2004
ANALYSIS OF AVIAN GUILD SPECIES DIVERSITY IN THE CARMEL RIVER RIPARIAN CORRIDOR

Thirteenth Annual Report

Prepared for the
Monterey Peninsula Water Management District
Monterey Peninsula Water Supply Project
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ANALYSIS OF AVIAN GUILD SPECIES DIVERSITY - 2004

ABSTRACT

The Monterey Peninsula Water Management District (MPWMD) restores vegetation along the Carmel River to provide habitat for wildlife indicator species, 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. Spring data collected from the seasonally dry reaches 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 Highway One bridge. In contrast, summer data collected from the seasonally dry reaches had slightly lower species diversity compared to the upper watershed. This is likely due to dispersing large flocks of waterfowl, Rock Pigeon, and black birds attracted to the Carmel River lagoon and the urban setting of Carmel. The 12-year and 13-year means for spring and summer, respectively, continued to show a trend toward higher overall diversity in the perennially watered reaches compared to the seasonally dry reaches. 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 diverse birds and other wildlife.

BACKGROUND

This report presents results of avian monitoring along the lower Carmel River during spring and late summer, 2004. 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 and the 2003 report was prepared by Sarah Stock and Chris Tenney of the Ventana Wilderness Society. This 2004 report, prepared by Sarah Stock, is intended for inclusion as Appendix Q 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 mist-net or an area 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 $i = S$, $\quad SDI = - \Sigma (p_i)(\log p_i), \quad i = 1,2,\ldots S$
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 Q-2 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 (2004), 73 species were recorded from nine transect sites, 11 more than from the same time period in 2003. Species richness recorded at each site during a two-hour period ranged from a low of 33 at De Dampierre Park (transect 2A), to a high of 50 at Valley Greens Drive bridge (transect 3C). White-tailed Kites, first observed three years ago near the Highway One Bridge in fields newly-restored to native vegetation, were again observed this year from the Highway One bridge, as well as from the Riverwood transect.

Abundance ranged from 177 and 178 individuals observed at De Dampierre Park (transect 2A) and San Carlos Ranch Road (transect 4A), respectively, to 578 individuals observed at Highway One bridge (transect 4C). Diversity indices ranged from a low of 3.00 at De Dampierre Park (transect 2A) to a high of 3.56 at Valley Greens Drive Bridge (transect 3C). The mean SDI value for all nine transects combined this year increased from 3.16 in 2003 (Table P-1) to 3.27 this year. From 1992 to present, there is a trend toward increasing species diversity in the spring ($n = 12$, $r^2 = 0.16$, $P = 0.20$).

Summer. Table Q-3 presents species richness, abundance, and diversity indices from 18 hours of observations obtained during surveys in late August. This year (2004) 57 species were

recorded from nine transect sites, three more than were recorded in 2003. Species richness recorded at each site during a two-hour period ranged from a low of 25 at San Carlos Ranch Road bridge (transect 4A) to a high of 38 at Valley Greens Drive bridge (transect 3C).

Abundance ranged from 118 individuals observed at Garland Park (transect 2B) to 236 individuals observed at Carmel Valley Ranch Golf Club (transect 2C). Diversity indices ranged from a low of 2.23 at San Carlos Ranch Road Bridge (site 4A) to a high of 3.26 at Carmel Valley Ranch Golf Club (transect 2C). The mean SDI value increased from 2.81 in 2003 (Table P-2) to 2.92 in 2004. This year's value (2.92) is 0.21 higher than the 13-year mean of 2.71. From 1992 to present, there is a trend toward increasing species diversity in the summer ($n = 13$, $r^2 = 0.26$, $P = 0.07$).

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 Q-5, Figure Q-1). Species diversity decreased significantly at San Carlos Ranch Road bridge (transect 4A) in summer (Table Q-5, Figure Q-1). Species diversity along all other transects showed no significant trend for either season (Table Q-5).

