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Trends in Capture Rates for Summer, Winter, and Permanent Resident Songbirds at Big Sur, California

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ABSTRACT

I determined 15-year trends in capture rates for 25 songbird species at Big Sur, CA, in 1993-2007. Of the permanent residents, I found positive trends for Hutton's Vireos (Vireo huttoni), *Wrentits* (Chamaea fasciata), *and Spotted Towhees* (Pipilo maculatus). *Of the winter residents, capture rates increased for wintering and transient Hermit Thrushes* (Catharus guttatus) *and Fox Sparrows* (Passerella iliaca)*; capture rates also increased for wintering Golden-crowned Sparrows* (Zonotrichia atricapilla). *Summer residents showed the greatest variability among species and populations. Capture rates decreased for breeding Warbling Vireos* (V. gilvus) *and House Wrens* (Troglodytes aedon), *but increased for breeding Swainson's Thrushes* (C. ustulatus), *Orange-crowned Warblers* (Oreothlypis celata), *and Wilson's Warblers* (Cardellina pusilla). *Capture rates for transients of all summer species were either stable or negative. Some of the species with increasing breeding populations were associated with willows and understory vegetation, perhaps benefitting from local riparian restoration. I found increasing local trends for several species with decreasing regional Breeding Bird Survey trends, indicating the value of breeding habitat at Big Sur for some songbird species and the differences data from a local area can bring to bear on questions of species' viability.*

INTRODUCTION

Patterns of widespread population declines have been reported for Neotropical migrant songbirds during the last half-century (e.g., Robbins et al. 1989). Declines have been particularly severe for migrants breeding in grassland or forest habitats in central and eastern North America (Robbins et al. 1989, Murphy 2003). There is also evidence for widespread declines in western songbird populations in the 1980s and 1990s (DeSante and George 1994, Pyle et al. 1994, Yong and Finch 1997, Ballard et al. 2003). Given such a pattern of widespread declines, it is important to continue monitoring trends in the 21st century.

Interpreting songbird trends requires careful consideration, because the spatial scale of trends is often unclear. Trend studies intended to evaluate local changes for summer or winter resident birds at a site might be ineffective if data samples include substantial numbers of non-resident migrant individuals. Conversely, trend studies intended to evaluate regional, or even continental, changes by sampling at a migration stopover area must account for local processes that affect trends. The Breeding Bird Survey (BBS) can effectively identify trends for local summer residents, and regional trends can be evaluated by analyzing data for multiple sites. However, the BBS does not address permanent or winter resident species outside of the breeding season. Bird banding offers several advantages for evaluating trends, including the ability to differentiate local and transient populations, and the ability to sample during winter when singing is relatively infrequent for many species.

I determined 15-year trends in capture rates for songbirds at a banding station along the Big Sur River on the central California coast in 1993-2007. The Big Sur River is part of an Audubon-designated Important Bird Area and is considered to provide important riparian habitat for migrating songbirds (Roberson 2002). Although most spring and fall

captures at the station were considered non-resident migrants, many local permanent, summer, or winter residents were also captured at various times of the year. My objectives were to determine 1) species-specific trends in capture rates for local summer and winter resident individuals, 2) trends for transients of those summer and winter species, and 3) trends for permanent residents. Evaluating results for local and transient birds can provide multiple-scale perspective on current population trends and perhaps determine the value of local sites for avian conservation.

METHODS

Study Area. Ventana Wildlife Society conducted mist-netting at Andrew Molera State Park (36° 17' N, 121° 50' W) in Big Sur, Monterey County, CA. The banding station was located approximately 1.5 km from the Big Sur River mouth. Banding personnel used 21 nylon mist nets (12 m x 2.6 m, 30-mm mesh) in or adjacent to riparian thickets; several nets bordered coastal scrub. The same net locations were used for the duration of the study. Predominant tree species included western sycamore (*Platanus racemosa*), black cottonwood (*Populus trichocarpa*), arroyo willow (*Salix lasiolepis*), California bay laurel (*Umbellularia californica*), red alder (*Alnus rubra*), and coast live oak (*Quercus agrifolia*). The coastal scrub community included western poison-oak (*Toxicodendron diversilobum*), coyote brush (*Baccharis pilularis*), coffeeberry (*Rhamnus californica*), and California sagebrush (*Artemisia californica*). A riparian restoration project was conducted along the Big Sur River in 1995-1998, mostly downstream from, but including, the netting area. Of 3,764 trees planted during the restoration project, 700 (19%) had survived by 2007 (Ventana Wildlife Society, unpubl. data).

