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AUTECOLOGY OF COASTAL SAGE SCRUB BIRDS AND SMALL MAMMALS

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AUTECOLOGY OF COASTAL SAGE SCRUB BIRDS AND SMALL MAMMALS

I. OVERVIEW

BACKGROUND: SOUTHERN CALIFORNIA COASTAL SAGE SCRUB AND THE NATURAL COMMUNITIES CONSERVATION PLANNING PROGRAM

Formerly widespread, California coastal sage scrub (CSS) now occupies only about 20% of its original area (Westman 1981). Concurrent with reduction in the extent of this vegetation type has been reduction in the population abundances of a variety of vertebrate species dependent on CSS, such that the continued persistence of several is of serious concern. CSS now supports approximately 100 animal and plant species considered rare, sensitive, threatened, or endangered by California or federal wildlife agencies (Atwood 1993, McCaull 1994). This vegetation type has been the focus of the State of California s Natural Community Conservation Planning (NCCP) program, which aims to design a reserve system to protect biological diversity while allowing economic development to proceed in areas of lower biological significance (Atwood 1993, State of California 1993, McCaull 1994). The NCCP program has evolved largely in response to the legal protection given to one coastal sage scrub species, the California Gnatcatcher (*Polioptila californica*). Thus, planning decisions have emphasized the conservation of this species, as well as other target species (Atwood 1993, State of California 1993, Atwood and Noss 1994).

Numerous surveys of the distribution and abundance of the gnatcatcher were performed throughout its range in Southern California in anticipation of its listing, and much research on its biology continues through the present (see Rotenberry and Scott 1998 and other papers in *Western Birds*, volume 28). Unfortunately, considerably less is known about other bird species, much less other vertebrate groups such as small mammals, reptiles, and amphibians. Our study was designed to remedy this lack of knowledge for birds and small mammals by characterizing the geographical distributions and habitat associations of representative CSS species on sites likely to serve as core CSS reserves. Our sampling permits an evaluation of the relative contributions of spatial (both local and landscape) and temporal (seasonal and yearly) variation to the distribution of individual species as well as the species composition of vertebrate communities. The results of our study provide an important baseline of information for predicting the presence or absence of a variety of birds and small mammals in coastal sage scrub habitats of southern California. Such information is prerequisite to designing a set of ecological reserves to preserve the biological diversity of this unique habitat type.

OBJECTIVES OF THE STUDY

Our original proposal to the USGS Biological Resources Division (then known as the National Biological Service) identified four main objectives of the study:

> (1) To establish quantifiable baseline information on habitat associations and environmental variables that may be useful in predicting the presence or absence of a variety of birds and small mammals in coastal sage scrub of southern California;

(2) To monitor annual variation in species abundances;

(3) To determine the sensitivities of these species to habitat fragmentation over multiple spatial scales; and

(4) To identify processes associated with "edge effects" on these species, particularly those that have implications for reserve buffers.

In addition to producing new information on abundances and habitat associations of vertebrates found throughout CSS, by sampling sites likely to serve as core CSS reserves as part of the California Natural Communities Conservation Plan, we can evaluate the efficacy of these sites for protecting a variety of species. We will also identify important processes occurring at the boundaries of CSS patches, which will provide information useful for developing and managing reserve buffers. Finally, we will attempt to place our results on habitat associations and edge effects in a landscape context, potentially determining how the surrounding habitat matrix and fragment size influences the probability that any particular piece of CSS will contain certain species.

OVERVIEW OF THIS REPORT

In this report we present results of our sampling from 1995-1997. Following a presentation of our sampling design and analytical methods (Sections II and III), we describe the study areas and geographic patterns in the floristic composition and structure of coastal sage scrub vegetation, and in the landscape context of coastal sage scrub fragments (Section IV). We then outline the composition and temporal variation of animal comminutes detected at each site, followed by individual species habitat relationships with respect to local and landscape variables, and geographical variation (Section V). Following some brief concluding remarks (Section VII), we present species-by-species summaries of the results (Section VIII). Finally, we attach as appendices papers arising from the study that have been published, are in press, or are currently being prepared for submission.

The numerous tables and figures are interspersed in small groups within the body of the text, usually near their first reference in the text. The bulk of the basic data are presented in a series of large tables that are included in the body of the report. These tables include

Tables 7, 10, and 11: Means and standard errors of habitat, floristic, and landscape variables for each site.
Tables 17-21: Distribution of bird species among sites for each of five seasons.
Tables 22-25: Distribution of small mammal species among sites for each of four seasons.

Patterns of annual variation in species abundances are presented in

Tables 34-35: Significant changes in species abundances between sampling periods.
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The major analyses are the animal-habitat regressions. These results are presented in several large tables, including

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II. SAMPLING STRATEGIES AND METHODS

This section provides a comprehensive description of the focal study areas (sites) in terms of both local, site-specific vegetation composition and habitat structure, and landscape-level attributes, especially regional composition of major vegetation types. These are are the variables against which vertebrate distributions will be compared. They also provide a baseline against which future environmental change can measured.

SOUTHERN CALIFORNIA COASTAL SAGE SCRUB

Coastal sage scrub vegetation in Southern California has been distinguished from other vegetation types in Southern California by its distinct plant species composition and structure. It is a drought-deciduous shrubland found in cismontane southern California and Baja California that is dominated by shrubs of 0.5 to 2.0 m in height (Westman 1981). The dominant shrubs include California sagebrush (*Artemisia californica*), black sage (*Salvia mellifera*), white sage (*Salvia apiana*), California encelia (*Encelia californica)*, brittlebush (*Encelia farinosa*), and California buckwheat (*Eriogonum fasciculatum*; O'Leary et. al. 1992, Westman 1981, 1983). Plant species composition varies within this broadly defined habitat, and several distinct types of coastal sage scrub have been identified (Westman 1983, White & Padley 1997).

SAMPLING STRATEGIES - AN OVERVIEW

Our goal was to sample birds and small mammals across as large a range of coastal sage scrub habitat types as possible, given certain logistical constraints. Our study was thus presented with the classic dilemma of the tradeoff between extensive vs. intensive sampling. Following recommendations in Ralph et al. (1995), and our own need to survey throughout a broad region, we traded more exhaustive sampling at each point for an increase in the number of points and sites sampled. Therefore, we chose sampling methods that would allow us to detect as many species as possible while still allowing us to maximize the number of geographically distinct sites sampled in the three-county study area.

Since the project aims were to identify the range of diversity across coastal sage habitats, it was our objective to sample bird and mammal diversity (Magurran, 1988), not to exhaustively enumerate species richness at individual census points within sites. Species enumeration is a technique that is conventionally used for detecting species losses in small fragments (Lynam, 1995; Soule et al. 1988; Bolger et. al. 1997a) and was not appropriate for this study. Instead, alpha (within-point) and beta (between-point or between-site) diversity were determined by comparing samples of bird or mammal diversity across census points and sites. This approach is typically used in many landscape studies (e.g., Bolger et al., 1997a,b). Moreover, the adequacy of this approach for detecting species can be tested (see below).

FOCAL STUDY AREAS

The NCCP conservation planning region encompasses an area approximately 2,000 square kilometres in size (State of California 1993) (Fig. 1). At this large spatial scale we chose a suite of study sites to obtain maximum geographic coverage over the planning region. These sites were located on lands variously owned or managed by federal, state, and county authorities, and by private organizations including National Audubon Society and Irvine Company/The Nature Conservancy. We then identified multiple locations (points) within each study site to conduct actual counts/samples of birds and small mammal presence and abundance.

SITE SELECTION

Sites (Table 1, Fig. 1) were chosen with the goal of collecting baseline data on the habitat associations of coastal sage scrub species of birds and small mammals in both small and relatively large habitat reserves. We attempted to choose sites with approximately equal representation in each of the three counties in the study area (Riverside, Orange and San Diego). Although all sites contained CSS vegetation type, they were also selected based on their accessibility for sampling birds and small mammals. During the first year (1995), suitability for sampling reptiles and amphibians (surveyed by UCSD researchers) also played a role in site selection, but this criterion was subsequently relaxed. Ten sites were selected between January 1995 and April 1995 based on consultation with CDFG NCCP staff and logistical considerations. One additional site,Torrey Pines State Park, was added for the fall program of mammal sampling but was not censused for birds, and one was added for fall bird censusing, Dawson Canyon, but was not sampled for mammals. (As Dawson Canyon subsequently burned prior to vegetation sampling, it was omitted from most analyses.) Issues of sampling adequacy arose after examination of preliminary data collected the first year. We performed a theoretical analysis of the issue (see below) and, as a result, we elected to add new sites rather than expand the number of points at existing sites. Thus, for 1996 we added ten more sites, selected after consultation with CDFG and NBS (now USGS/BRD) NCCP staff, to bring the total up to 22 sites. For a variety of logistical reasons, not all sites were sampled for all taxa in all years or seasons (Table 2).

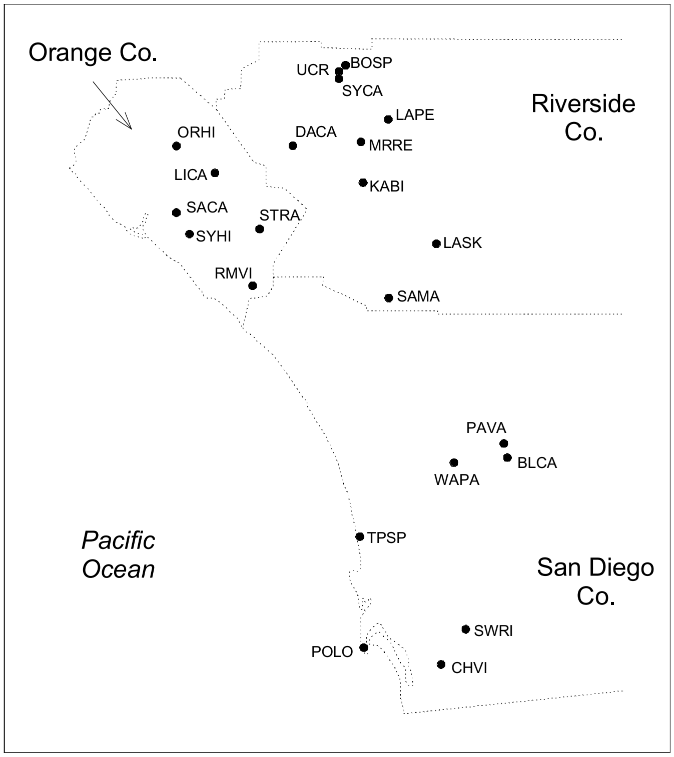


Figure 1. NCCP bird and small mammal study sites, 1995-1997. See Table 1 for site codes.

Table 1. Site names, codes, and locations, NCCP coastal sage scrub survey, 1995-1997. See also Fig. 1.

Site	Code	Owner/Manager	Location (UTM)[a] Easting ($x 10^4$)	Location (UTM)[a] Northing ($x 10^5$)	County
Black Canyon	BLCA	U.S. Forest Service	51.6	36.6	San Diego
Box Springs	BOSP	Riverside County Parks	47.2	37.6	Riverside
Chula Vista	CHVI	Chula Vista Parks and Open Space	49.8	36.1	San Diego
Dawson Canyon	DACA	Riverside County	45.8	37.4	Riverside
Kabian Park	KABI	Riverside County Parks	47.7	37.3	Riverside
Lake Perris	LAPE	California Parks and Recreation	48.4	37.5	Riverside
Lake Skinner	LASK	Metropolitan Water District	49.7	37.2	Riverside
Limestone Canyon	LICA	Irvine Co./Nature Conservancy	43.7	37.3	Orange
Motte Rimrock Reserve	MRRE	University of California	47.6	37.4	Riverside
Orange Hills	ORHI	Orange County Regional Parks	42.7	37.4	Orange
Pamo Valley	PAVA	U.S. Forest Service	51.5	36.7	San Diego
Point Loma	POLO	Naval Research and Development	47.7	36.2	San Diego
Rancho Mission Viejo	RMVI	Rancho Mission Viejo	44.7	37.1	Orange
Sand Canyon Reservoir	SACA	Orange County	42.7	37.2	Orange
Santa Margarita	SAMA	San Diego State University	48.4	37.0	Riverside
Starr Ranch	STRA	National Audubon Society	44.9	37.2	Orange
Sweetwater River	SWRI	U.S.D.I. National Wildlife Refuge	50.5	36.2	San Diego
Sycamore Canyon	SYCA	Riverside County Parks	47.0	37.6	Riverside
Sycamore Hills	SYHI	Orange County	43.0	37.2	Orange
Torrey Pines State Park	TPSP	California Parks and Recreation	47.6	36.4	San Diego
University of California, Riverside	UCR	University of California	47.0	37.6	Riverside
Wild Animal Park	WAPA	San Diego Zoological Society	50.2	36.6	San Diego

[a] Average UTM of all sampling points within each site

Table 2. Vertebrate sampling effort, NCCP coastal sage scrub survey, 1995-1997. All sites were sampled for vegetation (N = 234 points) and landscape variables (N = 229 points). See Table 1 for site names.

Site	Birds					Mammals			
	1995		1996		1997	1995		1996	
	spring	fall	spring	fall	spring	spring	fall	spring	fall
BLCA	+	+	+	+	+	+	+	+	+
BOSP			+	+	+				+
CHVI			+	+	+				
DACA		+		+	+				
KABI			+	+	+			+	+
LAPE	+	+	+	+	+	+	+	+	+
LASK			+	+	+				
LICA	+	+	+	+	+	+	+	+	+
MRRE	+	+	+	+	+	+	+	+	+
ORHI			+	+	+				+
PAVA	+	+	+	+	+	+	+	+	+
POLO			+	+	+			+	+
RMVI			+	+	+			+	+
SACA			+	+	+				+
SAMA			+	+	+			+	+
STRA	+	+	+	+	+	+	+	+	+
SWRI	+	+	+	+	+	+	+	+	+
SYCA	+	+	+	+	+		+	+	+
SYHI			+	+	+			+	+
TPSP			+	+	+		+	+	+
UCR	+	+	+	+	+		+	+	+
WAPA	+	+	+		+	+	+	+	+
Total points	120	125	219	207	238	78	125	168	163
Total sites	10	11	21	21	22	8	11	16	19

CENSUS POINT LOCATIONS

We attempted to find locations within each site that were amenable to sampling multiple taxa and that satisfied the different constraints imposed by the sampling methodologies used for different taxa. Census points were selected in areas dominated by shrub species characteristic of coastal sage scrub, and were at least 50 meters from ecotones with other habitat types.

To maintain independence of sample units (i.e., to avoid sampling the same individuals at neighboring points), census points were at least 200 m (and usually >250 m) apart. For example, this distance is far greater than the average lifetime movements of individual rodents (Price et. al. 1994). In 1995, census points were placed in flat areas where possible to accomodate reptile/amphibian sampling constraints, although this constraint was subsequently relaxed as herpetological sampling became independent of our effort. Bird and mammal sampling points (see below) were centered within 15 meters of each other.

Between 4 and 20 points were placed at each site, depending on the area of coastal sage scrub habitat available. The minimum number of points established at a particular site was determined by the area of the site and amount of coastal sage scrub vegetation available at the site. The upper limit was determined by the amount of time it took to move among points. In general, we could process 10 points for bird surveys in a morning, and about that many for small mammal counts in an evening. Thus, most sites had a maximum of either 10 or 20 sampling points.

VEGETATION SAMPLING METHODS

LOCAL VEGETATION ATTRIBUTES

Vegetation structure and composition were measured at sampling points using a modified version of the technique described by Wiens and Rotenberry (1981a). Most measurements were taken between 19 March to 15 May, 1996, but a few were completed in spring, 1997. Vegetation was sampled along two perpendicular 50-m transects connected at the end in an L shape. The vertex of the L was placed either at the center of the bird sampling point (which usually lay within the mammal trapping grid) with the first transect arm oriented in a randomly determined direction, or at the center of a random edge of the trapping grid with the first transect arm set 90° to the edge and passing through the grid. For each vegetation sample, the compass direction and slope of each of the transect arms was recorded. Vegetation data were gathered using both line intercept and pin drop methods, as well as a visual assessment (Table 3).

Line intercept

We used line intercept to estimate coverage values for different classes of emergent (as opposed to substrate or ground cover) vegetation. These structural classes (and mnemonic codes) were (1) percent cover of bunch grass (PC_BUNGRAS), (2) percent cover of exotic forbs, the most common of which was a species of *Brassica* (PC_BRASS), (3) percent cover of native forbs (PC_NATFORB), (4) percent cover of exotic grass (PC_EXGRASS), (5) percent cover of shrub (PC_SHRUB), (6) percent cover of woody standing dead (PC_DEAD), and (7) percent cover of trees (PC_TREE). For the two, 50-m line intercept transects, only vegetation that was directly under the tape was recorded. Vegetation in each decimeter directly under the two, 50-m tapes was placed into the appropriate category, then coverted to percent cover by dividing the number of decimeters in each category by the total number of decimeters (1000). We also assessed the degree of horizontal patchiness or heterogeneity of vegetation by recording the number of transitions between different vegetation cover types along the tapes (NUMCHANG).

Pin drop

Pin drops were conducted at a random point within each 2-m interval along each of the two 50-m tapes, for a total of 50 sampling points. At each point we recorded the nature of the gound cover or substrate, and the species identity of each plant that touched the pin. Substrate classes included (1) bare ground (GC_BARE), (2) cryptogamic crust (GC_CRYP), (3) fine litter, usually from grass or small forbs (GC_LITTER), (4) coarse litter, usually from woody shrubs (GC_WOOD), and (5) rock (GC_ROCK). We recorded the total number of species contacted at each point. We also recorded the number of vegetation contacts (hits) occurring in three height classes: 1-3 dm, 3-5 dm, and >5 dm above the substrate surface. Litter depth was measured to the nearest 1cm at the point. Contact data were converted to percent cover by dividing the number of pin drops on which each substrate category or plant species occurred by the total number of pin drops (50). The occurrence of vegetation in each height class was converted to a percent cover in a similar manner(HITS_1_3, HITS_3_5, HITS_5). We averaged litter depth (LITTERDE) and number of species (NO_SP) over the 50 points. Note that because multiple plant species may occur at a point, the sum of individual species coverages can exceed 100%.

