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PASSERINE MIGRATION ALONG THE INNER COAST RANGE OF CENTRAL CALIFORNIA

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With mist nets and ground traps we sampled the spring and fall flows of land birds migrating along Mission Ridge, just southeast of the south tip of San Francisco Bay. Few such studies have been made of land-bird migration along the Pacific coast of North America. In northern California, the broadest-based of these is the annotated field list prepared by McCaskie et al. (1979), which presents graphically the relative abundance by months, hence the timing of migration, of all species known from that area. It was based on many years of records from the Middle Pacific Coast Region reports in *American Birds* and their back-up files. These files were initiated by Howard L. Cogswell in 1954 and are now maintained by the regional editors of the quarterly reports.

Several studies have reported the timing of migration at specific locations. Weston (1948) reported spring arrival dates of 15 species at Berkeley, California, for the years 1911 to 1947. Littlefield and McLaury (1973) reported on spring migration and arrival dates at Malheur National Wildlife Refuge in eastern Oregon. Stewart (1972) dealt with the timing of peak migration of several passerines in central coastal California, while Ralph (1971) and Stewart et al. (1974) demonstrated that unusually high numbers of young passerines of some species appear along the central California coast in fall migration. The most comprehensive of these specific location studies is the monograph of DeSante and Ainley (1980), which analyzed the origins of the transient avifauna of Southeast Farallon Island, California. For this transient avifauna they provide spring and fall dates of occurrence, numbers encountered on daily censuses, and numbers captured in mist nets and a Heligoland trap for 331 species for the years 1968 to 1976.

Other studies, such as Wolfson's (1945) pioneering work on the experimental manipulation of migration in juncos (*Junco hyemalis*), have dealt with single species. Johnson (1965, 1970, 1973) studied the migratory patterns of Hammond's Flycatcher (*Empidonax hammondii*) and the Western Flycatcher (*E. difficilis*). There is also the broad spectrum of studies dealing

with the migratory biology of the White-crowned Sparrow (*Zonotrichia leucophrys*), such as those of Farner (1955), Mewaldt et al. (1964), Cortopassi and Mewaldt (1965), King et al. (1965), DeWolfe et al. (1973), and King and Mewaldt (1981a,b).

Several workers have discussed apparent differences between passerine migration in the eastern and western parts of the continent (e. g., Paxton 1965, Lowery and Newman 1966, DeBenedictis 1967). In western North America the movements of the fewer migratory land-bird species are obscured by a more rugged topography and by more complex weather patterns. Western observers do not often see the massive landfalls of grounded migrants that are seen in the mid-western and eastern parts of North America. These are usually correlated with certain weather conditions. Especially in central California there are few strictly passage migrants. Here along the Pacific Coast the presence of resident components (winter, summer, permanent) of many species tends to obscure migratory movements by the migratory components of those same species.

We report on a two-year study of the abundance and timing of passage of migrant land birds along the inner Coast Range of central California. Using mist nets and traps we captured, banded, and recaptured more than 14,000 individual birds in two spring and two fall seasons from August of 1970 to May of 1972. We have compared these findings with those reported for the nearby Farallon Island station of Point Reyes Bird Observatory (DeSante and Ainley 1980).

STUDY AREA

Our studies were on the E. O. Wool Ranch on Mission Ridge, a northwest extension of the Diablo Range lying 55 km east of the Pacific Ocean and overlooking the south end of San Francisco Bay (Figure 1). Our operations were centered in a valley 615 m above sea level, just east of the 800-meter crest of Mission Ridge and astride the boundary between Santa Clara and Alameda counties. The surrounding physiography consists of grassy rolling hills, interspersed to the east with steep canyons, wooded on their north- and east-facing slopes, and to the west with the grassy uplands of Mission Ridge. The west slope of Mission Ridge drops abruptly to South San Francisco Bay near the city of Fremont. Land east of the Wool Ranch drops off to Calaveras Reservoir (water surface elevation 233 m), beyond which additional ridges of the Diablo Range rise to more than 1000 m.

The study area is characterized by warm, dry summers and cool, rainy winters. Although the Pacific Ocean and San Francisco Bay exert a moderating influence on temperature, the effect is somewhat diminished at higher elevations. In our study area temperatures were from 3 to 6°C higher in summer and lower in winter than those recorded in nearby Milpitas (elevation 33 m). Thermograph records maintained during operations showed a high of 41°C (10 Aug 1971) and a low of −2°C (2 Feb 1972). Especially in spring and early summer, thermal inversions prevent ocean fog flowing inland from reaching high ground. Mission Ridge then stands out at dawn, as though an island or peninsula, above the surrounding fog, which often totally obscures areas below 500 m elevation.

Rainfall records, maintained by the Wool family from 1942 to 1972, reveal a yearly mean of 66 cm (range 35 to 102 cm). This amount is approximately double that falling on the south end of San Francisco Bay 10 km to the west. Virtually all precipitation falls from October to April, with mean highs of 13 cm in both December and January. Precipitation, including some snow, was substantially higher than average in the 1970-71 winter season and substantially lower than average in the 1971-72 winter season.

The uplands of the study area support open grassland, oak woodland, and chaparral. Grassland, occupying the ridges and the more exposed south- and west-facing slopes, is composed primarily of annual grasses and herbs, with wild oats (*Avena fatua*) predominating. Oak woodland occupies the north- and east-facing slopes. This woodland consists principally of Coast Live Oak (*Quercus agrifolia*) and Valley Oak (*Q. lobata*), with California Bay