Data Collection. Banding was conducted year-round in 1993-2007, for an average of about 246 days per year (range 114-328). Banding days were more frequent during the first half of the study (average 283 days per year in 1993-2000) than during the second half (203 days per year in 2001-2007). On banding days, biologists opened nets about 15 min after sunrise and closed nets about five hr after sunrise. Nets were closed during periods of rain or excessive wind. Captured passerines and near-passerines were banded and released at the station.

Data Analysis. I determined annual capture rates for selected species as the number of birds caught per 1,000 net-hours. I selected species with 375 total captures (average 25 per year) and categorized species by resident status. Permanent resident species were present during all seasons. Summer resident species were present throughout the nesting season but not during the winter, except infrequently (<25 winter captures in 15 years). Winter resident species were present during the winter but not the nesting season. By these criteria, I selected 10 permanent, seven summer, and eight winter resident species. Captures of summer and winter resident species consisted of numerous non-resident transient individuals stopping at the site but not remaining throughout either the winter or summer. Because different populations of the same species could exhibit different trends, I calculated annual capture rates separately for local and transient individuals of each summer and winter species. I considered individuals to be "local" if they were recaptured at least once within a season over a period of at least seven days, a criterion used by Chase et al. (1997) and Gardali et al. (2000) for classifying local Wilson's Warblers (*Cardellina pusilla*) and Warbling Vireos (*Vireo gilvus*), respectively. This criterion is based on data reported by Moore and Kerlinger (1987) indicating a stopover of less than seven days for most migrants. I considered all other captures to be transients. For summer species, I did not include hatching-year individuals when classifying locals and transients, because I could not always be certain if these birds fledged from nests in Big Sur or other regions, especially when captured during fall. I calculated annual capture rates by dividing the number of captures each year by the number of net-hours, multiplied by 1000. I included recaptures when calculating capture rates, but excluded recaptures within the same year, although the latter were used to classify local and transient individuals. For summer and permanent resident species, annual net hours were based on effort from January through December. For winter species, annual net hours were based on effort from July through June of the following calendar year. I used effort for the entire 12-month period when calculating capture rates for simplicity and to allow for possible temporal changes in arrival/departure dates for local and transient migrants. This approach incorporated some effort

during months when a species was not present, but the proportion of this type of effort was generally consistent among years and unlikely to greatly influence trends.

I used linear regression to determine trends in annual capture rates for each of the 10 permanent residents, and for local and transient populations of each of the seven summer and eight winter resident species. I used SYSTAT 13 (SYSTAT Software, Inc., Chicago, IL) for all statistical analyses. I log transformed annual capture rates to ensure that residuals were normally distributed (Zar 1998). I present coefficients ± SE and considered trends statistically significant if $P \leq 0.05$.

RESULTS

Of the 10 permanent residents, capture rates increased for Hutton's Vireos (*Vireo huttoni*), Wrentits (*Chamaea fasciata*), and Spotted Towhees (*Pipilo maculatus*) (Table 1). Capture rates were stable for the remaining seven permanent residents: Black Phoebes (*Sayornis nigricans*), Chestnut-backed Chickadees (*Poecile rufescens*), Bushtits (*Psaltriparus minimus*), Bewick's Wrens (*Thryomanes bewickii*), Song Sparrows (*Melospiza melodia*), Dark-eyed Juncos (*Junco hyemalis*), and Purple Finches (*Carpodacus purpureus*).

Trends for the seven summer residents varied among species and populations. Capture rates decreased for local Warbling Vireos and House

Table 1. Estimated linear trends (% annual change ± SE) for 10 permanent resident species at Big Sur, California, in 1993-2007. Mean number of annual captures are indicated in parentheses and significant relationships are indicated in bold print.

Species	Linear Trend	r^2	*P*
Black Phoebe (32)	-0.5 ± 1.5	0.01	0.74
Hutton's Vireo (32)	**6.8 ± 1.7**	**0.55**	**<0.01**
Chestnut-backed Chickadee (142)	2.7 ± 1.7	0.17	0.13
Bushtit (108)	-5.0 ± 2.9	0.18	0.11
Bewick's Wren (97)	-1.9 ± 1.6	0.10	0.26
Wrentit (90)	**3.5 ± 1.2**	**0.40**	**0.01**
Spotted Towhee (61)	**5.7 ± 1.5**	**0.51**	**<0.01**
Song Sparrow (193)	-1.8 ± 1.4	0.12	0.22
Dark-eyed Junco (31)	7.3 ± 3.9	0.22	0.08
Purple Finch (121)	-1.1 ± 2.8	0.01	0.69

Table 2. Estimated linear trends (% annual change ± SE) for local and non-resident transient populations of seven summer resident species at Big Sur, California, in 1993-2007. Mean number of annual captures are indicated in parentheses and significant relationships are indicated in bold print.