Visual assessment

We visually assessed the presence/absence of three conspicuous features within a 50-m radius of each sampling point: (1) any large (>2-m diameter) clumps of *Opuntia* (CACTUS); (2) any large (>2-m diameter) rock outcrops (ROCK); and (3) any distinct footpath or dirt road (TRAIL).

LANDSCAPE VARIABLES

Landscape variables were generated from digital vegetation maps provided by San Diego, Riverside, and Orange counties. Each county had prepared their maps based upon the vegetation classification used by the state of California's Natural Diversity Database (Holland 1986). However, each county modified this system to varying degrees, and each had chosen a somewhat different level in the hierarchical classification system to apply. As a result, the different maps needed to be brought into the same classification system before any cross-county analyses could be conducted. The map from Riverside County used the coarsest habitat classes, and therefore we used it as the standard to which the other maps were brought into agreement. We collapsed the habitat types found in each map into a common set (Table 4), based roughly upon the types found in the Riverside map. Once each map was re-coded to the new habitat types, the boundaries between habitat polygons with the same new type were dissolved. The resulting maps were based upon the same, consistent habitat classification, and were much more similar in their polygon geometry (particularly their mean polygon areas). We based our landscape variable measurements upon these maps. The resulting maps had minimum mapping units of approximately 0.1 ha.

The location (Universal Transverse Mercator, or UTM) of each sampling point was determined with a Trimble® global positioning system. Coordinates were recorded in the field, then differentially corrected to a circular error of ± 5-10 m. Each point was then overlain on the vegetation map layer in a geographical information system using ARC/INFO.

To characterize the landscape context of each point we calculated the area (m^2)of each of the 9 landscape vegetation types in circles of 500 and 1000 m radius around each of our points. We also calculated the perimeter (m) of each vegetation type within each of the circles, and the perimeter/area ratio for coastal sage scrub. Subsequent analysis revealed that, for each vegetation type, the amount within the 1000-m radius was very highly correlated ($r_s \approx 0.80$ — 0.95, $N = 230$) with the amount within the 500-m radius. Therefore, we dropped the 1000-m data from further consideration. Subsequent analysis also revealed that, for all vegetation types except coastal sage scrub and other shrublands, perimeter was highly correlated ($r_s \approx 0.85$ — 0.95, $N = 233$) with area. Therefore, we also dropped perimeters (except for coastal sage scrub and other shrublands) from further consideration. Although one might argue that perimeter might be a more important correlate of some biological attribute than area, because of the high correlations we would be unable to distinguish its effects from those of area. We also measured the distance (m) from each point to the edge of the vegetation polygon it was in, and the distance (m) to the edge of the nearest urban polygon (Table 4).

Table 3. Structural vegetation measurements measured and calculated for each sample point.

Type of Measurement	Codes	Description
Pin Drop Measures	Substrates (percent cover)	
	GC_BARE	bare ground
	GC_CRYP	cryptogammic crust
	GC_LITTER	fine litter (grass and small forbs)
	GC_WOOD	coarse litter (woody debris)
	GC_ROCK	rock
	LITDEPTH	average litter depth (cm)
	HITS_1_3	average number of hits 1-3 dm per pindrop
	HITS_3_5	average number of hits 3-5 dm per pindrop
	HITS>5	average number of hits > 5 dm per pindrop
	NO_SPECIES	average number of species at each pindrop
Line Intercept Measures	Canopy vegetation (percent cover)	
	PC_BNGRS	bunch grass
	PC_BRASS	exotic forb (mainly the mustards *Brassica*, *Hirschfeldia*)
	PC_NATFORB	native forb
	PC_EXGRASS	exotic grass (mainly *Avena*, *Bromus*, *Schizmus*)
	PC_SHRUB	shrub
	PC_DEAD	standing dead (woody)
	PC_TREE	tree
	NUMCHANG	number of changes between cover classes along the length of the transects
Vicinity Attributes	Presence within 50m-radius of point	
	CACTUS	large (>2-m diameter) clumps *Opuntia*
	ROCK	large (>2-m diameter) outcrops of rock
	TRAIL	distinct footpath or dirt road

Table 4. Landscape-level variables calculated for each sample point.

Type of Measurement	Code	Description
Total area (ha) within 500-m of point:		
	AGRIC_A5	Agriculture (fields and orchards)
	AQUAT_A5	Aquatic (mainly lakes)
	CSS_A5	Coastal sage scrub
	NATGR_A5	Native grassland
	EXGR_A5	Exotic grassland
	WOOD_A5	Woodland (including forest)
	URBAN_A5	Urban
	SHRB_A5	Shrublands (e.g., chaparral; excluding CSS)
	RIP_A5	Riparian
Total perimeter (m) of polygons within 500-m of point:		
	CSS_P5	Coastal sage scrub
	SHRB_P5	Shrublands (excluding CSS)
Perimeter/Area ratio within 500-m of point:		
	CSS_P_A5	Coastal sage scrub
Distance (m) from point to other features:		
	EDGEDIST	to edge of polygon containing point
	URBDIST	to nearest urban polygon

ANIMAL SURVEY METHODS

We refer to our primary sampling units interchangeably as points (positions where bird counts were made) or as grids (where mammals were trapped). Mammal grids consisted of four rows of four traps positioned 8m apart (see below). Where both bird and mammal sampling took place, the bird point was generally located inside the mammal grid, or in a few cases within 15 m of it.

BIRDS

Slightly different techniques were used to sample birds during and fall seasons.

Spring

In spring, breeding resident and migrant birds were sampled using two 5-minute unlimited-radius counts conducted at each point (Ralph et al. 1995). All birds detected from the point center were included, except for those not using the scrub habitat type or those species that are not well-sampled by point counts (see Sampling Biases, below). Individual birds known to be previously recorded at another sampling point were not recorded again. First counts each year began in mid- to late March, after breeding had begun, and were usually concluded by late-April or early May. Second counts began shortly after conclusion of the first counts, and were completed by late May or early June. Thus samples at a point were usually 4-5 weeks apart, ensuring an opportunity to detect both early breeders and late arriving species (as suggested by Ralph et al. 1995). Second samples at each site were made in the same order as first samples to ensure that each site was sampled in both early and late spring. To avoid observer bias, each point was sampled by different observers on the first and second visit. To avoid potential bias due to time of day and weather conditions, point counts took place between sunrise and 5 hours after sunrise on mornings with no rain or strong wind, and the order in which points were sampled within each site was reversed between the first and second visits to the site. Due to these time constraints, sites with more than 15 points were surveyed over two mornings (usually by visiting half on one day and the other half on the following day).

Fall

Fall surveys of nonbreeding residents and overwintering migrants were conducted at the same points as spring surveys but consisted of a single 15-min visit to each point between early November and late December. The survey technique was modified because of the reduced detectability of many bird species during the non-breeding season (Ralph et. al. 1995). Each survey included a 5-min fixed radius point count followed by a 10-min area-restricted search within 50 meters of the point location. All detections were classified as in the spring point counts with one additional category for individuals detected in the 10 minute area search. Surveys took place between sunrise and 5 hours after sunrise on mornings without rain or strong wind.

SMALL MAMMALS

Small mammals were sampled over three consecutive days of trapping at each point, using folding Sherman live-traps spaced 8 m apart in a 4 x 4 grid. Spring samples were taken in May-June and fall samples in October-December. Three-day trapping periods were chosen because longer-term trapping at a subset of points showed that 90% of all species detected with a 7-day trap period were detected at each trapping point by the third day (see below). Because small mammal activity can be affected by moonlight (Price et al. 1984), trapping was not done for two days before and after the full moon.

Traps were baited with a mixture of rolled oats, peanut butter and corn syrup. Traps were opened at dusk, then cleared between 0530 and 1100 the following day. If any endangered species was detected at any census point, the protocol was immediately changed so that traps were opened at dusk, and then cleared and closed immediately after dawn for the duration of sampling at all census points at the particular site. The overall mortality rate attributable to trapping stress was 1.75% of a total of 6813 captures and 26,832 trap-nights of sampling. Losses to mammalian predators and ants increased the total mortality to 2.22% of captures.

Mammals were identified to species using customized keys derived from Ingles (1965), Jameson and Peeters (1988), Price and Endo (1989), and Erickson and Patten (in press), and were aged, sexed, weighed, and marked, then released at the point of capture. Toe-clipping was used to individually mark all animals except *Dipodomys stephensi* in the first census. In the second census, mammals were marked either by toe-clipping or eartags. Toe-clipping was discontinued in 1996.

Our censuses obviously sample only those species that enter Sherman live-traps. Pit-trapping has elsewhere been used to detect small mammals that may avoid other types of live-traps (Laurance 1992, Lynam 1995; see below). We did not use pit-trapping in our surveys, in part out of concerns for animal mortality, and in part so as not to interfere with ongoing pit-sampling for reptiles and amphibians conducted by UCSD researchers.

POTENTIAL SAMPLING BIASES

It is impossible to document every individual in an ecological community (Magurran 1988). Therefore, a sampling approach was used to compare bird and mammal diversity between sites and among points within sites. A sample is as good as the methods used to observe or trap animals.

BIRDS

Point counts are most effective at detecting diurnal songbirds (Ralph et al. 1995). Although we occasionally recorded diurnal raptors, many have large home ranges and are better detected using transects that cover large areas in a short period of time (e.g., roadside surveys). We intentionally restricted our sampling to coastal sage scrub vegetation, and species that were present within the sites but occurring primarily in other habitats (waterfowl, wading birds, grassland species such as Horned Larks) were detected only sporadically. Our counts do not effectively sample owls or other nocturnal species, nor do they sample cryptic species.

SMALL MAMMALS

Sherman traps and standard baits were used in all censuses. Box traps are the most effective capture device for trapping most small mammals without injury (Wilson et. al. 1996), and Shermans are equal or superior in capture success to wire-cage traps (C. Kendall, unpublished data). Bait mixtures consisting of peanut butter and oats are a standard and effective attractant for live-trapping (Wilson et. al. 1996). Sherman traps of the size used in this study (8x9x23cm) have been effectively used elsewhere to detect most groups of non-volant mammals (mainly rodents) that potentially occur in coastal sage habitats, including murids, heteromyids, cricetines (M'Closkey 1972, Meserve 1976, Clarke et al. 1988, Price and Endo 1989), and microtines (Salvioni and Lidicker 1995). Sherman live-traps are also approved for detecting two federally-listed species (Stephens' kangaroo rat and Pacific pocket mouse) that occur within the geographic areas where we sampled. Because we did not sample typical habitat for thiese species, we expected that they would be captured only incidentally. Nonetheless, we worked under the authority of appropriate Federal and State permits for any sensitive species we could have encountered.

Sherman live-traps of the size we used are ineffective for several groups of small mammals, including shrews, moles, and pocket gophers. Therefore, our sampling method was potentially less effective for detecting four small mammal species potentially occurring at NCCP sites: gray shrew (*Notiosorex crawfordi*), ornate shrew (*Sorex ornatus*), broad-footed mole (*Scapanus latimanus*), and valley pocket gopher (*Thomomys bottae*). However, these groups, especially shrews, are readily captured in pitfalls (the method of choice for soricids; Wilson et al. 1996). Thus, detailed shrew distribution and abundance should be available from the intensive pitfall trapping efforts of the herpetological sampling group (T. Case and R. Fisher). Likewise, small box traps are inefficient at capturing sciurids and rabbits, which are more typically caught in wire-mesh cage traps (Salmon and Marsh 1989, Daly and Patton 1990). Thus, although they potentially occur at several of our sites, California ground squirrels (*Spermophilus beecheyi*) and rabbits are unrepresented in our samples.

Because our sampling was confined to sites typical of coastal sage habitats, we expected species commonly occurring in other habitats (e.g., grassland, riparian, chaparral) to be rare in our samples. Hence, the rarity in our samples of such species as Stephens' kangaroo rat, *Microtus californicus*, *Perognathus longimembris*, and *Peromyscus maniculatus* should not be taken as an indication of the status of those species in Southern California.

SAMPLING ADEQUACY

Sampling adequacy must be assessed relative to the goal of the sampling design. In turn, sampling designs are constructed to address particular questions. For this project, a primary purpose was to characterize patterns of variation in the bird and small mammal communities found in coastal sage scrub vegetation in Riverside, Orange, and San Diego counties. To address this question, it is important both to characterize the communities found at each study site, and to include a variety of sites from throughout the three-county area. Spending large amounts of time at particular reserves to obtain very detailed information would have meant less time to spend at other sites. In other words, it was necessary to balance our need for intensive, site-specific information against our need for extensive spatial coverage of the entire region. We provide an analysis to support the reasoning behind employing rapid survey methods to characterize a particular segment of the bird and mammal communities at each site, and to indicate that, at the same time, we sampled each site with sufficient intensity.

The number of sample units required to detect a species is a function of its commonness and its detectability (Fig. 2). The commonness of a species is the proportion of points at which the species actually occurs. The detectability is the probability that a species that is actually present is actually detected, and can be affected by the population density, activity level, and conspicuousness of common activities (or trappability of individuals, in the case of mammals). Each curve on Figure 2 represents a species with a different detectability, expressed as a percent chance of detection. It is important to note that these detectabilities assume that the species is actually within the plot sampled, and it is the combination of the probability that a species is within the plot and its detectability when present that causes the curves to differ. The range of values plotted in Figure 2 illustrate a general point about the relationships between commonness, detectability, and sampling intensity, using a broad but realistic range of values for each variable: for species that are uncommon, difficult to detect, or both, it would require disproportionate amounts of sampling to have a reasonable chance of documenting their presence.

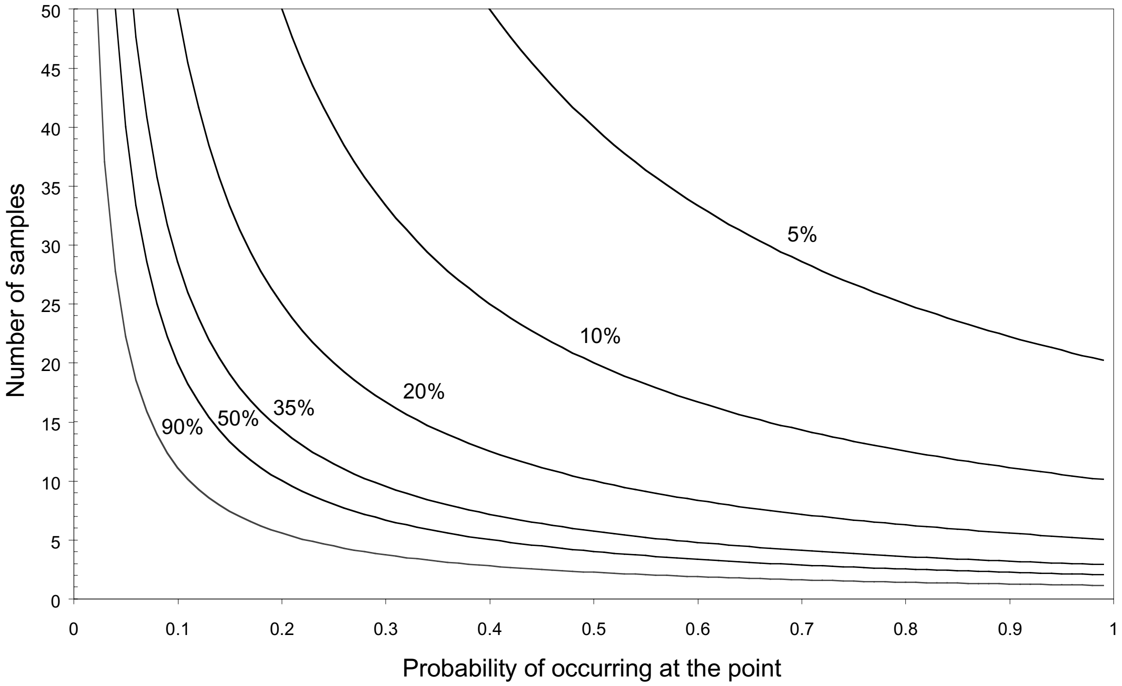


Figure 12. Sampling intensity (number of samples) required on average to detect species of different probabilities of occurrence and different intrinsic detectabilities. Each curve represents a different detectability (probability of observing a species when it is actually present).

It is important to consider the conditions that will cause each of these variables to change. We employed point-based methods to detect birds and mammals, and we placed points within coastal sage scrub vegetation. Given our sampling design, species that are numerically abundant but spatially clumped in their distribution would be more difficult to detect than if they were distributed more evenly across the area we sampled. In this sense, Figure 2 is implicitly using a concept of commonness that is based more strongly upon how species are distributed across the landscape, rather than upon population size. In general, then, the proportion of points in which a species is present will be most strongly influenced by the spatial distribution of the species, with species that occur in a small number of restricted areas less likely to be within a sample plot than species that are widely distributed, even if the latter are at lower densities.