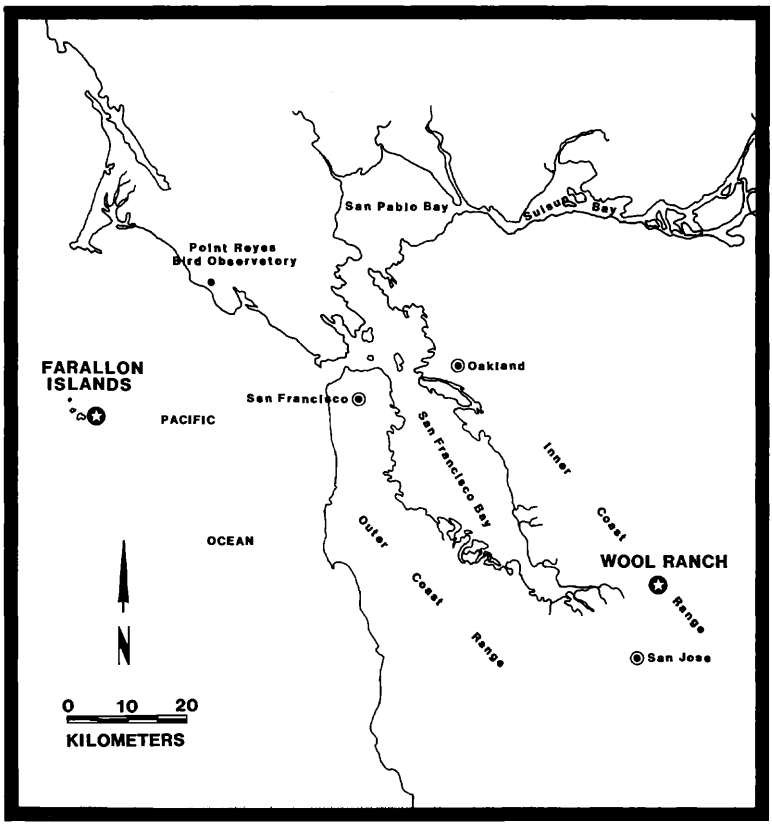

Figure 1. Greater San Francisco Bay area, showing the location of the Wool Ranch on Mission Ridge and the Farallon Islands.

(*Umbellularia californica*) and California Buckeye (*Aesculus californicus*) as associates. California Sycamores (*Platanus racemosa*) and Bigleaf Maples (*Acer macrophyllum*) grow at springs and along resulting streams. Isolated areas of chaparral, some composed mostly of Chamise (*Adenostoma fasciculatum*), occur on the dry, rocky slopes facing Calaveras Reservoir. These and most other areas of chaparral contain substantial amounts of Poison Oak (*Toxicodendron diversilobum*), Toyon (*Heteromeles arbutifolia*), Coyote Bush (*Baccharis pilularis*), Coffeeberry (*Rhamnus californicus*), Sticky Monkey Flower (*Mimulus guttatus*), ceanothus (*Ceanothus* sp.), and small Coast Live Oaks.

Most of the ranch (about 530 ha), as well as the surrounding 3500 ha of undeveloped regional park and watershed lands, were grazed by cattle. The immediate study area (Figure 2) was dominated by a 20-ha irrigated (well water) orchard of prunes (*Prunus* sp.) and walnuts (*Juglans* sp.). A usually dry gully, draining from north to south through the eastern portion of the orchard, contained intermittent patches of willows (*Salix* sp.), small Coast Live Oaks, Coyote Bushes, and Poison Oak (Figure 3). This gully, terminating in a 0.1-ha permanent stock pond with willows on two sides, proved a substantial attractant to residents and grounded migrants. Another important attractant was a large wooden water tank, continually seeping, at the southwest corner of the orchard and at the base of a hill wooded with Coast Live Oak, California Bay, and understory clumps of Coffeeberry. Surface water on the higher portions of Mission Ridge was usually restricted to the immediate vicinity of the orchard and ranch buildings, except for a few springs usually associated with a stock-watering device or pond. In the wet spring of 1971 there were scattered vernal pools on the higher portions of the ridge.

METHODS

Capture Methods and Data Collection

Birds were captured with Japanese mist nets and Potter traps. The basic netting unit, a net-hour, consisted of a 4-panel nylon mist net 12 m long and 2 m high set with the bottom trammel line about 0.15 m above the ground and operated for 1 hour. At several sites a second net was joined to and mounted above the ground-level net and elevated with lanyards and pulleys on guyed 5-m poles to a height of about 4.15 m. Such an arrangement, although probably not twice as efficient as a single net run for 1 hour, was counted as 2 net-hours. Nets were made of 70-denier black nylon yarn with stretched 36-mm mesh or occasionally with 30-mm mesh.

Nets were placed in lanes cut across the willow-dominated draw, in the prune orchard, and at strategic locations under trees adjacent to the leaking water tank (Figure 2). The nets in the willow draw and at the water tank, consisting of 20 nets at 7 sites, were operated nearly constantly from season to season. The nets in the orchard and nets set occasionally at sites up to 300-400 m from the orchard were run opportunistically. Opened 20 minutes before sunrise and closed shortly before noon, nets were operated daily during the spring and fall periods of migration and intermittently in other seasons — except during June and July when none was operated. Net hours and numbers of birds caught at each site were logged.

Four-celled welded-wire Potter traps (each cell 20 × 25 × 20 cm high) were baited with chick scratch and placed in nearby brushy areas associated with oak woodland and along the edge between grassland and chaparral. A trap-hour was a four-celled trap open for 1 hour. Trap lines, consisting of 10 to 40 traps at 4 to 15 stations, were run irregularly, but most often in early