TABLE Q-1
LATITUDE, LONGITUDE, AND ELEVATION OF FIXED TRANSECTS ALONG SELECTED REACHES[2] OF THE CARMEL RIVER RIPARIAN CORRIDOR

Transect	Point Count	Latitude	Longitude	Elevation
2A	1	36.478752	-121.741166	78.953
2A	2	36.477062	-121.741106	73.666
2A	3	36.476426	-121.739255	73.186
2A	4	36.476383	-121.737572	75.829
2B	1	36.510399	-121.769463	61.169
2B	2	36.510781	-121.770611	40.501
2B	3	36.510959	-121.771445	41.943
2B	4	36.511696	-121.773137	47.230
2C	1	36.520840	-121.805455	30.167
2C	2	36.521752	-121.803347	39.540
2C	3	36.521953	-121.801880	41.222
2C	4	36.522454	-121.800253	37.377
3A	1	36.519217	-121.813737	20.794
3A	2	36.520491	-121.815239	25.841
3A	3	36.521936	-121.816377	23.918
3A	4	36.523405	-121.817443	23.678
3B	1	36.525465	-121.831472	26.802
3B	2	36.526711	-121.832185	40.741
3B	3	36.527633	-121.833205	18.151
3B	4	36.528651	-121.835221	14.305
3C	1	36.530946	-121.858032	64.053
3C	2	36.529198	-121.857220	15.988
3C	3	36.527794	-121.855567	18.151
3C	4	36.527101	-121.852951	34.973
4A	1	36.536384	-121.871143	6.615
4A	2	36.536441	-121.872409	19.833
4A	3	36.536588	-121.874078	6.855
4A	4	36.536662	-121.875753	16.228
4B	1	36.536658	-121.901671	6.374
4B	2	36.536299	-121.903522	5.173
4B	3	36.536253	-121.905006	0.126
4B	4	36.535840	-121.906927	31.849
4C	1	36.538549	-121.921013	-3.239
4C	2	36.538432	-121.917998	7.336
4C	3	36.537667	-121.915450	-0.355
4C	4	36.536543	-121.913218	-8.526

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

[2] See Appendix L-A for maps, locations, and descriptions of transect sites.

4C = HIGHWAY ONE BRIDGE, west for 2250’ along south bank

TABLE Q-2
BIRD SPECIES ENCOUNTERED[3] DURING TIME CONSTRAINED SURVEYS[4]
ON FIXED TRANSECTS ALONG SELECTED REACHES[5] 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	5	6		2	10	5	
Allen's Hummingbird	1		1	2		2	1	3	4
American Crow	9	19	14	5	18	11	6	20	11
American Goldfinch				2			3	2	1
American Kestrel			2						
American Robin			3	3	3	5	4		
Anna's Hummingbird	2	2	2	7	3	5	7	10	16
Ash-throated Flycatcher								2	
Band-tailed Pigeon				1	22	4			15
Barn Swallow			3		1	2	3		4
Belted Kingfisher	1	3	1	3	3				
Bewick's Wren	2	5	2	4	4	1	4	6	10
Black Phoebe	6	8	6	4	2	3			4
Black-headed Grosbeak	10	2	8		4	4	3	3	10
Brewer's Blackbird			10		3	1	4	7	
Brown-headed Cowbird				1	3		2		
Brown Pelican									12
Bullock's Oriole				2		1			1
Bushtit	3	11	6	27	8	20	10	8	17
California Quail	5	1	21	12		3	6	12	15
California Towhee	1	2	1	1	9	4	1	4	5
Canada Goose			6					8	
Cedar Waxwing		33							14
Chestnut-backed Chick.	17	23	10	17	14	17	7	15	18
Cliff Swallow	2	16	7	5	16	2	1	2	3
Common Merganser	8	1	1			1			
Downy Woodpecker			1			1	4		2
European Starling	5	1	17	11	46	8		3	29
Green Heron	1				3	1		1	
Hairy Woodpecker			2			1		1	
Hooded Oriole					1				
House Finch				15	7	4	5	13	22
House Wren	1						1		
Hutton's Vireo				1					
Killdeer						2		1	
Lesser Goldfinch		12	2	10	8	7	4	4	8
Mallard	12	7	3		1	5	4	7	2
Mourning Dove	3	4	7	4	13	16	9	23	20
N. Rough-winged Swallow	1	5	4		2	4			6
Northern Flicker				1	1		1		
Nuttall's Woodpecker		1	2	2	5	4		3	3

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

TABLE Q-2 (continued)