At each study site we established as many points as could be located in the available coastal sage habitat, and which could be sampled completely by one bird observer or one mammal team in one or two sampling sessions. Five to twenty independent census points were established per site, fewer points at smaller sites, more points at larger sites. The efficacy of the sampling effort used in this study can be assessed by considering the number of census points required to detect species of different abundances and detectabilities (Fig. 2). Given a reasonable detection probability (>0.3), uncommon species (occur at 10% of census points) would be detected at least half of the time, and common species (occur at 20% of census points) would always be detected with the sampling efforts used in this study. For rare species (occur at 5% of census points) with restricted distributions, a larger number of points than actually sampled (>20) would be required to detect these species at any one site, even if they were very conspicuous. However, rare species that are broadly distributed across the study region might still be detected at some sites, given the wide geographic spread of our sampling net (125 points would yield approximately 6 detections; Fig. 2). Thus, we conclude that, at the scale of a site, our strategy provided an adequate sample.

We empirically validated the efficacy of our use of three-day trapping periods for small mammals by trapping a subset of our points for a longer period (seven days). Species accumulation curves (total number of species detected as a function of time) rapidly leveled off, such that 90% of all species detected at each point during the entire 7-day trap period were detected by the third day (Table 5).

Table 5. Cumulative mammal species richness at a point vs. number of consecutive days of sampling. Total = cumulative species richness at that point over all four census periods. Note that 90% of the total species richness observed at a point during a 7-day census period had been recorded in the first three days of sampling.

Site	Point	Cumulative number of species							
		1 Day	2 Days	3 Days	4 Days	5 Days	6 Days	7 Days	Total
LAPE	2	4	4	4	4	4	4	5	5
	3	3	3	4	4	5	5	5	6
	11	0	3	4	4	4	4	4	5
	12	0	3	4	4	4	4	4	5
STRA	2	3	3	3	3	3	3	--	4
	8	2	2	2	2	3	3	--	3
	17	0	1	2	2	2	2	--	4
% within-census richness		43.8	75.7	89.5	89.5	97.1	97.1	100	--
% total richness		38.8	59.5	71.2	71.2	78.3	78.3	85.8	100

At the conclusion of the first year s sampling, we performed an additional analysis to assess whether increasing sampling intensity within sites (which would come at the expense of expanding the number of sites) would improve overall statistical precision. We used analysis of variance to determine the relative importance of variation in species composition between the study sites and between census points within sites (Cochran 1977; Table 6). We conducted independent detrended correspondence analyses for spring and fall birds and mammals. We then used DCA Axis 1 point scores (which are weighted averages of species scores; see Methods in Habitat section) as generalized measures of species composition. Variation in species composition was 2.8 and 5.3 times as great between sites as it was within sites for fall 1995 mammals and for spring 1995 birds, respectively. In the fall, variation in bird species composition was greater within sites than between. This was partly due to the influx of migrant species during the fall, and partly to the decreased territoriality of many resident species. Migrant birds (and many wandering resident species) were distributed evenly over all sites leading to a decrease in the between-site component of variance, while spring bird data are more indicative of resident bird distributions. If the current study sites are typical of other coastal sage habitats, this analysis suggests that improved overall sampling precision will better be achieved for both birds and mammals by increasing the number of study sites rather than sampling existing sites more intensively.

Table 6. Variation in species composition (as indexed by Detrended Correspondence Analysis axis 1 scores) within and between study sites, NCCP surveys, 1995. DCA calculated for each census period separately.

	Census		
	Spring 1995 Birds	Fall 1995 Birds	Fall 1995 Mammals
Weighted Within-site Variance	621.74	2105.59	3781.67
Weighted Between-site Variance	3297.98	2043.40	10672.15
Ratio of Between to Within	5.30	0.97	2.82

We note that rare species (e.g., those that would actually occur on only 1% of the census points) that are also difficult to detect (e.g., only a 1% chance of detection even when present) require on average 10,000 census points to be likely to be detected. This number would be discouragingly large (but appropriate in magnitude) if we were simply sampling at random throughout the region. However, in practice we improve those odds considerably by (1) focusing our efforts on certain habitat types (e.g., coastal sage scrub), which increases the probability of a rare CSS species being at a site, and (2) using techniques that increase the probability of detection (i.e., multiple site visits, using an appropriate sampling method, employing audio playbacks to elicit a response). This improvement of odds by judicious site- and technique selection is also appropriate when designing a monitoring program for rare species. *We reaffirm, however, that our principal focus is not on documenting the specific occurrence of rare species at a given site, but on characterizing the habitat associations of typical CSS species throughout the region.*

III. ANALYTICAL STRATEGIES AND METHODS

VARIABLE REDUCTION

Our sampling resulted in 21 local-level structural habitat variables, 24 plant species variables (see below), and 14 landscape-level variables (56 total). Since the number of points with bird and/or small mammal survey data ranged from 78 — 239 (Table 2), this yielded relatively small observations/variables ratios for correlating or regressing vertebrate distributions and habitat characteristics. Additionally, because of large scale patterns in the distribution of habitat attributes (e.g., patterns of co-occurrence of plant species throughout the region) many were highly intercorrelated. Thus, from both a statistical and biological perspective it was appropriate to reduce the number of habitat variables using standard, correlational-based multivariate techniques. These techniques produce new, synthetic variables that account for major patterns of covariation in the original habitat variables and that are logical combinations of them.

Habitat analysis strives to uncover the characteristics of habitat that affect the distribution of animals. In our case, we are attempting to determine which habitat variables (local and/or landscape level) influence the presence or absence of species (particularly sensitive ones), or are associated with changes in the bird and small mammal communities as a whole. A good habitat analysis must balance two conflicting requirements, the need for simplicity (which also relates to statistical considerations), and the need for realism. Realism suffers when the set of variables selected for analysis do not include the characteristics to which animals actually respond. The best way to guard against this possibility is to measure a large number of variables, and attempt to let the pattern of animal distributions determine which are most important. This practice is common (e.g., Capen 1981, Verner et al. 1985, Manly et al. 1993), and we employ it in this report. However, statistical analysis becomes unreliable when the ratio of the number of observations to the number of variables is too small (rules of thumb place minimum values of this ratio between 5 and 7). It is desirable to limit the number of variables that are actually used in analyses to improve the reliability of the results and conclusions drawn. Also, variable reduction should be done before any reference to the animal distribution data to avoid over-estimating the precision of the observed statistical relationships between animals and habitat.

We used several criteria for deciding which variables should be included in our analyses. We treated separately the set of structural variables (percent cover of different cover classes, height of the vegetation, etc.), the set of floristic variables (coverage values of each plant species), and the set of landscape variables (amount of different vegetation types surrounding a point). Many variables in the first two sets (presence of many plant species, the percent cover of uncommon cover types) had values of zero at most (+90%) of the points and were therefore excluded. However, some plant species were lumped to genus rather than simply eliminating several rare species. The plant species retained for analysis were sufficiently common to support statistical analysis, but still included species that were found at only a subset of our sites.

Structural variables could be reduced further by identifying sets of variables that measured the same quantity. In some cases, we had obtained measures of the same variable with two different methods (pin drops and line intercepts). Pin drops were more effective at measuring substrate cover (such as bare ground or litter), because these were detected beneath shrubs with pin drops but not with our line intercepts. Therefore, we retained only the pin drop measures for substrate-type variables. Likewise, line transects are more efficient at measuring emergent vegetation (e.g., shrubs, grasses), and we retained only the transect measures for those variables.

Although we could occasionally eliminate some variables in favor of better ones, some variables within each of the three data sets were strongly intercorrelated, and thus no single variable was clearly the most accurate or most likely to be subject to choice by the animals. Rather than simply selecting one variable to represent the entire set, we conducted principal components analyses of the structural and landscape variables, and detrended correspondence analysis of the floristic (plant species) variables.

PRINCIPAL COMPONENTS ANALYSIS

We used principal components analysis (PCA) to identify independent patterns of covariation among the local-scale habitat structure variables on the one hand, and among the landscape-level variables on the other. PCA constructs new, synthetic variables that can be used as proxies for sets of correlated raw variables, by building linear combinations of the raw variables. The first principal component (PC1) accounts for the major pattern of covariation among the raw variables. Subsequent components (PC2, 3, ...p) describe major patterns remaining after those accounted for by previous components have been removed. Components are constrained to be independent from (i.e., uncorrelated with) each other. Because PCA s are functions of the raw variables, it is possible to interpret the meaning of variation in a PCA axis in terms of vegetative characteristics based on the axis correlation with the raw variables. These correlations are called *factor loadings*, and range from —1.0 to +1.0. It is frequently possible to find a commonality or theme among the variables correlated with a principal component that suggests a general ecological interpretation of the component. Ideally, one hopes for each component to have high loadings (positive or negative) for several variables and near zero loadings for the remainder. A simple rule of thumb is that variables with factor loadings > |0.5| are important contributors to a component, and others are not.

Each principal component has a variance associated with it represented by its *eigenvalue*. Depending on the patterns of correlation among the original variables, eigenvalues can range from near p, where p is the number of original variables, to near zero. When the original variables are measured on a variety of different scales, as ours were, PCA is usually performed on a correlation matrix (which is identical to a variance-covariance matrix of the original variables after they have been standardized). After standardization, each original variable has a variance of 1.0; thus the total amount of variance in the original data set = p, the number of variables. The variances of the components also total to p, although now individual variances are no longer all equal, as with the original variables. As a simple rule of thumb, components with eigenvalues greater than 1 are retained for further interpretation, whereas those with eigenvalues less than 1 are discarded. Ideally, one hopes for a few components with high eigenvalues that, collectively, account for a substantial fraction of the original total variance.

Each sampling point can be given a score on each PCA axis based upon the values of its raw variables, yielding *factor scores*. Two sampling points with similar PCA scores have similar vegetation or similar landscape structure. PCA axes are better than the raw variables they characterize when they contain a large amount of the information in a set of correlated raw variables, and can be interpreted meaningfully as a gradient of habitat structure. This approach increases simplicity by reducing the number of variables used in an analysis (and thus increases statistical reliability) without sacrificing realism, again provided that the PCA axes represent observable gradients in vegetation characteristics.

There are numerous general and specific statistical textbooks that deal with PCA. We recommend Capen (1981), Gauch (1982), Legendre and Legendre (1983), Pielou (1984), and Tabachnick and Fidell (1983) for further details.

DETRENDED CORRESPONDENCE ANALYSIS

DCA is an ordination technique that quantifies the relationship among a set of points based on the similarity of their species composition, while at the same time quantifying the relationship among species based on the similarity of their distribution among points (Gauch 1982, Pielou 1984). Points and species are ordered on axes so that points with similar species composition will have similar axis scores, and species with similar patterns of distribution will also have similar scores. The score of a point on a DCA axis is a weighted average of the abundance of the species that occur there, and the score of a species on a DCA axis is a weighted average of its distribution among points. To a considerable degree, then, DCA condenses information about the relative abundances of all species at a point down to a single number for that point, and likewise for each species, based on its distribution among all points. Thus, the scores of points on ordination axes can be used as an index of the species composition at those points.

DCA, similar to PCA, produces eigenvalues that are measures of statistically explained variance. In this case, the eigenvalue of an ordination axis represents the amount of variation in species abundance distributions along that axis which is accounted for by variation among points (maximum possible = 1.0), and vice versa. The relative magnitude of eigenvalues associated with DCA axes describe the relative strength of the pattern which each axis represents. By "strength" we mean how well the new axis can distinguish among a group of censuses based on their overall species composition.

A particular advantage to DCA is that, unlike PCA and numerous other ordination techniques, it is not affected by non-linearity in species distributional patterns. Additionally, DCA is largely insensitive to deviations in the shapes of these curves due to skewness or kurtosis.

Finally, DCA axes are biologically scaled such that one unit on an axis is equal to one standard deviation of the average distribution of all species on it. Thus, on average, a species arises, reaches a peak, declines, then disappears in the space of about four units (four standard deviations) along the axis. This implies that censuses four units apart on a correspondence axis likely share no species in common. Furthermore, this scaling is linearized, such that beta diversity (the compositional difference between two points) is constant along an entire axis. Thus a unit difference between two points at one end of a gradient represents the same compositional change as a unit difference between two points at the other end. Additionally, each axis has length, which is simply the difference in DCA units between the two censuses at opposite endpoints of the axis. It corresponds to the total amount of compositional change (species turnover) associated with the underlying gradient that axis represents, and, along with eigenvalues, can be used to compare different axes.

DCA is explicitly discussed in several texts. We suggest Gauch (1982), Pielou (1984), and ter Braak (1987) for further reading.

NON-METRIC MULTIDIMENSIONAL SCALING

Overall patterns of relationships among points or sites were also summarized using Non-metric Multidimensional Scaling (NMS; Gauch 1982, McCune and Mefford 1997). NMS differs fundamentally in design and interpretation from other ordination techniques, and serves more as an aid in describing relationships among samples rather than variable reduction. For our purposes, it represents in a two-dimensional space the overall patterns of similarities or distances among sites that occurs in multidimensional space. It is descriptive, not inferential.

One can imagine that each point, or site average of all its points, is a point in *p*-dimensional space, where *p* = the total number of variables in a dataset (reduced or otherwise). The sample s location is determined by its score on each of the variables, and the relationships among points are described by the Euclidean distance between each possible pair. NMS squashes that *p*-dimensional space down to some fewer dimensions (in our case, 2), while trying to preserve the original distance relationships among all points with as little distortion as possible. Ideally, distances among all points calculated in the new reduced space will be perfectly correlated with the original distances among the set of points; deviation from this perfect correlation is termed stress . Axis numbers are arbitrary, so that the percent of variance on a given axis is generally irrelevant. Likewise, axes are not interpreted in the sense one might interpret principal component or correspondence analysis axes, although one may calculate their correlations with any variable.

ASSESSING TEMPORAL VARIATION

ANNUAL CHANGES IN ABUNDANCE

The most direct assessment of annual change in abundance (indexed in our samples by the number of points occupied) is to test for changes in the proportion of points occupied between sampling periods, based on points that were sampled in common in each period. This is accomplished with a simple contingency analysis using the Chi-squared or G-statistic (e.g., Zar 1984). Note, however, that this region-wide analysis lacks any finer spatial resolution; that is, a species may occur on 50% of the points in each of two sample periods (hence, no detectable change in abundance), but the points of occurrence in one sample may be completely different from those of the second.

CONCORDANCE ANALYSIS

How consistent is the distribution of a species between two sampling periods? In other words, how concordant is the presence (and absence) of a species among points that were sampled in each of two censuses that we might want to compare (e.g., spring in consecutive years, once in the fall then again in the spring, or vice versa)? A species distribution is concordant between two sampling intervals if it mostly occurs at the same points in the second interval that it did in the first interval, and at the same time is mostly absent at the same points in the second interval that it was absent from in the first.

The analysis is best visualized as a 2 x 2 contingency table, which shows the frequency of occurrence of points where the species was absent in both periods, present in both periods, and present in one but not the other (Fig. 3). Concordance is highest when all of the points are in the - - and + + cells, and lowest (high negative concordance) when all the points are in the - + and + - cells. Clearly, if a species is redistributed among sampling points at random between periods (the checkerboard effect ; Wiens and Rotenberry 1981b), then all cells have entries and concordance is near zero. In other words, the presence of a species at a point in one period does not predict its occurrence at that point in a subsequent period.

		First Sampling Period	
		Absent	Present
Second Sampling Period	Absent	- -	+ -
	Present	- +	+ +

Figure 3. Possible patterns of species occurrences between two consecutive surveys. Minuses indicate species was not detected on a survey, plusses indicate that it was detected. Order of symbols represents outcome on first and second surveys, respectively.

Another way in which concordance may be reduced between periods is if the proportion of detections of a species changes between periods, either rising or falling, even if points occupied the first period are likely to be occupied the second. This produces a lack of symmetry in the table, inflating either the - + cell if the species increases between periods or the + - cell if the species decreases.

Although presented as a contingency table, use of Chi-squared or G-statistics to analyze concordance (vs., for example, annual change in abundance) is inappropriate. For example, although tables that consist of all - - and + + entries or all + - and - + entries are highly significant with a Chi-squared or G-test, their concordances are opposite. Likewise, strong asymmetry produced by changes in abundance between periods will influence these tests. Instead, we use the point-biserial correlation coefficient, which is analogous to a standard Pearson correlation coefficient, but for data where both variables are dichotomous (Thorndike 1978). This correlation is high and positive when most observations are + + and - -, decreasing towards zero as observations become randomly scattered among cells, then increasingly negative as most observations are + - and - +. It also is reduced by asymmetry, and when most observations are in one cell (e.g., for uncommon or rare species, where most observations are - -). Thus, because meaningful concordences (and annual contingencies) cannot be evaluated for uncommon species, we confined our species-by-species analyses to those taxa that were detected on at least 10% of the points during at least one sampling period.

We compared contingency and concordance across consecutive years on a season-by-season basis for species in both major taxa. We also compared consecutive seasons for small mammals. However, because survey techniques differed between spring and fall for birds, we did not calculate their contingencies/concordences between seasons.

We could potentially measure contingency/concordance at both large (site-by-site) and small (point-by-point) spatial scales. Because we have relatively few sites (22) compared to points (>200), however, site-level analysis is likely to be insensitive to all but major changes in the distribution of a species. Additionally, sites differed in the number of points each contained. Therefore, because of relatively low statistical power coupled with differential sensitivity of sites to detect species changes, we did not calculate large-scale contingencies/concordences.

COMMUNITY-LEVEL CONCORDANCE

We assessed community-level concordance in two ways. First, we examined the similarity of point scores in a detrended correspondence analysis that included data from two consecutive years (e.g., all points sampled in both spring 1995 and spring 1996). If concordance is high, then we expect a high correlation between scores of points from one year with their scores from a subsequent year. We also expect a low mean difference in scores of points across comparisons.

