# Increase In Abundance of Wintering Swallows in California's Central Valley

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It is now beyond any reasonable doubt that climate change is causing significant shifts in the phenology (timing of various life events) of many species. Parmesan and Yohe (2003) and Root et al. (2003) studied over 1,000 species of plants and animals worldwide and found that changes in range, dates of arrival, departure, and reproduction have shifted as predicted by climate change for nearly 90% of all species examined. Cotton (2003) was among the first to document earlier spring arrival and later fall departure dates for a large number of bird species that breed in the United Kingdom and winter in south of the Sahara Desert. More recently, numerous studies in North America have shown similar changes in migration dates and changes in breeding and wintering ranges for many birds (e.g., La Sorte and Thompson 2007, Swanson and Palmer 2009, Zuckerman et al. 2009).

In light of these climate-change induced alterations to phenology, I examined Christmas Bird Count (CBC) and eBird data to evaluate whether changes in the winter abundance of swallows have occurred in the Central Valley (CV) in recent years. These species could be considered likely to exhibit responses to warming winter temperatures since they feed on flying insects, whose activity is sensitive to temperature. Seven species of swallow are found regularly in California in the spring/summer breeding season: Purple Martin (*Progne subis*), Tree Swallow (*Tachycineta bicolor*), Violet-green Swallow (*Tachycineta thalassina*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), Bank Swallow (*Riparia riparia*), and Cliff Swallow (*Petrochelidon pyrrhonota*), and Barn Swallow (*Hirundo rustica*). Of these, only Tree Swallows are fairly common in winter in California. Violet-green and Barn Swallows occur rarely but regularly in winter, while Purple Martins, Northern Rough-winged, Bank and Cliff Swallows are exceedingly rare in winter (Table 1). Therefore, I chose to examine winter occurrences of Tree, Violet-green, and Barn Swallows.

## HISTORICAL WINTER STATUS IN CALIFORNIA

From the 1920s through the 1970s the winter status in California of the three swallows I chose to examine has been characterized as noted below.

Tree Swallow: irregular in central and southern California (Hoffmann 1927); irregular or localized in southern and west-central California (Grinnell

and Miller 1944); regular on the coast north to Sonoma County and throughout the CV (McCaskie et al. 1979); common in southern California interior and uncommon on the coast (Garrett and Dunn 1981).

Violet-green Swallow: irregular coastally from Santa Barbara south (Hoffmann 1927), a few found in southern California and on the coast north to San Francisco Bay (Grinnell and Miller 1944); localized most winters along the coast north to Sonoma County and in the CV (McCaskie et al. 1979); sporadic visitors on the southern California coast, occasionally in large flocks (Garrett and Dunn 1981).

Barn Swallow: winters sparingly in the Imperial Valley (Hoffmann 1927); no winter status reported (Grinnell and Miller 1944); stragglers occasionally found in the CV (McCaskie et al. 1979); casual in southern California (Garrett and Dunn 1981).

I found no recent studies of winter abundance of any of these swallows in California.

| | CBC all CA | eBird CA | CBC CV only |
|---|---|---|---|
| Purple Martin | 0 | 0 | 0 |
| Tree Swallow | 80,616 | 77,826 | 43,174 |
| Violet-green Swallow | 6,368 | 9,341 | 693 |
| Northern Rough-winged Swallow | 595 | 1,407 | 8 |
| Bank Swallow | 27 | 12 | 0 |
| Cliff Swallow | 11 | 35 | 0 |
| Barn Swallow | 3,169 | 2,751 | 249 |

Table 1. Number of swallows recorded on CBCs (Count Years 2000-2012) and through eBird in December and January (all years).

## DATA SOURCES, STUDY AREA, AND METHODS

I obtained CBC data from National Audubon Society (2010) and eBird data from eBird (2013). The CV study area included 17 CBC circles within the CV which had been conducted on at least two-thirds (67%) of all years between Count Year (CY) 79 (winter 1978-79) and CY 112 (winter 2011-12) (Figure 1). I used eBird data from all validated California checklists. I obtained temperature data from the Weather Underground web site (http://www.wunderground.com/history). I estimated average winter temperatures for the CV using data from the Redding, Sacramento, and Bakersfield weather stations and averaging them together for the months of December and January. Trends were assessed using linear regression and the Data Analysis Package of Microsoft Excel.

