2005
ANALYSIS OF AVIAN GUILD SPECIES DIVERSITY IN THE CARMEL RIVER RIPARIAN CORRIDOR

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ANALYSIS OF AVIAN GUILD SPECIES DIVERSITY - 2005

ABSTRACT

The Monterey Peninsula Water Management District (MPWMD) restores vegetation along the Carmel River to provide wildlife habitat, to stabilize river banks for preventing erosion, and to improve water quality. The MPWMD also oversees potential projects on the Carmel River such as drilling and operating wells and irrigation. To evaluate long-term restoration efforts and determine bird/habitat relationships over time in conjunction with current and proposed water management projects, in 1999 we resumed the Avian Guild Species Diversity project (begun in 1992) to elucidate annual trends pertaining to species diversity, abundance, and richness of breeding birds. We conducted surveys along 9 transects on selected reaches of the Carmel River riparian corridor during spring and late summer. Both spring and summer data collected from the seasonally dry reaches of the watershed had slightly higher species diversity compared to the perennially watered reaches, perhaps indicative of avian responses to ongoing habitat restoration efforts at Schulte bridge, Carmel River mouth, and the Highway One bridge. The 13-year and 14-year means for spring and summer, respectively, continued to show a trend toward higher overall species diversity along the river. In spring spanning from 1992 to present, species diversity at the Schulte restoration site and Valley Greens Drive increased significantly. In late summer spanning from 1992 to present, species diversity at the Schulte Bridge and Highway One restoration sites increased significantly but at the San Carlos Ranch bridge where there is no active restoration, species diversity decreased significantly. These findings reinforce the importance of ongoing habitat restoration to increase vegetative structural integrity for supporting a diversity of birds and other wildlife.

BACKGROUND

This report presents the results of avian monitoring along the lower Carmel River during spring and late summer, 2005. The monitoring is the continuation of a project first initiated in 1992 by David Mullen of EIP Associates, Berkeley, CA, and repeated most years through 1998; the 1999-2002 projects and reports were prepared by Chris Tenney, the 2003 report was prepared by Sarah Stock and Chris Tenney of the Ventana Wildlife Society (formerly Ventana Wilderness Society), and the 2004 report was prepared by Sarah Stock. This 2005 report, prepared by Jessica Griffiths of the Ventana Wildlife Society, is intended for inclusion as Appendix R to the 1993 report, to facilitate year-to-year data comparisons.

Since 1992 the Monterey Peninsula Water Management District (MPWMD) has funded monitoring of landbird diversity in selected habitats along the lower Carmel River riparian corridor. This long-term monitoring study is intended to elucidate trends in the diversity of breeding and dispersing landbirds dependent on riparian habitats that would be impacted by new water supply projects and current ground water extraction.

METHODS

We compiled species richness and landbird abundance for each transect by totaling species detections and total individuals, respectively. In addition, we reported values calculated using the Species Diversity Index (SDI) which has historically been applied to avian guilds in potentially effected project areas (Shannon and Weaver 1949, Odum 1971). SDI measurements provide accurate, repeatable, and reliable evaluation of the resources available to wildlife in various habitats through time (Mullen 1992). The SDI was derived from the Shannon-Wiener index (Krebs 1989) and reflects both the number and relative proportion of those species present in a sample. This index serves as a measure of the degree of uncertainty of predicting the species of an individual picked at random from a given search survey. The diversity index increases as the number of species and equability among species increases. We used the following formula to calculate species diversity (Pielou 1966).

For the Sum of $i = 1$ to $i = S$, $\quad SDI = - \Sigma (p_i)(\log p_i), \quad i = 1,2,\ldots S$

Where S = the number of species in the sample, and p_i = the proportion of all individuals belonging to the *i*th species. The index varies from 0, in which all individuals belong to the same species, to a relatively high number with many species and an even distribution of individuals among species. In general, greater species diversity implies greater heterogeneity in the sample (Nur et al. 1999).

Specific methods by which SDI field data are collected, statistically analyzed, and interpreted for this study were provided in the 1993 Report (EIP Associates 1993). Site 5A (see Appendix M-1) at the Rancho Canada golf course was sampled only during the year 2000. Aerial photos and detailed descriptions of all sites are provided at the end of the 1999 report (Appendix L-2); see Table Q-1 for latitude, longitude, and elevation of each point count location.

