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THE CIRCUMANNUAL DISTRIBUTION OF WHITE-CROWNED SPARROWS

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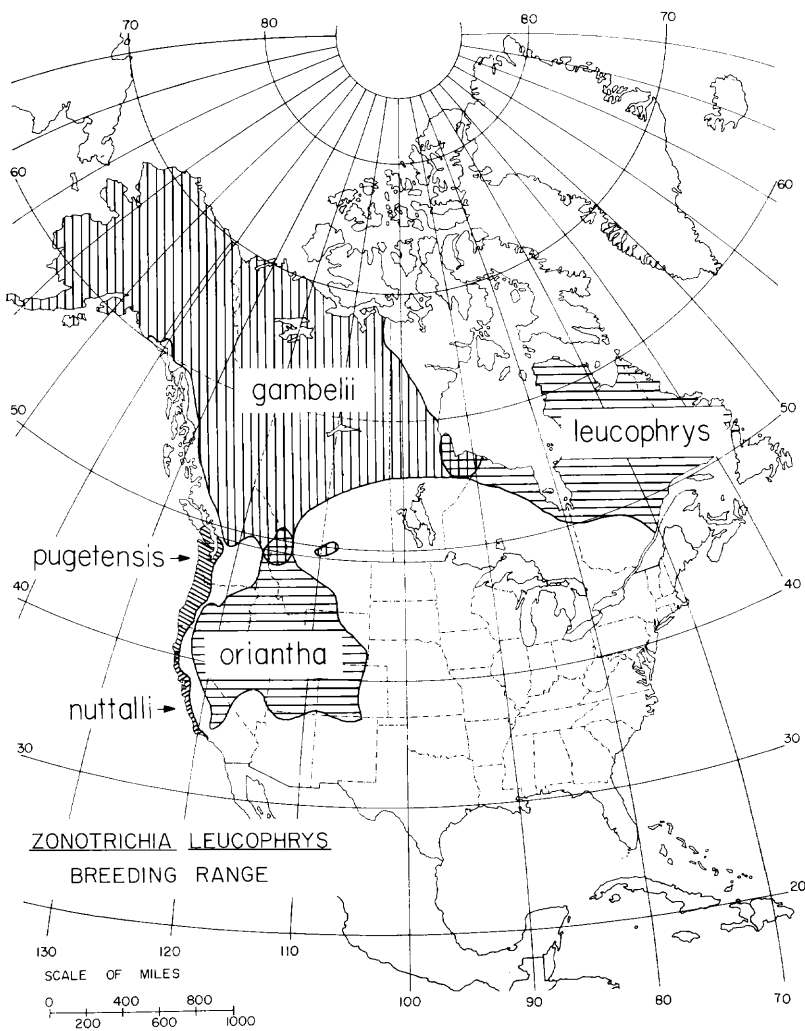
The White-crowned Sparrow, *Zonotrichia leucophrys*, is one of the most widely distributed passerine birds in North America. It is found (Figure 1) as a breeding bird from the Atlantic (Newfoundland) across the continent to the Aleutian Islands in the Pacific and from the limits of woody vegetation in the north to southern Colorado and the southern Sierra Nevada of California in the south (Grinnell, 1928; Blanchard, 1941; Snyder, 1957; Banks, 1964). The five (or four according to Banks who would reduce the race *Z. l. oriantha* to a synonym of the race *Z. l. leucophrys*) geographical races break into two unequally distributed groups: (1) the *pugetensis-nuttalli* populations of the Pacific coast from California to British Columbia; and (2) the *leucophrys-orianta-gambelii* populations of the rest of North America. The breeding grounds of these two groups approach each other in western Oregon (*pugetensis* and *orianta*) and in northwestern Washington and southwestern British Columbia (*pugetensis* and *gambelii*). No actual contact in either case is known and no individual bird intermediate between *pugetensis* and either of *orianta* or *gambelii* has been demonstrated.

The principal objective of this report is to make available some of the results from more than 40 years of banding of White-crowned Sparrows by cooperators of the Federal Bird-Banding Agencies of the United States and Canada. Because of economies forced upon these agencies, they have heretofore been unable to make banding return and recovery data on non-game birds available for detailed analyses. Conversion of all return and recovery data and some of the more recent banding data to machine records in about 1960 has made some of these results from the last 40 years available on a limited basis.

Many laboratories in North America are using birds of the genus *Zonotrichia* for experimental work, especially in the physiology of reproduction and in the physiology and dynamics of migration. We at San Jose, therefore, have undertaken with the cooperation of the U. S. Bird Banding Laboratory the task of making the results of banding of *Zonotrichia* available in the literature. These reports should be useful in the interpretation of experimental findings as they apply to the biology of *Zonotrichia*.

Our reports will emphasize those general findings which cannot be disclosed from the efforts of a single bird bander or small group of

Figure 1. Known breeding limits of the races of the White-crowned Sparrow, *Zonotrichia leucophrys* as adapted from Grinnell (1928), Blanchard (1941), Snyder (1947) and Banks (1964).



bird banders. It is generally thought, and is certainly confirmed by this study, that for the effort expended little is learned from the promiscuous banding of *Zonotrichia*. This is principally because the ratio of recoveries to birds banded is very low. Much more valuable are specific studies made in which the investigator uses bands to mark birds for studies of local movements, weight and molt cycles, territorial and nesting studies, population dynamics, etc.

TABLE 1. NUMBER OF WHITE-CROWNED SPARROWS BANDED AND NUMBERS OF RETURNS AND RECOVERIES AVAILABLE BY YEARS 1920-1963.

Year	Number banded*	Number of returns	Number of Recoveries	Number banded that were recovered
1920	500**	0	0	0
1921	500**	0	0	0
1922	1,000**	4	0	1
1923	1,000**	5	0	0
1924	1,184	83	0	1
1925	3,757	140	1	4
1926	3,465	96	2	1
1927	3,269	225	2	2
1928	3,860	204	1	4
1929	4,395	193	4	6
1930	4,951	200	7	3
1931	2,894	133	3	4
1932	4,335	169	4	5
1933	4,835	189	6	9
1934	5,919	202	8	6
1935	4,141	147	4	4
1936	4,912	203	6	5
1937	4,917	242	6	6
1938	5,869	357	6	7
1939	7,838	396	5	12
1940	6,569	489	13	7
1941	4,745	338	5	4
1942	4,730	330	6	4
1943	3,824	278	4	1
1944	3,219	303	3	4
1945	2,539	236	1	1
1946	2,814	265	4	3
1947	3,589	323	5	6
1948	10,983	537	4	3
1949	6,840	379	3	3
1950	3,317	236	2	5
1951	3,369	302	4	1
1952	3,886	200	3	6
1953	5,000**	254	4	8
1954	5,920	243	5	2
1955	6,502	343	5	11
1956	8,898	418	10	12
1957	8,025	371	9	2
1958	8,159	60	6	7
1959	10,319	0	11	10
1960	9,728	4	5	5
1961	10,000**	1	11	7
1962	10,000**	9	6	5
1963	10,000**	0	4	1
Total	226,516	9,207	198	198

*Banding year has varied but since 1953 has agreed with the calendar year.

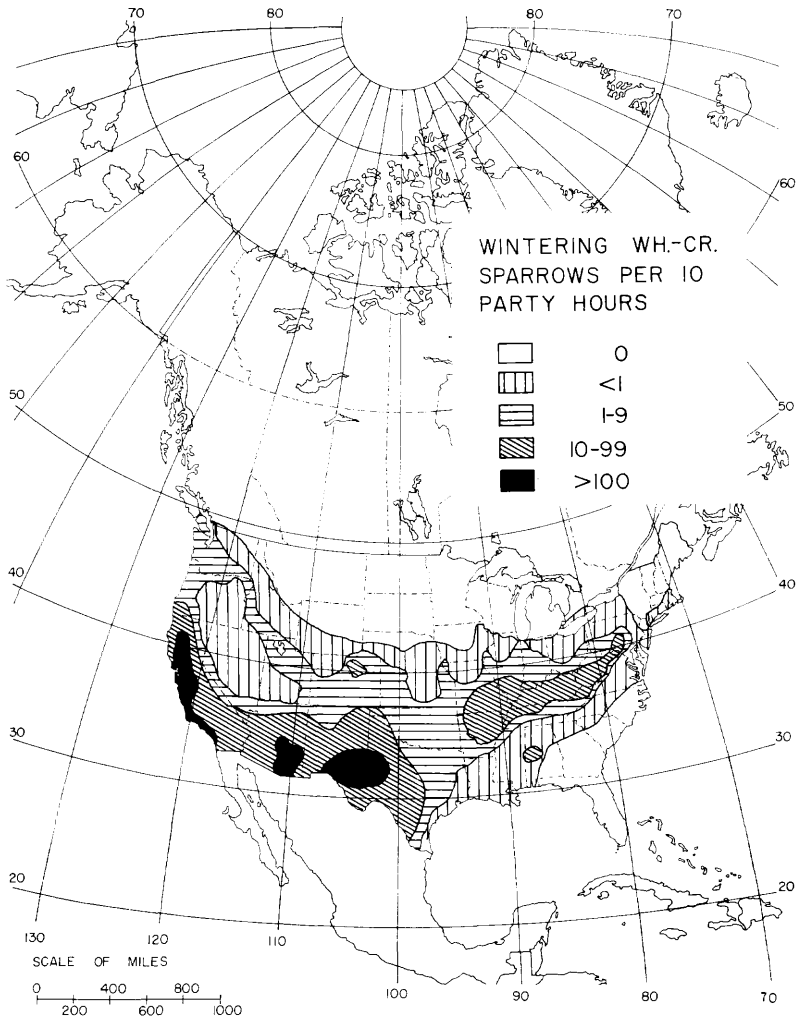
**Estimated

Among the more obvious data obtained by a later observation of the same bird are its change in geographical position or the elapsed time between observations. Subsequent observations have been classified for this report as repeats, returns or recoveries in accord-

ance with the following plan which approximates the classification used by the U. S. Banding Office at Laurel, Maryland.

1. Repeat: A banded bird apprehended in the same one degree grid (latitude and longitude) as that of banding during the same season is classified as a repeat. Repeats are not considered in this report.

Figure 2. Winter density distribution of White-crowned Sparrows (*Zonotrichia leucophrys*), based on more than 3000 Christmas Bird Counts for the years 1957 to 1961 as published in *Audubon Field Notes*.