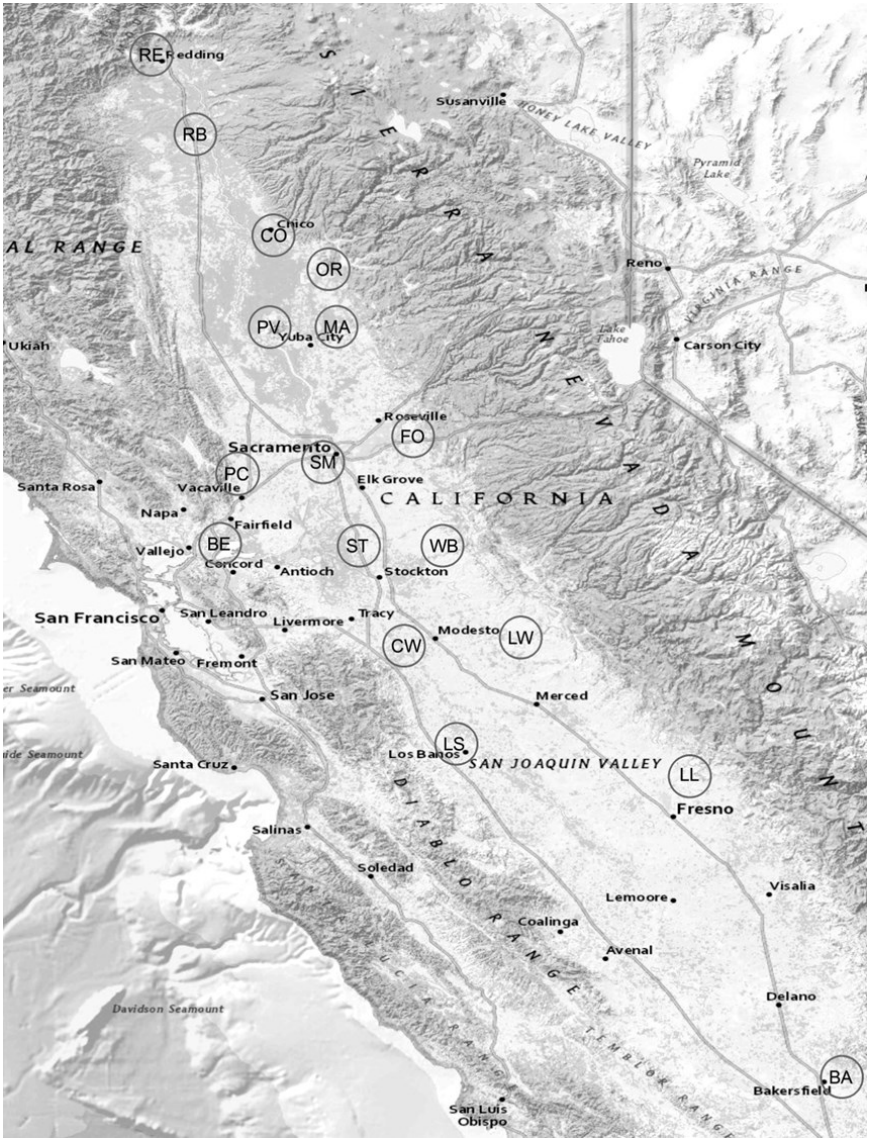



Figure 1. The 17 CV CBC circles used to analyze winter swallow abundance, from north to south: Redding (RE), Red Bluff (RB), Chico (CO), Oroville (OR), Peace Valley (PV), Marysville (MA), Folsom (FO), Sacramento (SM), Putah Creek (PC), Benicia (BE), Stockton (ST), Wallace-Bellota (WB), Caswell-Westley (CW), La Grange-Waterford (LW), Los Banos (LS), Lost Lake-Fresno (LL), and Bakersfield (BA).