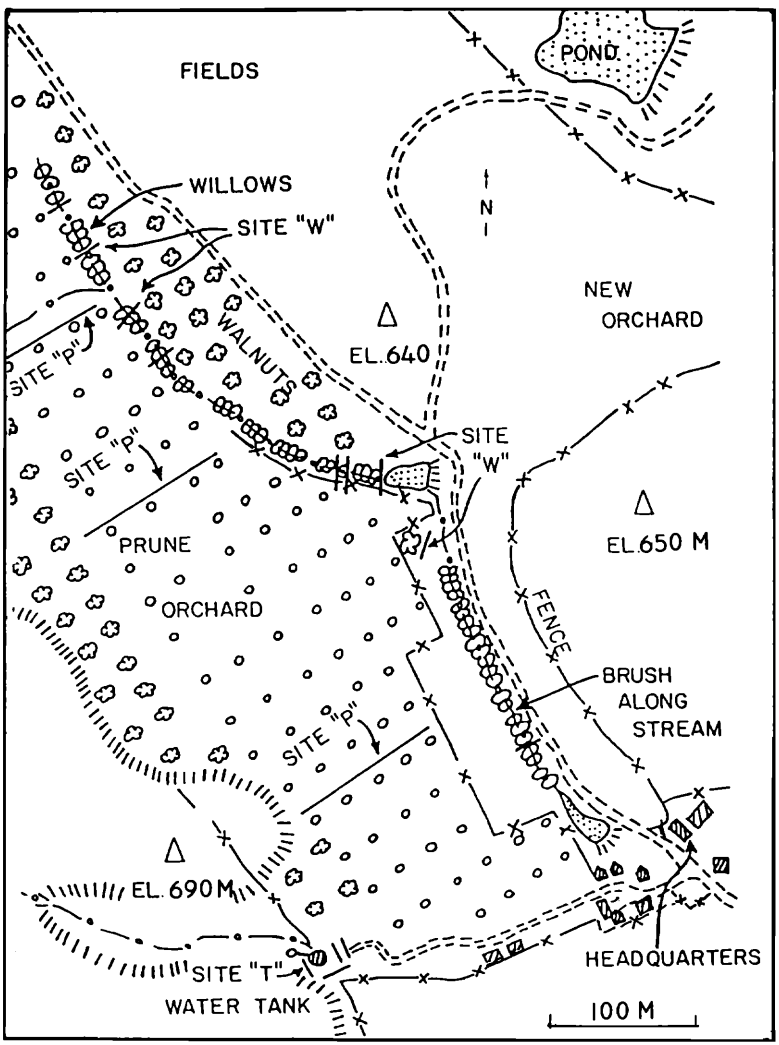

Figure 2. The main study area on the Wool Ranch. Mist net locations on the several sites are indicated by heavy solid lines.

spring and late fall, when they were operated 2 to 4 days a week. Trap hours and the numbers of birds caught at each site were logged.

All birds except hummingbirds (tail-clipped to detect recaptures) were banded with U.S. Fish and Wildlife Service aluminum bands. Data recorded on each capture and recapture included species, age, sex when possible, hour of capture, site of net or trap, wing chord (mm), weight (g), and, in appropriate season, reproductive condition (brood patch, cloacal protuberance, etc.), condition of molt, amount of fat, skull pneumatization, and standard notes related to determination of age and sex. Photographs were taken of rare and unusual species.

Project Personnel

Nets and traps were operated and most of the banding and data collection were done by advanced undergraduate and graduate students enrolled in Field Studies in Bird Migration at San Jose State University. All had either taken Ornithology or were taking it concurrently. Several participated during all four migratory seasons. Four to six students each day, in rotation from a roster of 14 to 16, worked seven days of each week during spring and fall migration. When heavy waves of migrants appeared or special problems arose, additional help was summoned by telephone. Daily crew chiefs were selected from among those with greater experience.

RESULTS AND DISCUSSION

The 14,159 birds of 109 taxa (107 species including 2 with 2 races distinguished in each) were captured and recaptured 22,671 times in two fall and two spring seasons from August 1970 to May 1972 (Table 1). Only six species (two hummingbirds, two flycatchers, and two warblers) are strictly passage migrants through the San Francisco Bay region. The rest are residents of one kind or another in the greater San Francisco Bay region. Our determination of the migratory status of central California residents was based in part on whether or not the species in question appears on the Farallon Islands as a migrant (DeSante and Ainley 1980). Supplemental data, including the capture of four additional species, were obtained in the spring of 1970 and from sporadic field work from the fall of 1972 to 1979 (Appendix).

The data are biased in two ways that limit effective application of biometrical analyses. (1) Many net lanes and trap lines were changed from season to season to maximize capture efficiency. (2) Operations could not be continued beyond 31 May in the springs of either year. Thus we had no data for June and coverage of July and August was weak. Nonetheless, the data provide a valuable sample of land bird migration through the south San Francisco Bay region in the early 1970s. Kaiser (1976) reported further detailed information on the subjects we cover and other items such as median migration dates, age ratios, fat deposition, and correlations with weather.

Captures in Nets

Of 14,338 captures in mist nets, 9392 were first encounters with migrants, 2108 were first encounters with resident species, and 2838 were recaptures