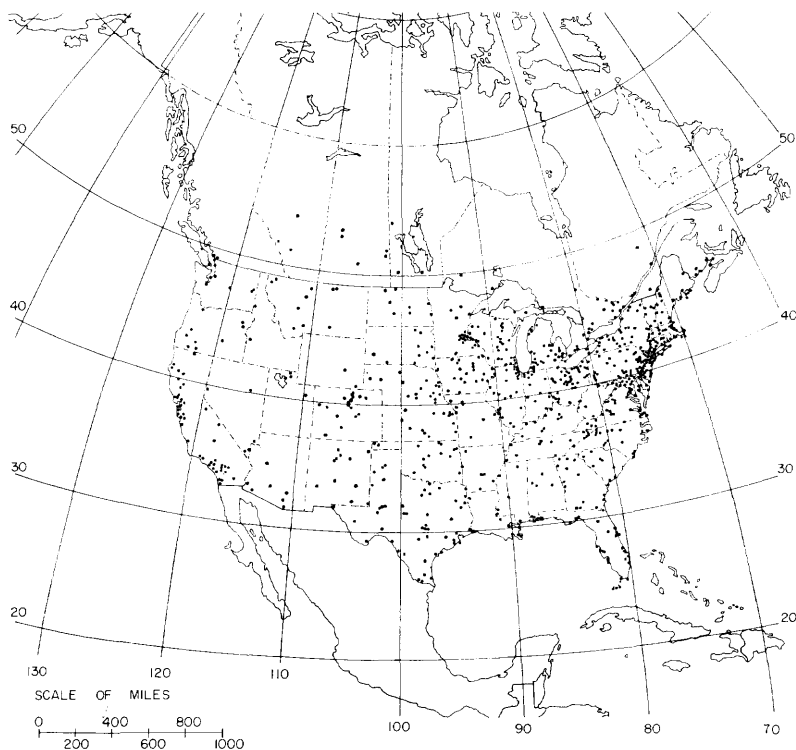


2. Return: A banded bird which is presumed to have left the station of banding in normal migration and been apprehended in the same degree grid in a subsequent season is classified as a return. Only selected groups of returns for certain geographical areas have been considered in this report. No detailed analysis has been attempted on the nearly 10,000 returns on file for the White-crowned Sparrow.

3. Recovery: A banded bird which presumably traveled by its own devices and was recovered in a degree grid other than that of the station of banding has been classified as a recovery. Recoveries are the principal concern of this report.

Of continuous concern in any analyses of bird-banding recovery data are several important sources of bias. The most obvious is the unequal distribution of the species (especially widely distributed species) in relation to the distribution of man (source of recoveries) and of bird banders. Especially pertinent in this report are the

Figure 3. Distribution of the 833 Christmas Bird Count census areas represented one to five times in the five years 1957 to 1961 as reported in *Audubon Field Notes*.



paucity of man and banders in the breeding areas, and the scarcity of banders on the winter range in south central United States, especially Texas. The consequences of these sources of bias will be repeatedly apparent in this report. In agricultural areas numbers of white-crowns are killed for depredations on crops or perhaps killed incidental to the destruction of other pests. In suburban areas, however, passerines are usually protected and few banded birds are recovered. Attitudes toward reporting recovered bands are likewise suspected to differ regionally and among various cultural groups.

The earliest recovery on record of a White-crowned Sparrow is that of a *gambelii* banded in 1922 (Table 1) in California and recovered in 1925 in Washington. Included in this report are recoveries verified as late as 30 June 1963. These banding data were processed from IBM cards on file at the U. S. Bird Banding Laboratory at Laurel, Maryland. The facilities of the Computer Center at San Jose State College were used to accomplish the desired groupings of recovery records and the associated listings. Records of bandings by geographical areas (States and Provinces) coupled with returns and recoveries are available for the years 1954 through 1957 only.

To provide a basis for a better understanding of winter recoveries of banded White-crowned Sparrows, we have made an analysis of the Christmas Bird Counts (jointly sponsored by the National Audubon Society and the U. S. Fish and Wildlife Service) for the five years 1957 to 1961 inclusive as published in *Audubon Field Notes*. This analysis provides an account of winter distribution of the species (no racial distinctions are possible) in the United States and Canada (Figure 2). No attempt was made to represent Northern Mexico, for which no equivalent data are available.

By design each Christmas Bird Count is made to cover (preferably) or fit within a 15-mile diameter circle. Many count areas are broken up into sectors, each of which is worked by a separate party of counters. Each of the approximately 3000 counts (in 5 years) was made in a 24-hour period of choice between about December 20 and January 3 of each winter season. Counts had a duration of at least eight hours and usually extended from dawn to dusk. If no White-crowned Sparrows were included in the count we considered this to be a report of none (0). For all counts reporting one or more white-crowns we recorded the number counted for each ten party hours each year. The arithmetic means of these counts for the one to five years for each count area were then spotted on a work map to provide the index to winter density.

It should be noted that the distribution (Figure 3) of the 833 reporting census areas shows an approximate direct relation to the distribution of man in North America north of Mexico from 1920 to 1960. We can expect more balanced data from areas where a number of counts tend to supplement each other. Other areas known to be inhabited by white-crowns (literature and personal experience) are sparsely populated with people and are often not represented in the counts.

It must be acknowledged that the abilities of the count-takers vary from one area to another and even in the same area from one

year to the next. It is probable that a species as well known as the White-crowned Sparrow has been more or less equally treated. The patterns which have emerged seem to justify this optimism. There is no other source of data in North America which even remotely approaches the coverage provided by these Christmas Bird Counts.

The high numbers of wintering birds reported for Arizona and New Mexico are probably excessive. Most counts in those two states were made in, and adjacent to, suburban and agricultural developments which have provided an oasis-effect especially suitable to White-crowned Sparrows. Most of the land area has not been so developed and does not support such high concentrations of birds.

This tendency of white-crowns to flock in winter in agricultural and suburban areas is widespread. In grassland and desert areas the plantings of shrubs and field crops provide cover and food. In areas which were originally wooded, the clearings made by man for agriculture, roads and habitations provide additional suitable habitat. Such disturbed grounds are included in most count areas and reflect the actual wintering ground conditions available to the species during the years considered in this study (see Graber and Graber, 1963 and Mewaldt, 1964).

ACKNOWLEDGMENTS

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THE PATTERN OF BANDING

From 1920 through 1963 about 226,500 White-crowned Sparrows of five races were banded in North America (Table 1). Details of bandings by political subdivisions in the United States and Canada are represented for the years 1954 through 1960 (Figure 4). Many white-crowns were banded in migration in the spring and fall months in the States and Provinces bordering the Great Lakes east to the Atlantic Ocean. The largest numbers were banded during the fall, winter, and spring months in California. It is noteworthy that relatively few birds were banded on the principal wintering grounds of *Z. l. leucophrys* from Texas to West Virginia. Even fewer were banded on the breeding grounds of *leucophrys* and *gambelii* in Canada and Alaska and of *oriantha* in the high mountain areas of Western United States.

The seasonal pattern of total bandings since 1920 probably approximates the pattern for the years 1954-60 as seen in Figure 5. Certainly the close parallel in numbers between month of banding of recoveries 1922-63 and month of all bandings 1954-60 suggest such an extension may be valid.

Figure 4. Geographical distribution of bandings by months of White-crowned Sparrows (*Zonotrichia leucophrys*) 1954-60. In each circle figure the full wedge represents the month with the most banding and of months when at least 88 percent as many birds were banded. Fractional wedges represent percentages centering on 75, 50 or 25 percent of the month with the most banding. Months with 12 percent or less are not represented. Number banded in the seven years is below each figure.

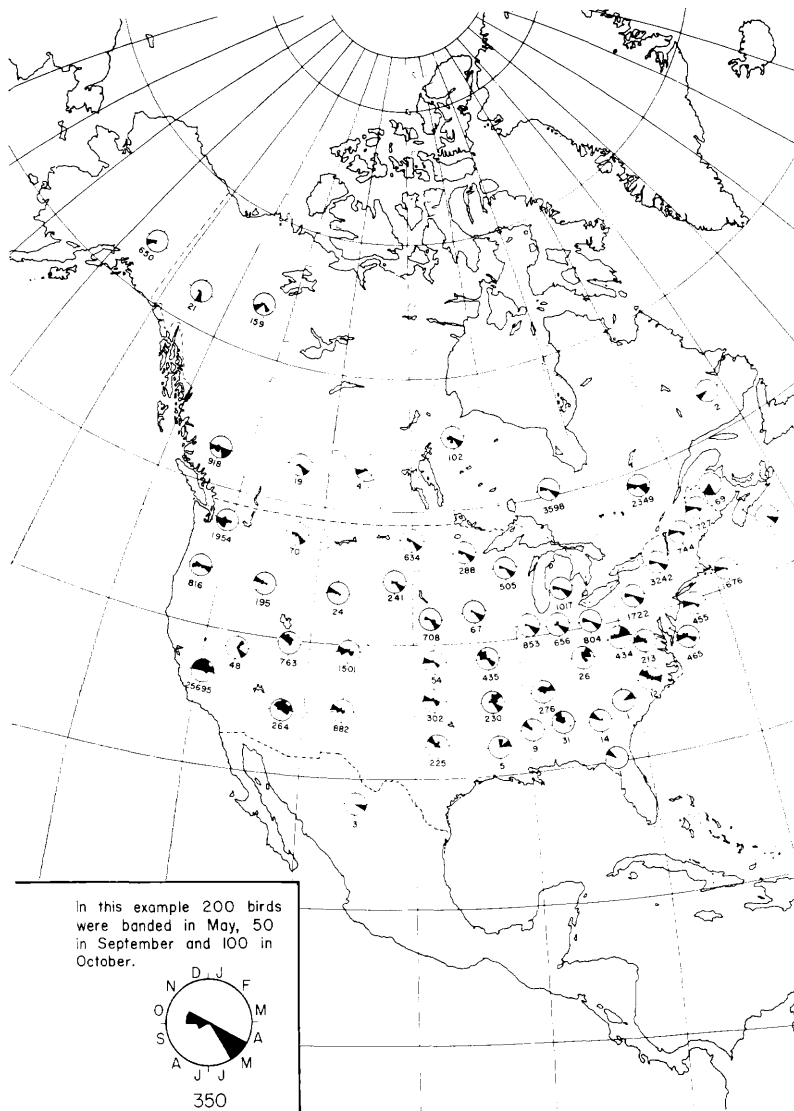
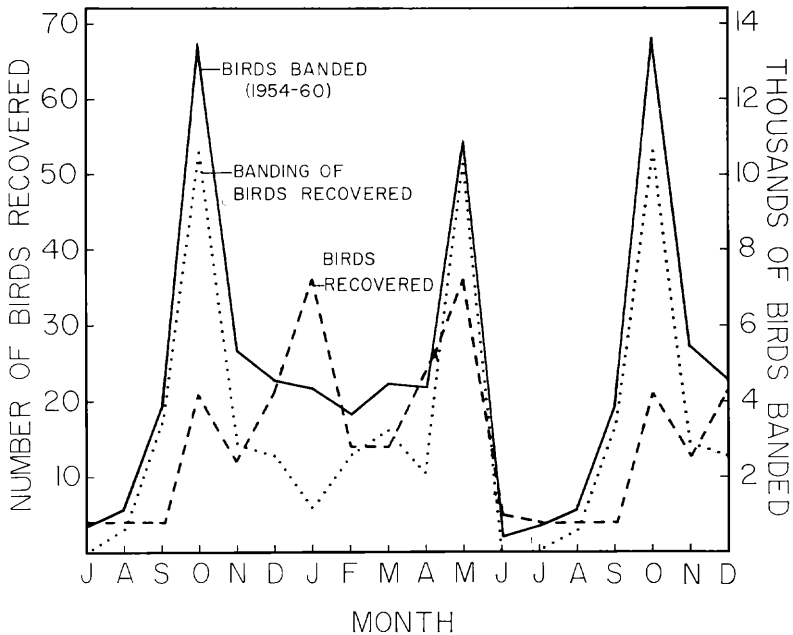


Figure 5. Numbers of White-crowned Sparrows, *Zonotrichia leucophrys*, banded by months 1954-60; numbers recovered by months 1920-63; and numbers recovered by month of banding 1920-63.