RESULTS AND DISCUSSION

*Tree Swallow*

Winter abundance of the Tree Swallow in the CV showed a fairly steady increase throughout the period (Figure 2) that was highly significant ($p<0.001$). Based on the historical qualitative assessments of the status of wintering Tree Swallows summarized above, it is likely that this species has been increasing as a wintering species in California for much of the last century. Its status increased from "irregular" in the 1920s and 1940s (Hoffmann 1927, Grinnell and Miller 1944), to "common" or "regular" by the 1970s (McCaskie et al. 1979, Garrett and Dunn 1981). The CBC data analyzed here showed a continued upward trend in the CV from the late 1970s to the present. The geographic distribution of wintering Tree Swallows in the CV was concentrated in the southern two-thirds of the valley, with 96% of all birds recorded on CBC circles south of Marysville. The two most northerly circles, Redding and Red Bluff, have yet to record their first Tree Swallow during CBCs.

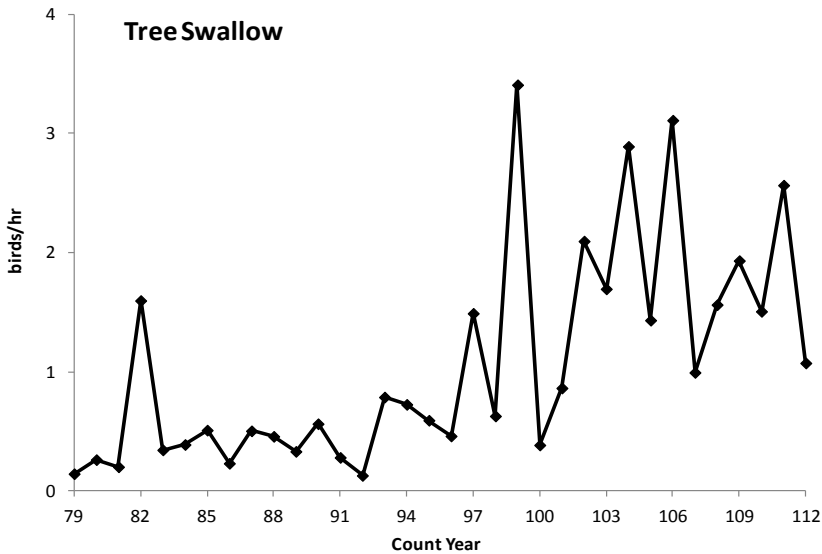



Figure 2. Abundance (birds/party hr) of Tree Swallows on CV CBCs (CY 79-CY112)

*Violet-green Swallow*

While the data for Violet-green Swallow (Figure 3) did not show a significant positive trend (p=0.09), the average abundance for the first half of the period more than doubled in the latter half of the period (0.014 vs. 0.034 birds/party hr.). Notably, most (62%) of all the Violet-green Swallows recorded were in just one circle, Benicia. This circle includes some portions of the San Francisco Bay; thus the high abundance there is consistent with the mainly coastal distribution of this species in winter (Hoffmann 1927, Grinnell and Miller 1944, McCaskie et al. 1979, Garrett and Dunn 1981). Of the birds recorded on other circles, 94% were found south of Marysville, consistent with the geographic distribution noted above for Tree Swallows.

