not increase from 1963 to 1967. It is proposed that the western sub-population has decreased in the order of magnitude of the increase in the eastern sub-population.

The western sub-population was sampled during a 1961 to 1964 autumn banding program in western Saskatchewan. Average first-year mortality rates during the 1961-63 period, estimated from band recoveries, were 0.441 for all immatures and 0.313 for all adults. The weighted average first-year mortality rate was 0.34 for all cohorts of the banded sample. The average production was 25 per cent during these same years. It is submitted the western sub-population did not maintain itself during the banding years and that the apparent decrease from 1963 to 1967 was real.

Recommendations included the establishment of population goals geared to the extensive breeding and wintering ranges which makes mandatory a decrease in the harvest of the western sub-population of white-fronted geese.

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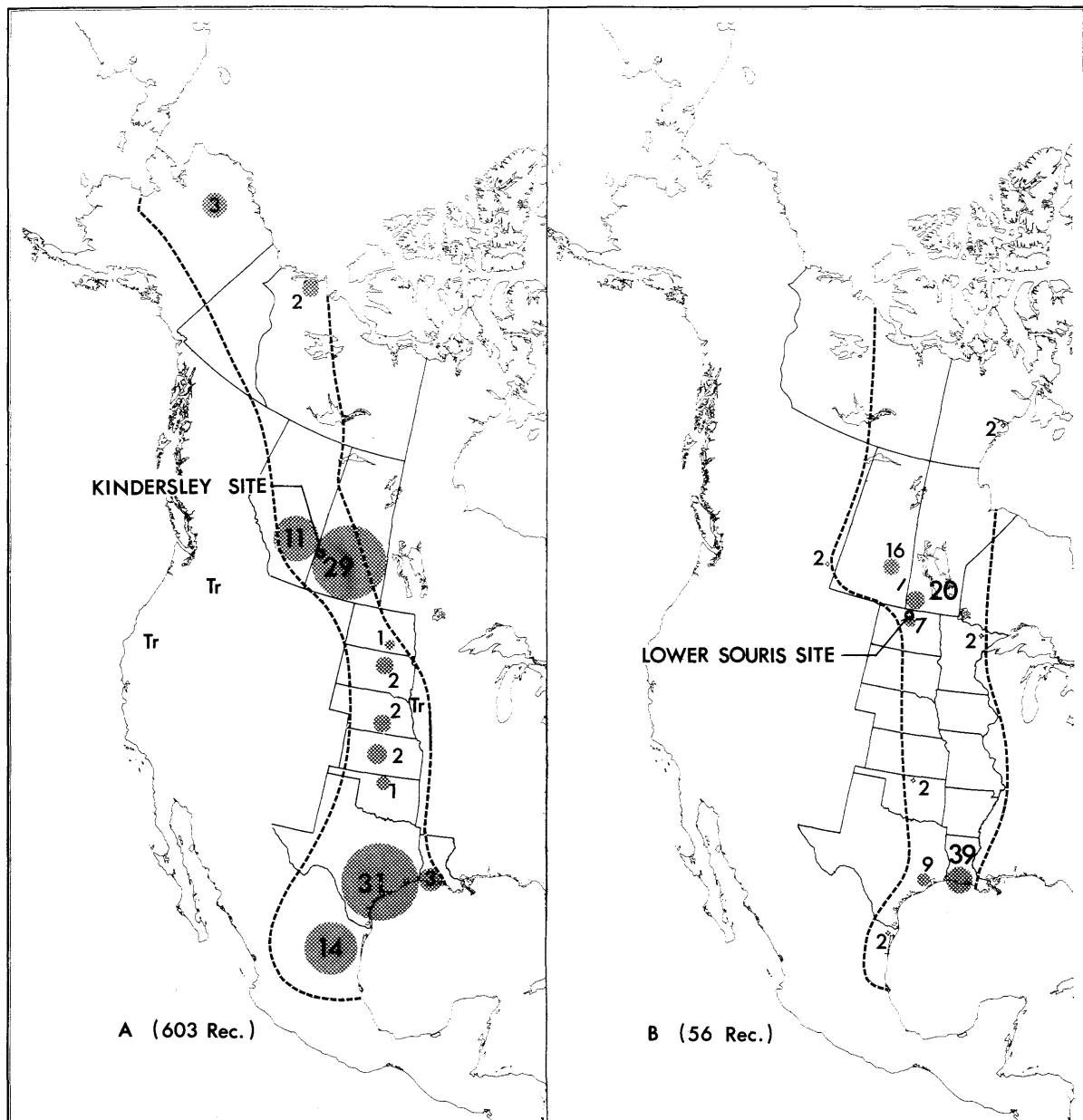


Figure 1. Distribution of indirect recoveries (in per cent) of Mid-continent White-fronted Geese banded at (A) Kindersley, Saskatchewan and (B) Lower Souris National Wildlife Refuge, North Dakota (Schroeder, 1967). Shaded areas are proportional to the number of recoveries and are not always indicative of location. Broken lines delineate approximate ranges.