RACIAL CLASSIFICATION OF RECOVERED BIRDS

East of the 90th meridian only the nominate race *leucophrys* occurs regularly. Most of these have been banded as transients during fall and spring migrations between breeding grounds (Figure 1) in Canada, south and east of Hudson Bay, and the winter grounds (Figure 2) in central and southern United States.

West of the 90th meridian, where two and even three races may occur simultaneously outside of the nesting season, an effort has been made by most banders to distinguish race. These efforts have involved somewhat different problems in the Great Plains and on the Pacific coast. The junior author has banded all five races under regular banding conditions in both areas and thus knows firsthand the problems involved. He also knows personally many of the banders who have handled large numbers of white-crowns in both areas since 1930. In his judgment most of these birds were correctly identified to race upon banding. Some banders, however, either did not make racial identifications or assigned racial names which we judge to have been incorrect. Our knowledge of the distribution of the races and knowledge of banding practices has given us confidence to assign (or in some instances to reassign) the few doubtful recoveries to a particular race. Were this not done, the entire group

of recoveries could be treated only as a whole and the rather important racial differences in winter distribution and migratory route could not be inspected.

Between the 90th and 105th meridians, *leucophrys* and *gambelii* occur together in migration and on the wintering ground. Adults of these two races are readily separated on the basis of the lores which are white in *gambelii* and black in *leucophrys*. A few intergrades, commonly called the Intermediate Sparrow, apparently come from an area southwest of Hudson Bay and are encountered especially in the Dakotas. None of the recoveries seem to have come from this intermediate group. As in the areas east of the 90th meridian, most birds banded between the 90th and 105th meridians prior to 1957 were taken as transients.

Relatively small numbers of the race *oriantha*, which was not described until 1932 (Oberholser, 1932), have been banded. They nest in the higher mountain areas of western United States. They most resemble the eastern *leucophrys* (Banks, 1964) and are lumped with them in the machine records at the Bird-Banding Laboratory. Little is known of the movements of these western mountain white-crowns and there are no recoveries to help clarify their migratory routes or wintering areas.

Most White-crowned Sparrows banded west of the Great Plains were banded in the States and Provinces bordering on the Pacific Ocean. The strongly migratory *gambelii* have been banded as wintering birds in substantial numbers in southern and central California especially. Smaller numbers have been banded in northern California and in the States and Provinces up to and including Alaska. A few breeding *gambelii* have been banded in northern Canada and in Alaska.

Numbers of the non-migratory *nuttalli* have been banded in sufficient numbers to confirm their essentially sedentary nature (Blanchard, 1941 and 1942). They occur only along the immediate coast of California from about Cape Mendocino south to Santa Barbara.

Many of the birds banded as *nuttalli* must now be assigned to the migratory race *pugetensis* which was described in 1928 (Grinnell, 1928), but did not have returns or recoveries reported separately by the Bird-Banding Laboratory until 1939. The race *pugetensis* is found in summer from about Cape Mendocino, where they intergrade with *nuttalli* (Grinnell, 1928; Mewaldt, Manuscript), to Vancouver Island and the adjacent mainland. They have been banded in limited but significant numbers in the vicinity of Puget Sound in northwestern Washington and extreme southwestern British Columbia. Most *pugetensis*, however, have been banded in the San Francisco Bay Area of California which is the important wintering area for the race.

Within a few hundred yards of the surf on the outer coast from Cape Mendocino south to Santa Barbara, the races *gambelii*, *nuttalli*, and *pugetensis* commonly occur together in the same flocks during the winter months. There is a limited area in Berkeley, California where this same situation occurs. In these areas it has not

TABLE 2. RECOVERIES OF WHITE-CROWNED SPARROWS BY RACE, AREA OF RECOVERY, RECOVERY AGENT AND AREA OF BANDING.

	<i>Z. l.</i> <i>leucophrys</i>	<i>Z. l.</i> <i>gambelii</i>	<i>Z. l.</i> <i>pugetensis</i>	Total
Total recoveries	102	60	36	198
Recovered on:				
Breeding range	4	1	26	31
By the public	(4)	(1)	(24)	(29)
By banders	(0)	(0)	(2)	(2)
Migratory route	37	24	2	63
By the public	(27)	(24)	(2)	(53)
By banders	(10)	(0)	(0)	(10)
Winter range	61	35	8	104
By the public	(59)	(34)	(6)	(99)
By banders	(2)	(1)	(2)	(5)
Area of banding:				
Breeding range	1	0	5	6
Migratory route	97	24	3	124
Winter range	4	36	28	68

usually been possible to distinguish with certainty between *nuttalli* and *pugetensis* in winter. Beyond these immediate coastal areas, *gambelii* and *pugetensis* occur together (Mewaldt and Woon, 1959). Bird banders separate *gambelii* from *pugetensis* and *nuttalli*, where necessary, using several minor but cumulatively important chromatic differences (Banks, 1964).

THE PATTERN OF RECOVERY

In all, 198 recoveries of White-crowned Sparrows have been screened from approximately 10,000 listings of returns and recoveries from 1920 to 1963. This represents a recovery rate of about 0.08 percent or about one recovery for each 1,200 birds banded.

The 198 recoveries were made in 32 States and Provinces including most prominently California 39, Texas 39, Washington 22, British Columbia 12, Arkansas 10, Quebec 9, New York 8, Missouri 6, Oklahoma 6, Oregon 6, Ontario 5, etc. These same 198 recoveries had been banded in 34 States and Provinces including California 64, New York 17, Illinois 13, Massachusetts 11, Quebec 11, North Dakota 9, Ontario 7, Arizona 6, Washington 6, Virginia 5, etc.

Of only six recoveries of birds banded on the breeding range (Table 2) five (*pugetensis*) were banded within a few miles of Puget Sound in northwest Washington and southwest British Columbia. This is the only breeding area where there is a significant number of regular bird banders. A single bird of the nominate race (*leucophrys*) banded in its breeding range (Quebec in August) was recovered on its winter range (Kentucky in January). Similarly, 62 of the 68 banded on the winter range received their bands in California and Arizona. Only 4 white-crowns banded on wintering grounds from Texas eastward were recovered elsewhere and only two

TABLE 3. METHOD OF RECOVERY BY RACE

Method of Recovery	<i>Z. l. leucophrys</i>	<i>Z. l. gambelii</i>	<i>Z. l. pugetensis</i>	Total
Found dead	26	21	13	60
Shot	35	13	3	51
Trapped (bird-bander)	12	1	4	17
Trapped (non-bird-bander)	7	2	2	11
Killed by cat	0	6	5	11
Killed by flying into object	4	2	2	8
Killed by auto	2	2	3	7
Found injured	1	2	2	5
Killed by weather	2	2	0	4
Killed by shrike	0	1	0	1
Killed by reptile	0	1	0	1
Drowned	0	0	1	1
Collected scientific specimen	1	0	0	1
Misc. causes	2	0	0	2
No information	11	6	1	18
Total recovered	102	60	36	198

birds banded elsewhere were recovered by banders in this same area. This contrasts with 66 white-crowns recovered in this same area (Texas eastward to the Atlantic) by the public at large. This is the reasonable consequence of the low incidence of bird banders working on the wintering grounds from Texas east-northeastward to West Virginia. This is in spite of a human population density sufficient to record the substantial number of recoveries (66) of birds banded elsewhere. The remaining 2, of the 68 white-crowns banded on winter range, were banded in Nevada and in Colorado and were recovered in British Columbia and Wyoming respectively.

More than 60 percent of all birds recovered (198) were banded in migration (124). Most of these birds were recovered on the winter range (82) or in a subsequent migratory flight (38) between breeding and wintering grounds.

Of the 27 birds banded on their winter range and recovered on their breeding range, 26 were of the race *pugetensis*. All of these 26 were banded in California, and 24 of the 26 were recovered within a few miles of Puget Sound (16 in Washington and 8 in British Columbia). The two additional *pugetensis* were recovered in western Oregon. A single *gambelii* banded in southern California in February was recovered in the interior of British Columbia. The May 17 recovery date suggests the bird may have still been in migration even though already well into the southern part of the breeding range for *gambelii*.

The 16 birds (15 *gambelii* and 1 *pugetensis*) banded and recovered on their winter range (all except one in California and Arizona) suggest some shifts in winter home by individual birds. Distances between banding station and recovery site ranged from 30 to 340 miles (mean = 126 miles and median = 70 miles). Six of these recoveries (30, 70, 90, 135, 150, and 210 miles) were in the season of banding.

TABLE 4. ACKNOWLEDGED METHOD OF RECOVERY OF WHITE-CROWNED SPARROWS IN PERCENT OF TOTAL RECOVERED BY SELECTED GEOGRAPHICAL AREAS.

	Shot	Found dead	Captured and Released	Killed by cat	Misc.	No Inform- ation
Oregon, Washington and British Columbia (N = 40)	2	40	8	18	27	5
Illinois to Ontario and east to Atlantic (N = 37)	8	30	35	0	19	8
California (N = 39)	23	38	8	8	13	10
Texas, Oklahoma, Arkansas and Missouri (N = 59)	56	15	7	0	7	15

In our opinion, however, several of the 16 would be classified as repeats or returns if we knew the actual recovery site of the bird rather than the mailing address of the person reporting the recovery.