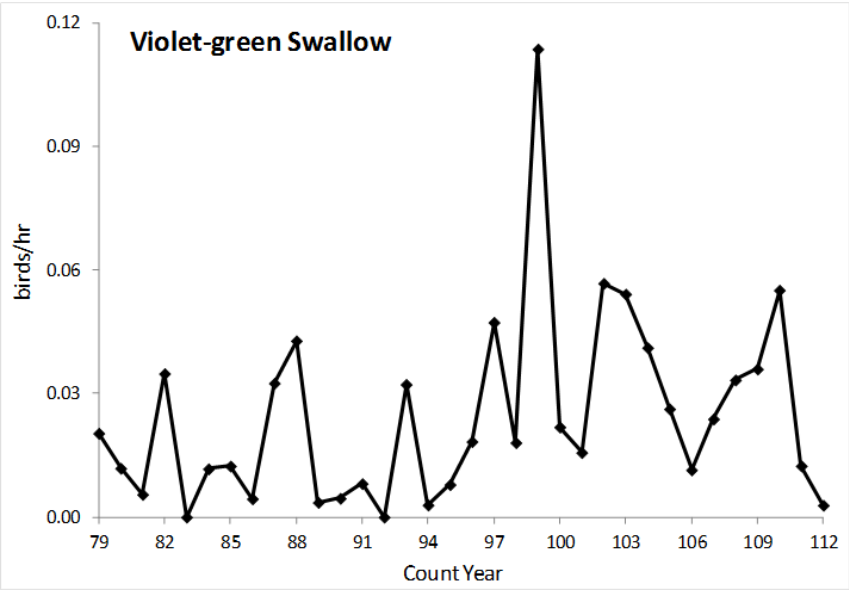



Figure 3. Abundance (birds/party hr) of Violet-green Swallows on CV CBCs (CY 79-CY112).

*Barn Swallow*

Barn Swallows were rarely recorded on CV CBCs prior to 2001, but have been relatively regular since then (Figure 4) and show a significant positive trend (p = 0.02). The Los Banos circle recorded most Barn Swallows (75%) during the entire period. To ensure that the recent increase in Barn Swallows was a widespread phenomenon, I examined the patterns of occurrence over time using both abundance on all circles and the percent of circles recording the species (Figure 5). The increase in Barn Swallow abundance coincided with an increase in the proportion of circles recording the species, confirming

that Barn Swallows have become more common in winter across much of the CV. As with the other swallows, this species was found mainly in the southern portions of the valley, with nearly 99% of all winter Barn Swallows found south of Marysville.

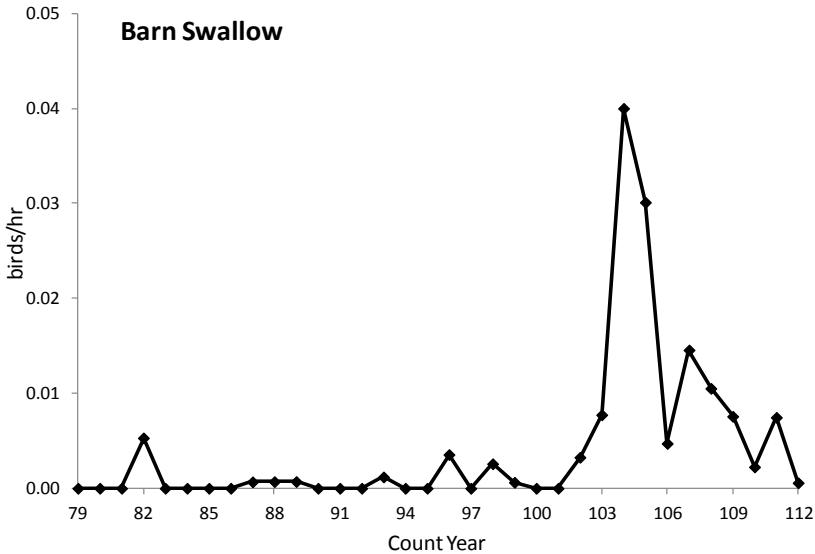



Figure 4. Abundance (birds/party hr) of Barn Swallows on CV CBCs (CY 79-CY 112).

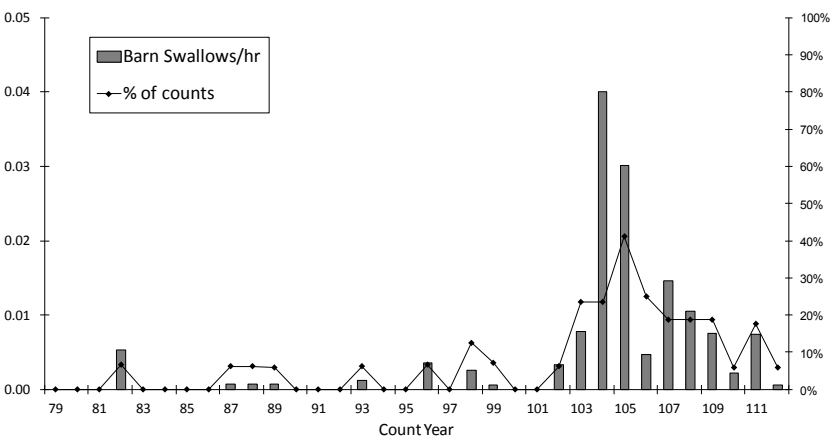



Figure 5. Barn Swallow abundance (birds/party hr) and percent of CBC circles reporting Barn Swallows from CV CBCs (CY 79-CY 112).