SPECIES	TRANSECTS								
	2A	**2B**	**2C**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**
Oak Titmouse				1		1	1		1
Olive-sided Flycatcher		1		2			1		
Orange-crowned Warbler	10	4		4	1	6			1
Oregon Junco	1					9	1		
Pacific-slope Flycatcher	3	4	7	6	11	5	5	3	9
Pine Siskin							1		
Purple Finch		4	1	3	4	3	1		6
Pygmy Nuthatch						7		11	
Red-shouldered Hawk	2	3	1		1				4
Red-tailed Hawk	1		1	4	1	1	1		4
Red-winged Blackbird				6	6	2	2	11	7
Rock Pigeon							9	20	173
Sharp-shinned Hawk	1								
Song Sparrow	19	17	27	16	20	15	11		21
Spotted Sandpiper					1			20	
Spotted Towhee	10	4	2	5	1	3		5	7
Steller's Jay	18	8	13	1		3			
Swainson's Thrush				1	1	6	7	6	15
Tree Swallow			1	2	2	1	9	12	5
Turkey Vulture	3	9	4	3	4		4		2
Violet-green Swallow	4	1		5	7	3			4
Warbling Vireo	2	10	11	8	5	4	2	7	7
Western Bluebird						4			
Western Gull							1	2	27
Western Scrub-Jay	9	2	2	14	13	14	14	24	10
Western Wood-Pewee						3	3	1	
White-tailed Kite								5	5
White-throated Swift			15		1				
Wild Turkey			1						
Wilson's Warbler	4	3		3	2	9	3	8	15
Wrentit			3	1		2	2	2	1
Yellow Warbler		3			1	2		1	2
species richness	33	34	41	42	43	50	42	40	46
abundance	177	231	236	231	282	244	178	301	578
diversity index	3.00	3.08	3.27	3.34	3.21	3.56	3.45	3.35	3.06
mean diversity index	**3.27**								
total species richness	**73**								

2A = DE DAMPIERRE PARK, west from eastern park boundary, 1750’ along north bank
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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 Q-3

BIRD SPECIES ENCOUNTERED[6] DURING TIME CONSTRAINED SURVEYS[7] ON FIXED TRANSECTS ALONG SELECTED REACHES[8] OF THE CARMEL RIVER RIPARIAN CORRIDOR DURING THE SUMMER, 19 AUG - 28 AUG, 2004.

SPECIES	TRANSECTS								
	2A	2B	2C	3A	3B	3C	4A	4B	4C
Acorn Woodpecker	4	1	6	8	2	11	14	1	
American Crow	8	14	13	8	6	3	8	12	14
American Goldfinch	2	2						1	10
American Kestrel	1		2						
American Robin	1	2		3		3			
Anna's Hummingbird	7		6	2	12	6	11	20	14
Band-tailed Pigeon	61	1	8		5				2
Barn Swallow		2	5	1	6	7		1	8
Belted Kingfisher	2	4	4	1	1				
Bewick's Wren	6	3	6	4	8	2	3	2	12
Black Phoebe	2	1	5	4	2	7		5	
Black-headed Grosbeak	3					1			
Black-th. Gray Warbler						1			
Brewer's Blackbird			6		2	23		37	
Blue-gray Gnatcatcher					1				1
Bushtit	7		26	14	3	7	2	23	
California Quail	2		3	2	13	4	4	22	18
California Towhee	3	4			5		1	7	8
Canada Goose			12					28	
Caspian Tern									1
Chestnut-backed Chick.	16	17	16	9	20	11	3	13	30
Cooper's Hawk								2	
Downy Woodpecker		1	1			3	2	2	3
European Starling	1		15		39	20	4		
Great Blue Heron					1				
Greater Yellowlegs									2
Green Heron		1	1						
Hairy Woodpecker	1					1			
House Finch		2	5	19	8	10	22	5	1
Hutton's Vireo		1	1	6	1	3	1	1	
Killdeer	1		4			1			1
Lesser Goldfinch	10	15	10	8	9		4	18	8
Mallard			8						
Mourning Dove	3	3	12	5	15	5	8	2	5
Northern Harrier									1
Northern Flicker			1	2		1	1		
Nuttall's Woodpecker	3	1	1	1	3		1		4
Oak Titmouse	3		3	2		5			
Olive-sided Flycatcher									1
Orange-crowned Warbler				1	1	1			1

TABLE Q-3 (continued)