We also assessed concordance using Mantel tests (Mantel 1967, Douglas and Endler 1982). The Mantel test evaluates the null hypothesis of no relationship between two dissimilarity (distance) or similarity matrices. A matrix of the similarity (or distance) among all points in a sample represents a description of the relationship of each point to every other point in species-space. If concordance between two samples is high, then points in one sample have the same relationships to each other in species-space as points in the other sample do, and thus the correlation between distances or similarities should be high. However, because there exists a partial dependence of similarities/distances within each matrix (i.e., the distance between any two points is constrained by their mutual distances to a third), we cannot use a standard test of the significance of the correlation coefficient. Instead, the Mantel test provides a test of the significance of the correlation (which is also called the standardized Mantel statistic) using permutation procedures (see Douglas and Endler 1982 for details). These permutation procedures have the additional advantage that they are not dependent on any assumed underlying distributional properties of the data (e.g., univariate or multivariate normality).

We restricted all analyses to the communities defined by the 40 bird and 8 mammal species deemed non-rare (see V. VERTEBRATE DISTRIBUTION, Tables 15, 16). DCA and Mantel tests were conducted using PC-ORD (McCune and Mefford 1997).

ANALYSIS OF HABITAT RELATIONSHIPS

We expect that species abundances and distributions will fluctuate through time, and that some of these fluctuations may lead to redistributions of individuals among points. Such redistribution will, of course, influence our detection of patterns of habitat associations based on vegetation and landscape attributes measured at those points. However, by sampling a point repeatedly we will be able to examine habitat characteristics associated with a species persistence at a point or site, at least over a 3-year period. Habitat that permits the persistence of a species is probably the most important attribute from a management perspective. Although our sampling period is relatively short compared to the time line associated with preserving NCCP reserves, an analysis that includes such persistence will nonetheless represent a first approximation in the definition of what constitutes appropriate habitat.

We also expect that landscape-level variables will influence species distributions over and above that of the local-level variables that have been employed in traditional habitat association analyses. This can occur in two ways: (1) directly, in that species may appear to be specifically influenced by the value of certain landscape variables; and (2) indirectly, where we observe changes in regression coefficients for local variables when landscape variables are included in statistical models of a species distribution. As an example of the former, Knick and Rotenberry (1995) observed that the presence of Sage Sparrows (the Great Basin form *A. b. nevadensis*) was strongly influenced by the size of the patch of sagebrush vegetation type in which a sampling point was located. As an example of the latter, Bolger et al. (1997b) documented that including landscape variables changed which local-level variables were significantly associated with the presence of Sage Sparrows (the local form, *A. b. belli*) and a suite of other coastal sage scrub species, at Naval Air Station Miramar in San Diego county.

Finally, the expanded geographical scope of our sampling (22 sites that occupy a rectangle roughly 150 x 90 km; Fig. 1) will enable us to detect a geographical influence on habitat relationships, if one exists. What we mean by a geographical influence is whether the details of a species' habitat association changes from one area to the next. For example, is the pattern of correlation of, say, California Gnatcatchers with various shrub species different in coastal areas than in inland areas? Finding such differences informs management decisions undertaken in different local areas.

A variety of techniques have been developed to assess habitat relationships of organisms (see, for example, papers in Capen 1981, Verner et al. 1985, Manly et al. 1993). Most involve some sort of regression approach, and we employ two types of regression.

SPECIES PATTERNS: LOGISTIC REGRESSION AND LOG-LIKELIHOOD RATIOS

For the bulk of our statistical assessments of species habitat relationships we used multiple logistic regression (e.g., Hosmer and Lemeshow 1989). Ordinary multiple logistic regression determines the relationship between a dichotomous dependent variable (e.g., species presence or absence at a point) and multiple independent variables (e.g., habitat variables measured at a point). In our case, logistic regression measures the effect of the independent variables on the probability of a species presence. The overall relationship can be tested for statistical significance; its strength is indexed with concordance, the proportion of all pairs of points for which the presence or absence of a species is correctly predicted. The importance of each independent variable (in the specific context of all of the other independent variables included in the regression model)in predicting the presence of species can also be statistically evaluated.

Because not all points were sampled for the same number of years (although most were sampled in at least two years, and about half were sampled in three years), we used a variant of logisitic regression sometimes known as ordinal regression. We used as the dependent variable the number of times a species was detected at a point, which could range from 0 to the maximum number of times the point had been surveyed. To statistically control for the fact that points varied in the number of times surveyed, we always included the number of surveys conducted at a point as a covariate in each regression. This means that a point at which a species was detected once is treated differently depending on whether the point was sampled one year vs. three years. It is somewhat analogous to using the proportion of censuses on which a species was detected as the dependent variable, but avoids the messy statistical problems associated with the use of ratios or proportions. Also, it means that a point at which a species was detected on 100% of the surveys will be treated differently if the point was surveyed once vs. surveyed three years. These distinctions seem potentially biologically meaningful as well.

An additional advantage of using logistic regression is that the models are typically fitted using maximum likelihood methods (Hosmer and Lemeshow 1989). It is possible, then, to structure an analysis as a set of hierarchical models (one overall model, plus others that include subsets of the independent variables that were included in the overall model). Using likelihood ratio tests, one can statistically evaluate the gain in fit when variables are added to an existing model (or, conversely, the loss of fit that occurs when a variable or set of variables is dropped from a more inclusive model). For example, we can contrast the overall importance of landscape vs. local-level variables in influencing a species distribution. First, we construct a logistic regression model that includes local variables, then construct a second model in which we add landscape variables, then test for the significance of the increase in fit. If there is no significant increase in fit, then the effects of landscape variables are either negligible, or at least indistinguishable from the effects of local variables. If there is a significant increase in fit, then variation in landscape variables is making a unique contribution to explaining variation in animal distribution. The principal drawback to this procedure is that, when both components being tested are significant, we cannot calculate a percent of variance uniquely explained by each, so a direct comparison of relative importance is not explicit.

The test is simple. We created a dataset that had, for each point, its score on each local and landscape variable and the number of times it was surveyed for a particular taxonomic group in spring, fall, or overall. For each animal species we counted the number of times it was detected at each point during spring surveys, fall surveys, or over all surveys, and then combined it with the habitat dataset. For each animal species we then did three sets of three ordinal logistic regressions: (1) the sets were all surveys, spring surveys, and fall surveys; (2) the regressions included local variables only, landscape variables only, and both sets of variables. In all regressions the dependent variable was the number of times a species was detected at a point, and we always included the number of times each point was surveyed as a covariate.

The significance test of each individual regression analysis is interpreted in the conventional way; we presume that the set of independent variables accounts for a significant proportion of the probability of detecting a species at a point. The test of local vs. landscape effects is based on the difference in the log-likelihood ratios between a model that includes both sets of effects and one that includes only one set. That difference follows a Chi-squared distribution with degrees of freedom equal to the difference in degrees of freedom between the two regressions being compared. If significant, one may conclude that a second set of variables explains a significant amount of variation in the dependent variable in addition to that already explained by the first set. Alternatively, one can view a significant result as indicating that there a significant loss of fit to the regression model containing both sets of variables when one set is removed.

To ensure the most parsimonious description for each species and season (and for all seasons combined for small mammals), we applied the following criteria to the regression statistics to determine the best model: (1) the model must be statistically significant (i.e., overall $P < 0.05$); (2) the model was both (i.e., that containing both local and landscape variables) if each set was a significant contribution over and above the other one; or (3) the model was local or landscape if the other set was not was not a significant contributor to the already included set. In several instances it occurred that neither set made a statistically significant additional contribution to the set already in the model. In these cases, we examined the degree of symmetry in the regression concordances and P-values. If strongly asymmetrical (i.e., one was substantially higher or lower than the other), we chose the set with the higher concordance (which usually was very close to the model with both sets) and/or lower P-value; if roughly symmetrical, we chose the both model.

Standardized regression coefficients allow us to estimate the relative contribution of statistically significant independent variables to explaining variation in the dependent variable, and also to identify the direction of the association. Note that this significance is evaluated in the context of all other variables in the model (i.e., it is an estimate of the contribution of an independent variable to explaining variation in the dependent variable, given that all the other independent variables are already in the model). Note that it is possible, therefore, to have a highly significant overall model with a lack of significance for any single variable. It also means that when other independent variables are included in a model, a variable formerly significant may become insignificant. Such changes in the the magnitude (and even sign) of local variables when landscape variables are added implies that the statistical effects of a local variable is dependent on its landscape context.

COMMUNITY PATTERNS: MULTIPLE REGRESSIONS AND F-RATIOS

We also wished to see how entire communities responded to habitat variation. First, we extracted patterns from both bird and small mammal communities using Detrended Correspondence Analysis (DCA). Because of differences in the number of points surveyed in each season, we performed these DCAs on a season-by-season basis. As noted above (see ?), the scores of points on ordination axes can be used as an index of the species composition at those points. Because these scores are continuous variables rather than ordinal or dichotomous, we can use ordinary multiple regression (e.g., Tabachnick and Fidell 1983) to relate them to habitat variables.

To assess the independent effects of local and landscape variables, we followed the same basic approach as we did for individual animal species using logistic regression. We performed three sets of regressions, one with local variables, one with landscape variables, and one with both. But rather than using log-likelihood ratios to evaluate the contribution of one set over the other, we used F- to-add ratios (also called F-to-enter ratios). This F-ratio measures the significance of the increase in explained or model sums-of-squares (which always rises as variables are added to a regression model, but with a cost in degrees of freedom). To evaluate the significance of adding variable set 1 to variable set 2, the test statistic is the ratio (difference between model $SS_{\text{set1+set2}}$ and model $SS_{\text{set 1}}$/model df_{set2}) / (error $SS_{\text{set1+set2}}$/error $df_{\text{set1+set2}}$) (Tabachnick and Fidell 1983). Interpretation of patterns of statistical significance are analogous to those described for logistic regression above.

We evaluated and report the statistical significance of regression coefficients as well, but did not calculate standardized coefficients. Otherwise, their interpretation is analogous to that described for logistic regression.

GEOGRAPHICAL VARIATION

Finally, we wished to evaluate how or whether any habitat associations we identified varied as a function of geography, and whether there remained geographical variation in species distribution patterns after accounting for habitat variation. If the habitat variables we measured vary geographically (we show below that they do), it is possible that animal-habitat associations may become confounded by geographical co-variation. If a species is geographically restricted in its distribution in the sampling region, say, confined to coastal areas by physical rather than biotic factors, then a spurious correlation with habitat variables that vary significantly along an east-west gradient can result. It is also possible that a species may have different habitat associations in different parts of its range, preferring, for example, more grassland-like habitats in more coastal areas, vs. more shrubby habitats inland. Patterns such as these pose a potential challenge to the interpretation of standard habitat models.

Our attempts to assess the role of geographical variation in producing or altering perceived habitat associations are currently exploratory. Although we can conceive of a variety of statistical approaches, we will stick with a simple one here. In this case, as with our assessment of local vs. landscape variables, for each species-season we contrast the log-likelihood results of three logistic regression models: one including all the variables of the best local-landscape-both comparison (which we call habitat); one including each point s UTM coordinates (which we call geography); and one including both habitat and geography (both). From these results we then identified the best overall model and its statistically significant variables as above. In a similar manner we assessed geographical variation in community-habitat relationships using regular multiple regression.

We performed all regression analyses in SAS, Version 12 for personal computers (SAS Institute 1996). To generate meaningful associations, we confined our species-by-species analyses to those taxa that were detected on at least 10% of the points during at least one sampling period.

IV. LOCAL AND LANDSCAPE VEGETATION— THE HABITAT TEMPLATE FOR ANIMAL SPECIES DISTRIBUTIONS

SITE DESCRIPTIONS

Below for each set of variables we describe (1) results of the variable reduction process; and (2) the baseline habitat for each of the sites. These results describe the general patterns of local and landscape-level variation among the sites we sampled. However, because our study sites were consciously selected to represent CSS rather than a random sample of points throughout the region, these results do not necessarily describe the major patterns of landscape level variation and covariation present in cismontane southern California. Inferences from our results about landscape patterns are most properly restricted to areas surrounding CSS.

HABITAT STRUCTURE

Site means (and standard errors) for each of the 21 structural variables varied widely (Table 7). To detect patterns of correlation among these variables (excluding those assessing presence/absence of cactus clumps, rock outcrops, and trails or roads), and to initiate the variable reduction process, we performed a principal components analysis that included all 18 quantitative variables. This yielded 6 components with eigenvalues greater than 1. These 6 components together explained 70.0% of the variance in the original data. Although most components had multiple variables with high factor loadings, two had only single variables (GC_CRYP and PC_BNGRS) with high loadings, indicating that those variables were not correlated with any others and hence could not be usefully combined with other variables. One other raw variable (PC_TREE) had no high loading on any of the 6 components, which indicates that it also was not highly correlated with other variables. Since variables that are uncorrelated with others cannot combined with them to achieve variable reduction, we removed the 3 non-contributing variables and re-ran the PCA to derive a better set of composite variables that we could use in addition to the three raw variables.

Table 7. Means and standard errors of structural variables measured at NCCP coastal sage scrub survey sites, 1996, and principal component factor scores derived from those measures. Visual features reported as proportion of points containing each attribute. See Table 3 for variable codes.

Site	Code	N	Pin Drop Measures					
			GC_BARE	GC_CRYP	GC_LITTER	GC_ROCK	GC_WOOD	LITDEPTH
Black Canyon	BLCA	5	0.192	0.032	0.584	0.020	0.004	0.608
			0.041	0.014	0.075	0.013	0.004	0.264
Box Springs	BOSP	9	0.196	0.024	0.160	0.042	0.013	0.430
			0.034	0.009	0.026	0.013	0.007	0.046
Chula Vista	CHVI	8	0.234	0.013	0.675	0.011	0.014	0.398
			0.032	0.008	0.061	0.007	0.008	0.044
Kabian Park	KABI	10	0.158	0.000	0.196	0.026	0.018	0.362
			0.023	0.000	0.032	0.009	0.010	0.044
Lake Perris	LAPE	23	0.125	0.026	0.162	0.036	0.017	0.431
			0.020	0.006	0.021	0.009	0.005	0.053
Lake Skinner	LASK	10	0.068	0.008	0.337	0.032	0.038	0.879
			0.022	0.006	0.035	0.013	0.010	0.084
Limestone Canyon	LICA	23	0.144	0.011	0.519	0.011	0.007	1.002
			0.022	0.004	0.029	0.004	0.003	0.129
Motte Rimrock Reserve	MRRE	10	0.140	0.030	0.252	0.056	0.002	0.312
			0.037	0.011	0.032	0.013	0.002	0.049
Orange Hills	ORHI	6	0.043	0.000	0.237	0.063	0.050	0.940
			0.017	0.000	0.049	0.019	0.016	0.051
Pamo Valley	PAVA	7	0.077	0.051	0.309	0.009	0.031	0.374
			0.027	0.020	0.070	0.006	0.010	0.091
Point Loma	POLO	10	0.108	0.042	0.710	0.004	0.020	1.504
			0.019	0.021	0.047	0.004	0.008	0.245
Rancho Mission Viejo	RMVI	10	0.065	0.002	0.476	0.003	0.056	1.097
			0.015	0.002	0.051	0.003	0.014	0.077
Sycamore Canyon	SYCA	6	0.120	0.007	0.090	0.017	0.007	0.200
			0.025	0.004	0.035	0.008	0.007	0.055
Sycamore Hills	SYHI	10	0.070	0.024	0.524	0.018	0.198	2.002
			0.023	0.008	0.022	0.006	0.018	0.230
Sand Canyon Reservoir	SACA	6	0.068	0.007	0.395	0.000	0.124	1.429
			0.016	0.004	0.056	0.000	0.033	0.144
Santa Margarita	SAMA	5	0.125	0.008	0.376	0.004	0.052	0.881
			0.027	0.005	0.074	0.004	0.020	0.057
Starr Ranch	STRA	22	0.130	0.001	0.562	0.022	0.003	0.757
			0.015	0.001	0.038	0.005	0.002	0.060
Sweetwater River	SWRI	23	0.067	0.016	0.223	0.028	0.012	0.365
			0.011	0.006	0.032	0.006	0.003	0.067
Torrey Pines	TPSP	12	0.130	0.003	0.698	0.002	0.021	1.577
			0.017	0.003	0.029	0.002	0.005	0.214
UCR	UCR	5	0.292	0.052	0.088	0.020	0.008	0.068
			0.117	0.038	0.033	0.013	0.005	0.045
Wild Animal Park	WAPA	14	0.173	0.061	0.244	0.020	0.009	0.162
			0.036	0.018	0.026	0.010	0.006	0.040
Total		234	0.125	0.019	0.378	0.022	0.028	0.742
			0.007	0.002	0.015	0.002	0.003	0.041

Table 7, continued.