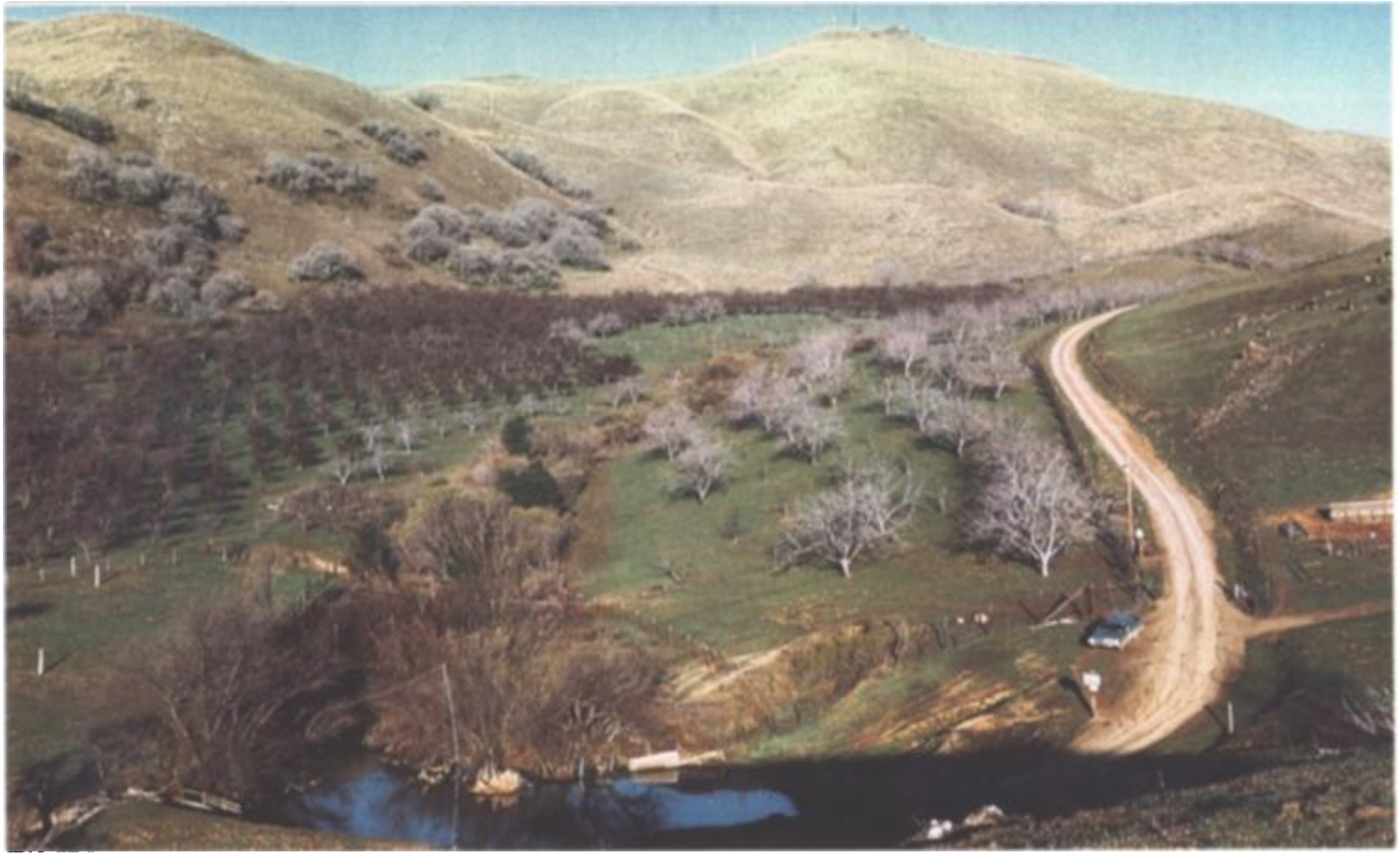

Figure 3. Willow draw, where most migrants were captured, extends upward and to the right from the pond. Photo taken 20 February 1972 shows prune trees on the left and walnuts on the right A tethered mist net pole may be seen at the edge of the pond The red and white fence posts in the lower center were part of a temporary fencing to keep cows from the net lanes

Table 1 Status and Number of First Captures of the 109 Taxa of Birds Captured in Mist Nets and Potter traps on the Wool Ranch from August 1970 through May 1972

Species		Number
Resident with no apparent migratory component:		
California Quail	*Callipepla californica*	199
Western Screech-Owl	*Otus kennicottii*	2
Nuttall's Woodpecker	*Picoides nuttallii*	20
Downy Woodpecker	*Picoides pubescens*	2
Hairy Woodpecker	*Picoides villosus*	6
Steller's Jay	*Cyanocitta stelleri*	64
Scrub Jay	*Aphelocoma coerulescens*	49
Yellow-billed Magpie	*Pica nuttalli*	7
Chestnut-backed Chickadee	*Parus rufescens*	55
Plain Titmouse	*Parus inornatus*	105
Bushtit	*Psaltriparus minimus*	136
White-breasted Nuthatch	*Sitta carolinensis*	24
Bewick's Wren	*Thryomanes bewickii*	65
Western Bluebird	*Sialia mexicana*	30
Wrentit	*Chamaea fasciata*	6
California Thrasher	*Toxostoma redivivum*	17
Brown Towhee	*Pipilo fuscus*	147
Rufous-crowned Sparrow	*Aimophila ruficeps*	10
Resident with a migratory component:		
Cooper's Hawk	*Accipiter cooperii*	3
American Kestrel	*Falco sparverius*	5
Mourning Dove	*Zenaida macroura*	83
Long-eared Owl	*Asio otus*	1
Anna's Hummingbird	*Calypte anna*	42
Acorn Woodpecker	*Melanerpes formicivorus*	5
Northern Flicker	*Colaptes auratus*	48
Black Phoebe	*Sayornis nigricans*	17
Horned Lark	*Eremophila alpestris*	118
Red-breasted Nuthatch	*Sitta carolinensis*	1
Brown Creeper	*Certhia americana*	11
Rock Wren	*Salpinctes obsoletus*	1
Winter Wren	*Troglodytes troglodytes*	8
Golden-crowned Kinglet	*Regulus satrapa*	4
Hermit Thrush	*Catharus guttatus*	994
American Robin	*Turdus migratorius*	95
Northern Mockingbird	*Mimus polyglottos*	27
Phainopepla	*Phainopepla nitens*	1
Loggerhead Shrike	*Lanius ludovicianus*	5
European Starling	*Sturnus vulgaris*	47
Hutton's Vireo	*Vireo huttoni*	30
Orange-crowned Warbler	*Vermivora celata*	387
Audubon's Warbler	*Dendroica coronata auduboni*	149
Common Yellowthroat	*Geothlypis trichas*	4
Rufous-sided Towhee	*Pipilo erythrophthalmus*	177
Lark Sparrow	*Chondestes grammacus*	713
Sage Sparrow	*Amphispiza belli*	1

Table 1 (Continued)

Species		Number
Savannah Sparrow	*Passerculus sandwichensis*	130
Song Sparrow	*Melospiza melodia*	2
Oregon Junco	*Junco hyemalis* sspp.	1516
Red-winged Blackbird	*Agelaius phoeniceus*	184
Western Meadowlark	*Sturnella neglecta*	12
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	1
Brewer's Blackbird	*Euphagus cyanocephalus*	53
Brown-headed Cowbird	*Molothrus ater*	1
Purple Finch	*Carpodacus purpureus*	280
House Finch	*Carpodacus mexicanus*	1088
Pine Siskin	*Carduelis pinus*	1
Lesser Goldfinch	*Carduelis psaltria*	256
Lawrence's Goldfinch	*Carduelis lawrencei*	12
American Goldfinch	*Carduelis tristis*	61
Summer resident:		
Allen's Hummingbird	*Selasphorus sasin*	10
Olive-sided Flycatcher	*Contopus borealis*	3
Western Wood-Pewee	*Contopus sordidulus*	33
Western Flycatcher	*Empidonax difficilis*	701
Ash-throated Flycatcher	*Myiarchus cinerascens*	14
Western Kingbird	*Tyrannus verticalis*	1
Violet-green Swallow	*Tachycineta thalassina*	1
House Wren	*Troglodytes aedon*	27
Swainson's Thrush	*Catharus ustulatus*	850
Solitary Vireo	*Vireo solitarius*	10
Warbling Vireo	*Vireo gilvus*	210
Yellow Warbler	*Dendroica petechia*	148
Black-throated Gray Warbler	*Dendroica nigrescens*	8
MacGillivray's Warbler	*Oporornis tolmiei*	74
Wilson's Warbler	*Wilsonia pusilla*	461
Yellow-breasted Chat	*Icteria virens*	5
Western Tanager	*Piranga ludoviciana*	66
Black-headed Grosbeak	*Pheucticus melanocephalus*	118
Lazuli Bunting	*Passerina amoena*	43
Chipping Sparrow	*Spizella passerina*	494
Black-chinned Sparrow	*Spizella atrogularis*	1
Grasshopper Sparrow	*Ammodramus savannarum*	1
Bullock's Oriole	*Icterus galbula bullockii*	55
Winter resident:		
Sharp-shinned Hawk	*Accipiter striatus*	12
Red-breasted Sapsucker	*Sphyrapicus ruber*	22
Ruby-crowned Kinglet	*Regulus calendula*	259
Varied Thrush	*Ixoreus naevius*	12
Water Pipit	*Anthus spinoletta*	1
Cedar Waxwing	*Bombycilla cedrorum*	43
Myrtle Warbler	*Dendroica coronata coronata*	21
Townsend's Warbler	*Dendroica townsendi*	4
Fox Sparrow	*Passerella iliaca*	236
Lincoln's Sparrow	*Melospiza lincolnii*	41