Species	Local	*r*-squared	*P*	Transient	*r*-squared	*P*
Pacific-slope Flycatcher (203)	0.5 ± 1.9	0.16	0.14	-3.6 ± 3.2	0.09	0.28
Warbling Vireo (182)	**-8.6 ± 3.1**	**0.37**	**0.02**	-4.1 ± 3.6	0.09	0.27
House Wren (52)	**-8.1 ± 2.1**	**0.54**	**<0.01**	**-8.9 ± 2.5**	**0.50**	**<0.01**
Swainson's Thrush (160)	**8.6 ± 2.1**	**0.56**	**<0.01**	4.4 ± 3.3	0.12	0.20
Orange-crowned Warbler (204)	**10.9 ± 2.7**	**0.55**	**<0.01**	4.2 ± 3.2	0.12	0.21
Wilson's Warbler (518)	**9.9 ± 1.7**	**0.72**	**<0.01**	1.1 ± 4.3	0.01	0.81
Black-headed Grosbeak (102)	-4.0 ± 3.5	0.09	0.27	**-7.5 ± 2.9**	**0.34**	**0.02**

Table 3. Estimated linear trends (% annual change ± SE) for local and non-resident transient populations of eight winter resident species at Big Sur, California, in 1993-2007. Mean number of annual captures are indicated in parentheses and significant relationships are indicated in bold print.

Species	Local	r^2	*P*	Transient	r^2	*P*
Ruby-crowned Kinglet (187)	-1.3 ± 2.3	0.03	0.57	-4.4 ± 2.7	0.17	0.13
Hermit Thrush (185)	**3.8 ± 1.7**	**0.27**	**<0.05**	**3.3 ± 1.2**	**0.38**	**0.01**
Yellow-rumped Warbler (346)	1.8 ± 5.7	0.01	0.76	1.5 ± 4.0	0.01	0.71
Towsend's Warbler (34)	5.1 ± 4.5	0.10	0.28	-0.9 ± 2.8	0.01	0.75
Fox Sparrow (41)	**9.2 ± 3.7**	**0.32**	**0.03**	**9.6 ± 2.7**	**0.49**	**<0.01**
Lincoln's Sparrow (84)	-2.0 ± 4.5	0.02	0.67	2.2 ± 2.2	0.07	0.34
White-crowned Sparrow (64)	-2.8 ± 2.3	0.10	0.25	-0.3 ± 2.0	0.00	0.88
Golden-crowned Sparrow (130)	**6.7 ±1.0**	**0.76**	**<0.01**	4.8 ± 2.4	0.24	0.07

Wrens (*Troglodytes aedon*), but increased for local Swainson's Thrushes (*Catharus ustulatus*), Orange-crowned Warblers (*Oredthlypis celata*), and Wilson's Warblers (Table 2). Capture rates were stable for local Pacific-slope Flycatchers (*Empidonax difficilis*) and Black-headed Grosbeaks (*Pheucticus melanocephalus*). Capture rates decreased for transient House Wrens and Black-headed Grosbeaks and were stable for transients of the remaining five summer species.

Of the eight winter residents, capture rates increased for local and transient Hermit Thrushes (*C. guttatus*) and Fox Sparrows (*Passerella iliaca*); capture rates also increased for local Golden-crowned Sparrows (*Zonotrichia atricapilla*) (Table 3). Capture rates were stable for local and transient Ruby-crowned Kinglets (*Regulus calendula*), Yellow-rumped Warblers (*Setophaga coronata*), Townsend's Warblers (*S. townsendi*), Lincoln's Sparrows (*M. lincolnii*), and White-crowned Sparrows (*Z. leucophrys*).