Site	Code	N	Pin Drop Measures				Visual Assessment		
			HITS_1_3	HITS _3_5	HITS>5	NO_SPECIES	CACTUS	ROCK	TRAIL
Black Canyon	BLCA	5	0.456	0.436	0.644	1.65	-	0.60	-
			0.035	0.023	0.031	0.07			
Box Springs	BOSP	9	0.174	0.279	0.388	0.71	-	0.78	0.33
			0.032	0.029	0.040	0.05			
Chula Vista	CHVI	8	0.470	0.584	0.733	1.47	1.00	0.25	0.88
			0.039	0.028	0.029	0.07			
Kabian Park	KABI	10	0.432	0.366	0.298	0.64	0.40	0.10	0.40
			0.038	0.023	0.037	0.04			
Lake Perris	LAPE	23	0.343	0.349	0.474	0.90	0.17	0.78	0.48
			0.027	0.029	0.028	0.03			
Lake Skinner	LASK	10	0.343	0.330	0.359	0.74	0.10	0.10	0.50
			0.032	0.029	0.042	0.06			
Limestone Canyon	LICA	23	0.560	0.465	0.669	1.16	0.57	-	0.43
			0.023	0.021	0.028	0.03			
Motte Rimrock Reserve	MRRE	10	0.292	0.280	0.380	0.80	0.10	1.00	0.70
			0.013	0.017	0.033	0.04			
Orange Hills	ORHI	6	0.273	0.247	0.220	0.69	0.83	-	1.00
			0.030	0.041	0.042	0.08			
Pamo Valley	PAVA	7	0.311	0.277	0.443	0.99	-	0.71	0.57
			0.028	0.033	0.036	0.07			
Point Loma	POLO	10	0.536	0.522	0.552	1.22	0.10	0.10	0.30
			0.019	0.039	0.068	0.07			
Rancho Mission Viejo	RMVI	10	0.640	0.536	0.520	1.37	1.00	-	0.60
			0.041	0.044	0.053	0.09			
Sycamore Canyon	SYCA	6	0.180	0.170	0.200	0.43	-	0.83	0.50
			0.035	0.045	0.051	0.07			
Sycamore Hills	SYHI	10	0.570	0.602	0.638	1.06	0.60	-	0.60
			0.025	0.030	0.035	0.09			
Sand Canyon Reservoir	SACA	6	0.544	0.465	0.487	1.01	0.67	-	0.33
			0.069	0.064	0.065	0.13			
Santa Margarita	SAMA	5	0.378	0.465	0.580	0.98	0.20	-	0.20
			0.049	0.065	0.084	0.06			
Starr Ranch	STRA	22	0.625	0.565	0.608	1.22	0.95	-	0.50
			0.022	0.024	0.046	0.06			
Sweetwater River	SWRI	23	0.362	0.390	0.399	0.96	0.04	0.57	0.70
			0.024	0.024	0.028	0.05			
Torrey Pines	TPSP	12	0.460	0.437	0.541	1.44	0.83	-	1.00
			0.024	0.022	0.050	0.06			
UCR	UCR	5	0.220	0.244	0.312	0.75	-	1.00	0.20
			0.036	0.032	0.037	0.05			
Wild Animal Park	WAPA	14	0.327	0.323	0.368	0.99	0.79	0.64	0.79
			0.027	0.026	0.021	0.05			
Total		234	0.427	0.412	0.485	1.03			
			0.011	0.010	0.013	0.02			

Table 7, continued.

Site	Code	N	Line Intercept Measures			
			NUMCHANG	PC_BNGRS	PC_BRASS	PC_NATFORB
Black Canyon	BLCA	5	49.0	0.000	0.000	0.000
			4.5	0.000	0.000	0.000
Box Springs	BOSP	9	61.8	0.055	0.025	0.111
			5.7	0.018	0.020	0.046
Chula Vista	CHVI	8	29.3	0.000	0.035	0.004
			2.6	0.000	0.022	0.004
Kabian Park	KABI	10	70.0	0.042	0.011	0.072
			4.0	0.094	0.011	0.032
Lake Perris	LAPE	23	51.3	0.004	0.146	0.012
			3.2	0.003	0.031	0.007
Lake Skinner	LASK	10	61.7	0.000	0.000	0.000
			5.0	0.000	0.000	0.000
Limestone Canyon	LICA	23	43.7	0.031	0.000	0.010
			2.6	0.007	0.000	0.003
Motte Rimrock Reserve	MRRE	10	48.7	0.000	0.007	0.008
			2.3	0.000	0.005	0.005
Orange Hills	ORHI	6	64.2	0.029	0.000	0.089
			4.0	0.014	0.000	0.057
Pamo Valley	PAVA	7	47.7	0.001	0.004	0.000
			3.3	0.001	0.003	0.000
Point Loma	POLO	10	45.5	0.000	0.000	0.005
			9.9	0.000	0.000	0.005
Rancho Mission Viejo	RMVI	10	60.6	0.128	0.000	0.020
			5.8	0.025	0.000	0.010
Sycamore Canyon	SYCA	6	49.0	0.000	0.094	0.016
			7.5	0.000	0.034	0.006
Sycamore Hills	SYHI	10	55.4	0.037	0.000	0.027
			4.8	0.008	0.000	0.012
Sand Canyon Reservoir	SACA	6	64.5	0.045	0.000	0.082
			5.5	0.027	0.000	0.056
Santa Margarita	SAMA	5	55.6	0.052	0.000	0.032
			4.8	0.016	0.000	0.013
Starr Ranch	STRA	22	43.1	0.097	0.004	0.004
			3.4	0.014	0.003	0.003
Sweetwater River	SWRI	23	49.9	0.001	0.013	0.000
			3.0	0.001	0.003	0.000
Torrey Pines	TPSP	12	43.5	0.001	0.007	0.010
			4.4	0.001	0.003	0.010
UCR	UCR	5	51.2	0.000	0.113	0.030
			7.4	0.000	0.047	0.030
Wild Animal Park	WAPA	14	52.7	0.000	0.039	0.000
			2.4	0.000	0.012	0.000
Total		234	51.0	0.023	0.027	0.019
			1.1	0.005	0.005	0.004

Table 7, continued.

Site	Code	N	Line Intercept Measures			
			PC_EXGRAS	PC_SHRUB	PC_DEAD	PC_TREE
Black Canyon	BLCA	5	0.026	0.718	0.060	0.000
			0.018	0.045	0.010	0.000
Box Springs	BOSP	9	0.227	0.490	0.023	0.001
			0.039	0.051	0.009	0.001
Chula Vista	CHVI	8	0.014	0.803	0.018	0.000
			0.008	0.032	0.004	0.000
Kabian Park	KABI	10	0.422	0.433	0.031	0.000
			0.089	0.023	0.008	0.000
Lake Perris	LAPE	23	0.192	0.527	0.041	0.001
			0.022	0.041	0.009	0.001
Lake Skinner	LASK	10	0.324	0.547	0.030	0.000
			0.064	0.041	0.010	0.000
Limestone Canyon	LICA	23	0.131	0.718	0.015	0.026
			0.025	0.027	0.003	0.008
Motte Rimrock Reserve	MRRE	10	0.175	0.518	0.044	0.000
			0.031	0.036	0.007	0.000
Orange Hills	ORHI	6	0.376	0.269	0.012	0.005
			0.062	0.060	0.005	0.005
Pamo Valley	PAVA	7	0.206	0.617	0.061	0.000
			0.061	0.042	0.017	0.000
Point Loma	POLO	10	0.025	0.811	0.030	0.000
			0.015	0.038	0.012	0.000
Rancho Mission Viejo	RMVI	10	0.109	0.657	0.021	0.000
			0.021	0.035	0.008	0.000
Sycamore Canyon	SYCA	6	0.381	0.219	0.045	0.000
			0.102	0.041	0.009	0.000
Sycamore Hills	SYHI	10	0.017	0.707	0.066	0.006
			0.009	0.039	0.010	0.006
Sand Canyon Reservoir	SACA	6	0.162	0.580	0.043	0.000
			0.042	0.065	0.016	0.000
Santa Margarita	SAMA	5	0.129	0.716	0.007	0.000
			0.090	0.102	0.053	0.000
Starr Ranch	STRA	22	0.086	0.719	0.009	0.023
			0.027	0.027	0.002	0.011
Sweetwater River	SWRI	23	0.337	0.535	0.025	0.000
			0.028	0.028	0.006	0.000
Torrey Pines	TPSP	12	0.033	0.676	0.078	0.008
			0.011	0.039	0.014	0.005
UCR	UCR	5	0.196	0.441	0.066	0.000
			0.092	0.047	0.022	0.000
Wild Animal Park	WAPA	14	0.220	0.520	0.027	0.002
			0.047	0.030	0.005	0.002
Total		234	0.180	0.598	0.032	0.006
			0.012	0.012	0.002	0.001

Table 7, continued.

Site	Code	N	Principal Component Factor Scores			
			STFAC1	STFAC2	STFAC3	STFAC4
Black Canyon	BLCA	5	0.98	-0.68	-0.18	0.58
			0.06	0.39	0.31	0.16
Box Springs	BOSP	9	-0.55	-0.74	1.41	-0.16
			0.19	0.27	0.58	0.26
Chula Vista	CHVI	8	1.27	-1.13	-0.53	-0.20
			0.09	0.22	0.22	0.19
Kabian Park	KABI	10	-0.81	0.02	0.93	-0.34
			0.14	0.18	0.41	0.27
Lake Perris	LAPE	23	-0.44	-0.63	-0.07	0.74
			0.15	0.13	0.20	0.28
Lake Skinner	LASK	10	-0.74	0.66	-0.01	-0.25
			0.28	0.17	0.31	0.26
Limestone Canyon	LICA	23	0.61	-0.08	-0.34	-0.53
			0.12	0.16	0.12	0.09
Motte Rimrock Reserve	MRRE	10	-0.58	-0.60	0.13	-0.05
			0.16	0.20	0.19	0.18
Orange Hills	ORHI	6	-1.18	0.77	1.31	-0.60
			0.18	0.18	0.66	0.17
Pamo Valley	PAVA	7	-0.55	0.18	-0.70	0.35
			0.26	0.27	0.17	0.25
Point Loma	POLO	10	0.90	0.48	-0.40	-0.06
			0.18	0.19	0.29	0.28
Rancho Mission Viejo	RMVI	10	0.66	0.79	0.23	-0.19
			0.21	0.17	0.22	0.15
Sycamore Canyon	SYCA	6	-1.86	-0.24	-0.55	0.62
			0.32	0.29	0.34	0.21
Sycamore Hills	SYHI	10	1.08	2.14	0.90	1.04
			0.14	0.35	0.21	0.23
Sand Canyon Reservoir	SACA	6	0.33	1.56	1.04	0.38
			0.32	0.26	0.49	0.33
Santa Margarita	SAMA	5	0.27	0.17	0.27	-0.69
			0.47	0.27	0.27	0.90
Starr Ranch	STRA	22	0.80	-0.24	-0.21	-0.74
			0.16	0.09	0.14	0.08
Sweetwater River	SWRI	23	-0.72	0.09	-0.45	-0.52
			0.15	0.13	0.13	0.12
Torrey Pines	TPSP	12	0.77	0.51	-0.56	1.07
			0.14	0.21	0.16	0.29
UCR	UCR	5	-0.70	-1.47	0.19	1.38
			0.34	0.63	0.61	0.96
Wild Animal Park	WAPA	14	-0.50	-0.71	-0.17	0.06
			0.15	0.21	0.15	0.13
Total		234	0.00	0.00	0.00	0.00
			0.07	0.07	0.07	0.07

The second PCA yielded four components with eigenvalues greater than 1, all with multiple variables having high factor loadings (Table 8). These four components accounted for 67.1% of the total variation of the variables included in this second PCA. The first structural principal component (Shrub vs. grass) represented a gradient between shrub-dominated vs. grass-dominated points. Points that had high scores on this component had greater shrub cover, more vegetation hits in all three height categories, had greater coverage of litter with greater litter depth, and had more shrub species. This component captured over a third of the total variation among points in the structural variables. The second component (Litter vs. bare) contrasted points with relatively high coverage of bare ground vs. those with more woody debris on the surface and greater litter depth. Points with high scores had more litter. The third component (forbs/patchy) represented a gradient of increasing coverage of forbs and rock, which were also associated with increasing horizontal heterogeneity reflected in the number of transitions among vegetation categories per transect (NUMCHANG). Points with high scores were more patchy. The fourth component (disturbed) was associated with increasing coverage of exotic forbs and standing dead material (often large forbs such as *Hirschfeldia incana*, which may persist as standing dead material for many months after death), which indicate severe disturbance. Thus, for all further analyses, we retained these four structural principal components, plus the original variables GC_CRYP, PC_BNGRS, and PC_TREE, all of which were more or less independent of one another. These four components plus three variables represented 72.6% of the total variation in the original structural variables. We also retained the three visually assessed variables, CACTUS, ROCK, and TRAIL.

Table 8. Principal components analysis of habitat structural variables. Entries are factor loadings after varimax rotation of four components. Bold denotes factor loadings > 0.5. See Table 3 for variable names.

Variable	Structural Components			
	STFAC1	STFAC2	STFAC3	STFAC4
PC_EXGRASS	**-0.85**	0.16	-0.02	-0.22
PC_SHRUB	**0.84**	0.01	-0.27	-0.26
HITS_1_3	**0.74**	0.25	-0.07	-0.16
HITS_3_5	**0.82**	0.20	-0.11	-0.17
HITS>5	**0.82**	0.04	-0.27	-0.11
NO_SPECIES	**0.83**	-0.02	-0.22	0.06
GC_LITTER	**0.81**	0.24	-0.26	-0.06
LITDEPTH	**0.50**	**0.70**	0.00	0.15
GC_BARE	0.26	**-0.74**	0.14	0.22
GC_WOOD	0.22	**0.64**	0.31	0.19
NUMCHANG	-0.33	0.18	**0.67**	0.21
GC_ROCK	-0.21	-0.21	**0.51**	-0.15
PC_NATFORB	-0.11	0.10	**0.71**	-0.09
PC_BRASS	-0.22	-0.35	-0.05	**0.52**
PC_DEAD	-0.05	0.18	-0.05	**0.84**
Component name	shrub vs. grass	litter vs. bare	forbs/ patchy	disturbed
Eigenvalue	5.23	1.88	1.62	1.35
% Total variance	34.9	12.5	10.8	9.0

The gradients represented by each principal component can also be visualized by examining values for the original variables at sites at the extreme ends of each component (Fig. 4). For example, Sycamore Canyon (SYCA) has the lowest average point score on structural factor 1 (grass-shrub), whereas Chula Vista (CHVI) has the highest (Table 7; Fig. 4). SYCA has 38% grass cover vs. 1% for CHVI, and 20% shrub cover vs. 80% (Table 7). Likewise, U.C. Riverside (UCR) and Sycamore Hills (SYHI) were the extremes on the second component (bare-litter). UCR had 29% bare ground cover vs. 7% for SYHI, whereas its woody ground cover was <1% vs. 20% for SYHI. Other extremes include Pamo Valley (PAVA, 0% forb cover, 48 changes/100m) vs. Box Springs (BOSP,11% forb, 62 changes) on component 3 (forbs/patchy), and Starr Ranch (STRA,<1% exotic forb cover, <1% standing dead cover) vs. UCR (11% exotic forb, 7% standing dead) on component 4 (disturbed). All the values noted above tended to be extreme for original variables as well (Table 7).

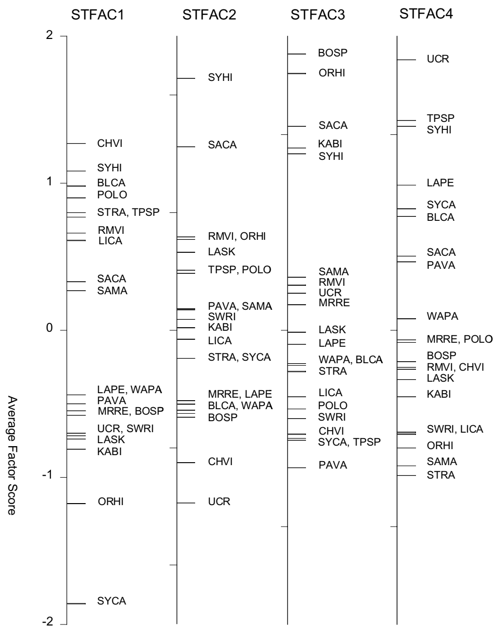


Figure 4. Ordination of NCCP study sites on four principal components derived from local habitat structural variables. See Table 6 for interpretation of components. See Table 1 for site codes.

There were several simple geographical patterns in habitat structure at the site level (Fig. 4). Component 1 was significantly negatively correlated with north UTM (r = -0.48, df = 19, P = 0.026), implying that southern sites tended to have higher coverages of shrubs whereas northern sites had higher coverage of grasses. Component 2, on the other hand, was negatively correlated with east UTM (r = -0.54, df = 19, P = 0.011); inland (i.e., eastern) sites tended to have more bare ground and less litter than coastal sites. Component 3 was correlated with both north (r = 0.56, df = 19, P = 0.008) and east (r = -0.56, df = 19, P = 0.008) UTMs. Thus northwestern sites tended to have higher horizontal heterogeneity and higher forb cover than southeastern ones. Component 4 was uncorrelated with either UTM (both P > 0.65), implying that structural features associated with standing dead exotic forbs were distributed throughout the region.

Overall relationships among the sites with respect to the 7 habitat structure variables could be represented in 2 dimensions with relatively little distortion (NMS stress = 0.120; Fig. 5). Although the axes themselves have no particular intrinsic meaning, serving mainly as placeholders, the ordination scores of the sites were correlated with several of the structural variables. For example, NMS axis 1 had high correlations with structural factors 1 and 2 (r = 0.82 and 0.71, respectively), but little correlation with the other variables (all r < |0.3|). NMS axis 2 was highly correlated with structural factors 2 and 3 (r = 0.70 and 0.76), but with nothing else (all r < |0.4|).

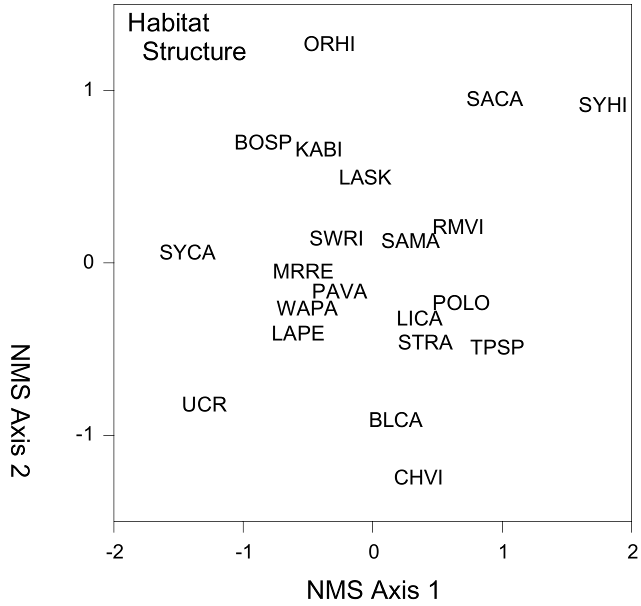


Figure 5. Non-metric multidimensional scaling ordination of NCCP study sites based on site mean values for seven habitat structural variables (three raw plus four principal components). See Table 1 for site codes.