The sharp spike in Barn Swallow abundance in CY 104 is particularly intriguing. I examined both CBC and eBird data for California and all of the continental U.S. and Canada, and it appears that this phenomenon was seen statewide and was largely restricted to California (Figure 6). Examination of state-by-state CBC data from all the southern tier states from Arizona to Florida showed no such spike in any other state.

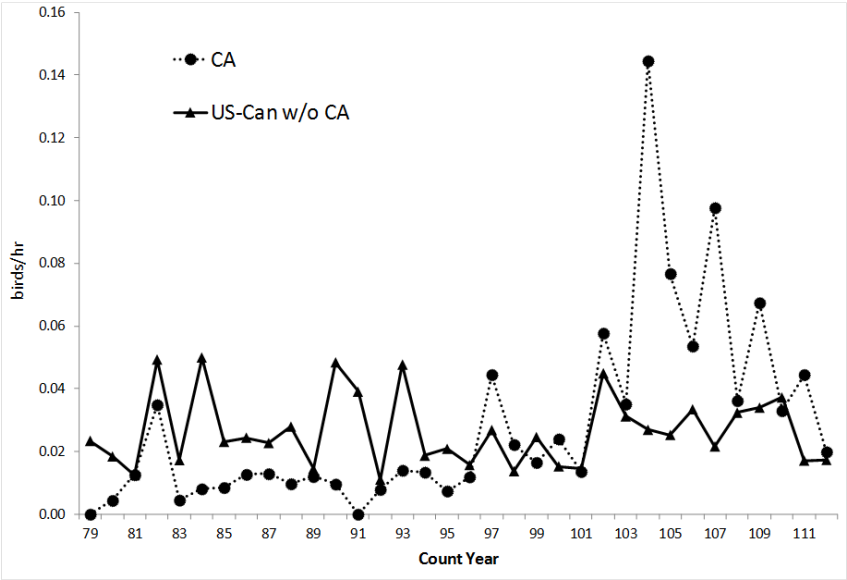



Figure 6. Abundance (birds/party hr) of Barn Swallows on California CBCs compared to abundance of Barn Swallows on all U.S. and Canadian CBCs excluding California CBCs (CY 79-CY 112).

A question that arises is whether the large numbers of Barn Swallows seen in CY 104 in California were breeders lingering from fall, early spring arrivals, or migrants from some other population. The steadily improving quantity and quality of eBird data now allows examination of such questions. California eBird data from fall 2003 through spring 2004 (Figure 7A) showed a pattern suggesting an unusually large number of birds present late into fall, then falling to normal levels, then increasing again in winter and dropping back to normal levels before spring. Data from the following year (Figure 7B) (also a high abundance winter in the CV) showed a similar pattern. The apparent decline in Barn Swallow reports in mid-late November could be due to a period of inclement weather inhibiting the ability of the birds to forage and thus making them more difficult to detect. However, with the exception

