

# LONG-TERM TRENDS OF CHICKADEE POPULATIONS IN WESTERN NORTH AMERICA<sup>1</sup>

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**Abstract.** We evaluated population trends of Black-capped (*Parus atricapillus*), Chestnut-backed (*P. rufescens*) and Mountain (*P. gambeli*) chickadees in the Pacific Northwest of North America using 41 years (1944-1985) of data from Christmas Bird Counts. Most (76-83%) locations showed no significant trends (long-term increases or decreases in numbers of chickadees detected per observer hours) for any of the three species. Five to 14% of the locations had significant declines and 10 to 13% had significant increases. The recent range expansion by Chestnut-backed Chickadees in the Sierra Nevada of California was not accompanied by declines in Mountain Chickadee numbers. Chestnut-backed Chickadee populations no longer appear to be increasing in the Sierra Nevada; however, some populations in the San Francisco Bay region of California are apparently still increasing.

**Key words:** Christmas Bird Count; *Parus atricapillus*; *Parus gambeli*; *Parus rufescens*; population monitoring.

## INTRODUCTION

During the past several decades, at least two species of parids have expanded their ranges in North America. In the eastern United States, the Tufted Titmouse (*Parus bicolor*) has expanded its range in several states (Kricher 1981, Loery and Nichols 1985). In California, the Chestnut-backed Chickadee (*P. rufescens*) has undergone a range expansion both in the San Francisco Bay area (Root 1964) and in the Sierra Nevada (Crase 1976). Whereas long-term population trends of parids have been studied in the eastern United States (Loery and Nichols 1985) and Europe (Lack 1966, Perrins 1979), scant attention has been given to population trends of chickadees in western North America.

Although data from Christmas Bird Counts provide a means for monitoring bird populations, such data have been virtually ignored for evaluating population trends of chickadees (Ferner 1984), especially in western North America. The recent range expansion by Chestnut-backed Chickadees in California inspired us to investigate the recent trends of chickadee populations at other locations in the west. Our objectives were to: (1) evaluate long-term population trends

of chickadees in the Pacific Northwest of North America; (2) examine whether the recent range-expansion by Chestnut-backed Chickadees coincided with declines of sympatric populations of Mountain Chickadees (*P. gambeli*), a species that was formerly the only resident parid in areas where Chestnut-backed Chickadees invaded; and (3) examine some possible reasons for the Chestnut-backed Chickadee range expansion.

## METHODS

We used data from Christmas Bird Counts (CBC) published in *Audubon Field Notes* and *American Birds* during a 41-year period (1944-1985) to evaluate population trends of Black-capped (*P. atricapillus*), Chestnut-backed, and Mountain chickadees. Arbib (1981) provides a description of CBC methodology. A total of 85 CBC circles from Alaska (4), British Columbia (17), California (27), Idaho (2), Montana (5), Oregon (17), and Washington (13) were used. Count data (total number of chickadees of each species detected within each 24 km diameter count circle) were standardized by dividing the counts by the number of terrestrial party hours (Bock and Root 1981). Trends were evaluated using simple linear regression of the standardized count data in relation to the years that counts were made, and judged to be significant if the resulting *r*-value from the regression analysis had an associated

<sup>1</sup> Received 12 June 1990. Final acceptance 25 September 1990.

probability of  $<0.05$  of being statistically different from zero. We used counts from as many years as possible from all sites. Based on the recommendations of Bock and Root (1981), a minimum of 8 count years from a location was required for inclusion in our analyses.

## RESULTS

### BLACK-CAPPED CHICKADEE

Of the 49 localities that reported counts of Black-capped Chickadees, 6 (12.2%) showed significant declines, 5 (10.2%) showed significant increases, and 38 (77.5%) no change (Table 1). The localities with declines were Alaska (1), British Columbia (2), Montana (1), and Oregon (2). Those with increases were: British Columbia (1), California (1), Montana (1), and Washington (2) (Table 1).

### MOUNTAIN CHICKADEE

Of the 28 localities that reported counts of Mountain Chickadees, 2 (7.1%) showed significant declines, 3 (10.7%) significant increases, and 23 (82.1%) showed no statistical change (Table 1). The localities with declines were Montana (1) and Oregon (1). The localities with increases were British Columbia (1) and Montana (2) (Table 1).