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

SPECIES	TRANSECTS								
	2A	**2B**	**2C**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**
Oregon Junco	12	3	1			6			
Osprey				1					
Pacific-slope Flycatcher		1		1		2	1	2	
Pygmy Nuthatch				3	5	14		5	9
Red-shouldered Hawk		2		1	1		1	2	4
Red-tailed Hawk	1	2	2			2		3	1
Rock Pigeon					1	27	85	37	13
Sharp-shinned Hawk					1				
Song Sparrow	7	9	13	6	5	4	7	1	5
Spotted Towhee	4		1	1		1	1	1	1
Steller's Jay	20	6	13		11	4			
Townsend's Warbler			1		1	2			1
Turkey Vulture	2	3	1	2	2	2	1	5	3
Warbling Vireo		1			1	3		1	
Western Scrub-Jay	10	13	12	20	21	17	17	22	25
Western Tanager				1					
White-breasted Nuthatch				1		1			
White-tailed Kite								1	8
White-throated Swift			4						
Wilson's Warbler	3	2	5	2		1		1	3
Wrentit	5		3	4	7	3	1	2	3
Yellow Warbler		1		1	2		1		2
Duck Species	3							6	
species richness	32	29	37	32	34	38	25	33	34
abundance	214	118	236	144	221	225	204	291	223
diversity index	2.80	2.88	3.26	3.00	3.00	3.18	2.23	2.88	3.05
mean diversity index	**2.92**								
total species richness	**57**								

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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 Q-4
SPECIES DIVERSITY OF BIRDS
UTILIZING LOWER CARMEL RIVER RIPARIAN CORRIDOR HABITATS

SPRING	Perennially Watered Reaches Transects 2A-3A	Seasonally Dry Reaches Transects 3B-4C*	Percent 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
Mean (12 years)	**3.14**	**3.11**	**-1.0**
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
Mean (13 years)	**2.74**	**2.68**	**-2.2**

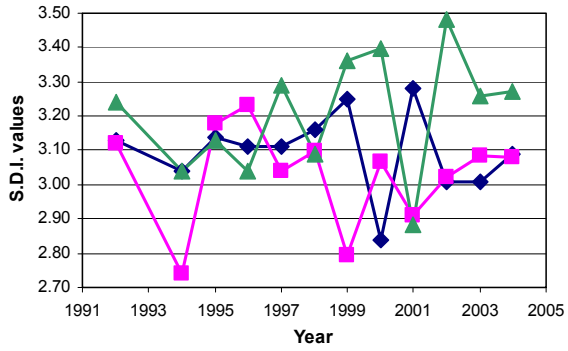
TABLE Q-5
RESULTS FROM LINEAR REGRESSION EXAMINING SPECIES DIVERSITY INDICES
FROM 1992 TO 2004 IN THE CARMEL RIVER RIPARIAN CORRIDOR

SPRING 1992 - 2004					**SUMMER 1992 - 2004**				
Transect	**Mean ± SE**	***n***	r^2	***P*-value**	**Transect**	**Mean ± SE**	***n***	r^2	***P*-value**
2A	3.10 ± 0.03	12	0.03	0.62	2A	2.72 ± 0.06	13	0.00	0.93
2B	3.03 ± 0.04	12	0.00	0.91	2B	2.68 ± 0.06	13	0.27	0.59
2C	3.21 ± 0.05	12	0.10	0.32	2C	2.79 ± 0.08	13	0.00	0.83
3A	3.20 ± 0.04	12	0.11	0.30	3A	2.78 ± 0.06	13	0.03	0.58
3B	**3.10 ± 0.07**	**12**	**0.57**	**0.01**[9]	**3B**	**2.69 ± 0.06**	13	**0.56**	**0.00**[9]
3C	**3.20 ± 0.07**	**12**	**0.46**	**0.02**[9]	3C	2.88 ± 0.05	13	0.25	0.09
4A	3.21 ± 0.05	12	0.01	0.83	**4A**	**2.72 ± 0.06**	**13**	**0.38**	**0.03**[10]
4B	3.00 ± 0.13	12	0.01	0.83	4B	2.67 ± 0.08	13	0.05	0.45
4C	3.06 ± 0.08	12	0.02	0.64	**4C**	**2.43 ± 0.13**	**13**	**0.35**	**0.04**[9]

[9] Significant positive trend in species diversity from 1992 to 2004.
[10] Significant negative trend in species diversity from 1992 to 2004.

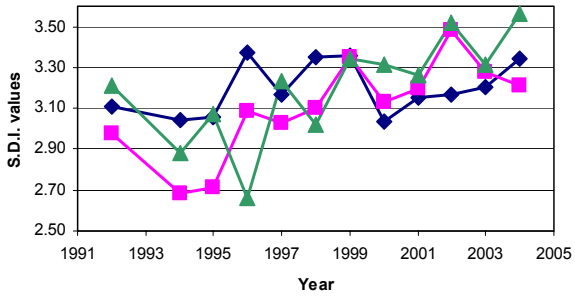
FIGURE Q-1
SPECIES DIVERSITY INDICES DURING SPRING 1992 - 2004
IN THE CARMEL RIVER RIPARIAN CORRIDOR