DISCUSSION

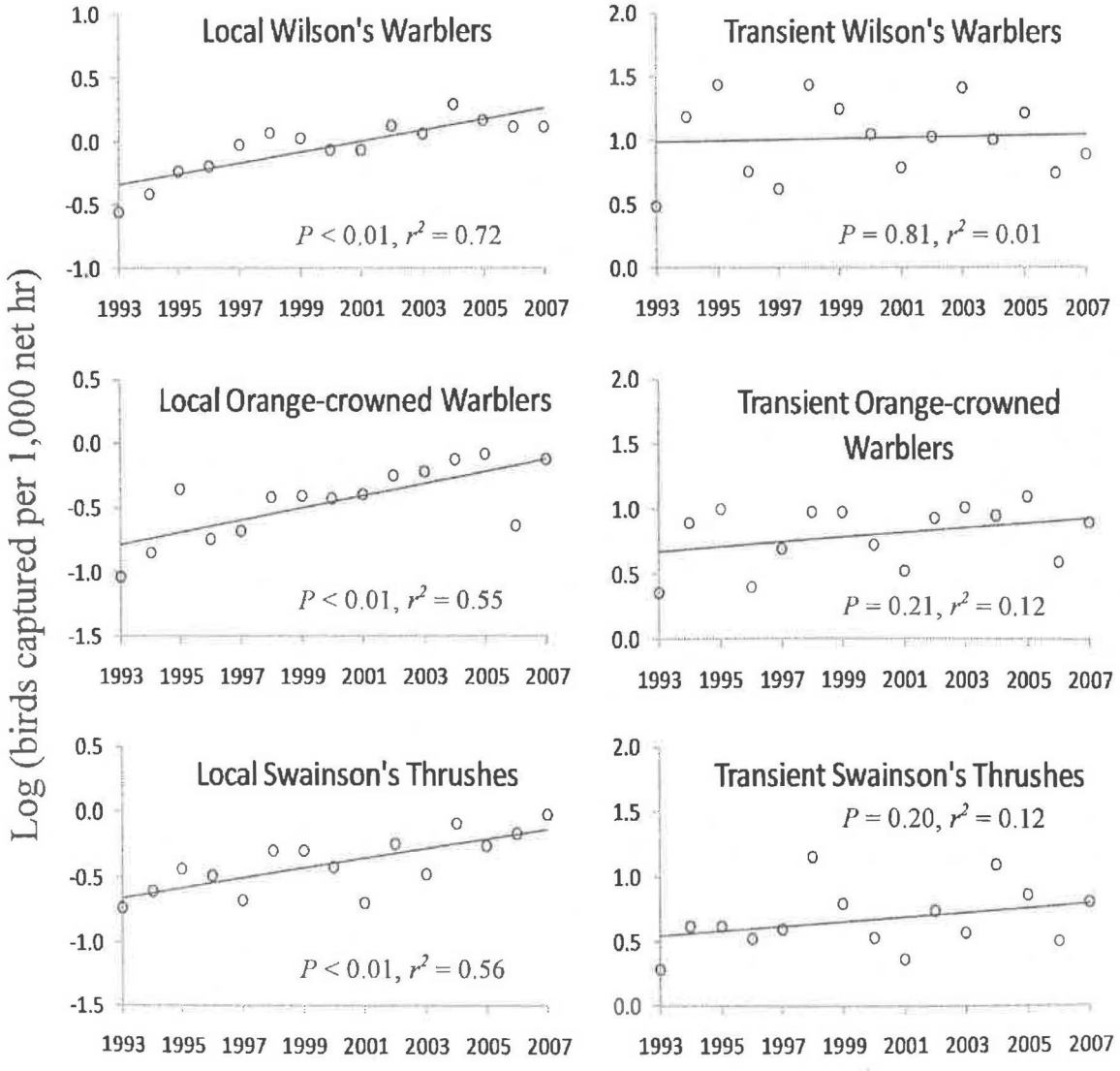
Among local populations of permanent, summer, and winter residents, more species had increasing capture rates than decreasing capture rates in 1993-2007. I considered the possibility that a reduction in sampling effort could have favored positive trends, particularly if the reduced average of net hours in the second half of the study was still sufficient for capturing the majority of local individuals. I found that for all species with an increasing local capture rate, the actual number of birds also increased significantly, indicating that results were not influenced heavily by the reduction in sampling effort. Several of the species with increasing local populations were species associated with willows and understory vegetation, perhaps indicating benefits of local riparian restoration. Although most of the planted trees were outside of the netting area, and only a modest proportion survived, this restoration probably increased vegetative cover for riparian songbird populations along the Big Sur River. Habitat improvement along the river, and growth of riparian vegetation in the netting area during the 15-year period, likely affected capture rates.