### CHESTNUT-BACKED CHICKADEE

Of the 85 localities that reported counts of Chestnut-backed Chickadees, 4 (4.7%) showed significant declines, 11 (12.9%) showed significant increases, and 70 (82.3%) showed no statistical change (Table 1). The localities with declines were: British Columbia (2), Oregon (1), and Washington (1). Those with increases were: Alaska (1), British Columbia (2), California (5), Montana (1), Oregon (1) and Washington (1) (Table 1).

### AREAS WITH SYMPATRIC CHICKADEE POPULATIONS

None of the localities reporting counts of more than one species of chickadees showed statistically significant inverse trends for either species (e.g., one species increasing when the other was decreasing, or vice versa; Table 1). A breakdown of population trends from count circles with sympatric populations showed no significant increase or decrease (Table 2). In all cases where Mountain Chickadees showed a significantly in-

creasing or decreasing trend, Chestnut-backed Chickadees also showed similar (though not always statistically significant) trends. The locality with the largest number of consecutive years reporting both Chestnut-backed and Mountain Chickadee counts—Yosemite National Park—indicated that populations of both species have declined slightly (but not significantly;  $P > 0.05$ ). The slopes of these regressions were statistically different between Chestnut-backed and Mountain chickadees at Yosemite ( $b = -0.004$  and  $-0.02$ , respectively,  $P < 0.05$ ).

## DISCUSSION

Chickadees are, in many ways, ideal subjects for investigations using Christmas Bird Count (CBC) data. Unlike rare species, which frequently receive a disproportionate amount of effort and attention from Christmas Count observers (Bock and Root 1981), chickadees are typically common and widespread. Thus, it is unlikely that CBC observers made an extra effort to locate chickadees within a particular count circle. Furthermore, chickadees are easy to identify, and the mixed-species flocks in which they forage during winter when CBC counts are conducted make them easy to detect. One potential negative bias that may confound our results is that some CBC observers may have become bored with counting parids, and directed their efforts to other less common species. These kinds of confounding effects must be considered whenever CBC data are analyzed and published. Nevertheless, the fact remains that chickadees are usually highly detectable, easy to identify birds. These factors make it likely that the data reflect actual population trends of these chickadees, even if they do not represent absolute population numbers.

Overall, most populations of Black-capped, Chestnut-backed, and Mountain chickadees in the Pacific Northwest region of North America were apparently stable during the past 40 years: most reporting locations (76–83%) indicated no significant changes (either increases or decreases) in populations of these three species. Selecting a significance level of  $P \leq 0.05$  means that one out of every 20 tests for  $r$  being different from zero could be significant due to random chance. Thus, there is a possibility that two or three (5% of 49 localities = 2.5) Black-capped Chickadee population trends, one or two (5% of 28 localities = 1.4) Mountain Chickadee trends and four or

TABLE 1. Population trends of three species of chickadees from western North America obtained from Christmas Bird Count data (1944–1985), based on linear regression analyses. Positive regression coefficients with associated  $P < 0.05$  indicate an increasing trend. Negative regression coefficients with associated  $P < 0.05$  indicate a decreasing trend.

Locality	Years (number) <sup>a</sup>	<i>r</i> -value ( <i>P</i> )		
		Black-capped Chickadee	Mountain Chickadee	Chestnut-backed Chickadee
<b>ALASKA</b>				
Cordova	1966–1985 (17)	-0.65 (0.01)	— <sup>b</sup>	-0.36 (0.15)
Glacier Bay	1968–1985 (14)	—	—	0.67 (0.01)
Juneau	1967–1985 (12)	—	—	0.23 (0.47)
Sitka	1974–1985 (8)	—	—	-0.34 (0.42)
<b>BRITISH COLUMBIA</b>				
Chilliwack	1972–1985 (12)	-0.61 (0.03)	-0.95 (0.20)	-0.51 (0.15)
Comox	1961–1985 (24)	—	—	0.06 (0.78)
Deep Bay	1975–1985 (11)	—	—	-0.15 (0.66)
Duncan	1961–1985 (16)	—	—	0.12 (0.68)
Ladner	1957–1985 (27)	0.46 (0.02)	—	0.44 (0.02)
Naniamo	1963–1985 (20)	—	—	-0.47 (0.04)
Pender	1964–1985 (20)	—	—	0.63 (0.005)
Penticton	1974–1985 (10)	0.25 (0.48)	0.54 (0.11)	-0.08 (0.84)
Pitt Meadows	1972–1985 (14)	-0.61 (0.02)	—	-0.64 (0.24)
Sayward	1973–1985 (12)	—	—	-0.16 (0.61)
Shuswap Lake	1972–1985 (14)	-0.38 (0.19)	-0.33 (0.23)	-0.37 (0.23)
Terrace	1963–1985 (21)	0.45 (0.86)	—	-0.19 (0.40)
Vancouver	1957–1985 (29)	0.18 (0.36)	-0.49 (0.33)	-0.32 (0.09)
Vaseux Lake	1974–1985 (9)	0.67 (0.25)	0.74 (0.02)	0.46 (0.29)
Vernon	1975–1985 (10)	-0.27 (0.49)	0.27 (0.47)	-0.07 (0.92)
Victoria	1958–1985 (28)	—	—	-0.47 (0.01)
White Rock	1971–1985 (15)	-0.76 (0.004)	—	-0.04 (0.89)
<b>CALIFORNIA</b>				
Angwin	1956–1985 (23)	—	—	0.72 (0.000)
Ano Nuevo	1971–1985 (11)	—	—	-0.38 (0.26)
Arroyo Cheap Thrills	1977–1985 (9)	—	—	0.42 (0.25)
Benecia	1945–1985 (28)	—	—	0.64 (0.000)