RESULTS

Spring. Table R-1 presents species richness, abundance, and diversity indices from 18 hours of observations obtained during surveys on the lower Carmel River riparian corridor in late May. This year (2005), 67 species were recorded from nine transect sites, six fewer than from the same time period in 2004. Species richness recorded at each site during a two-hour period ranged from a low of 31 at Garland Park (transect 2B), to a high of 46 at Valley Greens Drive bridge (transect 3C).

Abundance ranged from 135 individuals observed at Garland Park (transect 2B) to 480 individuals observed at Highway One bridge (transect 4C). Diversity indices ranged from a low of 3.02 at Garland Park (transect 2B) to a high of 3.53 at Valley Greens Drive Bridge (transect 3C). The mean SDI value for all nine transects combined this year increased from 3.27 in 2004 (Table Q-2) to 3.31 this year. From 1992 to present, there is a trend toward increasing species diversity in the spring ($n = 13$, $r^2 = 0.30$, $P = 0.053$) (Figure R-1).

Summer. Table R-2 presents species richness, abundance, and diversity indices from 18 hours of observations obtained during surveys in late August. In 2005, 58 species were recorded from nine transect sites, one more than was recorded in 2004. Species richness recorded at each site

during a two-hour period ranged from a low of 21 at Carmel Valley Ranch Golf Club (transect 2C) to a high of 35 at Schulte Road bridge (transect 3B).

Abundance ranged from 113 individuals observed at Carmel Valley Ranch Golf Club (transect 2C) to 271 individuals observed at the Highway One bridge (transect 4C). Diversity indices ranged from a low of 2.63 at Carmel Valley Ranch Golf Club (transect 2C) to a high of 3.05 at Schulte Road bridge (transect 3B). The mean SDI value decreased from 2.92 in 2004 (Table Q-3) to 2.82 in 2005. From 1992 to present, there is a trend toward increasing species diversity in the summer ($n = 14$, $r^2 = 0.28$, $P = 0.054$) (Figure R-2).

Annual Trends. Species diversity increased significantly at Schulte Road bridge and Valley Greens Drive bridge (transects 3B and 3C) in spring and at Schulte Road bridge and Highway One bridge (transects 3B and 4C) in summer (Table R-4). Species diversity decreased significantly at San Carlos Ranch Road bridge (transect 4A) in summer (Table R-4). Species diversity along all other transects showed no significant trend for either season (Table R-4).

TABLE R-1
BIRD SPECIES ENCOUNTERED[2] DURING TIME CONSTRAINED SURVEYS[3]
ON FIXED TRANSECTS ALONG SELECTED REACHES[4] OF THE CARMEL RIVER
RIPARIAN CORRIDOR DURING SPRING, 21 MAY-1 JUNE 2004.

SPECIES	TRANSECTS								
	2A	2B	2C	3A	3B	3C	4A	4B	4C
Acorn Woodpecker			2	6		3	14	10	
Allen's Hummingbird	1		2			1			1
American Crow	11	14	12	4	9	9	9	17	8
American Goldfinch								1	2
American Kestrel			2						
American Robin		2	4	8	2	8			
Anna's Hummingbird	5	5	3	7	5	4	11	12	7
Ash-throated Flycatcher						1		2	1
Barn Swallow		2	2	3	5		9	1	3
Band-tailed Pigeon	2		5		5	19			13
Belted Kingfisher		1	2			2			1
Bewick's Wren	1		6	11	9	5	7	6	18
Black-headed Grosbeak	5	2	4	4	1	5	1	3	25
Black Phoebe	14	5	7	2		9	1	2	7
Brewer's Blackbird	2	1	1	14	11			26	1
Brown-headed Cowbird					4	2	3	2	7
Bullock's Oriole			1	3	1	1			
Bushtit	22	14	8	15	10	25	1	2	13
California Quail	7	5	4	9	7	3	17	27	15
California Towhee	3	5	7	6	7	3	5	15	8
Canada Goose	2				2		6	1	
Cedar Waxwing							26		75
Chestnut-backed Chickadee	26	16	12	16	8	10	12	17	10
Cliff Swallow	2		6	5	1	10	8	9	18
Common Merganser	4		1	2			1		2
Cooper's Hawk							1		
Downy Woodpecker		2		1	3			2	1
European Starling	8		29	5	17	9	1	8	30
Green Heron	1	2	1		1				
Hairy Woodpecker						1		1	
Hooded Oriole									1
House Finch		7	4	11	8	4	3	21	8
House Wren	2					1			
Killdeer			2						1
Lesser Goldfinch	3	2	4	1		3	1	3	1
Mallard	12	3	1	1	3	12	1		5
Mourning Dove	8	3	6	13	8	4	9	17	10
Northern Flicker			2						1
N. Rough-winged Swallow			4	8		3			
Nuttall's Woodpecker	2	1	3	1	1	1	2	1	2

[2] Total of all visual and auditory identifications.
[3] Four 15-minute transect stations per 2,000-foot census line X two repetitions of each transect = 120 minutes of census time per transect.
[4] See Appendix L-A for maps, locations, and descriptions of transect sites.