Table 1 (Continued)

Species		Number
White-throated Sparrow	*Zonotrichia albicollis*	3
Golden-crowned Sparrow	*Zonotrichia atricapilla*	1753
Puget Sound White-crowned Sparrow	*Z. leucophrys pugetensis*	203
Gambel's White-crowned Sparrow	*Z. l. gambelii*	344
Migratory with no resident component:		
Calliope Hummingbird	*Stellula calliope*	10
Rufous Hummingbird	*Selasphorus rufus*	168
Willow Flycatcher	*Empidonax traillii*	72
Hammond's Flycatcher	*Empidonax hammondii*	8
Nashville Warbler	*Vermivora ruficapilla*	25
Hermit Warbler	*Dendroica occidentalis*	8
Vagrant, no resident or migratory component:		
Gray Flycatcher	*Empidonax wrightii*	11
Bell's Vireo	*Vireo bellii*	1
Blackburnian Warbler	*Dendroica fusca*	1
American Redstart	*Setophaga ruticilla*	1
Green-tailed Towhee	*Pipilo chlorurus*	1
Black-throated Sparrow	*Amphispiza bilineata*	2
Slate-colored Junco	*Junco hyemalis hyemalis*	3
Additional species captured in the supplemental periods (see Appendix)		
Killdeer (resident)	*Charadrius vociferus*	3
Say's Phoebe (winter resident)	*Sayornis saya*	1
Canyon Wren (resident)	*Catherpes mexicanus*	1
Tennessee Warbler (vagrant)	*Vermivora peregrina*	1

(Table 2). Most of the recaptures were of resident species. The 3664 spring migrants were caught in mist nets at a rate of 24 per 100 net hours (15,116 net hours), whereas fall migrants, numbering 5728, were caught at a rate of 38 per 100 net hours (14,877 net hours). This 56% increase in numbers of fall migrants over spring migrants, resulting from approximately equal spring and fall efforts, is consistent with an expectation of greater numbers following summer reproduction. Similarly, the 153% increase in late summer and fall nonmigrants or residents (597 Jan-May versus 1511 Aug-Dec) roughly fulfills our expectation of encounters with dispersing juveniles of resident species.

Captures in Traps

Of 8333 captures in Potter traps, 2659 were first encounters and 5674 were recaptures (Table 2). Traps captured mostly granivorous species, including both migratory winter residents such as Golden-crowned Sparrows and residents such as Lark Sparrows. The trend seen in mist net captures toward more captures in the late summer and fall was even greater with trap-caught birds. The 749 spring captures (9 per 100 trap hours) were much less

Table 2 Captures in Mist Nets and Potter Traps, August 1970 to May 1972, by Months and Seasons

Item	Jan	Feb	Mar	Apr	May	Spring total	Aug	Sep	Oct	Nov	Dec	Fall total	Total
All captures	191	602	2746	2987	2721	9247	1786	3089	6067	2117	365	13,424	22,671
First captures	85	248	864	1456	2357	5010	1353	2243	4369	1044	140	9149	14,159
Recaptures	106	354	1882	1531	364	4237	433	846	1698	1073	225	4275	8512
Captures in nets	24	321	970	1444	2588	5347	1261	2626	4327	756	21	8991	14,338
Net hours	48	226	2926	5424	6492	15,116	2321	5604	5859	1032	61	14,877	29,993
(Per 100 net-hrs)	(50)	(142)	(33)	(27)	(40)	(35)	(54)	(47)	(74)	(73)	(34)	(60)	(48)
Migrants in nets	4	35	483	1136	2006	3664	591	1578	3068	474	17	5728	9392
(Per 100 net-hrs)	(8)	(15)	(17)	(21)	(31)	(24)	(25)	(28)	(52)	(46)	(28)	(39)	(31)
Non-migrants in nets	11	138	78	50	320	597	396	520	466	127	2	1511	2108
(Per 100 net-hrs)	(23)	(61)	(3)	(1)	(5)	(4)	(19)	(9)	(8)	(12)	(3)	(10)	(7)
Recaptures in nets	9	148	409	258	260	1084	274	528	795	155	2	1754	2838
(Per 100 net-hrs)	(19)	(65)	(14)	(5)	(4)	(7)	(12)	(9)	(14)	(15)	(3)	(12)	(9)
Captures in traps	167	281	1776	1543	135	3902	525	463	1738	1357	348	4431	8333
Trap hours	235	426	2449	4162	1244	8516	447	637	2051	1702	1463	6300	14,816
(Per 100 trap-hrs)	(71)	(66)	(73)	(37)	(11)	(46)	(117)	(73)	(85)	(80)	(24)	(70)	(56)
New captures in traps	70	75	303	270	31	749	366	145	835	443	121	1910	2659
(Per 100 trap-hrs)	(30)	(18)	(12)	(6)	(2)	(9)	(82)	(23)	(41)	(26)	(8)	(30)	(18)
Recaptures in traps	97	206	1473	1273	104	3153	159	318	903	918	223	2521	5674
(Per 100 trap-hrs)	(41)	(48)	(60)	(31)	(8)	(37)	(36)	(50)	(44)	(54)	(15)	(40)	(38)

than half the 1910 late summer and fall captures (30 per 100 trap hours). Part of this substantial difference was due to dispersing juveniles of residents such as Lark Sparrows and Brown Towhees. Another component adding to fall numbers was the banding of newly arrived winter residents, such as Golden-crowned Sparrows, including substantial numbers of juveniles raised in Canada and Alaska. Because these wintering birds were still present in the spring, they did not contribute to spring counts of newly banded birds.