Of the 198 recoveries, at least 145 were recovered dead (Table 3). Although most of these birds ostensibly met death on the date of recovery, some may have been dead some days or even weeks prior to the date of recovery. The likelihood of recovery varies, perhaps substantially, from one part of North America to another as may be inferred from Table 4. In the south-central states and in Southern California, man's principal contact with white-crowns is probably in agricultural areas. Here shooting is far more apt to occur, especially when white-crowns are involved in crop depredations. In the Pacific Northwest, in the vicinity of the Great Lakes, and in New England, most contact between white-crowns and man is probably in suburban areas. Here those few that are recovered have usually run afoul of some unnatural structure or device (e.g. building, wire, cat, or window).

It is probably that substantially fewer than half the banded passerine birds recovered are reported through appropriate channels. This opinion is rendered by the junior author after many years of observing the attitudes and practices of individuals of the general public when banded birds (except waterfowl) came to their attention.

The mean interval between banding and recovery for the 198 birds was 14.4 months (1.2 years). The range was from 1 day to 153 months with a median of 10 months. About 10% survived recovery (e.g. trapped and released by bird bander) and may reasonably have been expected to live another 14.4 months. It is therefore likely that the mean span of life for these 198 birds was about 16 months. This should not be equated with normal life expectancy because most of these birds died by the hand of man, or at least in close proximity to man. Such mortality is probably not typical for the species as a whole.

The weighted mean survival rate for the 198 recoveries, calculated in accordance with method discussed by Farner (1955) is 43%. As

he points out, however, this assumes a constant rate of mortality throughout the year. It is clear from peaks of numbers recovered in January and May (Figure 5) that the mortality rate was not constant.

Only 153 of the 198 recoveries were classified as to age upon banding. Bandings from September through February, when immatures and subadults can be clearly distinguished, included 35% adults. By projection to the balance of the banding year, it is likely that approximately 65% of all birds recovered were banded in their first year of life.

A comparison of the survival of the 32 known adults and 60 known immatures banded from September through February suggests that birds banded as adults enjoy no survival advantage over immatures banded as migrants or on their winter range. Excluding the record of one immature which lived 12 years and 9 months, the 59 remaining immatures lived 11.5 months (arithmetic mean) between banding and recovery (range 1-51 months and median 12 months). The 32 adults from the same fall and winter months (September through February) lived 11.8 months from banding to recovery (range 1-48 months and median 10 months).

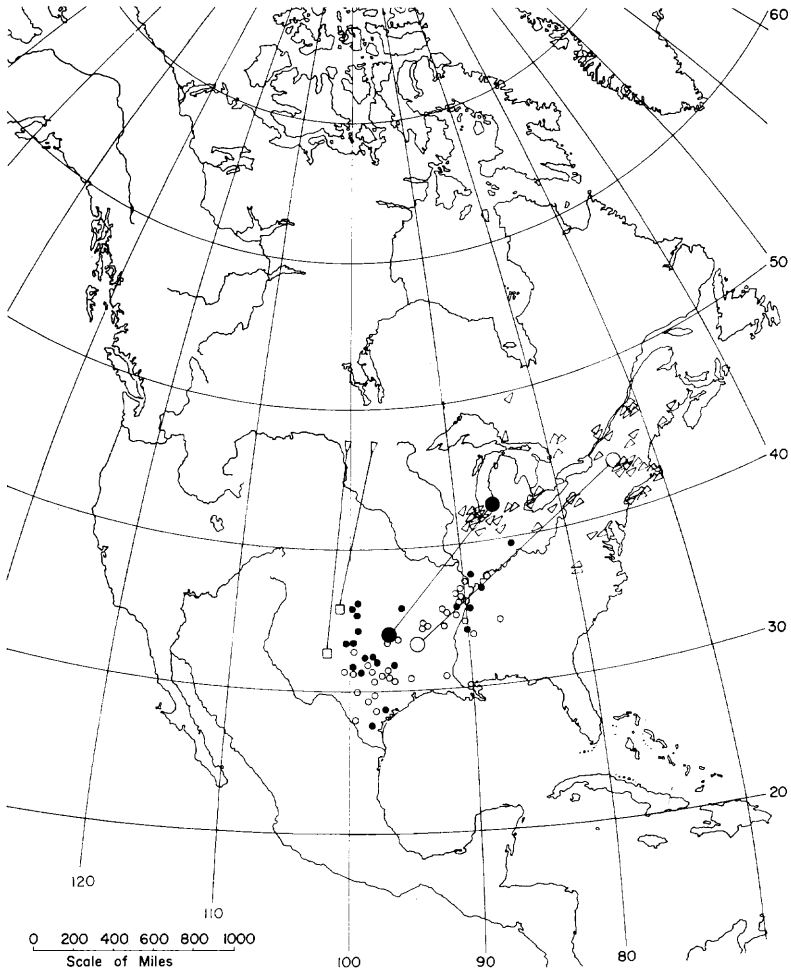
Recoveries were made in all months, but were most abundant in January and in May (Figure 5). Very few birds were recovered from June through September when most white-crowns were on their breeding grounds in sparsely settled areas (Figure 1). Nearly equal numbers of the birds recovered were banded in October (53) and in May (52). As would be expected the interval between banding and recovery was substantially shorter for the 53 birds banded in October (mean 11 months—median 6 months) than for the 52 birds banded in May (mean 15 months—median 12 months). Because there is apparently no survival disadvantage for the 65% immatures in the fall population, we may assume that the interval between banding and recovery of May banded birds was largely due to their presence in areas where man is scarce during the months from June until September.

A visual inspection of Figure 5 reveals a high correlation between the numbers of birds banded by months from the seven years 1954-60 and the months of banding of the 198 recoveries for the years 1920-62. This close correlation tends to inspire confidence in the randomness of the recovery sample. This composition of the recovery sample is, however, more nearly random with respect to the sample of birds banded than to the total population. Highs for recoveries in October and May would seem to be correlated with peaks of migration in those months. Reasons for the high in numbers of recoveries in January are not apparent to us.

MIGRATORY ROUTES

Most White-crowned Sparrows of the nominate race *leucophrys* recovered had been banded in fall or spring migration from the Dakotas and Manitoba east to the Atlantic. It is immediately apparent (Figure 6) that birds breeding in areas as much as 1500 to

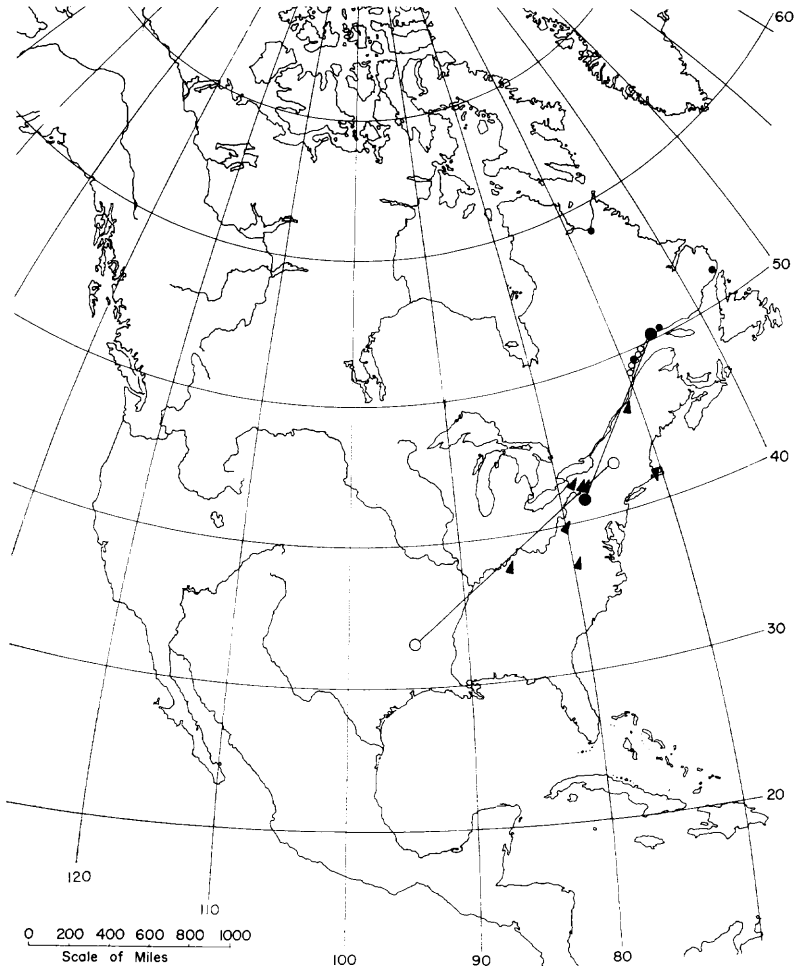
Figure 6. Bandings (in migration) and recoveries (on winter range) of White-crowned Sparrows. Wedges represent the direction of migration (e.g. north-east in spring) at time of banding. Open circles represent recoveries of birds banded east of the 80th meridian. Solid circles represent recoveries of birds banded between the 80th and 90th meridians. Open squares show recovery locations of birds banded west of the 90th meridian. Lines join mean banding and recovery locations for the principal groupings east and west of the 80th meridian.



2000 miles apart in their east-west distribution in Canada converge in their fall migration to areas only a few hundred miles apart and which appear radial to south central Texas.

Thirty-seven *leucophrys* banded east of the 80th meridian in migration in September, October and May, and recovered from No-

Figure 7. The small filled circles represent three White-crowned Sparrows (*Z. l. leucophrys*) recovered and one banded (farthest north) in June or August. Open circles represent four birds recovered in May or October perhaps in migration. Wedges represent direction of migration when banded or recovered south of the breeding grounds. Joined solid circles represent mean northern and southern banding and recovery locations. Joined open circles are taken from Figure 6 to represent probable continued direction of migration for birds breeding in extreme eastern Canada.



vement to April provide the best available data on the wintering ground of the eastern segment of the population (Figure 6). The mean banding location for this sample in extreme eastern New York (coordinates 431-0741) really reveals only the mean distribution of migratory white-crowns which were ultimately recovered and of

bird-banders. Somewhat more significant is the mean winter recovery location in northeast Texas (331-0942) which is nearly 1400 miles west-southwesterly (57° west of south) from the mean banding location. This wintering area is significantly west of the wintering ground of the White-throated Sparrow (*Zonotrichia albicollis*) which occupies the coastal plain from Louisiana to Maryland (Wilderman and Mewaldt, manuscript). Mean time span between banding and recovery was 15 months (range 1-78 months and median 10 months).

Seven *leucophrys* banded and one recovered in the United States (mean location 411-0773) were recovered and one banded, on the breeding grounds in Canada (mean location 504-0661). Four of these birds, represented by solid circles in Figure 7, were banded or recovered in June and August leaving little doubt they were on their breeding grounds. The remaining four recovered in May and October in the extreme southern portion of their breeding range (open circles) may have been in migration at the time of recovery. It is tempting to suggest that birds breeding east of the 70th meridian shift the direction of their southward migration from southwesterly to west-southwesterly in the vicinity of the 42nd parallel.