Table R-1 continued

SPECIES	TRANSECTS								
	2A	2B	2C	3A	3B	3C	4A	4B	4C
Oak Titmouse	6		4	2	1	3			
Olive-sided Flycatcher		1			2			1	
Orange-crowned Warbler	6			5	2	8	2		
Oregon Junco	1					9			
Pacific-slope Flycatcher		2	3	8	3	2	2	4	7
Purple Finch	1	1	1	8	2	4	3		5
Pygmy Nuthatch						9	3	10	
Red-shouldered Hawk		3	1	2		2	1		1
Red-tailed Hawk				1	1		2	1	2
Red-winged Blackbird				1	5			12	
Rock Pigeon			1	1			12	12	56
Song Sparrow	23	18	10	13	15	13	12	12	12
Spotted Towhee	2	2	2	3		4	1	3	11
Steller's Jay	7	2	3	3	2	2			1
Swainson's Thrush		1				5	5	7	10
Tree Swallow	6		5	5	8	6	13	5	23
Turkey Vulture	4	4	4	4	3	7	3	6	1
Violet-green Swallow	1		3	10			1	4	
Warbling Vireo	1	4	8	2	1	7	4		5
Western Gull							2		35
Western Scrub-Jay	10	3	8	11	7	7	11	8	9
Western Wood-pewee				2		4	4		
White-tailed Kite								1	
White-throated Swift			9						
Wilson's Warbler	3	2		2	1	10	3	6	7
Wrentit	1		3	4	2	3	2	5	
Yellow Warbler					2	1			
Species Richness	36	31	45	43	39	46	42	40	45
Species Abundance	215	135	212	243	185	264	235	303	480
Diversity Index	3.14	3.02	3.47	3.48	3.34	3.53	3.33	3.30	3.18
Mean Diversity Index	**3.31**								
Total Species Richness	**67**								

2A = DE DAMPIERRE PARK, west from eastern park boundary, 1750’ along north bank
2B = GARLAND PARK, west from Carmel River bridge 1750’ along south bank
2C = CARMEL VALLEY RANCH GOLF CLUB, west from eastern property limit 3300’ along south bank
3A = ROBINSON CANYON ROAD, east from barn area for 2000’ along south bank
3B = SCHULTE ROAD BRIDGE, west for 1375’ along south bank
3C = VALLEY GREENS DRIVE BRIDGE, east for 2200’ along south bank
4A = SAN CARLOS RANCH ROAD BRIDGE, west for 1250’ along south bank
4B = RIVERWOOD, west for 2500’ from eastern property boundary along north bank
4C = HIGHWAY ONE BRIDGE, west for 2250’ along south bank

TABLE R-2
BIRD SPECIES ENCOUNTERED[5] DURING TIME CONSTRAINED SURVEYS[6]
ON FIXED TRANSECTS ALONG SELECTED REACHES[7] OF THE CARMEL RIVER
RIPARIAN CORRIDOR DURING THE SUMMER, 19 AUG - 30 AUG, 2005.