Although trends for winter and permanent resident species were either stable or positive, summer trends showed more variable trajectories among species and populations. Capture rates of Swainson's Thrushes, Orange-crowned Warblers, and Wilson's Warblers increased among local individuals, but were stable among transients (Fig. 1). Variability among populations for the three species was even greater when evaluating Big Sur results within the context of Breeding Bird Surveys during the same time period. BBS trends, derived from the regional analytical tool provided by Sauer et al. (2011), indicate significant declines (i.e., credible intervals not including zero) for all three species in either what they term the coastal California or California regions. Therefore, local populations of Swainson's Thrushes, Orange-

crowned Warblers, and Wilson's Warblers increased at Big Sur in 1993-2007, while these species experienced stable or decreasing regional trends. Capture rates of Warbling Vireos and House Wrens decreased among local individuals, matching significant BBS declines in the California Region (Sauer et al. 2011). At Big Sur, stable and negative trends for transient Warbling Vireos and House Wrens, respectively, agreed with BBS trends in the Northwestern Interior Forest Region, a possible breeding destination for many of the individuals captured.

At Big Sur, Warbling Vireos and House Wrens were the only species with decreasing local capture rates, but these declines were not unique to Big Sur. Ballard et al. (2003) reported a 9% annual decline in fall migrant Warbling Vireo capture rates at Palomarin Field Station in north-central coastal California in 1979-1999. Gardali et al. (2000) found that breeding and migrant Warbling Vireos declined at Palomarin during that time and suggested that low productivity on the breeding grounds was a reason for the declines. A decline for fall migrants in 1987-1998 was also found by Gardali and Jaramillo (2001) at Coyote Creek Riparian Station, a banding site in the San Francisco Bay Area between Palomarin and Big Sur. These studies indicate that regional declines have likely occurred in the past three decades, although BBS data do not indicate a widespread

Fig. 1. Capture rates increased significantly for local populations of Wilson's Warblers, Orange-crowned Warblers, and Swainson's Thrushes, but they did not increase significantly for transient populations of those species at Big Sur in 1993-2007.



pattern of declines outside of California. For House Wrens, negative trends based on Big Sur and BBS data in 1993-2007 follow survey-wide periods of increase measured by the latter, particularly in 1966-1979 (Peterjohn et al. 1995). House Wren increases in the decades prior to our study have been attributed to land conversions and the benefits of widespread use of artificial nest boxes aimed at conservation of secondary cavity nesters (Purcell et al. 1997, Arguedas and Parker 2000). Verner and Purcell (1999) studied an interior central California House Wren population over 13 years and recorded the lowest annual counts, and a decline, during a severe drought in 1987-1992. This drought occurred just prior to the Big Sur study, and a second drought (2007-2009) began in the last year of the study. Therefore, the negative trend I measured did not directly correspond with drought years, although fluctuations in precipitation could affect House Wren numbers. Trend agreement for House Wrens between Big Sur and BBS data for multiple regions indicates that factors acting on a broad geographic scale have affected populations in recent years.

Considerable attention has been devoted to determining causes of declines for migrant songbirds. A variety of factors has been suggested to explain population changes for one or more migrant songbird species, including reduction of breeding or wintering habitat (DeSante and George 1994, Murphy 2003), predation or parasitism (Gardali et al. 2000, Schmidt 2003), weather (Sillett et al. 2000, Nott et al. 2002), and mortality during migration (Butler 2000, Sillett and Holmes 2002). No single factor is likely to explain the majority of declines (Robbins et al. 1989, Ballard et al. 2003). For example, recent studies have demonstrated how processes limiting wintering populations can carry over into the breeding season and affect reproduction (Norris et al. 2003, Holmes 2007).

However, increases for some permanent residents and local populations of summer and winter resident species are evidence that local factors at Big Sur could well have played a prominent role in the observed population trends. Positive trends for Wrentits and Spotted Towhees are indications that coastal scrub and understory plant communities at Big Sur provided sufficient habitat for these species. Chase et al. (2005) likewise found an increase in Wrentits at another central California site and suggested that they benefitted from local plant succession. Several winter bird residents of shrub and understory plant communities also increased at Big Sur, but local increases in some cases were shared with transients, and these increases could also be associated with conditions on the breeding grounds or at migration stopover sites. Some species maintain stable or positive trends in optimal habitat while declining in marginal or altered habitat (Wilcove and Terborgh 1984). Riparian woodland along the Big Sur River, particularly willows, attracted numerous Wilson's and Orange-crowned warblers, two of the station's most frequently captured species. Local populations for these two warblers, along with Swainson's Thrushes, increased at Big Sur, while declining in some Breeding Bird Survey regions, indicating the value of breeding habitat at Big Sur for some songbird populations.

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