Only one *leucophrys* was apparently handled on both its breeding and wintering ranges. This bird, banded in northern Quebec (582-0675) on 29 August 1956 was found dead in Kentucky (373-0854) on 4 January 1958 (Figure 7). The 1700 mile distance between these two points is substantially less than the approximately 2400 miles apparently traveled by birds breeding in Labrador and wintering in central Texas.

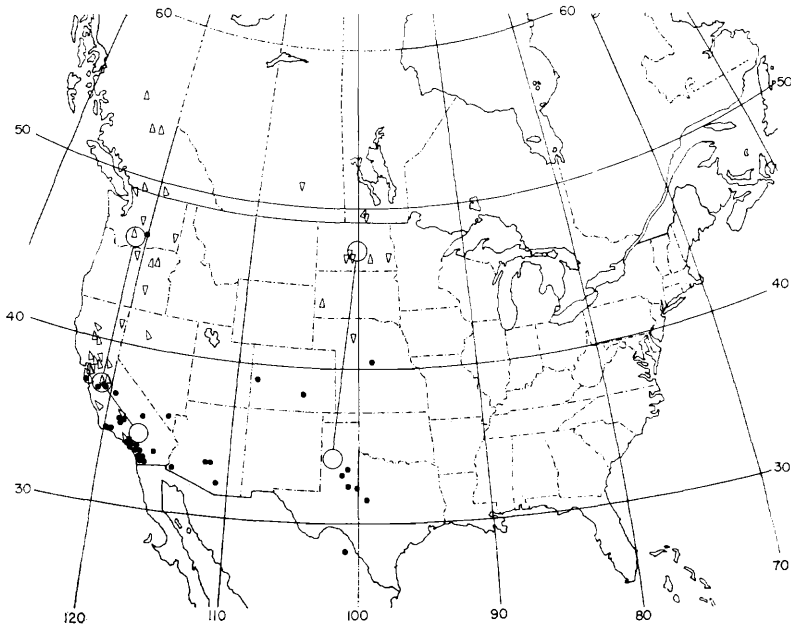
The mean banding location of 21 *leucophrys* banded in migration between the 80th and 90th meridians in October and May and recovered from October to April was in southwest Michigan (422-0854). The mean recovery location (334-0955) is only about 135 miles west of the mean recovery location for eastern birds whose mean banding location was 600 miles east of the mean mid-western banding location. The mean recovery location is 900 miles southwest (45° west of south) from the mean banding location. Mean time span between banding and recovery was 15 months (range 2-43 months and median 14 months).

The two *leucophrys* banded west of the 90th meridian were banded in North Dakota and recovered in western Texas. It is probably significant that both were recovered further west than any of the birds banded east of the 90th meridian and that the apparent direction of migration was southerly (10° west of south).

We have no records of White-crowned Sparrows crossing, or attempting to cross, the Gulf of Mexico. Although considerable numbers of (especially) western white-crowns are reported to winter in Mexico, banding and recovery records are all but absent from that important area.

The race *oriantha* has been banded in relatively small numbers and there are no recoveries which provide useful information on migratory routes or wintering areas of these birds, which breed in the higher mountains of western United States south of Canada (Figure 1).

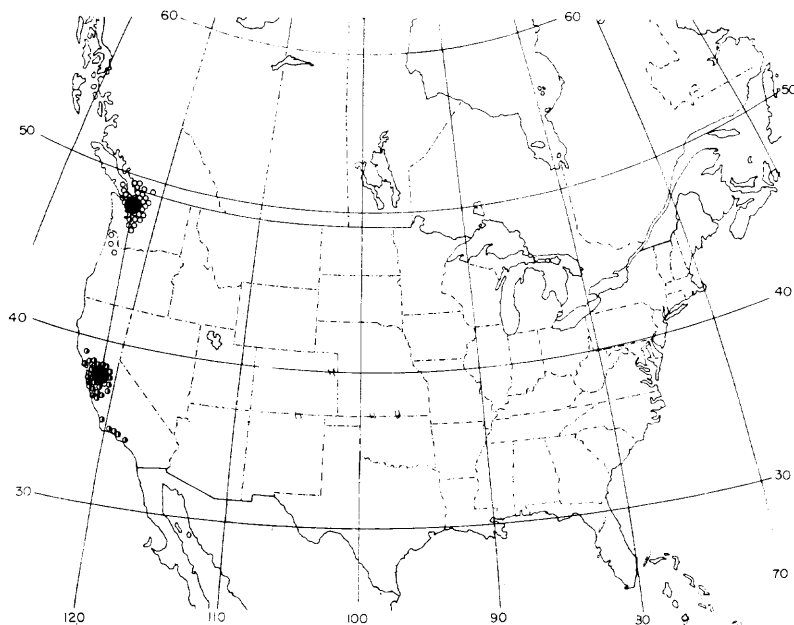
Figure 8. Solid circles represent southern banding (usually) or recovery site for White-crowned Sparrows (*Z. l. gambelii*). Wedges represent direction of migration at northern recovery or banding site. Southern large circles represent mean winter homes for *gambelii* recovered east or west of the 110th meridian. Circle in North Dakota represents mean banding location for birds east of the 110th meridian. The large circle in central California is mean location of wedges (mostly recoveries) south of the 40th parallel and west of the 110th meridian and that in Washington is the mean location for wedges (mostly recoveries) north of the 40th parallel and west of the 110th meridian.



The records of 10 *gambelii* banded and recovered east of the 110th meridian are considered separately from 31 *gambelii* banded and recovered west of that meridian (Figure 8). Only birds which were obviously banded or recovered on their winter range are included. In each case the complementary handling of that bird was in migration somewhere to the north. None (one possible but improbable exception) was banded or recovered on its breeding range. None of the 41 birds represented is known to have crossed the 110th meridian. One bird did cross the continental divide into western Colorado.

The mean winter range location for the ten *gambelii* which wintered east of the 110th meridian was in northwest Texas (341-1015). It is evident that the *gambelii* migrating through the Dakotas winter only slightly west of many *leucophrys* which migrate through Illinois. (Compare Figures 6 and 8). The 10 *gambelii* were recovered 900 miles nearly due south of their mean banding location in south central North Dakota (471-1004). The mean period between banding and recovery for this group of 10 birds was 25 months (range 3-100 months and median 15 months).

Figure 9. Half circles represent banding or recovery sites of White-crowned Sparrows (*Z. l. pugetensis*) on their winter range in California. Open circles represent banding or recovery location on breeding grounds in Oregon, Washington and British Columbia. Mean winter and summer homes for the recovered *pugetensis* are joined by a line.



The 31 *gambelii* from west of the 110th meridian appear to have performed a "dog-leg" migration inland from and parallel to the Pacific Coast (Figure 8). The mean winter range banding (or recovery) location for all 31 is somewhat inland from Los Angeles in southern California (345-1173). The 13 birds banded or recovered south of the 40th parallel appear to have moved on a north-west-southeast line from southern California about 300 miles into the central valley of California. From there the main movement seems to have been east of the Cascades of Oregon and Washington into the Carabou District of British Columbia. The mean period between banding and recovery was 19 months (range 1 to 153 months and median 11 months).

Thirty-one white-crowns of the race *pugetensis* were banded or recovered on their winter range from October to early April and were recovered or banded (respectively) on their breeding range from early April to September (Figure 9). The mean winter location for these 31 birds was in the south San Francisco Bay region (371-1214) and the mean breeding location in the Puget Sound Area of Washington (480-1224). The direction of migration is nearly due north and south and the mean distance about 760 miles. These re-

cords are closely grouped in both the San Francisco Bay area (San Francisco, San Jose and Oakland) and in the Puget Sound Area (Seattle, Vancouver and Victoria). Each grouping has probably been somewhat influenced by the high concentrations of man (including banders) in these same areas. It is apparent, however, that most *pugetensis* wintering in the San Francisco Bay Area breed in the immediate vicinity of Puget Sound and on islands in Puget Sound. Other areas in the Pacific Northwest with substantial suburban human populations (e.g. Tacoma, Washington to Portland, Oregon) have not reported recoveries of white-crowns and seem not to be important breeding areas. Mean interval between banding and recovery for these 31 *pugetensis* was 11 months (range 1 to 41 months and median 7 months).

Although *gambelii* and *pugetensis* are sympatric to a degree on their winter range and in migration (especially in the Santa Clara Valley just at the south end of San Francisco Bay), banding recovery data suggest strongly that they are in the main allopatric. The *gambelii*, which breed well to the north of *pugetensis* (Figure 1) also winter well to the south of *pugetensis* (Figures 8 and 9). The three recoveries of *pugetensis* from Oregon during the period of migration are all from west of the Cascade Mountain Range. The seven *gambelii* recovered in migration in Oregon and Washington were all taken east of the Cascades. This suggests that even in migration the two races tend to occupy different geographical areas.

SOME CHARACTERISTICS OF THE MIGRATORY MOVEMENT

Once established, White-crowned Sparrows return to the same few acres on their winter range each fall. They remain there from October until the following April when they return to the same few acres on their summer range where they nested the previous summer. Fidelity to winter home is abundantly verified by records of return of banded birds to specific banding stations on the winter range in California especially (Table 5). The paucity of banders of passerine birds in Texas probably accounts for the absence of records of return to the important wintering areas there. In the few instances when white-crowns have been trapped at banding stations operated for two or more successive seasons on the breeding grounds, they have been shown to return to the same breeding area once they have nested there (e.g. MacKenzie River).

Table 5 presents numbers of White-crowned Sparrows recorded as returns and as recoveries in relation to numbers banded by selected geographical areas. The sample represented includes all available data, yet is unfortunately small. Numbers of recoveries in Table 5, amounting to 0.07 percent of the 21,835 banded, however, may be typical of the entire universe of data since 1920. Recoveries since 1920 come to 0.08 percent of the 232,000 birds banded.

These data (Table 5) support the hypothesis that these small passerines make their migrations between widely separated nesting and wintering grounds on a broad-front type of movement. While more than 6000 birds were banded (1954-57) in areas where the birds are transient only, *there were no banding station returns*. This

TABLE 5. NUMBERS OF WHITE-CROWNED SPARROWS RECORDED AS RETURNS AND AS RECOVERIES IN RELATION TO NUMBERS BANDED, BY SELECTED GEOGRAPHICAL AREAS 1954-57.