TABLE 1. Continued.

Locality	Years (number) <sup>a</sup>	<i>r</i> -value ( <i>P</i> )		
		Black-capped Chickadee	Mountain Chickadee	Chestnut-backed Chickadee
Centerville Beach	1962–1985 (23)	—	—	−0.31 (0.15)
Clear Lake	1975–1985 (11)	—	—	−0.07 (0.83)
Contra Costa	1955–1985 (31)	—	—	0.37 (0.04)
Crystal Springs	1948–1985 (31)	—	—	−0.19 (0.32)
Del Norte	1962–1985 (18)	0.57 (0.03)	—	−0.21 (0.39)
Hayward/Fremont	1967–1985 (18)	—	—	0.23 (0.36)
Lewiston	1965–1985 (16)	—	−0.27 (0.41)	0.27 (0.22)
Marin County	1975–1985 (12)	—	—	0.07 (0.82)
Mendocino Coast	1958–1985 (13)	—	—	0.07 (0.82)
Monterey Peninsula	1944–1985 (40)	—	—	0.37 (0.02)
Morro Bay	1948–1985 (31)	—	—	0.24 (0.20)
Moss Landing	1973–1985 (11)	—	—	0.25 (0.45)
Mount Shasta	1972–1985 (8)	—	−0.61 (0.11)	−0.19 (0.65)
Oakland	1946–1985 (37)	—	—	0.22 (0.20)
Palo Alto	1944–1985 (29)	—	—	0.07 (0.71)
Point Reyes Peninsula	1970–1985 (15)	—	—	−0.07 (0.80)
Putah Creek	1971–1985 (11)	—	—	−0.13 (0.70)
San Jose	1945–1985 (37)	—	—	−0.22 (0.19)
Santa Cruz	1957–1985 (26)	—	—	0.07 (0.72)
Santa Rosa	1960–1985 (24)	—	—	0.55 (0.005)
West Sonoma County	1967–1985 (18)	—	—	−0.23 (0.34)
Willow Creek	1973–1985 (12)	—	0.28 (0.45)	0.14 (0.66)
Yosemite National Park	1947–1985 (37)	—	−0.24 (0.16)	−0.24 (0.14)
IDAHO				
Indian Mountain	1965–1985 (18)	−0.39 (0.13)	−0.26 (0.36)	0.12 (0.66)
Moscow	1950–1985 (13)	0.16 (0.61)	−0.11 (0.78)	0.31 (0.30)
MONTANA				
Bigfork	1974–1985 (12)	0.66 (0.02)	0.71 (0.01)	0.61 (0.03)
Glacier National Park	1962–1985 (17)	−0.56 (0.02)	−0.75 (0.01)	−0.15 (0.56)

TABLE 1. Continued.