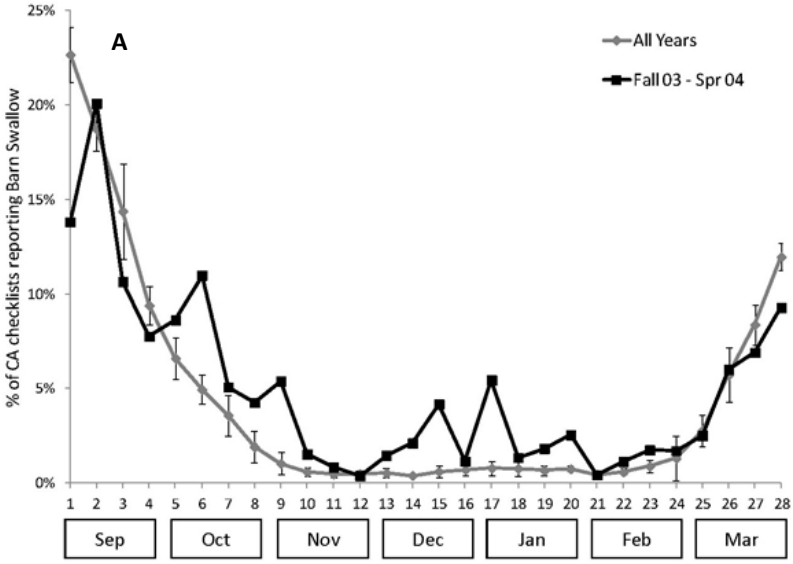
of a moderately cold spell in southern California in mid-November 2004, I could find no evidence of unusually cold or rainy conditions during those time periods. Likewise, winters of 2003-04 and 2004-05 were unremarkable in terms of temperatures and rainfall in the CV or in the state. Thus, there is no obvious weather event to explain the patterns of abundance of Barn Swallows during those winters.

If the late fall 2004 declines in Barn Swallow observations represent a true local departure of birds from California, it is possible that the birds found in winter were migrants from a population that bred elsewhere. Migration of Barn Swallows is complex due, in part, to the extraordinarily wide range of latitudes they occupy. Their breeding range extends from Alaska into southern Mexico and the winter range extends from Mexico to southern South America. Barn Swallows, like many other Neotropical migrants, may use "leap frog" migration (Swarth 1920, Welty 1982), where more northerly breeding populations winter further south than more southerly breeding birds. If so, different populations may be moving at different times, temporarily mixing together along their migration routes.

Perhaps the Barn Swallows responsible for the CY 104 event were more northerly breeding birds that delayed their southward migration and then remained in the CV through most of the winter. Or perhaps they were from the population wintering in Central America and moved north early, subsequently moving on to their normal breeding range as spring approached. Much of what we have learned about bird migration from use of new technologies such as satellite tracking and geolocation devices shows that birds often make substantial movements that seem to defy logic in terms of direction and distance (http://www.wildlifetracking.org/).

*CV Winter Temperature*

Over the 34 year time period covered by these analyses, average winter temperatures in the CV increased by 0.07$^{o}$ F/year or 2.5$^{o}$ F over the full period (Figure 8). Average winter temperatures since 1970 also have increased across the continental U.S. in every state except Nevada (Tebaldi et al. 2013). In general, the coldest areas of the country showed the largest increases in winter temperatures. The rate of increase computed by Tebaldi et al. (2013) for California as a whole of 0.25$^{o}$ F/decade was less than that shown in Figure 8 (0.8$^{o}$ F/decade) for the CV. This may be due to faster warming for the CV vs. statewide or to differences in the time periods used. Tebaldi et al. (2013) used the period from 1970-2012 and data from December through February, whereas I used data for December and January from 1979-2012.



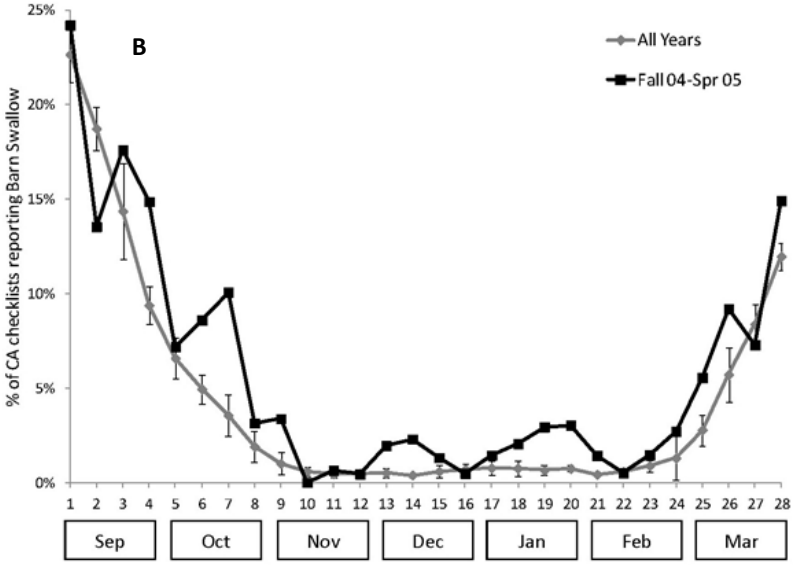




Figure 7A. Percent of eBird checklists reporting Barn Swallows in California from fall 2003–spring 2004 compared to percent of eBird checklists reporting Barn Swallows from all years.