SPECIES	TRANSECTS								
	2A	2B	2C	3A	3B	3C	4A	4B	4C
Acorn Woodpecker	3	6	6	4	1	8	8		7
American Crow	6	10	6	9	15	10	9	6	
American Goldfinch	4						6	9	
American Robin				6	3	7	3	4	1
Anna's Hummingbird	2		1	2	3	2	6	7	5
Band-tailed Pigeon					18	4			
Barn Swallow	2				1			12	8
Belted Kingfisher	2	1	7	2	3	1			1
Bewick's Wren		7	1	1				2	6
Black Phoebe	1	6	14	5	3	11	2	6	5
Brewer's Blackbird				1	1				
Brown Creeper				1					
Bushtit	16	6	14	14	31	13	3		8
California Towhee	4	5	1		8	1	3	9	7
California Quail	18				13	4	34	4	
Canada Goose					7				18
Chestnut-backed Chickadee	13	14	17	18	17	21	12	20	26
Downy Woodpecker					1		1	1	1
European Starling	1				18		4		1
Great Blue Heron		1			1	1			
Green Heron	1	3		1					
Hairy Woodpecker			1						
House Finch	2			2	1	10	31	52	36
House Wren		1		1					
Hutton's Vireo			2			2			
Lesser Goldfinch		3			1			11	6
Mallard		28			6	2			
Mourning Dove				10	21	4	5	8	66
Nashville Warbler	1								
Northern Flicker	1			3					3
Northern Mockingbird			1						
Nuttall's Woodpecker		1	2	3		2	2	1	2
Oak Titmouse	2	2	6	1		2	1	3	
Orange-crowned Warbler		1			4		1		
Oregon Junco	20		12	5		4	7	5	7
Pacific-slope Flycatcher									2
Pygmy Nuthatch					2	15		16	2
Red-shouldered Hawk	3	3	1	1	1		1		
Red-tailed Hawk		2		1	1			1	3
Red-winged Blackbird								3	6

[5] Total of all visual and auditory identifications.
[6] Four 15-minute transect stations per 2,000 census line X two repetitions of each transect = 120 minutes of census time per transect.
[7] See Appendix L-A for maps, locations, and descriptions of transect sites.

TABLE R-2 continued

SPECIES	TRANSECTS								
	2A	2B	2C	3A	3B	3C	4A	4B	4C
Rock Pigeon					1		2		
Sharp-shinned Hawk								1	
Song Sparrow	8	10	6	4	7	1	3	11	11
Spotted Towhee	1	1							1
Steller's Jay	13	6		10	9	2			
Swainson's Thrush							1		1
Townsend's Warbler					4				
Tree Swallow								4	1
Turkey Vulture				2	4	1		1	3
Violet-green Swallow							8		
Warbling Vireo		2		2	2				1
Western Gull									2
Western Scrub-Jay	9	7	10	14	22	12	9	15	6
White-breasted Nuthatch	1		1						
White-tailed Kite							1	1	3
Wilson's Warbler	5	1	1	1	7	3	1	8	5
Wrentit			3	2	1	6	2	5	10
Yellow Warbler		2		1	5				
Species Richness	25	25	21	29	35	26	27	28	34
Species Abundance	139	129	113	127	243	149	166	226	271
SDI	2.76	2.77	2.63	2.92	3.05	2.89	2.72	2.85	2.83
Mean Diversity Index	**2.82**								
Total Species Richness	**58**								

2A = DE DAMPIERRE PARK, west from eastern park boundary, 1750’ along north bank
2B = GARLAND PARK, west from Carmel River bridge 1750’ along south bank
2C = CARMEL VALLEY RANCH GOLF CLUB, west from eastern property limit 3300’ along south bank
3A = ROBINSON CANYON ROAD, east from barn area for 2000’ along south bank
3B = SCHULTE ROAD BRIDGE, west for 1375’ along south bank
3C = VALLEY GREENS DRIVE BRIDGE, east for 2200’ along south bank
4A = SAN CARLOS RANCH ROAD BRIDGE, west for 1250’ along south bank
4B = RIVERWOOD, west for 2500’ from eastern property boundary along north bank
4C = HIGHWAY ONE BRIDGE, west for 2250’ along south bank

TABLE R-3
SPECIES DIVERSITY OF BIRDS
UTILIZING LOWER CARMEL RIVER RIPARIAN CORRIDOR HABITATS

	Perennially Watered Reaches	Seasonally Dry Reaches	Percent
SPRING	Transects 2A-3A	Transects 3B-4C	Difference
1992	3.15	3.21	1.9
1994	2.96	2.91	-1.7
1995	3.13	3.14	0.3
1996	3.19	2.91	-8.7
1997	3.15	3.20	1.6
1998	3.22	2.78	-13.6
1999	3.19	3.29	3.1
2000	3.08	2.98	-3.2
2001	3.06	3.19	4.2
2002	3.17	3.27	3.2
2003	3.14	3.17	1.0
2004	3.20	3.33	4.1
2005	3.28	3.34	1.8
Mean (13 years)	**3.15**	**3.13**	**-0.5**
SUMMER			
1992	2.81	2.62	-6.8
1993	2.90	2.59	-10.7
1994	2.76	2.60	-5.6
1995	2.48	2.69	8.4
1996	2.83	2.47	-12.7
1997	2.85	2.66	-6.7
1998	2.62	2.51	-4.2
1999	2.70	2.69	-0.4
2000	2.52	2.65	5.2
2001	2.68	2.92	9.0
2002	2.73	2.73	0.0
2003	2.79	2.83	1.0
2004	2.99	2.87	-4.0
2005	2.77	2.87	3.6
Mean (14 years)	**2.75**	**2.69**	**-1.7**