	Banded 1954-57	Returns 1954-57		Recoveries 1954-57	
		Number	Percent of Banded	Number	Percent of Banded
Winter Residents					
(Include some transients)					
California	12,660	1317	10.40	0	0.00
Arizona	81	12	14.81	1	1.23
Alabama, Arkansas, Missouri, Tennessee and West Virginia	851	47	5.52	1	0.12
Texas	95	0	0.00	5	5.26
Total	13,687	1376	10.05	7	0.05
Summer Residents					
(Include some transients)					
Northwest Territories (Mackenzie River)	105	8	7.62	0	0.00
British Columbia and Washington	1622	67	4.13	5	0.31
Alaska	325	0	0.00	0	0.00
Total	2052	75	3.65	5	0.24
Transients					
New England States, New York and Pennsylvania					
Illinois and Michigan	4363	0	0.00	3	0.07
Minnesota, Nebraska, North Dakota and South Dakota	893	0	0.00	1	0.11
Total	840	0	0.00	0	0.00
Total	6096	0	0.00	4	0.07

compares with a better than 10 percent rate of return to station of banding on the wintering grounds in California where more than 12,000 birds were banded (1954-57). Individual banding stations on the wintering grounds commonly have from 30 to 50 percent of their adult white-crowns return each winter (Mewaldt, 1956 and 1964). It is also most significant to note (Table 2) that of 10 white-crowns (*leucophrys* only) recovered in migration by banders, none was trapped at its station of banding (in which case, of course, each would have been classified as a return). Thus, no White-crowned Sparrow banded as a migrant is known to us to have returned in a subsequent season to its station of banding. This suggests that birds en-route do not employ specific terrestrial landmarks to orient their flight. More consistent with such data would be use by these birds of some form of celestial navigation (Mewaldt, Morton and Brown, 1964) or perhaps inertial navigation as described by Drury and Nisbet (1964) possibly in combination with celestial navigation.

TABLE 6. TWENTY SHORTEST TIME INTERVALS BETWEEN BANDING AND RECOVERY OF WHITE-CROWNED SPARROWS ARRANGED IN ORDER OF MEAN MILES PER DAY

Miles per day	Days	Cumulative		Banded		Recovered		Taxon
		Miles*	Miles/day	Area	Date	Area	Date	
310	1	310	310	Ill	May 9	Mich	May 10	<i>leucophrys</i>
87	2	175	162	Ohio	May 4	N. Y	May 6	<i>leucophrys</i>
87	6	520	112	S D	May 1	Man	May 7	<i>gambelii</i>
47	13	614	74	Ariz	Apr 8	Nev	Apr 21	<i>gambelii</i>
42	22	920	58	Ont	Oct 11	Mo	Nov 2	<i>leucophrys</i>
38	37	1400	49	Penn	May 6	Lab	Jun 12	<i>leucophrys</i>
28+	23-	640	45	Ont	Oct 8	Ill	Oct ?	<i>leucophrys</i>
26	17	450	42	N H	May 7	Que	May 24	<i>leucophrys</i>
25	39	960	37	Wash	Sep 11	Calif	Oct 19	<i>pugetensis</i>
25	47	1190	35	Mass	Oct 21	Miss	Dec 7	<i>leucophrys</i>
22	34	760	33	Ore	Sep 9	Calif	Oct 13	<i>gambelii</i>
21	27	575	32	N Y	May 15	Que	Jun 11	<i>leucophrys</i>
18	35	615	30	N Y	May 6	Que	Jun 10	<i>leucophrys</i>
17	24	420	29	Mass	Oct 13	Penn	Nov 7	<i>leucophrys</i>
16	47	775	28	Calif	Mar 26	Wash	May 12	<i>pugetensis</i>
16	50	805	26	Wash	Sep 18	Calif	Nov 7	<i>pugetensis</i>
15	46	700	25	Calif	Apr 5	Wash	May 21	<i>pugetensis</i>
12	15	275	25	Ill	Oct 12	Mo	Oct 27	<i>leucophrys</i>
11	34	365	24	Calif	Mar 1	Calif	Apr 4	<i>gambelii</i>
9	32	285	23	N Y	Oct 13	Penn	Nov 14	<i>leucophrys</i>

*These distances in statute miles are within 5 percent of the great circle distances as calculated from the coordinates of banding and recovery locations.

Twenty of the 198 recoveries were made in 50 or fewer days following banding (Table 6). A few of these probably represent true travel time between points. Certainly the 310 mile one-day interval must represent a single night's migration. Similarly the 175 mile two-day interval probably represents a single night's migratory movement. In our opinion the next four records in the table represent travel time including one or more stop-over periods en-route. Allowing 4-day stop-overs this would suggest minimum migratory flights of about 200 miles and a daily mean rate of migration of about 50 miles. It is probable that most of the rest (14 records) include some time spent in the banding area prior to migration or in the recovery area following migration.

Recovery records provide some useful information on the yearly fidelity of the timing of migration. All but 3 of the 48 recoveries of *leucophrys* banded in spring migration were banded from 2 to 18 May with 11 May the median date. This represents the time for passage through the populated areas of northeastern United States and southeastern Canada (about 1000 miles). Although there is no real basis for estimate, these data suggest to us a daily mean rate of migration in the order of 100 miles. In fall, however, all but 8 of 48 *leucophrys* banded in migration were trapped from 1 to 27 October with 12 October the median date. The span of time in fall for the bulk of the passage (27 days) is substantially longer than the span

of time in spring (17 days). This suggests a more leisurely rate of migration or perhaps that the timing lacks the precision of the spring movement.

Birds of the race *gambelii* make their passage northward through the Dakotas in early May while those of the West Coast move northward through California and Oregon throughout April and early May. These data support the observations of Blanchard and Erickson (1949) on *gambelii*. This prolonged passage may be related to the great extent of the breeding range in western North America. These western *gambelii* breed through about 22° of latitude in the West compared to about 12° of latitude in the East (Figure 1) for *leucophrys* whose period of passage in spring is much shorter. Some western *gambelii* also breed at high elevations in mountainous areas where nesting habitat may not become available until late June or early July.

Several California wintering *pugetensis* have been recovered on their nesting grounds adjacent to Puget Sound (Figure 9) in the first two weeks of April. Available banding recovery data fit very well the temporal aspects of the movements of *pugetensis* as outlined by Blanchard (1941). It is apparent that the *pugetensis* move northward earlier than the *gambelii* which likewise winter in California.

The few data available on southward movements of *pugetensis* and *gambelii* in the West suggest their fall migrations may be more nearly synchronous than they are in spring. The southward movements appear to be accomplished mainly in September by both races. These data again confirm the observations of Blanchard (1941) and Blanchard and Erickson (1949).

SUMMARY

The circumannual distribution of the White-crowned Sparrow (*Zonotrichia leucophrys*) is described. Main subject of this report is the recovery of 198 individual white-crowns banded by co-operators of the Federal Bird Banding Laboratories of the United States and Canada. The recoveries were made in 32 States and Provinces and resulted from the banding of nearly 226,500 white-crowns of all races from 1920 through 1963.

White-crowned Sparrows are found as breeding birds from the Atlantic (Newfoundland) across the continent to the Aleutian Islands in the Pacific and from the limits of woody vegetation in the north to southern Colorado and the southern Sierra Nevada of California in the south. The migratory races (*leucophrys*, *gambelii*, *oriantha* and *pugetensis*) spend from April or May to September on their breeding grounds and winter over an extensive area from Maryland through Texas and New Mexico to central and coastal California. Very few are found to winter in the southeastern states from coastal North Carolina to Louisiana. The non-migratory race (*nuttalli*) is restricted to coastal California south of about Cape Mendocino and is discussed only incidentally in this report. No useful data are available for the race *oriantha* which nests in the higher mountains of western United States south of Canada.

The 198 recoveries consisted of 102 *leucophrys*, 60 *gambelii* and 36 *pugetensis*. Combining the races, 104 were recovered on the winter range, 63 while in migration and 31 on the breeding range. Only 6 were banded on the breeding range while 68 were banded on their winter range and 124 en route between winter and breeding ranges. Most white-crowns recovered were reported found dead (60), shot (51), trapped by bird bander (17) or trapped by a non-bird bander (11).

The mean interval between banding and recovery was 14.4 months (1.2 years). The range was from 1 day to 153 months with median survival 10 months. Because about 10 percent survived recovery it is probable that the mean span of life for the 198 birds recovered was about 16 months. Data suggest that life expectancy after banding is about equal for adults and for birds less than ten months old when banded. The mean interval between banding and recovery was substantially shorter for the 53 birds banded in October (mean 11 months—median 6 months) than for the 52 birds banded in May (mean 15 months—median 12 months). This is probably because birds banded in May spend the months from June through September on their breeding grounds where man is scarce and most of those banded in October spend their winter in agricultural and suburban areas where the chance of recovery is greater.

Eastern white-crowns (*leucophrys*) banded in migration from the Great Lakes eastward to the Atlantic migrate in a southwesterly direction to their winter range which extends from central Texas to the lower Ohio River valley. The complete absence of recoveries from the coastal plain of the southeastern states is consistent with the virtual absence of wintering white-crowns detected on Christmas Bird Counts 1957-61.

Mid-western *leucophrys* and *gambelii* banded in migration in the northern great plains migrate nearly due south into western Texas and Oklahoma.

Western *gambelii*, wintering mainly in southern and central California, are largely allopatric with *pugetensis* which winter mainly in central coastal California. The *gambelii* migrate inland through the central valleys of California, through Oregon and Washington east of the Cascades and into and through the Carabou Country of Canada. The *pugetensis*, on the other hand, apparently follow routes west of the crest of the Cascades as they migrate through Oregon and Washington to and from their rather restricted breeding grounds in the vicinity of Puget Sound of northwest Washington and southwest British Columbia.

Migratory White-crowned Sparrows tend to return to the same nesting grounds each spring and to the same precise winter area each fall. The complete absence of returns to banding stations on the migratory routes supports the hypothesis that these birds migrate on a broad front. They apparently do not employ terrestrial features for guidance except perhaps in the immediate vicinities of their established nesting and winter homes.

The rate of migration is probably greater in spring than in fall. A rate of 100 miles per day is suggested, but is only meagerly supported

by the data. The three shortest recovery times were 310 miles in 1 day (night), 175 miles in 2 days, and 520 miles in 6 days. Based upon the spring banding dates of 48 recovered *leucophrys*, spring passage through the populated areas of northeastern United States and southeastern Canada was 94 percent completed from 2 to 18 May (17 days). Similarly based upon the fall banding dates of another 48 recovered *leucophrys*, fall passage through the same area was only 83 percent completed from 1 to 27 October (27 days).

The modest volume of data upon which this report is based is the product of the efforts of hundreds of bird banding co-operators over a period of more than 40 years. The promiscuous banding of White-crowned Sparrows is obviously an uneconomical way of gaining information about the species. However, the banding of white-crowns in connection with more direct investigations of the biology of *Zonotrichia* and other passerines will continue to add to a very useful store of recovery data.