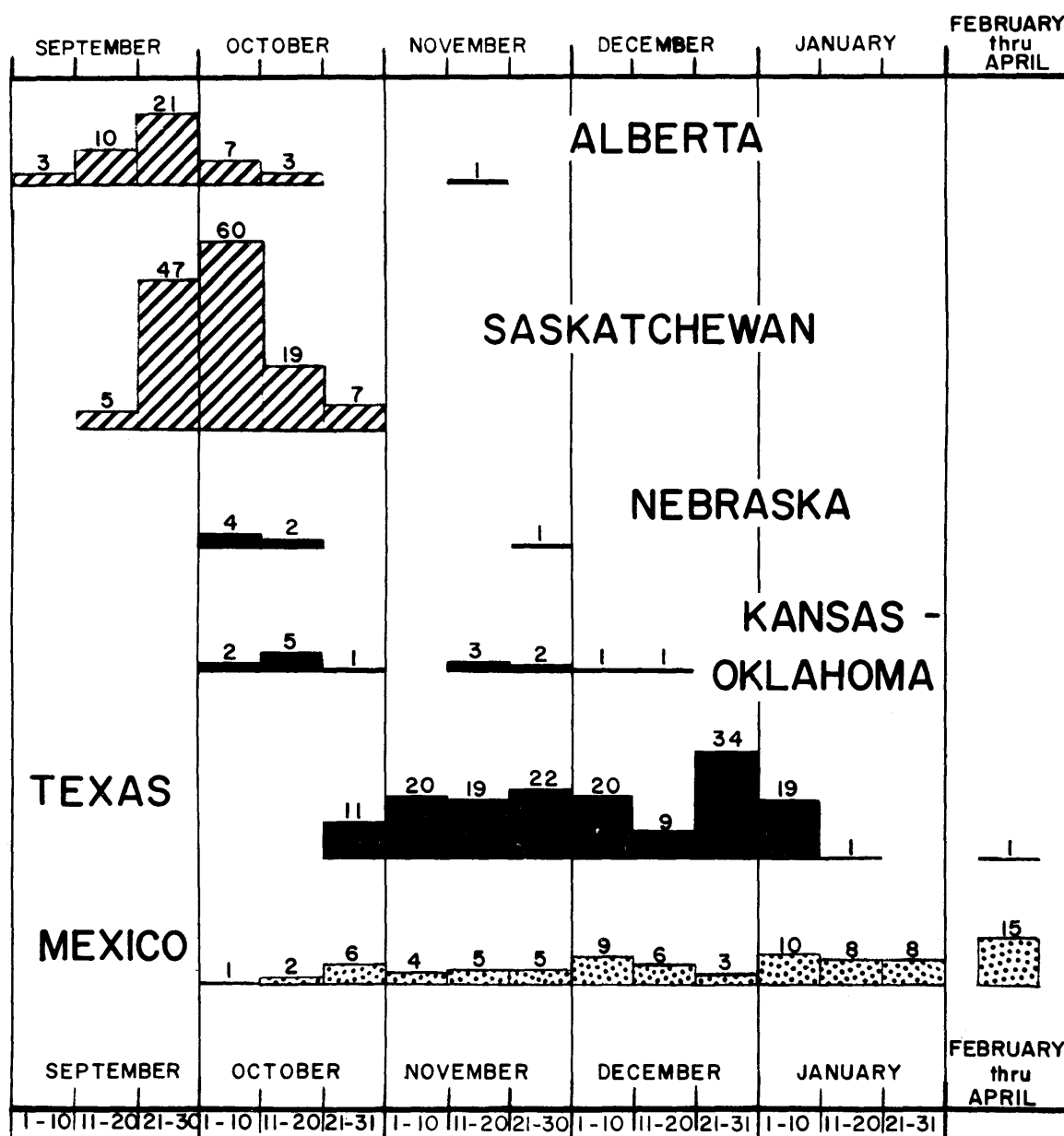


Figure 2. Temporal distribution of indirect recoveries of white-fronted geese (normal and dye-marked) banded at Kindersley, Saskatchewan.