Locality	Years (number) <sup>a</sup>	<i>r</i> -value ( <i>P</i> )		
		Black-capped Chickadee	Mountain Chickadee	Chestnut-backed Chickadee
Libby	1951-1985 (16)	0.40 (0.12)	0.56 (0.03)	0.64 (0.01)
Missoula	1969-1985 (17)	-0.15 (0.56)	-0.24 (0.35)	0.13 (0.61)
Troy	1977-1985 (9)	0.18 (0.64)	-0.33 (0.48)	-0.27 (0.48)
OREGON				
Alma-Upper Siuslaw	1977-1985 (9)	-0.09 (0.81)	—	-0.06 (0.88)
Coos Bay	1972-1985 (13)	-0.08 (0.78)	—	-0.26 (0.38)
Corvallis	1962-1985 (24)	-0.12 (0.59)	—	0.30 (0.15)
Cottage Grove	1971-1984 (13)	-0.53 (0.06)	-0.46 (0.42)	0.08 (0.77)
The Dalles	1969-1985 (17)	-0.71 (0.001)	—	-0.41 (0.11)
Eugene	1944-1985 (42)	0.19 (0.21)	-0.57 (0.17)	0.53 (0.001)
Medford	1953-1985 (31)	0.03 (0.86)	-0.42 (0.05)	0.01 (0.94)
Oakridge	1971-1985 (15)	0.35 (0.20)	0.08 (0.79)	-0.53 (0.04)
Portland	1944-1985 (42)	0.20 (0.19)	0.15 (0.68)	0.24 (0.12)
Roseburg-Sutherlin	1959-1985 (12)	-0.16 (0.66)	-0.85 (0.35)	-0.13 (0.68)
Salem	1967-1985 (23)	-0.39 (0.06)	-0.62 (0.18)	0.06 (0.77)
Sauvie Island	1967-1985 (19)	0.03 (0.91)	—	-0.09 (0.70)
Tillamook Bay	1949-1985 (22)	-0.04 (0.87)	—	-0.06 (0.78)
Upper Nestucca	1976-1985 (10)	-0.07 (0.85)	-0.20 (0.70)	0.42 (0.23)
Union County	1976-1985 (9)	-0.28 (0.45)	-0.11 (0.77)	-0.01 (0.96)
Wallowa County	1977-1985 (8)	0.47 (0.24)	-0.23 (0.58)	-0.65 (0.17)
Yaquina Bay	1973-1985 (11)	0.11 (0.74)	—	-0.10 (0.13)
WASHINGTON				
Bellingham	1952-1985 (20)	0.12 (0.62)	—	-0.47 (0.03)
Chewelah	1978-1985 (8)	0.39 (0.33)	0.31 (0.45)	-0.17 (0.71)
Everett	1974-1985 (12)	0.27 (0.40)	—	-0.21 (0.52)
Grays Harbor	1972-1985 (12)	-0.38 (0.21)	—	0.18 (0.59)
Kitsap County	1974-1985 (12)	-0.36 (0.24)	—	-0.35 (0.26)
Leadbetter Point	1973-1985 (13)	-0.47 (0.10)	—	-0.50 (0.08)
Olympia	1949-1985 (13)	0.94 (0.001)	—	0.31 (0.29)

TABLE 1. Continued.

Locality	Years (number) <sup>a</sup>	<i>r</i> -value ( <i>P</i> )		
		Black-capped Chickadee	Mountain Chickadee	Chestnut-backed Chickadee
Padilla Bay	1973–1985 (8)	–0.48 (0.22)	—	–0.03 (0.94)
Port Townsend	1977–1985 (9)	–0.01 (0.96)	—	0.20 (0.60)
Seattle	1949–1985 (36)	0.24 (0.17)	—	0.22 (0.20)
Sequim/Dungeness	1976–1985 (10)	0.68 (0.03)	—	0.85 (0.002)
Tacoma	1969–1985 (17)	0.40 (0.11)	—	0.16 (0.53)
Yakima Valley	1970–1985 (11)	0.10 (0.76)	—	0.41 (0.28)

<sup>a</sup> Some numbers of counts may be less than the possible number of count years due to counts not being conducted.

<sup>b</sup> Dashes indicate that the species was not present.

five (5% of 85 localities = 4.3) Chestnut-backed Chickadee trends may have been falsely identified as having *r* values significantly different from zero. However, even when this level of statistical error is considered, the CBC data indicated that there were significant trends in relation to particular species of chickadees. For example, Chestnut-backed Chickadees had the highest number of reporting locations with statistical increases (11), and Black-capped Chickadees had the highest number of reporting locations with statistical declines (6). Locations of populations of Black-capped and Mountain chickadees with significant long-term changes were widespread over a broad geographic area, whereas populations of Chestnut-backed Chickadees with significant increases tended to be clustered near central California.