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APPENDIX A

Zonotrichia leucophrys leucophrys

Band No.	Age	State	Coord.	Banded	Recovered	State	Coord.	Method
123870	A	Ind.	394-860	05-03-25	05-20-26	Que.	462-713	in bldg.
665636	A	Ill.	420-874	05-03-28	01-10-30	Tex.	340-991	shot
679269	—	Vt.	442-731	05-11-28	10-09-30	Ont.	452-785	found dead
686014	A	Ind.	413-854	05-09-29	12-08-29	Okla.	351-993	shot
2138176	A	Ill.	422-874	05-11-29	11-24-30	Tex.	312-992	no info.
2196315	—	N. Y.	420-742	05-18-30	12-09-31	Tex.	311-972	shot
3149796	A	N. Y.	420-742	05-11-31	12-15-32	Ky.	373-875	trapped
4118186	I	Maine	442-681	10-01-32	01-12-37	Tex.	312-974	weather
4116122	A	Mich.	443-855	05-09-32	10-18-32	Ont.	435-791	found dead
7002155	—	N. H.	425-715	05-16-33	03-19-34	Tex.	290-980	trapped
4190059	—	Mass.	423-713	09-29-33	05-19-34	Maine	445-684	specimen
4154173	—	N. D.	417-1004	10-04-33	12-15-33	Tex.	324-1015	shot
436051	—	Ill.	414-874	10-19-33	12-11-33	Okla.	351-995	found dead
4136924	A	N. B.	455-663	05-15-34	03-30-35	Mo.	360-994	trapped
3157310	I	Va.	371-802	10-27-36	01-16-38	Tex.	310-952	found dead
3157342	I	Va.	371-802	10-05-36	01-24-37	Ark.	353-902	shot
36018742	—	N. H.	432-713	05-07-36	05-24-36	Que.	480-664	no info.
36141421	—	Ill.	414-874	10-12-36	01-27-37	Okla.	355-953	shot
36130815	I	N. D.	471-1004	09-16-37	10-00-40	Nebr.	410-1002	no info.
36162480	A	N. D.	465-964	09-19-37	12-17-38	Tex.	345-1005	found dead
34110056	I	Mass.	422-715	10-14-37	01-29-40	Tex.	304-962	shot
37157986	I	Mass.	424-731	10-14-37	12-31-37	Ark.	352-911	shot
2238901	A	Mich.	421-842	10-13-38	02-12-40	Tex.	315-983	misc. causes
38003061	A	N. Y.	424-770	05-14-38	11-24-39	Tex.	305-970	no info.
38124504	A	Ill.	420-874	05-15-38	12-27-39	Tex.	331-1002	shot
40103087	I	Vt.	441-723	10-27-39	01-28-40	Tex.	330-950	no info.
39174021	I	Mass.	423-713	10-12-39	01-28-40	Tex.	300-991	found dead
38117303	I	Conn.	412-725	10-19-39	01-07-40	Tex.	332-954	hit object
38101858	A	Ont.	492-822	05-17-39	12-01-39	Tex.	331-995	shot
39168082	A	Vt.	440-720	05-20-39	01-07-42	Ark.	361-902	shot
39176525	—	Ill.	414-874	05-07-39	12-11-40	Okla.	345-992	shot
38164134	—	Ill.	422-874	05-16-39	11-05-39	Tex.	284-970	shot
40102067	—	Ill.	420-874	10-07-39	04-09-40	Tex.	274-975	shot
39113325	—	Tenn.	350-900	11-12-40	12-27-40	Tex.	303-981	shot
41122072	A	Que.	465-711	10-06-41	01-05-42	Tex.	324-995	shot
41140257	A	Ill.	410-875	05-11-42	01-19-44	Tex.	314-995	found dead
41173995	A	Que.	465-711	09-27-44	11-10-46	Tex.	312-994	shot
43132249	A	Pa.	410-785	10-10-45	01-02-46	Ark.	342-933	found dead
45101940	I	Mich.	424-830	10-11-46	05-14-47	Mich.	441-835	injured
42188740	A	Ky.	381-854	05-11-46	12-02-46	Tex.	315-993	no info.
43144104	I	Que.	465-711	10-04-47	03-13-48	Tex.	285-974	found dead
43144108	A	Que.	465-711	10-06-47	01-27-48	Tex.	331-962	no info.
43144117	A	Que.	465-711	10-07-47	01-20-48	Ark.	343-905	found dead
41162236	A	N. Y.	423-735	05-15-47	06-11-47	Que.	501-650	no info.
42199226	—	Md.	390-764	10-13-47	01-10-50	Tex.	280-992	no info.
46128541	I	Va.	371-802	03-19-47	05-26-47	Que.	495-672	found dead
43138411	A	Ont.	461-782	10-04-48	02-05-49	Mo.	373-894	shot
43138422	A	Ont.	461-782	10-11-48	11-02-48	Mo.	361-900	shot
46121291	A	Que.	453-733	05-11-48	05-09-49	N. Y.	431-750	found dead
49149002	I	Va.	371-802	11-29-49	02-07-51	Mo.	334-905	trap & rel.
40175812	A	Que.	453-733	05-14-49	12-29-52	Miss.	342-903	found dead
20110356	A	Mass.	423-723	05-17-50	02-07-51	Ala.	343-865	found dead
20126747	A	N. Y.	424-734	10-06-50	10-26-54	Ont.	451-754	automobile
20127752	A	Ont.	424-811	09-29-52	11-28-53	Tex.	315-972	shot
48131802	I	N. Y.	404-731	10-24-52	04-11-53	Ark.	340-934	shot
48138817	A	Md.	390-764	05-09-52	04-25-53	N. B.	474-643	trap & rel.
50177847	A	Que.	452-735	05-15-52	12-13-58	Ark.	351-912	found dead
21120632	I	Ont.	433-793	10-08-53	10-00-53	Ill.	382-901	shot
22158591	A	Pa.	404-751	05-06-53	05-14-54	Que.	473-701	hit object
20139235	A	Utah	400-1125	05-12-53	08-00-54	Colo.	401-1072	found dead

Band No.	Age	State	Coord.	Banded	Recovered	State	Coord.	Method
20116226	A	Va.	390-773	05-02-53	02-17-55	Ark.	340-930	no info.
23104862	A	N. Y.	423-770	05-14-54	05-26-56	Que.	482-683	misc. causes
21153278	—	Ind.	413-870	05-02-54	10-30-55	Tex.	320-983	shot
22110475	A	Ont.	452-791	10-03-55	02-01-57	Tex.	320-985	shot
24112003	I	N. Y.	425-741	10-09-55	05-13-57	N. Y.	424-770	trap & rel.
23194494	I	Mo.	384-904	11-01-55	10-25-56	Okla.	352-973	trap & rel.
23188810	A	N. Y.	423-770	05-06-55	06-10-55	Que.	490-681	found dead
54119869	A	Md.	390-764	04-08-55	04-02-56	Md.	392-785	trap & rel.
21110961	A	Que.	465-711	05-22-55	10-05-56	Que.	491-672	trapped
52165337	A	Que.	453-733	05-07-55	04-11-57	Tex.	315-983	shot
21156873	—	Mass.	421-723	10-13-55	05-28-56	N. B.	470-652	found dead
50105620	I	Ind.	394-845	12-16-56	05-25-59	Ont.	463-842	found dead
23169008	I	Tenn.	350-894	02-04-56	10-30-56	Ohio	400-822	found dead
21197817	A	Ohio	413-813	05-06-56	12-22-59	Ky.	371-881	shot
22114706	—	Que.	582-675	08-29-56	01-04-58	Ky.	373-854	found dead
24104173	A	N. Y.	430-753	05-09-56	05-13-57	N. Y.	424-763	hit object
24143339	A	Maine	444-695	05-18-56	10-13-56	N. Y.	414-734	trap & rel.
24109149	A	Ill.	415-873	05-11-56	01-27-57	Tex.	321-990	shot
24112112	—	N. Y.	425-741	05-14-56	05-17-58	N. Y.	430-760	found dead
24109171	A	Ill.	415-873	05-09-57	05-10-57	Mich.	450-832	shot
26172348	I	Mass.	411-701	10-13-58	02-03-61	Tex.	312-1002	shot
26112983	I	N. J.	405-740	10-20-58	10-21-59	N. Y.	430-755	automobile
26172364	I	Mass.	411-701	10-14-58	05-06-59	Que.	481-695	found dead
26171449	I	Mass.	411-695	10-13-58	11-07-58	Pa.	394-774	trapped
24146594	A	Conn.	410-733	05-16-58	01-01-61	Mo.	365-900	shot
25178960	—	Mass.	411-700	10-13-58	05-17-59	Ont.	423-800	trap & rel.
27161954	A	N. Y.	423-734	10-14-59	12-26-60	Tex.	295-974	shot
26188249	A	Mich.	421-841	10-01-59	03-03-60	Ark.	352-904	trap & rel.
27122198	A	N. Y.	435-755	10-13-59	11-14-59	Pa.	395-763	trap & rel.
27122193	I	N. Y.	435-755	10-13-59	01-01-60	Ark.	340-914	shot
26114915	I	Mass.	422-711	10-21-59	12-07-59	Miss.	330-892	shot
25170229	A	N. Y.	445-734	05-10-59	10-16-59	Pa.	395-800	trap & rel.
50167688	A	Wis.	450-870	05-17-60	04-24-61	Ill.	415-892	trap & rel.
61027226	A	Ill.	380-890	03-08-60	05-05-63	Ind.	403-845	trap & rel.
29141745	—	N. Y.	404-723	10-10-60	05-10-61	N. Y.	422-734	found dead
30183917	I	Ill.	411-904	10-12-61	10-27-61	Mo.	370-933	found dead
27140568	A	Ont.	415-823	05-13-61	01-12-62	Miss.	333-900	weather
29116747	A	S. D.	441-964	05-08-61	05-08-63	Iowa	431-955	shot
28189005	A	N. Y.	424-785	05-07-61	04-06-62	Tex.	305-984	found dead
29115977	—	Pa.	411-784	05-07-61	01-30-62	La.	310-920	found dead
30138556	A	Pa.	395-800	05-06-62	06-12-62	Lab.	521-552	trapped
31118262	A	Ohio	413-812	05-04-63	05-06-63	N. Y.	430-785	hit object