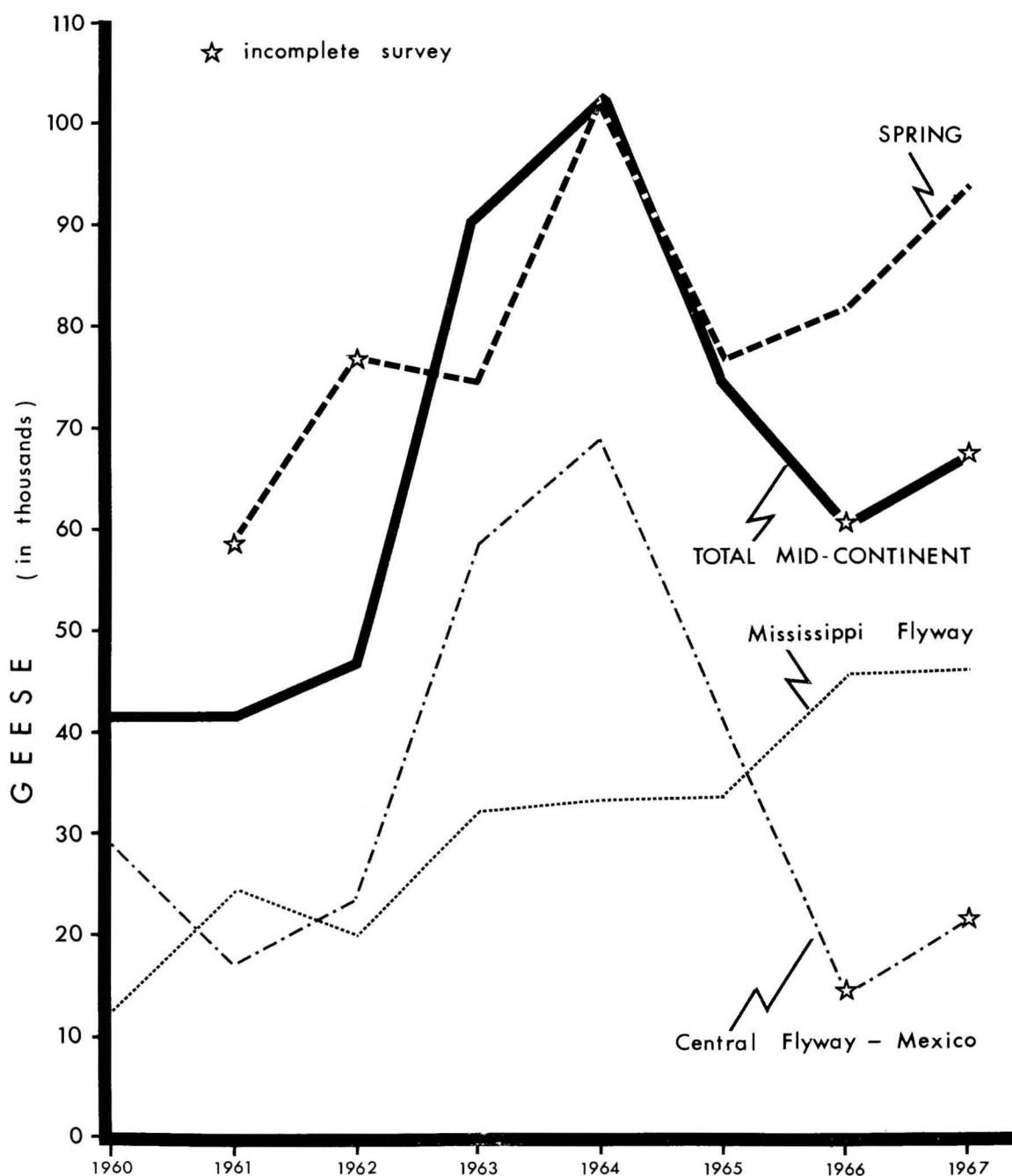


Figure 3. Recent status of Mid-Continent Population of White-Fronted Geese as indicated by mid-winter and spring surveys. Note the Mid-Continent Population (solid black line) is the sum of the Mississippi Flyway and Central Flyway-Mexico estimates.