It appears that the recent range expansion of Chestnut-backed Chickadees was not associated with population declines of Mountain Chickadees. There were no CBC localities with sympatric populations of these two species of chickadees where Chestnut-backed Chickadees showed an increasing trend and Mountain Chickadees a decreasing trend. The use of forest resources, especially with respect to species of trees used for foraging, differs significantly between Chestnut-backed and Mountain chickadees. In a three-year study of the foraging ecology of Chestnut-backed and Mountain Chickadees in a zone of sympatry in the western Sierra Nevada, Brennan (1989) observed that these two species of chickadees are apparently able to coexist as a result of the het-

erogeneous nature of the forest and the differential use of tree species for foraging.

The long-term trends of populations in areas with both Chestnut-backed and Mountain chickadees are similar to patterns observed by Loery and Nichols (1985) from an area where the Tufted Titmouse invaded habitats where Black-capped Chickadees were initially the only resident parid. Although Loery and Nichols (1985) observed a decrease in numbers of Black-capped Chickadees during the first year Tufted Titmice

TABLE 2. Breakdown of sympatric chickadee population trends from western North America, based on Christmas Bird Count data from Table 1.

	Sympatric species (number of count circles) <sup>a</sup>	
	Black-capped Chickadee	Mountain Chickadee
Significant increase	1	3
Significant decrease	3	2
No change	20	19
	Mountain Chickadee	Chestnut-backed Chickadee
Significant increase	3	3
Significant decrease	2	1
No change	23	24
	Black-capped Chickadee	Chestnut-backed Chickadee
Significant increase	5	5
Significant decrease	6	2
No change	37	42

<sup>a</sup> Chi-square statistics not calculated due to insufficient numbers of observations in the increasing and decreasing categories.

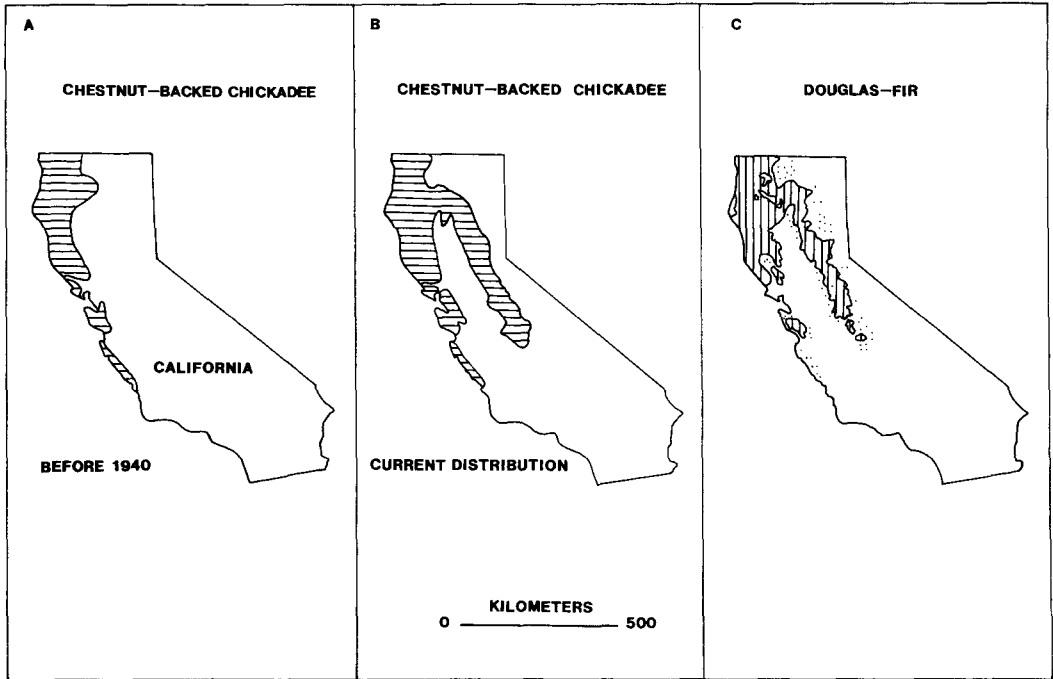


FIGURE 1. A. Distribution of the Chestnut-backed Chickadee in California prior to 1940, based on the distribution map published in Grinnell and Miller (1944). B. Current distribution of the Chestnut-backed Chickadee in California, compiled from information in Grinnell and Miller (1944), Verner and Boss (1980) and Zeiner et al. (in press). C. Distribution of Douglas-fir in California, based on the range map published in Griffin and Critchfield (1972). Shaded portions represent stands more than 3.2 km (2 miles) across. Dots represent stands less than 3.2 km across.