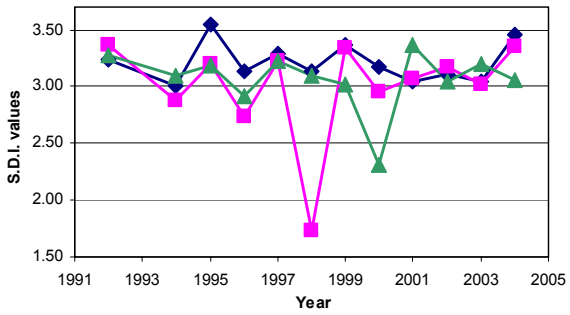
Spring 1992 – 2004



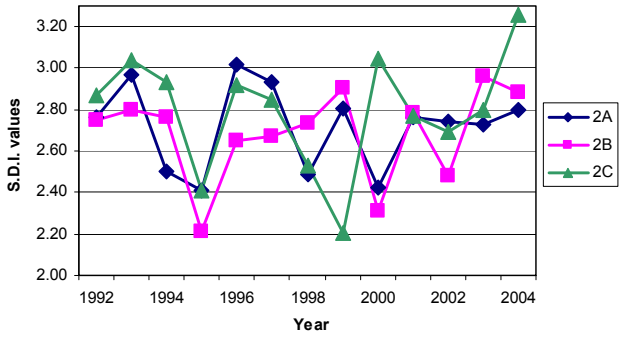
3B: $n = 12$, $r^2 = 0.57$, $P = 0.01$

3C: $n = 12$, $r^2 = 0.46$, $P = 0.02$

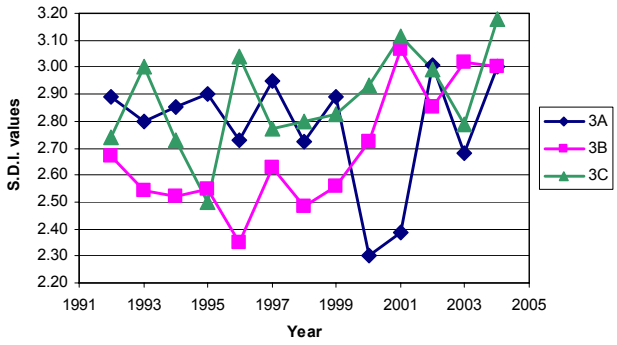




Summer 1992 - 2004

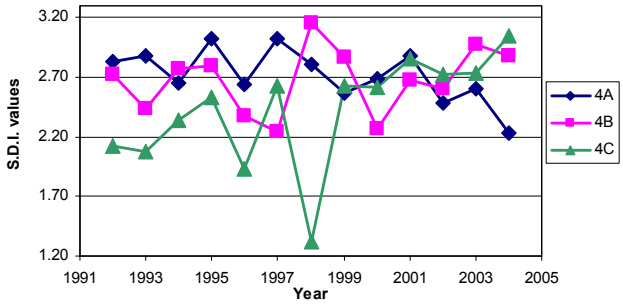


3B: $n = 13$, $r^2 = 0.56$, $P < 0.001$



4A: $n = 13$, $r^2 = 0.38$, $P = 0.03$

4C: $n = 13$, $r^2 = 0.35$, $P = 0.04$



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. The two sites undergoing active restoration, Schulte Road bridge (transect 3B) and Highway One bridge (transect 4C), both showed significant increases in avian species diversity since 1992. In contrast, San Carlos Ranch road (transect 4A) which lacks habitat restoration and is becoming increasingly infested with exotic vegetation, such as cape ivy (*Senecio mikanoides*) and poison hemlock (*Conium maculatum*), has decreased significantly in avian species diversity since 1992. 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 2004 data showed a continuation in the recent trend toward higher SDI values in the seasonally dry reaches than in the perennially watered reaches, however summer 2004 data showed higher SDI values in the perennially watered reaches (Table Q-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. However in late summer SDI values may have been greater in the perennially watered reaches due to the influence of large dispersing flocks of waterfowl, Rock Pigeons, and black birds observed in the lower reaches. 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.

Spring and summer species diversity at Schulte Road bridge (transect 3B) increased significantly from 1992 to 2004. 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 (*Populous tricocarpa*) 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. This assertion is further supported by Schulte Road bridge (transect 3B) having relatively high abundance, species richness, and species diversity in both spring and summer, compared to the other transects.

Spring species diversity at Valley Greens Drive bridge (transect 3C) also increased significantly over the 12 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 likely 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 in the understory.

As more baseline 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.

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