FLORISTIC COMPOSITION

Twenty-four plant taxa (mainly species, but some taxa were lumped to genus) occurred on at least 10% of the 233 points and thus were retained for additional analyses (Table 9). Sites varied widely in the presence and abundance of these taxa (Table 10).

Codes, scientific names, and common names of plant taxa measured at NCCP coastal sage scrub survey sites, 1996. Only taxa that occurred on at least 10% of all points are listed.

Code	Scientific name	Common name
ERFA	*Eriogonum fasciculatum*	California buckwheat
ARCA	*Artemisia californica*	California sagebrush
SAME	*Salvia mellifera*	Black sage
SAAP	*Salvia apiana*	White sage
LOSP	*Lotus scoparius*	Deerweed
MALA	*Malosma laurina*	Laurel Sumac
OPSP	*Opuntia* spp.	Prickly pear and cholla cacti
ENFA	*Encelia farinosa*	Brittlebush
RUSP	*Rhus* spp. [a]	Lemonadeberry
ENCA	*Encelia californica*	California encelia
GASP	*Galium* spp.	Bedstraw
ADFA	*Adenostoma fasciculatum*	Chamise
HIIN	*Hirschfeldia incana*	Short-pod mustard
LEFI	*Lessingia filaginifolia*	
MISP	*Mimulus* spp.	Monkey flower
GUSP	*Gutierrezia* spp. [b]	Broom matchweed
RASP	*Rhamnus* spp. [c]	Redberry
CNDU	*Cneoridium dumosum*	Bushrue
YUSP	*Yucca* spp. [d]	Chaparral and Mojave yuccas
STSP	*Stephanomeria* spp.	
ISOC	*Isocoma* spp.	
LECO	*Elymus condensatus*	Ryegrass
MAMA	*Marah macrocarpus*	Wild cucumber
BRSP	*Brassica* spp.	Mustard

[a] mostly *R. integrefolia*
[b] mostly *G. californica*
[c] mostly *R. crocea*
[d] *Yucca whipplei* and *Y. schidegera*

Table 10. Means and standard errors of floristic variables measured at NCCP coastal sage scrub survey sites, 1996, and detrended correspondence analysis scores derived from those measures. Entries are percent cover; - denotes taxon absent at that site. See Table 7 for plant taxa codes.

Site	Code	N	Plant Species or Taxonomic Unit					
			ERFA	ARCA	SAME	SAAP	LOSP	MALA
Black Canyon	BLCA	5	15.20	29.60	-	9.20	0.40	-
			3.20	6.52	-	3.26	0.40	-
Box Springs	BOSP	9	7.33	0.67	2.67	-	1.33	-
			7.09	0.47	2.67	-	1.33	-
Chula Vista	CHVI	8	1.50	46.75	-	-	0.25	-
			1.05	6.81	-	-	0.25	-
Kabian Park	KABI	10	23.00	24.00	-	-	0.60	-
			3.68	4.30	-	-	0.31	-
Lake Perris	LAPE	23	0.78	21.91	-	0.35	0.26	-
			0.39	5.64	-	0.20	0.26	-
Lake Skinner	LASK	10	37.00	8.60	11.40	1.20	1.80	-
			5.49	3.32	5.51	1.20	1.21	-
Limestone Canyon	LICA	23	5.13	12.00	32.00	3.65	0.87	1.57
			2.09	2.04	5.20	2.09	0.39	0.66
Motte Rimrock Reserve	MRRE	10	20.20	9.20	21.00	0.20	3.00	-
			3.10	2.50	4.87	0.20	1.69	-
Orange Hills	ORHI	6	18.00	8.00	-	-	0.33	4.67
			5.98	4.53	-	-	0.33	1.33
Pamo Valley	PAVA	7	15.43	14.29	-	7.14	1.43	-
			6.40	4.42	-	3.51	0.84	-
Point Loma	POLO	10	8.00	21.80	1.80	-	-	-
			2.31	5.48	1.21	-	-	-
Rancho Mission Viejo	RMVI	10	13.80	31.40	5.00	1.60	1.80	0.60
			2.77	3.50	2.39	0.58	0.81	0.60
Sycamore Canyon	SYCA	6	20.17	23.83	-	-	1.00	-
			7.60	4.20	-	-	1.00	-
Sycamore Hills	SYHI	10	4.80	49.20	1.20	16.40	-	5.20
			1.50	11.13	1.20	3.66	-	2.94
Sand Canyon Reservoir	SACA	6	12.09	37.45	2.09	12.27	9.09	1.82
			2.56	2.76	1.90	2.36	2.02	0.99
Santa Margarita	SAMA	5	15.74	28.17	-	0.87	0.70	8.17
			1.98	2.73	-	0.48	0.27	1.06
Starr Ranch	STRA	22	-	0.33	4.67	-	-	-
			-	0.33	3.00	-	-	-
Sweetwater River	SWRI	23	16.40	34.20	22.40	1.00	1.80	-
			3.87	8.16	7.64	0.68	1.38	-
Torrey Pines	TPSP	12	7.83	15.00	13.00	-	3.83	4.67
			1.96	3.65	5.08	-	1.42	1.69
UCR	UCR	5	-	2.00	0.80	-	-	-
			-	2.00	0.80	-	-	-
Wild Animal Park	WAPA	14	23.29	22.14	-	5.14	1.71	2.71
			4.85	5.24	-	2.85	1.44	2.13

Table 10. Continued.

Site	Code	N	Plant Species or Taxonomic Unit					
			OPSP	ENFA	RUSP	ENCA	GASP	ADFA
Black Canyon	BLCA	5	-	-	2.00	-	-	30.00
			-	-	2.00	-	-	4.98
Box Springs	BOSP	9	-	42.44	-	-	-	-
			-	9.15	-	-	-	-
Chula Vista	CHVI	8	3.50	-	5.00	15.00	-	-
			1.35	-	2.30	4.46	-	-
Kabian Park	KABI	10	-	5.60	-	0.40	-	-
			-	2.66	-	0.40	-	-
Lake Perris	LAPE	23	0.17	31.13	-	0.09	-	0.61
			0.12	5.82	-	0.09	-	0.61
Lake Skinner	LASK	10	0.20	-	-	-	-	3.00
			0.20	-	-	-	-	3.00
Limestone Canyon	LICA	23	1.57	-	0.78	-	1.39	15.57
			0.69	-	0.41	-	0.48	4.47
Motte Rimrock Reserve	MRRE	10	0.20	6.40	-	-	-	-
			0.20	4.07	-	-	-	-
Orange Hills	ORHI	6	16.67	-	-	1.00	-	-
			6.71	-	-	1.00	-	-
Pamo Valley	PAVA	7	-	-	0.29	-	-	28.57
			-	-	0.29	-	-	9.86
Point Loma	POLO	10	0.40	-	22.80	16.20	-	-
			0.27	-	5.01	6.17	-	-
Rancho Mission Viejo	RMVI	10	2.80	-	10.40	-	2.20	-
			1.40	-	2.79	-	0.63	-
Sycamore Canyon	SYCA	6	3.33	-	1.00	5.00	-	-
			1.52	-	0.68	3.86	-	-
Sycamore Hills	SYHI	10	0.80	-	-	-	0.40	-
			0.80	-	-	-	0.40	-
Sand Canyon Reservoir	SACA	6	1.00	-	0.09	-	1.09	-
			0.32	-	0.09	-	0.61	-
Santa Margarita	SAMA	5	-	-	-	0.09	0.17	0.78
			-	-	-	0.09	0.12	0.78
Starr Ranch	STRA	22	-	21.67	-	-	-	-
			-	5.99	-	-	-	-
Sweetwater River	SWRI	23	2.20	-	2.20	2.40	0.20	0.40
			1.99	-	1.21	2.40	0.20	0.40
Torrey Pines	TPSP	12	0.50	-	6.00	4.33	0.67	-
			0.36	-	2.76	1.94	0.38	-
UCR	UCR	5	-	49.60	-	-	-	-
			-	6.88	-	-	-	-
Wild Animal Park	WAPA	14	4.86	-	-	-	0.14	0.57
			2.22	-	-	-	0.14	0.57

Table 10. Continued.

Site	Code	N	Plant Species or Taxonomic Unit					
			HIIN	LEFI	MISP	GUSP	RASP	CNDU
Black Canyon	BLCA	5	-	-	-	0.40	-	0.40
			-	-	-	0.40	-	0.40
Box Springs	BOSP	9	-	2.00	-	-	-	-
			-	1.20	-	-	-	-
Chula Vista	CHVI	8	-	-	-	-	-	-
			-	-	-	-	-	-
Kabian Park	KABI	10	0.40	-	-	0.20	-	-
			0.40	-	-	0.20	-	-
Lake Perris	LAPE	23	14.09	0.87	-	0.09	-	-
			3.61	0.70	-	0.09	-	-
Lake Skinner	LASK	10	-	0.20	-	-	-	-
			-	0.20	-	-	-	-
Limestone Canyon	LICA	23	0.17	0.26	0.09	-	0.52	-
			0.17	0.19	0.09	-	0.23	-
Motte Rimrock Reserve	MRRE	10	1.40	0.40	-	0.20	-	-
			1.19	0.27	-	0.20	-	-
Orange Hills	ORHI	6	-	-	-	-	-	-
			-	-	-	-	-	-
Pamo Valley	PAVA	7	-	-	0.29	0.86	-	-
			-	-	0.29	0.86	-	-
Point Loma	POLO	10	-	-	-	-	0.60	2.00
			-	-	-	-	0.60	0.94
Rancho Mission Viejo	RMVI	10	-	0.20	0.80	-	-	-
			-	0.20	0.44	-	-	-
Sycamore Canyon	SYCA	6	-	-	2.67	-	-	-
			-	-	1.76	-	-	-
Sycamore Hills	SYHI	10	-	-	2.00	-	-	-
			-	-	1.55	-	-	-
Sand Canyon Reservoir	SACA	6	-	0.09	0.55	-	0.27	-
			-	0.09	0.40	-	0.20	-
Santa Margarita	SAMA	5	-	-	0.17	4.61	1.83	-
			-	-	0.12	1.69	0.75	-
Starr Ranch	STRA	22	10.33	1.00	-	-	-	-
			3.36	0.68	-	-	-	-
Sweetwater River	SWRI	23	-	-	2.80	-	-	-
			-	-	1.31	-	-	-
Torrey Pines	TPSP	12	-	1.00	0.83	-	0.67	3.67
			-	0.52	0.58	-	0.38	1.39
UCR	UCR	5	12.00	0.80	-	-	-	-
			7.77	0.49	-	-	-	-
Wild Animal Park	WAPA	14	-	-	0.57	0.29	-	1.00
			-	-	0.57	0.29	-	0.50

Table 10. Continued.

Site	Code	N	Plant Species or Taxonomic Unit					
			YUSP	STSP	ISOC	LECO	MAMA	BRSP
Black Canyon	BLCA	5	0.80	-	-	-	-	-
			0.80	-	-	-	-	-
Box Springs	BOSP	9	-	-	-	-	-	13.78
			-	-	-	-	-	6.41
Chula Vista	CHVI	8	0.50	-	-	-	-	7.00
			0.50	-	-	-	-	3.82
Kabian Park	KABI	10	-	-	-	-	-	0.40
			-	-	-	-	-	0.27
Lake Perris	LAPE	23	-	2.17	-	-	0.35	0.17
			-	1.02	-	-	0.20	0.17
Lake Skinner	LASK	10	-	-	-	-	0.20	-
			-	-	-	-	0.20	-
Limestone Canyon	LICA	23	0.61	-	0.17	1.65	0.09	-
			0.23	-	0.17	0.59	0.09	-
Motte Rimrock Reserve	MRRE	10	-	0.40	-	-	-	-
			-	0.27	-	-	-	-
Orange Hills	ORHI	6	-	-	-	-	-	15.67
			-	-	-	-	-	4.30
Pamo Valley	PAVA	7	0.57	-	-	-	-	-
			0.37	-	-	-	-	-
Point Loma	POLO	10	0.40	-	-	-	0.20	-
			0.40	-	-	-	0.20	-
Rancho Mission Viejo	RMVI	10	-	-	-	-	0.40	-
			-	-	-	-	0.40	-
Sycamore Canyon	SYCA	6	-	-	0.33	-	-	0.33
			-	-	0.33	-	-	0.33
Sycamore Hills	SYHI	10	-	-	-	-	-	-
			-	-	-	-	-	-
Sand Canyon Reservoir	SACA	6	0.09	-	0.09	0.36	0.18	0.27
			0.09	-	0.09	0.21	0.13	0.27
Santa Margarita	SAMA	5	-	-	0.61	-	-	0.26
			-	-	0.37	-	-	0.14
Starr Ranch	STRA	22	-	-	-	-	0.33	0.67
			-	-	-	-	0.33	0.67
Sweetwater River	SWRI	23	-	-	-	-	0.20	1.00
			-	-	-	-	0.20	1.00
Torrey Pines	TPSP	12	1.17	2.33	1.00	-	-	-
			0.58	1.37	0.58	-	-	-
UCR	UCR	5	-	-	-	-	-	5.20
			-	-	-	-	-	4.27
Wild Animal Park	WAPA	14	-	-	0.71	-	-	4.00
			-	-	0.34	-	-	1.29

Table 10. Continued.

Site	Code	N	Detrended Correspondence Analysis	
			DCA1	DCA2
Black Canyon	BLCA	5	1.23 0.17	1.67 0.12
Box Springs	BOSP	9	3.73 0.32	1.81 0.16
Chula Vista	CHVI	8	2.21 0.11	2.81 0.10
Kabian Park	KABI	10	2.29 0.11	1.91 0.06
Lake Perris	LAPE	23	3.61 0.15	1.65 0.09
Lake Skinner	LASK	10	1.67 0.09	1.37 0.13
Limestone Canyon	LICA	23	1.23 0.10	0.97 0.11
Motte Rimrock Reserve	MRRE	10	2.01 0.14	1.12 0.14
Orange Hills	ORHI	6	2.44 0.17	2.48 0.15
Pamo Valley	PAVA	7	1.09 0.28	1.50 0.10
Point Loma	POLO	10	1.48 0.11	3.00 0.12
Rancho Mission Viejo	RMVI	10	1.82 0.07	2.13 0.11
Sycamore Canyon	SYCA	6	2.04 0.06	2.19 0.12
Sycamore Hills	SYHI	10	1.99 0.12	1.95 0.09
Sand Canyon Reservoir	SACA	6	2.01 0.05	1.83 0.06
Santa Margarita	SAMA	5	1.88 0.05	2.04 0.04
Starr Ranch	STRA	22	3.85 0.26	1.20 0.21
Sweetwater River	SWRI	23	1.87 0.11	1.59 0.23
Torrey Pines	TPSP	12	1.69 0.13	1.97 0.13
UCR	UCR	5	4.20 0.12	1.60 0.18
Wild Animal Park	WAPA	14	2.00 0.07	1.99 0.05

Detrended correspondence analysis yielded two axes that we retained as part of the data reduction process (Table 10; Figs. 6-11). The first had an eigenvalue of 0.80, which indicates a robust ordination. Its length was 4.46, which implies that turnover from one extreme point to the other was virtually complete, and that those points shared few, if any, species in common. Although the second axis had a smaller eigenvalue of 0.42, it, too, was relatively long, with a length of gradient = 3.66.

Interpretation of the gradients resulting from the ordination is aided by examining the distribution of plant species and sample sites in the 2-dimensional DCA space (Figs. 6 and 7). The first axis represented a gradient from sites (e.g., the Riverside County sites UCR, Sycamore Canyon [SYCA], Lake Perris [LAPE], and Box Springs [BOSP]; Fig. 6) dominated by species characteristic of inland Riversidian coastal sage scrub (e.g., *Encelia farinosa* [ENFA]; Fig. 7), to those (such as Pamo Valley [PAVA] and Black Canyon [BLCA]) that included a substantial amount of chaparral vegetation (e.g., *Adenostoma fasiculatus* [ADFA]). The second axis contrasted southern coastal sites (e.g., Point Loma [POLO], Chula Vista [CHVI] with species *Encelia californica* [ENCA], *Rhus* spp. [RUSP], *Cneoridium dumosum* [CNDU]) with northern, mainly inland sites (e.g., Limestone Canyon [LICA], Motte Rimrock Reserve [MRRE], Sycamore Canyon with species *Elymus condensatus* [LECO], *Salvia mellifera* [SAME]).

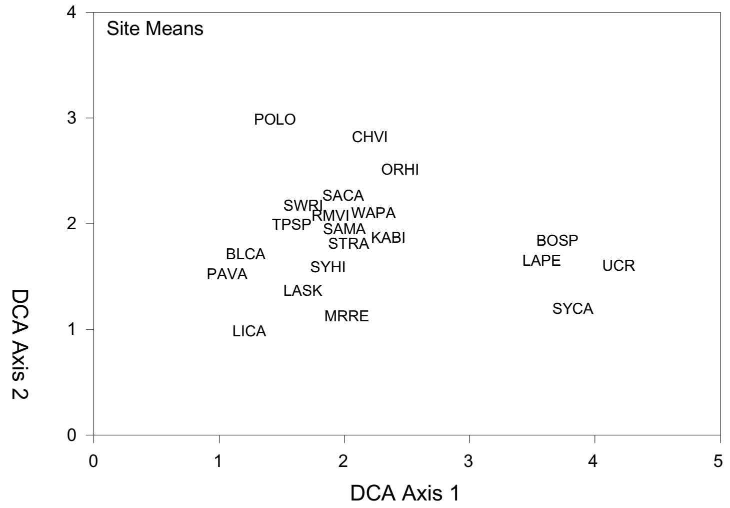


Figure 6. NCCP site mean scores on Detrended Correspondence Analysis axes based on plant species composition. See Table 1 for site codes.