Figure 7B. Percent of eBird checklists reporting Barn Swallows in California from fall 2004—spring 2005 compared to percent of eBird checklists reporting Barn Swallows from all years. The x axis represents weeks beginning from September 1. Error bars for data from all years based on Standard Error for the period 2000-2012 for each week.

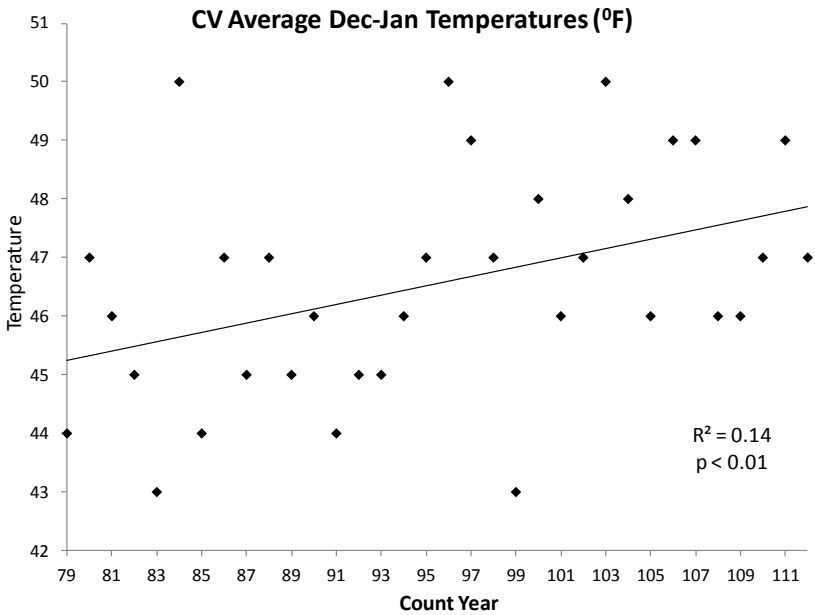



Figure 8. Average December—January temperatures in the CV from CY 79-CY 112. Trendline, $R^2$, and p value from linear regression.

*Conclusions*

It appears that Tree, Barn, and possibly Violet-green Swallows are all wintering in the CV in greater numbers in recent years than in the past. A rise in winter temperatures in the valley may have facilitated that increase, and the phenomenon remains limited to the southern two-thirds of the CV. The increase is most obvious for Tree Swallows, by far the most hardy of California swallows. Although all the swallows are primarily insectivores, Tree Swallows are able to switch to a diet of fruits and other vegetable matter (Winkler et al. 2011) to survive the periods of cold weather when insects become scarce. Higher winter temperatures may have increased the days when insects are plentiful and made remaining in the CV during winter advantageous. The advantages of not migrating to their usual wintering grounds in the southernmost U.S. and Central America could be twofold. Birds spending the winter here avoid the energy expenditure required to migrate, and they have first access to prime breeding locations and nesting cavities in the spring.

The number of overwintering Violet-green and Barn Swallows in the CV is still quite low, and they may be absent from most or the entire valley some winters. Both species are, unlike Tree Swallows, strictly insectivorous (Brown and Brown 1999, Brown et al. 2011). While both would benefit from warmer

winters, the risks of remaining north are much greater for these swallows. Any extended period of weather that makes insect prey unavailable would make survival difficult.

The effects of ocean currents and the varied topography of California make climate change predictions particularly difficult for this state (California Environmental Protection Agency 2010). However, if CV winters continue to warm, one can expect to see more swallows, and possibly other species, taking advantage of the changing conditions.

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Mountain Plover (*Charadrius montanus).* Progress Rd, Sutter Co.
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