TABLE R-4
RESULTS FROM LINEAR REGRESSION EXAMINING SPECIES DIVERSITY INDICES
FROM 1992 TO 2005 IN THE CARMEL RIVER RIPARIAN CORRIDOR

SPRING 1992-2005				
Transect	**Mean ± SE**	***n***	**r^2**	***P*-value**
		1		
2A	3.10+-0.03	3	0.01	0.75
		1		
2B	3.03+-0.04	3	0.00	0.89
		1		
2C	3.23+-0.05	3	0.19	0.13
		1		
3A	3.22+-0.04	3	0.25	0.09
		1		
3B	**3.12+-0.07**	**3**	**0.60**	**0.00**[8]
		1		
3C	**3.22+-0.07**	**3**	**0.53**	**0.01**[9]
		1		
4A	3.22+-0.05	3	0.00	0.93
		1		
4B	3.03+-0.12	3	0.02	0.63
		1		
4C	3.07+-0.07	3	0.01	0.80

SUMMER 1992-2005				
Transect	**Mean ± SE**	***n***	**r^2**	***P*-value**
		1		
2A	2.72+-0.05	4	0.00	1.00
		1		
2B	2.69+-0.06	4	0.37	0.51
		1		
2C	2.78+-0.07	4	0.00	0.96
		1		
3A	2.79+-0.06	4	0.01	0.81
		1		
3B	**2.72+-0.06**	**4**	**0.63**	**0.00**[9]
		1		
3C	2.88+-0.05	4	0.20	0.11
		1		
4A	**2.72+-0.06**	**4**	**0.30**	**0.04**[9]
		1		
4B	2.69+-0.07	4	0.08	0.33
		1		
4C	**2.46+-0.12**	**4**	**0.38**	**0.02**[9]

[8] Significant positive trend in species diversity from 1992-2005
[9] Significant negative trend in species diversity from 1992-2005

FIGURE R-1
SPECIES DIVERSITY INDICES DURING SPRING 1992 - 2005
IN THE CARMEL RIVER RIPARIAN CORRIDOR

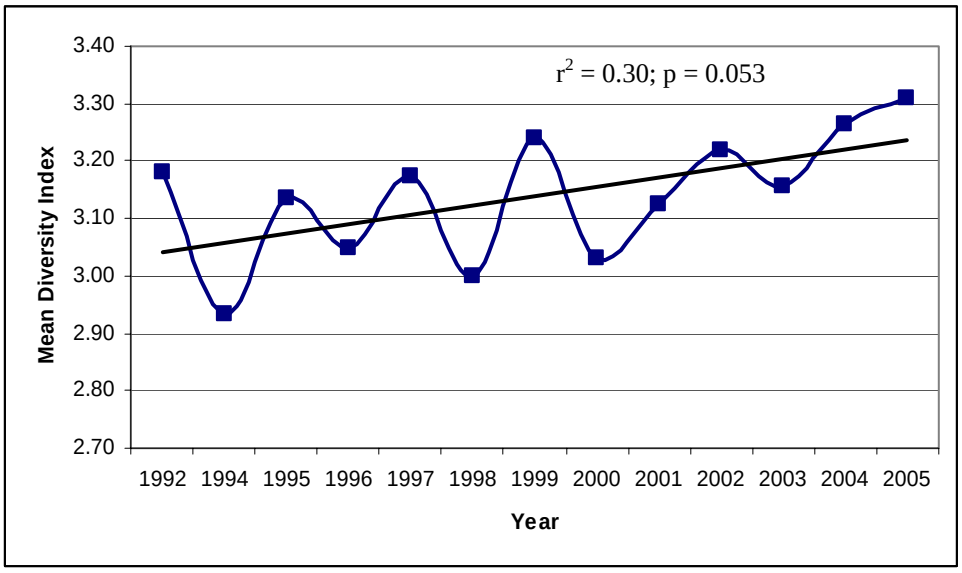
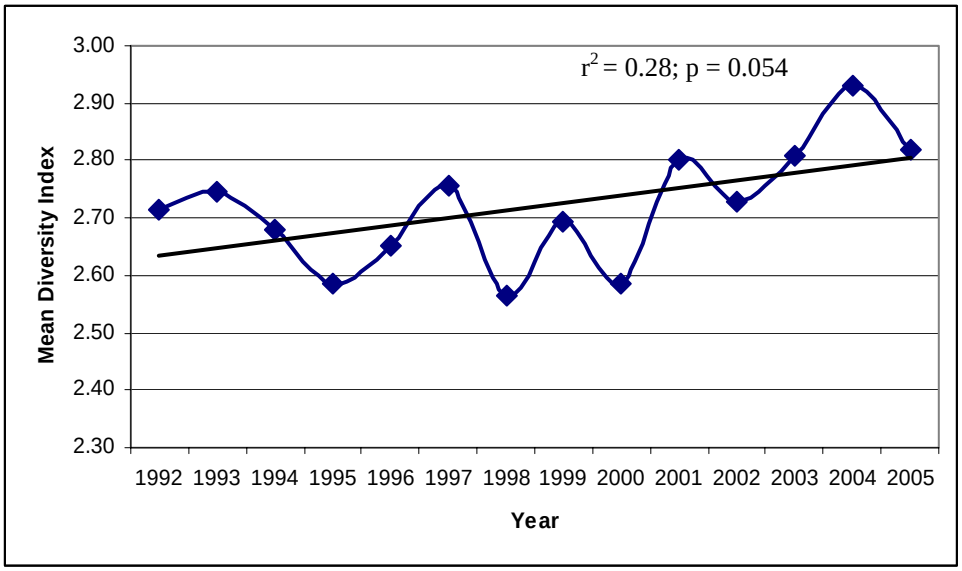