Although most species were caught almost exclusively in nets (e. g., flycatchers, thrushes, and warblers) or traps (e. g., California Quail, Horned Larks, and Lark Sparrows), a few, such as Golden-crowned and White-crowned Sparrows, Oregon Juncos, Fox Sparrows, towhees, and jays were caught in both nets and traps.

Post-breeding Dispersal

Experience (Mewaldt unpublished, DeSante and Geupel 1987) makes it clear that dispersal by juveniles and post-breeding wandering by adults of local breeding species begins as early as late May (e. g., Orange-crowned Warbler, see below) and increases in volume through June, July, and August. These post-breeding movements were evident on Mission Ridge (Table 3) in August and September for resident species such as Steller's and Scrub jays, Chestnut-backed Chickadees, and Brown Towhees, which probably lack a migratory component. Numbers of dispersing Rufous-sided Towhees and Oregon Juncos captured were supplemented by migrants of each species beginning in September. Dispersal of juveniles and local winter wandering by Lark Sparrows and House Finches certainly blended and may prove difficult to distinguish. The lack of data from June, July, and early August makes further discussion of dispersal unrewarding.

Spring and Fall Migration

The arrival, approximate duration, and peak of passage of spring migrants captured in significant numbers are displayed for both 1971 and 1972 in Table 4. It is evident from the numbers captured in the final six days of May, however, that some species must have continued as birds of passage on Mission Ridge into the first week or two of June. Noteworthy in this category were Western Flycatchers, Swainson's Thrushes, Warbling Vireos, Orange-crowned Warblers, Yellow Warblers, Townsend's Warblers, MacGillivray's Warblers, Wilson's Warblers, Western Tanagers, Black-headed Grosbeaks, and Lazuli Buntings. Clearly, some northern or mountain populations of these species were still migrating in late May and early June while local populations were already nesting. These 11 species have central California populations that regularly begin nesting in April or early May (e. g., Grinnell and Wythe 1927, Sibley 1952, Stewart 1972, Verner and Boss 1980). Noteworthy is the Orange-crowned Warbler, of which no fewer than 30% of the 88 captured 11-31 May were recently fledged birds.

The timing, approximate duration, and peak of passage of these same species are displayed in Table 5 for the fall seasons of both 1970 and 1971. Coverage of the month of August was weak, and the August data are complicated by probably including locally raised, pre-migratory, dispersing juveniles. Species probably subject to this complication are the Northern

Table 3 New Captures of Selected Local Breeders in Postbreeding Dispersal

	Aug					Sep						Oct						Nov	Dec
Species	1-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31	1-30	1-31
Western Wood Pewee		4	3	1	2		4	4		2		2							
Steller's Jay		7	2	5	13	9	4	1		7	4	1		2	3	2	3	1	
Scrub Jay		3	3	4	7	1	4	4	3	2	4		1			2		2	1
Chestnut-backed Chickadee		2	6	2	1	4	7	6	6	5	2	2	1	1	1				
Plain Titmouse		14	2	3	5	4	1		3	1	3	4		5	2	1	5	2	
Bushtit		14	2	2	4	13	2	1	4	4	11			11	6		11	4	
Brown Creeper		2	1		2			1								1		1	
Bewick's Wren	1	4	2	1	6	8	7	4	7	3	3	6	6	1	1	1		2	
Hutton's Vireo			1	3	4			2	4		3	3		2	2		2	1	
Rufous-sided Towhee		14	4	2	11	5	2	3	6	4	5	9	5	7	10	10	5	19	6
Brown Towhee		8	6	6	10	8	3	3	5	7	2	5	9	4	8	1	3	19	4
Lark Sparrow		75	138	82	46	32	44	23	36	14	9	11	17	16	19	20	17	28	4
Oregon Junco	9	15	22	6	6	8	9	17	19	13	17	52	32	56	123	94	174	289	25
Rufous-crowned Sparrow		3		2	1	1	1		1			1							
House Finch	1	35	63	16	24	57	76	87	67	25	28	41	14	36	92	114	87	54	
Net hours	46	372	428	558	917	823	979	888	933	931	1050	986	1078	1066	968	1010	751	833	61
Trap hours	63	55	196	81	52	60	60	65	187	149	116	169	198	204	411	536	533	1702	1463

Table 4 New Captures of Selected Spring Migrants

	Jan	Feb	Mar						Apr						May					
Species	1-31	1-28	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31
Calliope Hummingbird										1		2	3	3			1			
Rufous Hummingbird		1	2	2	4	5	5	9	9	29	18	27	19	18	5	5	7	2		1
Red-shafted Flicker						1			1	2										
Willow Flycatcher																1		1		3
Western Flycatcher						4		1	1		1	9	4	4	9	4	33	7	11	34
Ruby-crowned Kinglet	2		1	1	1		2	1	6	2	1	5	1	1	4					
Swainson's Thrush														2	19	35	146	85	203	231
Hermit Thrush			1	1		1	6	4	6	3	7	5	5	19	6	1	1			
Northern Mockingbird						1	1	2	1	1						3		1	1	
Warbling Vireo					1		1					3	2	2	9	7	30	17	35	36
Orange-crowned Warbler			3	3	17	19	14	10	8	26	16	32	16	33	33	17	31	24	22	11
Nashville Warbler										2	2	1	1	3	8	4	1	1		
Yellow Warbler															3		5	7	26	53
Audubon's Warbler	1	5		3	4	4		2	7	8	4	7	9	8	1	1	1			
Black-throated Gray Warbler												2	1	1						
Townsend's Warbler												2			4	5	6	5	4	15
Hermit Warbler																1	5	1	1	
MacGillivray's Warbler										1		1	3	3	8	5	22	1	7	14
Wilson's Warbler							1		1	1		2	3	24	46	38	128	25	50	90
Western Tanager														1	1	1	5		2	5
Black-headed Grosbeak												2			7	12	16	7	11	9