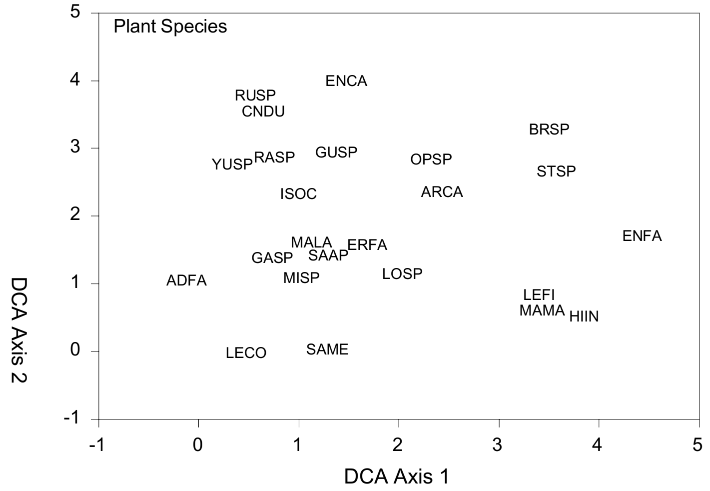


Figure 7. Plant species scores on Detrended Correspondence Analysis axes based on plant species composition. See Table 7 for species codes.

Geographic variation associated with the first DCA axis was evident when mean site scores were contoured onto a map of the sites (Fig. 8). Species turnover between the northern inland Riverside sites and those sites in Orange County was fairly steep, and although the same amount of compositional change occurred between the Riverside sites and southern San Diego County, it was spread over a longer physical distance. The geographical pattern associated with DCA axis 2 was more complex (Fig. 9). Although there was a clear northward trend in decreasing axis 2 scores emanating from the southern-most sites, the pattern became more obscure in Orange and Riverside counties.

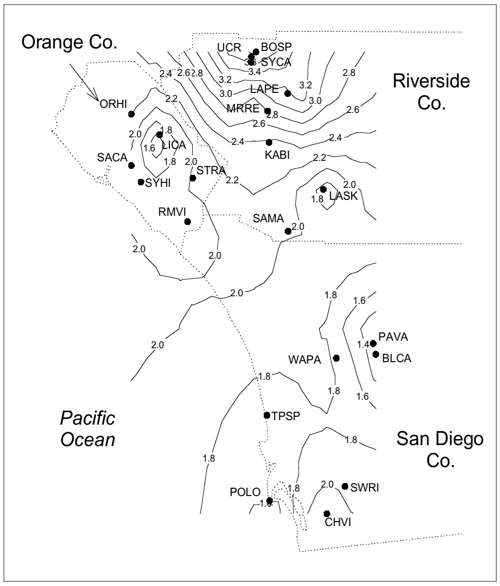


Figure 8. Contour map of NCCP site mean scores on plant species Detrended Correspondence Analysis axis 1. See text for interpretation of axis. See Table 1 for site codes.

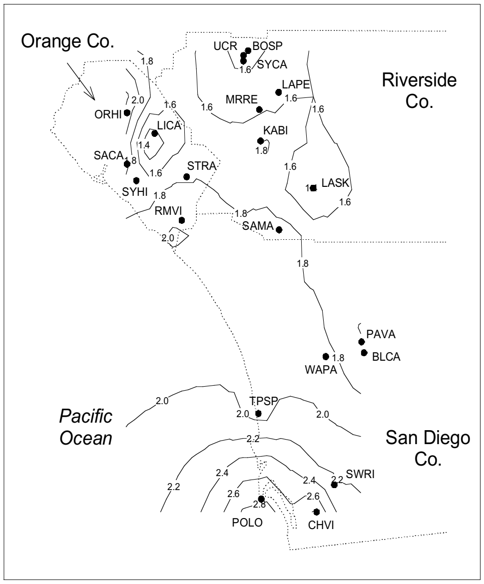


Figure 9. Contour map of NCCP site mean scores on plant species Detrended Correspondence Analysis axis 2. See text for interpretation of axis. See Table 1 for site codes.

There was also substantial among-point within-site heterogeneity in at least some of the sites (Fig. 10). For example, ± 1 standard deviation of point scores on DCA axis 1 at Box Springs spanned over 2 DCA units, and that of Pamo Valley almost as much. However, sites on average varied less on DCA axis 2. In general, points were fairly well scattered throughout the ordination space (Fig. 11), although those associated with the northeastern-most sites in Riverside County appeared distinct from the rest.

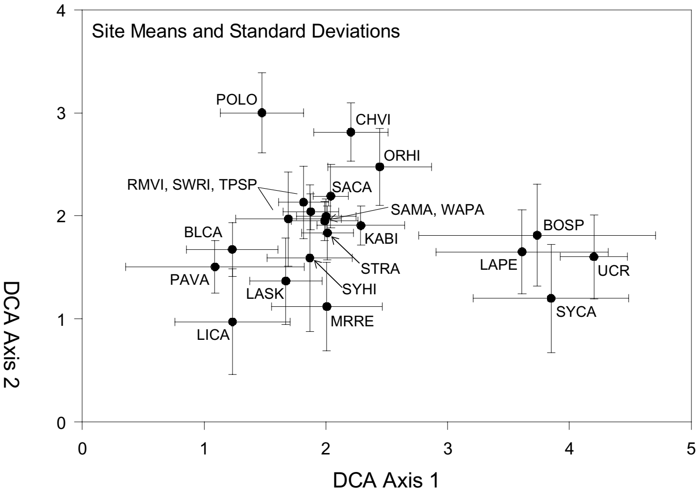


Figure 10. NCCP site mean scores and standard deviations on Detrended Correspondence Analysis axes based on plant species composition. See Table 1 for site codes.

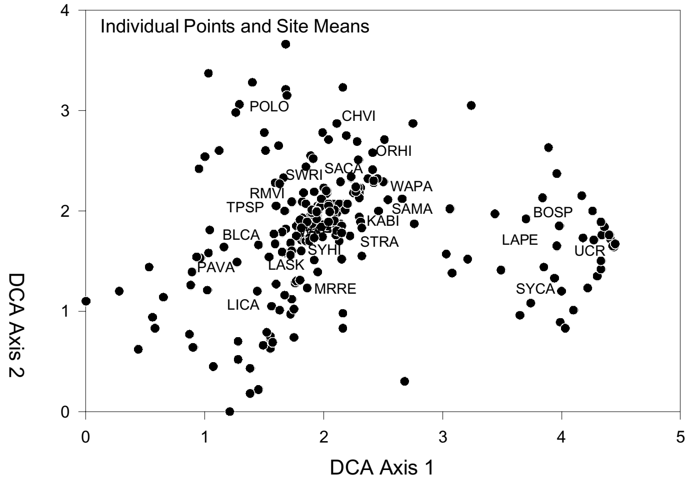


Figure 11. NCCP site point scores on Detrended Correspondence Analysis axes based on plant species composition. See Table 1 for site codes.

LANDSCAPE VARIABLES

The 14 landscape variables differed considerably among sites (Table 11). At some sites, such as Kabian Park (KABI) and Motte Rimrock Reserve (MRRE), nearly 90% of the vegetation type surrounding our points out to a radius of 500 m was CSS, whereas at Black Canyon (BLCA) it was less than 1%. Instead, points at Black Canyon were imbedded in other shrubland types, primarily chaparral (88%). The only sites with substantial native grasslands in the 78 ha surrounding each point were Rancho Mission Viejo (RMVI) (17%) and Starr Ranch (STRA,12%), and the former also had the highest proportion of riparian vegetation nearby (16%). The highest proportion of woodland was at Torrey Pines state Park (TPSP) (20%), which, along with Point Loma (POLO), the other site on the coast, also had high aquatic habitat type (16% and 25%, respectively). Chula Vista (CHVI) and Orange Hills (ORHI) were in the most urbanized landscapes (58% and 52%, respectively), whereas Santa Margarita (SAMA) contained the most agriculture (23%, mainly orchards). Points at CHVI and ORHI were also on average the second and third closest to urban boundaries (92 and 96 m), although POLO, situated on a relatively narrow peninsula, was closest (76 m). By any of the perimeter-based measures, RMVI contained the most dissected shrubland habitat.

Table 11. Means and standard errors of landscape variables measured within a 500-m radius of points at NCCP coastal sage scrub survey sites, 1996, and principal component factor scores derived from those measures. See Table 4 for variable codes.

Site	Code	N	Landscape Habitat Class (area in m^2)				
			AGRIC	AQUAT	CSS	NATGR	EXGR
Black Canyon	BLCA	5	12620	-	5461	-	-
			10599	-	3135	-	-
Box Springs	BOSP	9	13282	-	360979	-	69775
			7750	-	53363	-	24459
Chula Vista	CHVI	8	-	-	316938	54	-
			-	-	32328	54	-
Dawson Canyon	DACA	5	-	-	660786	-	19974
			-	-	8056	-	3682
Kabian Park	KABI	10	-	2856	684879	-	27362
			-	2478	18583	-	8332
Lake Perris	LAPE	23	382	70642	327756	-	279519
			382	25312	17513	-	29668
Lake Skinner	LASK	10	-	9485	372958	-	273640
			-	5265	46187	-	45538
Limestone Canyon	LICA	23	-	33672	341798	688	60817
			-	14855	42144	432	15237
Motte Rimrock Reserve	MRRE	10	137	-	687206	-	63089
			137	-	14076	-	16733
Orange Hills	ORHI	6	13546	-	296149	-	36657
			8181	-	28189	-	4394
Pamo Valley	PAVA	7	-	-	237845	-	-
			-	-	111200	-	-
Point Loma	POLO	10	-	193174	330455	-	-
			-	39170	21130	-	-
Rancho Mission Viejo	RMVI	10	-	-	264765	126946	38017
			-	-	12453	12114	17027
Sand Canyon Reservoir	SACA	6	97661	16121	138526	-	446023
			38935	6454	10117	-	45718
Santa Margarita	SAMA	5	176667	-	336945	-	4330
			37037	-	47480	-	3098
Starr Ranch	STRA	22	204	917	329014	94498	37223
			204	917	18746	14854	14010
Sweetwater River	SWRI	23	-	-	638468	30799	-
			-	-	23071	11722	-
Sycamore Canyon	SYCA	6	46566	-	492896	-	160657
			726	-	36784	-	24120
Sycamore Hills	SYHI	10	-	5104	407366	-	77994
			-	3411	25647	-	29957
Torrey Pines	TPSP	12	-	123075	102590	16382	-
			-	34203	12491	5320	-
UCR	UCR	5	3843	-	556787	-	16630
			3037	-	42648	-	7390
Wild Animal Park	WAPA	14	33320	932	468551	45582	-
			15115	932	28267	14104	-

Table 11. Continued.

Site	Code	N	Landscape Habitat Class (area in m^2)			
			WOOD	URBAN	SHRB	RIP
Black Canyon	BLCA	5	748	-	686554	75543
			748	-	22614	10743
Box Springs	BOSP	9	798	240094	96263	-
			700	30990	53741	-
Chula Vista	CHVI	8	-	454701	-	9410
			-	35208	-	3589
Dawson Canyon	DACA	5	19264	-	81610	-
			5668	-	9792	-
Kabian Park	KABI	10	-	50163	15222	470
			-	20239	4240	470
Lake Perris	LAPE	23	-	103017	-	-
			-	17860	-	-
Lake Skinner	LASK	10	-	7727	72995	43823
			-	4517	24938	23738
Limestone Canyon	LICA	23	50461	6064	219854	65898
			10621	3920	45655	12520
Motte Rimrock Reserve	MRRE	10	-	31082	-	-
			-	13057	-	-
Orange Hills	ORHI	6	-	402553	31654	-
			-	30090	11652	-
Pamo Valley	PAVA	7	-	-	494123	49589
			-	-	95438	18177
Point Loma	POLO	10	543	171950	79340	-
			291	40807	12010	-
Rancho Mission Viejo	RMVI	10	60566	3767	147146	118697
			9982	3376	16201	7184
Sand Canyon Reservoir	SACA	6	-	23199	27697	30036
			-	4242	10666	13778
Santa Margarita	SAMA	5	71137	3294	178234	10542
			9040	1511	39184	6515
Starr Ranch	STRA	22	69363	11746	181069	55511
			12129	11746	26102	10096
Sweetwater River	SWRI	23	-	63475	-	48867
			-	17517	-	8069
Sycamore Canyon	SYCA	6	-	81456	-	1231
			-	17955	-	424
Sycamore Hills	SYHI	10	46	186981	84462	17896
			46	41515	10605	5335
Torrey Pines	TPSP	12	153446	119246	240874	-
			22015	43112	24859	-
UCR	UCR	5	-	203633	-	-
			-	35060	-	-
Wild Animal Park	WAPA	14	4258	134968	80846	6234
			1288	27403	26848	1942

Table 11. Continued.

Site	Code	N	Landscape Habitat Class (distances in m)				
			CSS_PA	CSS_P	SHRB_P	EDGEDIST	URBDIST
Black Canyon	BLCA	5	0.038	351.75	5042.04	205.27	1079.31
			0.016	205.54	296.79	40.93	78.84
Box Springs	BOSP	9	0.014	3792.96	1274.40	77.93	115.69
			0.003	409.77	697.82	25.26	30.66
Chula Vista	CHVI	8	0.013	4058.62	-	91.91	91.91
			0.001	439.82	-	17.16	17.16
Dawson Canyon	DACA	5	0.011	7461.90	3124.72	40.63	1005.38
			0.000	230.53	311.97	23.55	33.20
Kabian Park	KABI	10	0.006	4238.14	463.83	173.79	376.95
			0.000	227.76	113.45	34.94	53.15
Lake Perris	LAPE	23	0.009	2895.71	-	57.68	394.29
			0.000	162.92	-	11.47	132.96
Lake Skinner	LASK	10	0.018	6344.48	1868.75	47.52	528.03
			0.002	896.22	434.18	13.04	88.06
Limestone Canyon	LICA	23	0.024	6202.46	2956.23	56.37	1022.02
			0.003	544.42	645.10	7.35	102.50
Motte Rimrock Reserve	MRRE	10	0.005	3644.78	-	237.53	403.18
			0.000	97.50	-	31.84	38.86
Orange Hills	ORHI	6	0.014	4054.52	1049.33	91.90	95.95
			0.000	331.86	371.78	15.50	16.85
Pamo Valley	PAVA	7	0.030	1604.12	3416.99	210.56	4627.68
			0.021	592.09	449.44	28.23	132.62
Point Loma	POLO	10	0.022	7183.67	4502.28	43.19	76.09
			0.001	507.91	623.55	8.43	20.58
Rancho Mission Viejo	RMVI	10	0.044	11566.56	7354.88	20.12	600.00
			0.002	412.65	610.59	6.12	59.40
Sand Canyon Reservoir	SACA	6	0.032	4488.89	1261.77	16.29	317.73
			0.001	325.10	335.73	2.58	27.37
Santa Margarita	SAMA	5	0.018	5512.33	3054.85	54.92	359.83
			0.003	149.49	538.00	11.46	80.84
Starr Ranch	STRA	22	0.025	8119.98	4507.19	37.82	1561.10
			0.001	280.79	583.98	5.26	98.48
Sweetwater River	SWRI	23	0.007	4112.81	-	190.11	405.88
			0.000	164.98	-	25.58	55.40
Sycamore Canyon	SYCA	6	0.010	4938.74	-	166.66	279.65
			0.001	282.00	-	31.07	51.30
Sycamore Hills	SYHI	10	0.016	6651.76	4183.52	53.26	207.77
			0.001	413.62	408.22	14.56	33.40
Torrey Pines	TPSP	12	0.022	2034.34	4069.78	32.40	395.25
			0.002	233.17	578.01	9.30	78.69
UCR	UCR	5	0.007	4038.52	-	175.69	311.55
			0.000	243.16	-	39.60	103.56
Wild Animal Park	WAPA	14	0.009	4098.54	1587.88	112.50	202.70
			0.001	243.19	498.74	18.93	34.13

Table 11. Continued.