FIGURE R-2
SPECIES DIVERSITY INDICES DURING SUMMER 1992 - 2005
IN THE CARMEL RIVER RIPARIAN CORRIDOR



DISCUSSION

Results from this study suggest that riparian restoration efforts of MPWMD have enhanced breeding and dispersing habitat for a wide variety of common migratory and resident species. Spring and summer species diversity at Schulte Road bridge (transect 3B) increased significantly from 1992 to 2005. Because this increase is not specific to season (statistical significance occurred in both spring and summer), on-going habitat restoration efforts west of Schulte Bridge have likely improved habitat features for all birds in the area. Since the restoration project began in 1987, western sycamore (*Platanus racemosa*), box elder (*Acer negundo*), and black cottonwood (*Populus trichocarpa*) have reached maturity and two floods have allowed for recruitment of understory species. This vegetative structural integrity is important for supporting diverse birds and other wildlife.

Spring species diversity at Valley Greens Drive bridge (transect 3C) also increased significantly over the 13 year period, perhaps due to the continued irrigation of the adjacent golf course. During summer, species diversity also increased significantly at the Highway One bridge (transect 4C) but decreased significantly at San Carlos Ranch Road bridge (transect 4A). The increase in diversity at the Highway One bridge (transect 4C) could be due to ongoing habitat restoration, and the decrease at San Carlos Ranch Road bridge (transect 4A) may be attributed to lack of restoration and increasing encroachment by exotic vegetation , such as cape ivy (*Delairea odorata*) and poison hemlock (*Conium maculatum*), in the understory. Continued monitoring at all sites using the same standardized point count format will further elucidate the benefits to birds and the ecosystems in general garnered by the habitat restoration efforts of the MPWPD.

Spring and summer 2005 data showed a continuation in the trend toward higher SDI values in the seasonally dry reaches than in the perennially watered reaches, (Table R-3). Ongoing habitat restoration at the Highway One bridge (transect 4C) and Schulte Road bridge (transect 3B) and golf course irrigation at Valley Greens Drive bridge (transect 3C) may be important factors influencing the trend toward higher diversity of breeding birds in the lower reaches. Mean SDI values (1992-2005) are now only slightly higher in the perennially watered reaches, 0.5% in the spring and 1.7% in the summer. To date, the most dramatic differences between watered and dry spring SDI values occurred in 1996 (-8.7%) and 1998 (-13.6%); these differences may have been responses to natural events – intense winter rains and floods along the Carmel River in 1995 and 1998. Since 1998, the mean SDI values have reflected this bias, despite the fact that in every year since 1998 the seasonally dry reaches have had higher SDI values than the watered reaches.

As more information is obtained from this long-term monitoring program, it should be possible to determine with some precision the reaction of bird populations to habitat manipulations. This study will guide the planning and development of mitigation measures, the success of which can be monitored using similar field techniques.

ACKNOWLEDMENTS

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