Zonotrichia leucophrys gambelii

24870	I	Calif.	341-1182	12-29-22	09-12-25	Wash.	471-1170	hit object
135125	—	Sask.	511-1055	09-16-24	01-30-33	Colo.	390-1083	trap & rel.
169732	A	Calif.	411-1200	10-02-25	01-15-27	Calif.	324-1170	no info.
2023816	A	Calif.	341-1180	03-29-25	01-25-30	Calif.	324-1170	found dead
153659	I	Calif.	334-1175	02-27-27	03-23-30	Calif.	340-1172	cat
635653	A	B. C.	530-1213	04-29-28	02-17-32	Calif.	364-1194	found dead
613746	I	Calif.	340-1174	12-26-29	10-21-42	Calif.	388-1218	shot
578110	A	Calif.	335-1175	04-05-29	04-15-31	Calif.	354-1204	reptile
3030405	—	Calif.	372-1220	01-26-29	04-29-29	B. C.	542-1241	no info.
2188985	I	Calif.	334-1161	03-23-30	10-14-30	Calif.	324-1170	injured
3101759	A	Calif.	334-1175	10-04-31	10-02-33	Ore.	454-1201	found dead
2175071	A	Calif.	333-1160	02-03-31	05-17-31	B. C.	530-1203	found dead
3191942	A	Calif.	374-1225	11-28-31	01-03-32	Calif.	360-1202	shot
4102415	A	Calif.	352-1190	12-29-32	04-08-36	Calif.	383-1212	found dead
7034596	I	Ariz.	352-1114	12-13-33	01-16-34	Ariz.	321-1105	found dead
6076883	A	Calif.	334-1161	03-06-33	12-16-34	Calif.	363-1193	shot
4186056	A	N. D.	465-984	05-01-33	00-00-34	Man.	504-993	trapped
4184210	—	Calif.	352-1190	03-01-33	04-04-33	Calif.	400-1220	trapped

Band No.	Age	State	Coord.	Banded	Recovered	State	Coord.	Method
5123071	—	N. D.	465-964	09-27-33	03-20-36	Nebr.	401-985	weather
7053129	—	S. D.	450-983	05-01-34	05-07-34	Man.	521-1011	shot
34111399	A	Calif.	373-1205	03-12-34	02-24-35	Calif.	380-1211	found dead
34112582	—	N. D.	465-984	05-08-34	03-25-35	Mexico	280-1010	no info.
34120856	I	Calif.	373-1205	12-19-34	03-10-37	Calif.	383-1212	found dead
4189296	A	B. C.	493-1194	04-25-35	09-29-35	Calif.	414-1223	injured
34145220	A	N. D.	471-1004	09-29-35	11-08-36	Tex.	332-1005	shot
36024572	I	Ariz.	325-1113	03-07-36	02-17-37	Calif.	340-1171	cat
36130933	I	N. D.	471-1004	09-25-37	01-17-38	Tex.	324-1002	shot
36153344	I	Calif.	375-1221	11-01-37	03-08-38	Calif.	353-1202	shot
36109306	A	Calif.	373-1205	04-05-38	10-18-38	Calif.	351-1203	found dead
37174247	—	Calif.	373-1205	11-14-38	03-07-40	Calif.	390-1220	found dead
37137294	I	Calif.	374-1221	11-12-39	01-22-40	Calif.	340-1191	found dead
39141015	—	Man.	493-993	09-21-39	04-19-42	Tex.	334-1004	shot
39189815	I	Calif.	372-1205	11-28-39	04-08-41	Calif.	401-1221	found dead
13819470	I	Calif.	340-1174	02-10-39	09-15-39	Wash.	463-1203	found dead
40137244	I	Calif.	333-1175	03-16-40	05-01-42	Wash.	463-1203	cat
2154405	I	Calif.	324-1170	03-04-40	04-21-40	Calif.	384-1204	found dead
40138073	I	Calif.	372-1205	03-30-40	12-31-40	Calif.	382-1204	no info.
40126590	I	Calif.	383-1214	01-22-41	04-05-41	Calif.	372-1204	shot
39052958	—	Ariz.	321-1105	02-06-41	01-10-43	Ariz.	332-1115	shrike
42028676	—	Ariz.	332-1115	11-21-42	04-28-45	Calif.	403-1222	found dead
41160177	A	Calif.	331-1171	10-19-42	02-01-43	Calif.	335-1181	shot
41166968	—	Calif.	342-1194	12-27-44	03-00-47	Calif.	372-1205	no info.
40065518	—	Ariz.	332-1115	04-08-44	04-21-44	Nev.	404-1180	found dead
43138718	I	N. D.	471-1004	10-08-44	11-25-47	Tex.	321-992	shot
42144432	I	Calif.	340-1180	02-24-46	04-16-46	Calif.	372-1215	found dead
48037246	I	Colo.	402-1044	10-25-50	11-28-50	Wyo.	415-1041	cat
20120815	A	Calif.	352-1190	02-10-50	01-16-51	Calif.	361-1191	found dead
49010166	I	Calif.	352-1190	02-06-50	04-26-51	Ore.	455-1185	cat
20181552	I	Nev.	355-1145	01-24-52	04-25-52	B. C.	491-1215	found dead
41118598	A	Calif.	354-1170	12-16-52	04-14-55	Ore.	454-1183	automobile
50173113	—	Man.	495-995	05-10-53	01-15-55	Colo.	381-1043	found dead
22159929	I	Nebr.	421-1001	10-16-53	12-25-54	Tex.	324-1000	no info.
24104734	—	Wash.	485-1224	09-23-55	02-14-56	Wash.	461-1200	cat
51064701	A	Calif.	330-1170	11-29-55	01-00-58	Calif.	323-1170	shot
24104728	I	Wash.	485-1224	09-17-55	05-08-56	B. C.	535-1224	found dead
23181500	A	Calif.	352-1191	03-31-56	03-01-57	Ariz.	323-1144	shot
57046101	A	S. D.	440-1031	04-28-56	03-23-57	Okla.	364-1015	weather
24176305	A	Calif.	392-1215	11-05-56	01-29-58	Calif.	352-1190	automobile
28136199	A	Ariz.	322-1110	02-19-61	05-01-61	B. C.	493-1193	found dead
29152558	I	Ore.	433-1190	09-09-62	10-13-62	Calif.	324-1170	hit object

Zonotrichia leucophrys pugetensis

165647	I	Wash.	473-1222	08-01-25	11-25-26	Calif.	365-1214	shot
179496	A	Calif.	375-1221	10-14-26	10-01-27	Ore.	450-1233	shot
578560	I	Calif.	375-1221	11-02-27	01-28-28	Calif.	360-1202	shot
1123588	I	Calif.	375-1221	12-14-28	07-02-29	B. C.	483-1233	automobile
2034320	—	Calif.	372-1220	04-12-29	06-14-29	Wash.	475-1221	injured
2178749	A	Calif.	375-1221	03-24-30	05-22-30	Wash.	473-1222	found dead
2181366	I	Calif.	375-1221	10-01-32	05-01-34	Wash.	472-1222	cat
4101945	I	Calif.	375-1221	10-06-32	07-01-33	Ore.	454-1231	cat
6009713	A	Calif.	385-1223	02-17-34	05-28-34	Ore.	452-1224	drowned
4144032	—	Ore.	445-1230	04-14-35	10-10-36	Wash.	475-1215	found dead
35060699	A	Calif.	375-1223	10-08-35	08-11-36	B. C.	491-1230	found dead
36109305	A	Calif.	373-1205	04-05-38	05-21-38	Wash.	473-1223	automobile
37170132	I	Calif.	375-1221	12-17-38	03-01-41	Wash.	483-1223	found dead
40074213	—	Calif.	375-1221	09-30-40	01-14-41	Calif.	364-1213	found dead
39183451	—	Ore.	445-1230	03-20-40	02-06-41	Calif.	374-1221	no info.
40129602	I	Calif.	365-1220	02-02-40	07-00-43	Wash.	471-1221	automobile
41135017	I	Calif.	342-1194	10-13-41	04-10-42	Wash.	473-1222	found dead
41164460	—	Calif.	342-1194	12-23-42	09-10-43	B. C.	482-1232	trapped

Band No.	Age	State	Coord.	Banded	Recovered	State	Corrd.	Method
41121080	I	Calif.	342-1194	01-12-43	05-26-44	B. C.	490-1224	found dead
47119626	A	Calif.	375-1221	02-08-49	06-25-49	Wash.	471-1221	found dead
50076019	I	Calif.	340-1182	12-20-51	05-04-52	B. C.	482-1232	trap & rel.
20177138	A	Calif.	380-1220	04-10-53	07-01-54	Wash.	481-1223	trapped
20148109	—	Calif.	375-1223	10-04-53	04-10-56	Wash.	485-1221	found dead
23147027	I	Calif.	374-1221	02-03-56	04-17-57	Wash.	473-1222	found dead
25118192	—	Calif.	372-1215	11-23-57	04-06-60	Wash.	485-1224	trap & rel.
24180958	I	Wash.	485-1224	09-06-58	02-10-59	Calif.	405-1240	found dead
27169506	I	Wash.	485-1224	09-10-59	10-19-59	Calif.	351-1203	cat
27169514	—	Wash.	485-1224	09-18-59	11-07-59	Calif.	372-1215	trap & rel.
27104107	—	Calif.	372-1215	11-11-59	08-22-60	B. C.	490-1234	found dead
22136419	—	B. C.	491-1230	08-26-59	12-31-61	Calif.	371-1214	trap & rel.
28121415	—	Calif.	365-1215	01-12-60	05-06-61	Wash.	461-1232	cat
28155446	I	Calif.	365-1220	10-08-60	05-25-61	Wash.	483-1223	found dead
29184084	A	Calif.	380-1220	03-04-61	05-25-61	B. C.	490-1230	injured
32175722	I	Calif.	371-1214	12-31-62	04-15-63	Wash.	473-1223	hit object
31188552	A	Calif.	370-1213	03-26-62	05-12-62	Wash.	480-1232	hit object
31138666	A	Calif.	372-1215	01-28-62	08-19-62	Wash.	484-1222	cat

PLUMAGES, MOLT AND MORPHOMETRY OF TENNESSEE WARBLERS

By DENNIS G. RAVELING* AND DWAIN W. WARNER

INTRODUCTION

Thousands of birds have been killed during fall migration at the Eau Claire, Eau Claire County, Wisconsin television tower (Kemper, 1958, 1959, 1964). Dr. C. A. Kemper has generously salvaged and donated thousands of specimens to the Minnesota Museum of Natural History. These large samples of migrants have much potential for study, as well pointed out by Tordoff and Mengel (1956).

Approximately 800 Tennessee Warblers (*Vermivora peregrina*) were killed at the Eau Claire tower in the fall of 1961 and 1962. cursory examination of these Tennessee Warblers indicated that previous plumage descriptions of the age-sex classes contained inaccuracies and were often incomplete. These TV tower killed samples provided an opportunity to learn more of the sex, age, and individual variability in plumage patterns and morphology of the Tennessee Warbler. To understand further plumage changes and variability, approximately 1200 Tennessee Warbler museum specimens collected throughout the entire year were examined.

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