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FURTHER EVIDENCE FOR A POPULATION DECLINE IN THE WESTERN WARBLING VIREO

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Recently, Gardali et al. (2000) reported that mist-net capture rates of breeding and migrating western Warbling Vireos (*Vireo gilvus swainsonii*) had declined in Marin County, California, from 1979 to 1997. Evidence of a population decline from a single site, though, may be misleading and simply represent site-specific changes in abundance. Here we report a trend in Warbling Vireo abundance from 12 years (1987–1998) of mist-net data at another site in California, the Coyote Creek Field Station of the San Francisco Bay Bird Observatory.

The Coyote Creek Field Station is situated at the extreme south end of San Francisco Bay, north of San Jose, Santa Clara County (37° 20' N, 122° 10' W). The site is 80 km southeast of the Marin County site reported on by Gardali et al. (2000). The habitat at the Coyote Creek Field Station is a mix of valley riparian forest and an open weedy field. The latter is within a non-concrete flood-control channel that flows periodically during wet winters. This overflow channel is mowed every several years to prevent woody vegetation from colonizing. The forest habitat includes an old stand immediately adjacent to Coyote Creek as well as two riparian restoration sites, one planted in 1986, the other in 1994. The forested habitats are dominated by Fremont cottonwood (*Populus fremontii*), willows (*Salix* spp.), boxelder (*Acer negundo*), western sycamore (*Platanus racemosa*), and coyote brush (*Baccharis pilularis*). For a more detailed description of the study area see Otahal (1995).

Warbling Vireos were sampled through standardized-effort mist-netting. A total of 48 nets at fixed locations (36 prior to 1995) were operated once weekly throughout the year. Nets were opened 45 minutes before sunrise and kept open for 5 hours during each day of operation. A variable number of additional nets were also operated as part of other research projects over the years, particularly during migration. However, netting effort remained relatively constant between 1987 and 1998, except for periods of greater effort in spring 1996 and fall 1998. Captured Warbling Vireos were banded with standard U.S. Fish and Wildlife Service bands, measured, and released immediately. Aging of birds in the hand was achieved by noting the extent of skull pneumatization in the fall (Pyle 1997).

Warbling Vireos do not breed at Coyote Creek, so our analyses were limited to examining trends for both migratory periods separately, fall (August–October) and spring (April–May). Our sample consisted of 335 individuals (202 in fall and 133 in spring). Using the program STATA (Stata Corp. 1997), we examined trends by linear regression. We used the number of individual birds captured per 1000 net-hours to standardize capture rate by netting effort. Capture totals were log-transformed in order to improve the normality of the model residuals (Zar 1996). We examined whether trends were nonlinear by testing for a significant quadratic coefficient for year in the presence of a linear term and found no trends to be nonlinear. Significance was assessed at a level of $P < 0.05$.

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Table 1 Fall Netting Effort and Captures of Warbling Vireos at Coyote Creek Field Station, 1987–1998

Year	Net hours	Vireos captured	Vireos per 1000 net hours
1987	2467.50	17	6.89
1988	2948.00	24	8.14
1989	2825.99	56	19.82
1990	3494.75	19	5.44
1991	2525.00	6	2.38
1992	2757.50	26	9.43
1993	2806.75	13	4.63
1994	2574.00	14	5.44
1995	2535.00	9	3.55
1996	2292.50	13	5.67
1997	3124.50	8	2.56
1998	4655.62	6	1.29

The captures of fall migrants declined significantly over the course of our study ($\beta = -0.13$, $SE = 0.046$, $P = 0.02$; Table 1; Figure 1); the average annual change was -12.2% per year. Fall captures were primarily of birds that hatched that year (86.8%). Capture rates of Warbling Vireos migrating through Coyote Creek in spring showed a negative but nonsignificant trend ($\beta = -7.98$, $SE = 0.0003$, $P = 0.79$).