Lazuli Bunting														1			1	4	1	3
Chipping Sparrow					1	1	2	4	5	8	8	3	10	8	7	12	8	7	6	4
Savannah Sparrow	31	11	1	3	2	3	5	4	4	2					2	1				
Fox Sparrow		1			1		1	1	4	1	1	4	2	3	1					
Lincoln's Sparrow				1		1	3				2	8		2						
Golden-crowned Sparrow		44	4	8	13	26	18	6	10	24	14	29	32	34	3	2				
Puget Sound White-crowned Sparrow							3	4	6	16	9	14	13	5	1					
Gambel's White-crowned Sparrow						2			7	5	7	7	6	28	3	1	1			
Bullock's Oriole								1			1	7	4	6	4	12	8	1	2	5
Purple Finch		29	15	17	25	15	3	27	32	15	12						1			
Lesser Goldfinch		3		4	2	2	6	3	3	10	4	5	3	1	4	8	8	1	6	5
American Goldfinch											1	1	27		2		1	1		
Net hours	48	226	259	337	394	444	578	914	821	1032	857	881	833	1000	1057	1174	1365	953	978	965
Trap hours	235	426	194	369	295	752	626	813	674	714	680	735	708	651	354	529	183	139	39	0

Table 5 New Captures of Selected Fall Migrants

	Aug					Sep						Oct						Nov	Dec
Species	1-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31	1-30	1-31
Red-shafted Flicker						1					4	7	10	10	6	1	2	3	
Willow Flycatcher				8	22	7	5	6	10	7	2								
Western Flycatcher	1	4	14	23	90	53	48	32	165	113	12	18	4	1	1				
Ruby-crowned Kinglet										2	5	24	37	39	53	29	14	28	
Swainson's Thrush				1	2	3	8	12	22	31	9	27	8	4	2				
Hermit Thrush							1		3	22	45	217	195	133	134	59	53	65	1
Northern Mockingbird			2	2		1	1		1			2	1	3	3				
Warbling Vireo		4	1	1	9	12	10	6	9	7	1	5	2						
Orange-crowned Warbler		3	2				7	10	5	11	2	3	3	5			1		
Nashville Warbler						2													
Yellow Warbler			1		1	5	8	13	5	11	5	4	1						
Audubon's Warbler									1		7	15	27	8	11	5	6	4	
Black-throated Gray Warbler								1	1		1	1							
Townsend's Warbler							1			1						1			
MacGillivray's Warbler			1	1		1	1		2	2				1					
Wilson's Warbler			1	1	5	4	4	7	10	5	5	8	2						
Western Tanager		1	1	1	4	3	1	3	5	21	2	5	4						
Black-headed Grosbeak		20	8	3	8	5	2	1	5	2									
Lazuli Bunting		2	4	2	2	2	8	8	5										
Chipping Sparrow	1	73	47	19	47	39	34	14	28	26	8	30	15	9	3	1	4	2	
Savannah Sparrow					1			1	1	4	2	9	5	10	6	3	3	7	9
Fox Sparrow							1	3	6	14	28	41	22	30	14	6	12	39	

Lincoln's Sparrow									3	2	2	6	1	5	3	1		1	
Golden-crowned Sparrow									1	19	49	162	152	182	198	205	192	290	36
Puget Sound White-crowned Sparrow						1	1	1	4	12	4	13	25	34	21	1	4	1	
Gambel's White-crowned Sparrow									3	14	23	47	36	24	28	39	35	28	
Bullock's Oriole				2	1	1													
Purple Finch												3	2	6	20	9	15	32	2
Lesser Goldfinch		11	17	7	12	24	24	16	16	10	5	6	6	12	3	2	3	4	
Lawrence's Goldfinch												2	8					2	
American Goldfinch											1			1		4	4	1	
Net hours	46	372	428	558	917	823	979	888	933	931	1050	986	1078	1066	968	1010	751	833	61
Trap hours	63	55	196	81	52	60	60	65	187	149	116	169	198	204	411	536	533	1702	1463

Table 6 Comparison of Numbers of Selected Spring and Fall Migrants Banded Fall 1970 to Spring 1972 on Mission Ridge and Spring 1968 (part) to Spring (part) 1976 on the South Farallon Islands (DeSante and Ainley 1980)

	Spring		Fall	
Species	Mission Ridge	Farallon Islands	Mission Ridge	Farallon Islands
Calliope Hummingbird	10	3	0	0
Rufous Hummingbird	168	32	0	0
Red-shafted Flicker	4	6	44	22
Willow Flycatcher	5	64	67	57
Western Flycatcher	122	106	579	224
Ruby-crowned Kinglet	26	164	231	188
Swainson's Thrush	721	89	129	114
Hermit Thrush	66	98	928	186
Northern Mockingbird	11	13	16	31
Warbling Vireo	143	45	67	124
Orange-crowned Warbler	335	440	52	101
Nashville Warbler	23	21	2	27
Yellow Warbler	94	116	54	357
Audubon's Warbler	59	268	84	192
Black-throated Gray Warbler	4	5	4	60
Townsend's Warbler	41	280	3	169
Hermit Warbler	8	13	0	56
MacGillivray's Warbler	65	33	9	77
Wilson's Warbler	409	1245	52	289
Western Tanager	15	70	51	91
Black-headed Grosbeak	64	38	54	24
Lazuli Bunting	10	16	33	71
Chipping Sparrow	94	45	400	355
Savannah Sparrow	27	7	61	518
Fox Sparrow	18	10	216	146
Lincoln's Sparrow	17	90	24	144
Golden-crowned Sparrow	223	81	1486	1207
Gambel's White-crowned Sparrow	67	106	277	496
Puget Sound White-crowned Sparrow	71	53	132	461
Bullock's Oriole	51	5	4	5
Purple Finch	161	23	89	142
Lesser Goldfinch	75	7	178	63
Lawrence's Goldfinch	0	1	12	3
American Goldfinch	50	8	11	2
Degree of correlation of numbers of spring and of fall migrants	Coefficient of correlation = +0.469712		Coefficient of correlation = +0.74201	
Probability of positive correlation	$P = 0.9880$		$P = 0.9997$	

Mockingbird, Warbling Vireo, Orange-crowned Warbler, Black-headed Grosbeak, Lazuli Bunting, Chipping Sparrow, and Lesser Goldfinch.

Species-by-species comparisons from Tables 4 and 5 with the accounts in DeSante and Ainley (1980) reveal close parallels in many species between passage periods and peaks of passage on Southeast Farallon Island and on Mission Ridge—except that at Mission Ridge we lack June-July records. Obvious examples of close agreement include peak migration periods for Hermit Thrushes in the last few days of April, compared to Swainson's Thrushes in the last few days of May, and Puget Sound White-crowned Sparrows in early April, compared to Gambel's White-crowned Sparrows in late April.