invaded their study area, they observed no long-term effect on the Black-capped Chickadee population size during the 15 years after the invasion. It is highly likely that Black-capped Chickadees and Tufted Titmice coexist through use of different resources, based on the differences in their body size and respective morphologies (Dixon 1961).

Attributing the declines or increases in the populations used for the study presented here to specific causes is difficult because it is not clear how specific factors and time scales relate to patterns of resource use and interspecific competition by parids (Dhondt 1989). Local patterns of forest management (e.g., clear-cutting and/or changes in tree species composition) could presumably be responsible for some declines. Alternatively, consistent winter feeding by local residents could account for the long-term increases observed at some areas. In the case of Chestnut-backed Chickadees in the San Francisco Bay region, the range expansion (and continuing population increases) in this area has been

attributed to vegetation changes resulting from suburbanization and planting of orchards (Dixon 1961, pers. comm.). Extensive areas of annual grassland habitat have been converted to orchards and ornamental trees and shrubs in this area. This change in land use has provided both foraging and nesting sites for Chestnut-backed Chickadees in the San Francisco Bay area, and apparently populations from surrounding localities have invaded these areas of "new" habitat.

Chestnut-backed Chickadee populations in the Sierras do not appear to be increasing since the initial invasion over 40 years ago. The cause of the initial range expansion is, however, unknown. We do know, however, that Douglas-fir (*Pseudotsuga menziesii*) is a key component of Chestnut-backed Chickadee habitat in both the Coast Range (Grinnell 1904, Grinnell and Miller 1944) and in the Sierra Nevada (Brennan 1989). Thus, a likely explanation for the range expansion is that successional patterns following widespread logging in the Sierras caused an increase in the proportion of Douglas-fir in the mixed-

conifer forest, which subsequently provided habitats favorable to Chestnut-backed Chickadees. Although data on the initial composition of the mixed-conifer forests in the western Sierras are not available, extensive forest stands on the west slope of the Sierras were clear-cut around the turn of the century, and Douglas-fir regenerates best under conditions of full sun (Franklin and Dyrness 1973, Roy and McDonald 1973). Thus, conditions in this region were ideal for an increase in the amount of Douglas-fir just prior to when the range expansion by Chestnut-backed Chickadees took place. Douglas-fir is the most common conifer in the humid coastal forest of the Pacific Northwest (Sudbury 1908, Franklin and Dyrness 1973), the region where Chestnut-backed Chickadees are thought to have evolved (Grinnell 1904). Chestnut-backed Chickadees foraged predominantly on Douglas-fir trees in the coastal region (Grinnell and Miller 1944), and subsequently continued to do so after they invaded mixed conifer habitats in the western Sierras (Brennan 1989). Furthermore, because the range expansion by Chestnut-backed Chickadees has apparently ceased in the Sierras, and their current distribution in California now coincides almost exactly with that of Douglas-fir (Fig. 1), there is strong circumstantial evidence that Chestnut-backed Chickadees followed the distribution of Douglas-fir during the expansion of their geographic range in the Sierra Nevada.

#### ACKNOWLEDGMENTS

We thank S. Lee for excellent, accurate data entry. C. E. Bock, J. B. Buchanan, K. L. Dixon, F. Hagan, G. A. Hurst, H. A. Jacobson, R. M. Kaminski, E. Stone and an anonymous reviewer commented on earlier versions of this paper and provided many suggestions which improved it. LAB owes a special debt of thanks to Teresa Pruden for support during the period of data analysis and writing. This study would not have been possible without the hundreds of people who volunteered their time and effort outside in the cold to do the counts in Alaska, British Columbia, California, Idaho, Montana, and Washington from 1944 to 1985. J. Verner, through the Pacific Southwest Forest and Range Experiment Station provided partial funding (PSW-84-0030-CA, PSW-86-0006-CA). This is publication number J-7546 of the Mississippi Agricultural and Forestry Experiment Station.

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