Over the course of this study there has been an increase in riparian habitat at the Coyote Creek Field Station due to restoration efforts. Capture rates of several species that occur at Coyote Creek only as migrants have increased over the study period (e.g., the Willow Flycatcher, *Empidonax traillii*), perhaps in response to restoration efforts (San Francisco Bay Bird Observatory unpubl. data), while the Warbling Vireo has declined. However, whether capture rates during migration are responsive to habitat restoration remains unknown. Our spring capture data suggest a stable pattern for adult migrants, though our sample size may not have been great enough to detect a trend. In fall, however, we did detect a decline in abundance of Warbling Vireos, of which the majority were first-year birds. Hence, the decline in fall captures probably represents a decline in breeding productivity, as also reported by Gardali et al. (2000).

Like this study and that of Gardali et al. (2000), the Breeding Bird Survey (BBS) has detected a decline in Warbling Vireo abundance in California (Sauer et al. 1999). We recorded a rate of decline, expressed as the slope of log-transformed data, similar to that of Gardali et al. (2000; $\beta = -0.13$ and $\beta = -0.10$, respectively). The BBS data showed a decline of 0.9% per year ($P = 0.06$) from 1966 to 1998 compared to our -12.2% . When the analysis of BBS data was limited to 1980–1998 it showed a more severe annual decline of 2.3% per year ($P = 0.01$; Sauer et al. 1999). Total fall captures at Southeast Farallon Island demonstrated no trend from 1968 to 1992 (Pyle et al. 1994). The Farallon captures were of both adults and young birds, in contrast with mostly young birds at Coyote Creek. The Farallon study did report a significant negative trend in the ratio of young to adult birds, supporting our contention that there has been a decline in the Warbling Vireo's breeding productivity.

The mechanisms responsible for a decline in Warbling Vireo abundance in California are not known. The decline in abundance of this species at Coyote Creek in autumn, where first-year birds constitute a preponderance of Warbling Vireos captured, suggests that fewer young have been produced annually; the extent of the

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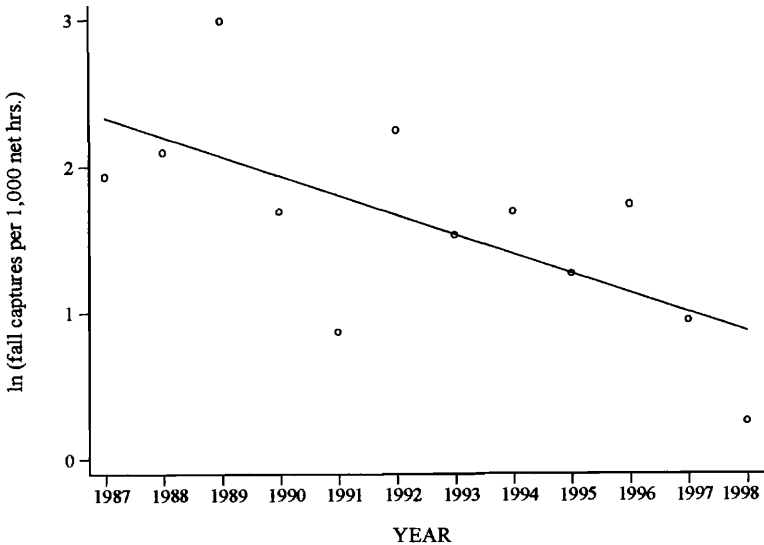


Figure 1. Trend in fall captures of Warbling Vireos, 1987–1998, at Coyote Creek Field Station. Each circle represents datum for one year; line is least-square line of best fit ($P = 0.02$, $r^2 = 0.39$).

breeding range sampled by our mist-nets is not known. Gardali et al. (2000) presented indirect evidence that linked poor reproductive success to population declines. Recent work in interior British Columbia suggests that local populations of western Warbling Vireos have the potential to be extirpated by high levels of parasitism by the Brown-headed Cowbird (*Molothrus ater*) but that even at low levels of parasitism vireo nesting success is low (Ward and Smith 2000). More studies are needed to examine the specific factors limiting the reproductive success of Warbling Vireos.

Our results, together with the BBS (Sauer et al. 1999) and Gardali et al. (2000), provide strong evidence that western Warbling Vireo populations are in a decline.

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