Patterns of numbers captured and banded of 34 of the more commonly captured species on Southeast Farallon Island and Mission Ridge (Table 6) are very well correlated. The actual numbers banded, treated as profiles, show better correlation for the fall period than for the spring period. Most species were captured in larger numbers in the fall migration than in spring in both places. However, a few species, including Orange-crowned, Townsend's, and Wilson's warblers, were more abundant in the spring on both Southeast Farallon and Mission Ridge.

SUMMARY

Mist nets and Potter traps were used to capture and band 14,159 land birds of 109 taxa on Mission Ridge, overlooking the south end of San Francisco Bay, on the western edge of the inner Coast Range of central California from August 1970 to May of 1972. Numbers of each species are tabulated by 5-day periods for March, April, May, August, September, and October and by months for January, February, November, and December. There were no operations during June and July. Definition of the timing of migratory passage varies from excellent to obscure as a function of such factors as type of residence and juvenile dispersal. Numbers of migrants and timing closely parellel similarly taken data from Southeast Farallon Island.

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APPENDIX

In shorter periods of operation in the spring of 1970, in late 1972, and in the years 1973 to 1979 another 2142 birds of 83 species were captured 2873 times in nets and traps (Table A). These included four species not captured during the main study: Killdeer, a resident (3), Say's Phoebe, a winter resident (1), Tennessee Warbler, a vagrant (1), and Canyon Wren, a resident (1).

Several resident passerines first encountered 1970-72 were still being recaptured as late as 1979. These included permanent residents as well as migratory summer and migratory winter residents. We received notice from the U.S. Bird Banding Laboratory of four recoveries:

1. Swainson's Thrush banded 4 May 1970, recovered 17 May 1973 at Salem, Oregon.
2. Starling banded 24 November 1971, recovered in July 1972 at Port Townsend, Washington.
3. Black-headed Grosbeak banded 22 September 1971, recovered 12 April 1974 at Taretan, Michoacan, Mexico.
4. Puget Sound White-crowned Sparrow banded 7 October 1970, recovered 25 April 1972 at Duncan, British Columbia.

Table A Birds Captured in Mist Nets and Potter Traps in the Spring of 1970 and from the Fall of 1972 to the Fall of 1979

Species	Jan	Feb	Mar	Apr	May	—	Sep	Oct	Nov	Dec	Total
Sharp-shinned Hawk			1					1			2
Cooper's Hawk								1			1
California Quail					1						1
Killdeer					3						3
Mourning Dove					4						4
Western Screech Owl					1						1
Anna's Hummingbird					3						3
Rufous Hummingbird				1	9						10
Allen's Hummingbird					1						1
Nuttall's Woodpecker					3						3
Hairy Woodpecker					1						1
Red-shafted Flicker					3						3
Olive-sided Flycatcher					1						1
Willow Flycatcher					5						5
Hammond's Flycatcher					4						4
Gray Flycatcher				1	10						11

Table A (Continued)

Species	Jan	Feb	Mar	Apr	May	—	Sep	Oct	Nov	Dec	Total
Western Flycatcher				4	64						68
Black Phoebe				1	1			1			3
Say's Phoebe								1			1
Ash-throated Flycatcher				1	6						7
Western Kingbird					3						3
Horned Lark	2		3		14				5	1	25
Steller's Jay				10	4						14
Scrub Jay		3	2	3	5						13
Yellow-billed Magpie			1		2		1	2			6
Chestnut-backed Chickadee							2				2
Plain Titmouse		8		10	18		6				42
Common Bushtit					1						1
Red-breasted Nuthatch					1						1
White-breasted Nuthatch				1	1						2
Brown Creeper					1						1
Canyon Wren					1						1
Bewick's Wren		1	1	1			1	1			5
House Wren				1	1						2
Ruby-crowned Kinglet		1			5		1				7
Western Bluebird					5		7	1			13
Swainson's Thrush					113						113
Hermit Thrush		2	3	8	36		3	23			75
American Robin				1	12						13
Wrentit					1						1
Northern Mockingbird					5						5
California Thrasher									1		1
Cedar Waxwing					2						2
Loggerhead Shrike					2		1				3
European Starling					2		1				3
Solitary Vireo					1						1
Warbling Vireo				1	11						12
Tennessee Warbler					1						1
Orange-crowned Warbler				8	38						46
Nashville Warbler				1	7						8
Yellow Warbler					7						7
Myrtle Warbler					1			2			3
Audubon's Warbler			1		2		1				4
Black-throated Gray Warbler					3						3
Townsend's Warbler					4						4
Hermit Warbler					2						2
MacGillivray's Warbler				1	19						20
Wilson's Warbler				5	53						58
Yellow-breasted Chat					3						3
Western Tanager					9						9
Black-headed Grosbeak				4	30						34
Rufous-sided Towhee		1	1	1	5		1				9
Brown Towhee	2	4	6	8	7		3	4	1		35
Rufous-crowned Sparrow							1				1
Chipping Sparrow				7	60			1			68
Lark Sparrow	5	2	9	3	29		27	1	3		79

Table A (Continued)

Species	Jan	Feb	Mar	Apr	May	—	Sep	Oct	Nov	Dec	Total
Savannah Sparrow			20		1		2	7	1		31
Fox Sparrow		4		1	5		2	2			14
Song Sparrow					1						1
Lincoln's Sparrow		1			6			1			8
Golden-crowned Sparrow	100	180	61	43	33		15	103	29	8	572
Puget Sound White-crowned Sparrow	2	6	2	15	2		4	10			41
Gambel's White-crowned Sparrow	1	29		10	7		6	12			65
Oregon Junco	1	56	57	20	9		5	42	17		207
Red-winged Blackbird		3			24		10				37
Western Meadowlark					7			1			8
Brewer's Blackbird		2	15	12	32		6				67
Bullock's Oriole				5	27						32
Purple Finch					1						1
House Finch				6	45		16	33			100
Lesser Goldfinch				5	29						34
Lawrence's Goldfinch				2	9						11
American Goldfinch				2	3						5
Total new captures	113	303	183	203	901		122	251	57	9	2142
Recaptures	28	83	161	183	220		2	44	8	2	731
Net hours	0	44	86	357	3997[a]		59	101	13	0	4657
Trap hours	132	90	239	261	33		19	106	91	12	983

[a] In May 1970 nets were run 3,847 net hours — from dawn to dusk.

Sage Sparrows

Sketch by Narca Moore-Craig