Site	Code	N	Landscape Principal Components				
			LAFACT1	LAFACT2	LAFACT3	LAFACT4	LAFACT5
Black Canyon	BLCA	5	2.77	-1.76	-0.18	-0.03	-0.03
			0.29	0.17	0.09	0.04	0.28
Box Springs	BOSP	9	-0.14	-0.49	-0.32	1.02	0.17
			0.29	0.08	0.03	0.25	0.13
Chula Vista	CHVI	8	-0.36	-0.21	-0.44	2.37	-0.22
			0.04	0.06	0.04	0.26	0.06
Dawson Canyon	DACA	5	-0.53	0.18	-0.42	-0.70	-0.84
			0.07	0.04	0.07	0.02	0.01
Kabian Park	KABI	10	-0.96	-0.36	-0.38	-0.32	-0.70
			0.03	0.03	0.03	0.14	0.06
Lake Perris	LAPE	23	-0.61	-0.96	0.51	-0.46	1.06
			0.03	0.05	0.23	0.14	0.21
Lake Skinner	LASK	10	0.00	-0.36	-0.45	-1.26	0.94
			0.25	0.18	0.13	0.07	0.31
Limestone Canyon	LICA	23	0.62	-0.04	0.16	-0.73	-0.23
			0.29	0.19	0.19	0.07	0.11
Motte Rimrock Reserve	MRRE	10	-1.05	-0.48	-0.35	-0.49	-0.48
			0.02	0.02	0.01	0.11	0.10
Orange Hills	ORHI	6	-0.19	-0.27	-0.40	2.08	0.13
			0.05	0.03	0.01	0.25	0.17
Pamo Valley	PAVA	7	1.21	-1.14	-0.24	-0.27	-0.44
			0.86	0.19	0.05	0.10	0.32
Point Loma	POLO	10	0.13	-0.23	1.19	0.25	-0.83
			0.12	0.11	0.38	0.31	0.08
Rancho Mission Viejo	RMVI	10	1.36	2.53	-0.52	-0.57	-0.09
			0.13	0.11	0.13	0.05	0.15
Sand Canyon Reservoir	SACA	6	0.42	-0.46	-0.27	-0.80	3.75
			0.09	0.23	0.19	0.25	0.33
Santa Margarita	SAMA	5	0.35	0.58	-0.00	0.61	1.99
			0.21	0.16	0.10	0.23	0.61
Starr Ranch	STRA	22	0.54	1.51	0.07	-0.28	-0.16
			0.15	0.24	0.17	0.12	0.15
Sweetwater River	SWRI	23	-0.78	0.03	-0.56	-0.21	-0.77
			0.05	0.12	0.04	0.13	0.04
Sycamore Canyon	SYCA	6	-0.71	-0.24	-0.43	-0.14	0.97
			0.06	0.05	0.02	0.11	0.19
Sycamore Hills	SYHI	10	0.12	-0.06	-0.58	0.36	-0.23
			0.03	0.07	0.04	0.32	0.17
Torrey Pines	TPSP	12	0.61	-0.01	2.59	0.76	-0.21
			0.20	0.16	0.51	0.28	0.07
UCR	UCR	5	-0.83	-0.31	-0.40	0.73	-0.47
			0.07	0.03	0.02	0.25	0.13
Wild Animal Park	WAPA	14	-0.37	0.17	-0.32	0.72	-0.09
			0.09	0.19	0.03	0.29	0.28

A principal components analysis of the 12 composition-based landscape variables (excluding EDGEDIST and URBDIST) yielded 5 factors with eigenvalues greater than 1, collectively accounting for almost three-quarters of the variation in the original data set (Table 12). The first component (chaparral vs. CSS) contrasted landscapes dominated by CSS (high negative scores) vs. those dominated by other shrublands (mainly chaparral) and riparian (high positive scores). As the amount of CSS decreased, the CSS perimeter/area ratio increased. The second component (native mosaic) described a gradient of increasing intermixing of native grasslands, woodlands, and CSS. The third component (aquatic/riparian) described a gradient of increasing aquatic habitats and fringing riparian woodlands. The fourth component (urban) was one of increasing urban landscape types, with all other variables near zero or slightly negatively associated with this factor. The fifth factor (ag/exotic) was associated with increasing agriculture and exotic grasslands, which is just as well since these two types can be difficult to distinguish with many forms of remote sensing. These five landscape factors, along with EDGEDIST and URBDIST, were retained for further analyses.

Table 12. Principal components analysis of landscape variables. Entries are factor loadings after varimax rotation of four components. Bold denotes factor loadings > 0.5. See Table 4 for variable codes.

Variable	Landscape Components				
	LAFAC1	LAFAC2	LAFAC3	LAFAC4	LAFAC5
SHRB_A5	**0.89**	-0.20	0.06	-0.05	-0.16
SHRB_P5	**0.81**	0.24	-0.01	-0.10	-0.24
RIP_A5	**0.61**	0.28	-0.27	-0.32	-0.17
CSS_A5	**-0.74**	0.03	-0.38	-0.27	-0.38
CSS_P_A5	**0.79**	0.27	0.09	-0.03	0.18
CSS_P5	0.06	**0.74**	-0.23	-0.31	-0.10
NATGR_A5	0.12	**0.82**	0.07	0.02	0.03
WOOD_A5	0.13	**0.53**	**0.64**	-0.00	0.05
AQUAT_A5	0.03	-0.19	**0.83**	-0.10	-0.15
URBAN_A5	-0.12	-0.16	-0.11	**0.90**	0.01
AGRIC_A5	0.03	0.08	-0.07	0.20	**0.59**
EXGR_A5	-0.19	-0.19	-0.04	-0.37	**0.77**
Component name	chaparral vs. CSS	native mosaic	aquatic/ riparian	urban	ag/exotic
Eigenvalue	3.09	1.84	1.40	1.27	1.27
% Total variance	25.7	15.4	11.7	10.6	10.6
Cumulative variance	25.7	41.1	52.8	63.4	74.0

As before, we can examine sites at the extremes of the components to gain additional insight into the sort of variation each landscape factor represents (Table 11; Fig. 12A and 12B). Landscape factor 1 contrasted Motte Reserve (MRRE, high negative) with Black Canyon (BLCA, high positive); the former is dominated by CSS whereas the latter contains mainly other shrublands (chaparral). Component 2 ranges from BLCA (negative) to Rancho Mission Viejo (RMVI, positive); BLCA had no native grasslands or woodlands, whereas RMVI had the highest proportion of each. The contrast between Sycamore Hills (SYHI), with no vegetation in the woodland or aquatic classes, and Torrey Pines (TPSP), which was highest in both, defined the ends of landscape component 3. Chula Vista (CHVI) and Orange Hills (ORHI) defined the high end of the urbanization component (factor 4), and contrasted with Lake Skinner (LASK) and several other sites with very little landscape in the urban class. Sand Canyon (SACA) had the most agricultural/exotic grasslands (factor 5), whereas several sites (e.g., Dawson Canyon [DACA] and Point Loma [POLO]) had little.

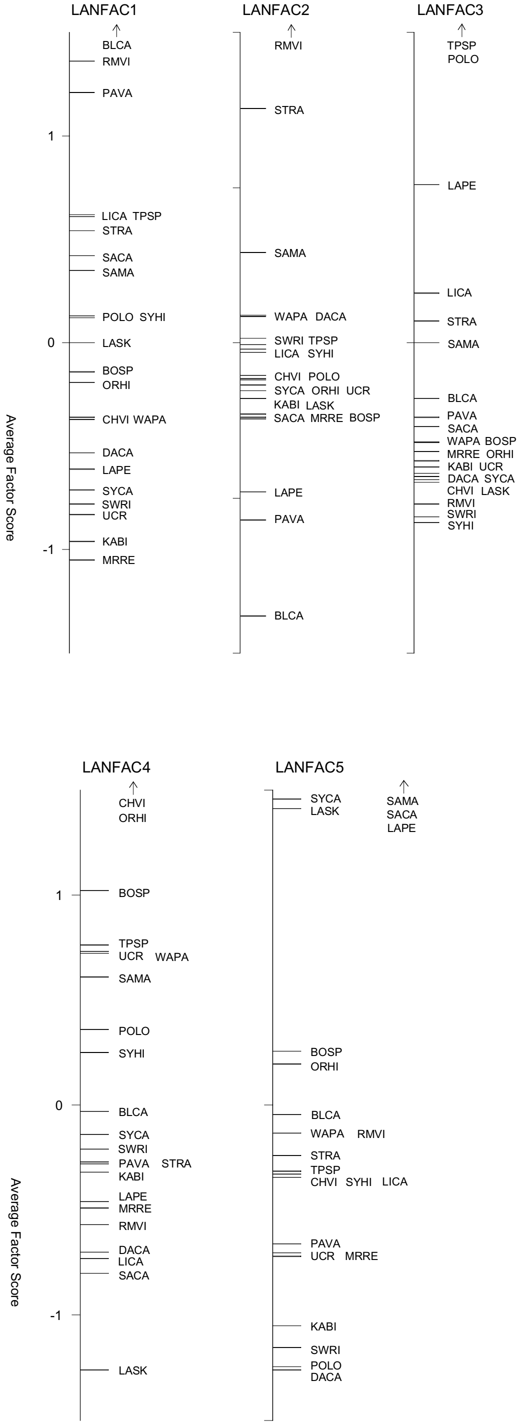


Figure 12A and B. Ordination of NCCP study sites on (top) the first three and (bottom) the last two of five principal components derived from landscape variables. See Table 12 for interpretation of components. See Table 1 for site codes.

These landscape compositional components were also correlated with the position of each point in the landscape with respect to habitat edges (EDGEDIST) and urban boundaries (URBDIST). For example, factors 1 (chaparral vs. CSS), 2 (native mosaic), 3 (aquatic/riparian), and 5 (ag/exotic) were all negatively correlated with distance from edge (r s = -0.25, -0.28, -0.20, and -0.21, respectively; df = 225; all P < 0.001). Thus, points closer to ecotones (i.e., boundaries between two habitat types; to be distinguished from edges, which we take as boundaries associated with human development) were more likely to be CSS rather than other shrublands. Likewise, such points were also more likely to be associated with other distinct vegetation classes in the landscape, such as native grasslands, woodlands, aquatic, and ag/exotic grasslands. These overlapping patterns reflected the relatively low r^2 values (all < 10%) associated with these statistically significant correlations with independent factors. Factor 1 was positively correlated with distance to an urban edge (r = 0.25; df = 225; P < 0.001), reflecting the fact that CSS, at least at the sites we selected, was more likely than chaparral to be embedded in an urbanizing matrix. Not surprisingly, factor 4 (increasing urban component to the landscape) was negatively correlated with distance to an urban edge (r = -0.32; df = 225; P < 0.001).

There were no simple geographical patterns to variation in the landscape components. None of the bivariate correlations of average site landscape factors with site east or north UTMs was statistically significant (all P > 0.05, df = 19). There was a tendency for factor 2 (native mosaic) to decrease with east UTM (r = -0.41, P = 0.06, df = 19), implying that points in more western sites had greater association with native grassland and woodland at the landscape scale.

Non-metric multidimensional scaling of the sites based on the five landscape components was not particularly informative (Fig. 13), although stress associated with two NMS axes was only slightly higher (0.168) than for structural components. NMS axis 1 was correlated only with factor 5 (r = 0.64; all other r s < |0.5|), whereas NMS axis 2 was correlated with factors 1, 4, and 5 (r s = -0.52, 0.60, and -0.63, respectively; all other r s < |0.4|). Overall, SACA and TPSP were the most dissimilar sites with respect to landscape composition.

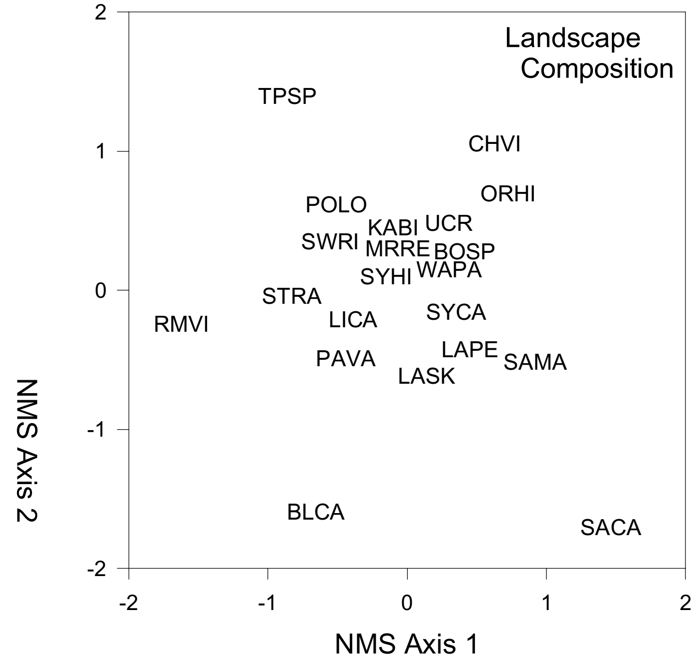


Figure 13. Non-metric multidimensional scaling ordination of NCCP study sites based on site mean values for five landscape principal components. See Table 1 for site codes.

RELATIONSHIPS AMONG SUMMARY VARIABLES

To conclude our description of the baseline habitat variables against which we will compare animal species distributions, we examined the correlations among the new, synthetic axes, and including the several raw variables that survived the variable reduction process (Table 13). Not only did this help our continued interpretation of each of the synthetic variables, it also alerts us to patterns of intercorrelation that may influence the outcome of subsequent analyses (mostly regression-based) of animal species habitat associations. We note that since there are 120 correlations possible among the 16 quantitative variables (7 structure + 2 floristic + 7 landscape), we would expect spurious significance among 5% of them, by the usual $P < 0.05$ criterion for significance. In recognition of this, we indicate several conventional levels of statistical significance, with the caveat that the most reliable relationships are those with $P < 0.0004$, which is the Bonferroni-adjusted significance level for alpha = 0.05 and 120 tests.

Habitat Structure

Habitat structural variables measured at the local scale were highly correlated with both local-scale species composition as well as landscape-level vegetation class composition (Table 13A). This confirmed that the two scales were linked. Even confining our interpretations to the most reliable correlations ($P < 0.0004$), several generalizations were possible:

(1) Cryptogamic soil crusts (PC_CRYP) were less likely to be found in landscapes composed primarily of natural grasslands and woodlands (LAFAC2).
(2) Local-scale native grass coverage (PC_BNGRS) increased, not surprisingly, in landscapes dominated by native grasslands and woodlands (LAFAC2). Grass coverage was also strongly associated with ecotones (EDGEDIST).
(3) Coverage of trees (PC_TREE) in our samples was not strongly associated with any other attribute.
(4) The grassland-shrubland structural gradient (STFAC1) was highly correlated with landscapes more dominated by shrublands other than CSS, native mosaics, and aquatic/riparian woodlands (STFAC1, 2, and 3), and with increasing local abundance of species more commonly associated with chaparral than with CSS (DCA1). Grassland structure was more prevalent closer to ecotones.
(5) Ground litter increased and bare ground decreased (STFAC2) as the abundance of CSS species decreased (DCA1). Likewise, litter increased and bare ground decreased closer to ecotones.
(6) Forbs and patchier small-scale vegetation structure (STFAC3) were not strongly associated with any other attribute in our samples.
(7) Habitat structure characteristic of local disturbance (more *Brassica* and more standing dead; STFAC4) was less likely in landscapes with increasing proportion of native grasslands (LAFAC2).

Table 13. Correlations among final sets of reduced and synthesized variables. Entries for quantitative variables indicate significance level of correlation; entries for qualitative variables indicate significance level of ANOVA (* denotes $P < 0.05$, ** denotes $P < 0.01$, *** denotes $P < 0.001$, **** denotes $P \leq 0.0004$). Parentheses denote negative associations. See Tables 3 and 4 for variable codes. See Tables 8 and 12 for description of principal components.

Variable Set	Variables	A. Habitat Structure						
		GC_CRYP	PC_BNGR	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4
Floristic	DCA 1			(*)	(****)	(****)	**	***
	DCA 2			(**)				(*)
Landscape	LAFAC1		***		****	*		
	LAFAC2	(****)	****		****	*		(****)
	LAFAC3				****		(*)	**
	LAFAC4							
	LAFAC5					*		
	EDGEDIST	*	(****)	(*)	(****)	(****)		
	URBDIST			*			(*)	

		B. Floristic Composition	
		DCA 1	DCA 2
Structure	GC_CRYP		
	PC_BNGRS		
	PC_TREE	(*)	(**)
	STFAC1	(****)	
	STFAC2	(****)	
	STFAC3	**	
	STFAC4	***	(*)
Landscape	LAFAC1	(****)	
	LAFAC2	(*)	
	LAFAC3		
	LAFAC4	*	****
	LAFAC5	****	
	EDGEDIST		
	URBDIST	(****)	(**)

		C. Landscape Composition						
		LAFAC1	LAFAC2	LAFAC3	LAFAC4	LAFAC5	EDGEDIST	URBDIST
Floristic	DCA 1	(****)	(*)		*	****		(****)
	DCA 2				****			(**)
Structure	GC_CRYP		(****)				*	
	PC_BNGRS	***	****				(****)	
	PC_TREE						(*)	*
	STFAC1	****	****	****			(****)	
	STFAC2	*	*			*	(****)	
	STFAC3			(*)				(*)
	STFAC4		(****)	**				

Table 13. Continued

Variable Set	Variables	D. Qualitative Variables		
		CACTUS	ROCK	TRAIL
Floristic	DCA 1	(**)	****	
	DCA 2	*		
Structure	GC_CRYP	(*)	**	
	PC_BNGRS		(*)	
	PC_TREE	*	(**)	
	STFAC1	****	(****)	
	STFAC2		(****)	
	STFAC3			
	STFAC4		**	
Landscape	LAFAC1	*	(****)	
	LAFAC2	****	(****)	
	LAFAC3			
	LAFAC4	*		**
	LAFAC5			
	EDGEDIST	(****)	****	
	URBDIST			

Floristic Composition

Variation in locally-measured plant species composition was not only associated with locally-measured structural variables, as expected, it was also associated with landscape composition, further confirming a linkage between the two scales (Table 13B). Some generalizations include:

(1) The shift from assemblages dominated by CSS-type species to those dominated by chaparral-type species (DCA1) was associated with a greater shrubland-like physical structure (STFAC1) and more litter and less bare ground (STFAC2). CSS-type species assemblages were more likely to occur in landscapes with higher proportions of CSS habitat type (LAFAC1; a result that would have been more surprising by its absence). In our samples, CSS species assemblages were less common in landscapes with a large urban component (LAFAC5), and were further away from urban edges. One may infer the opposite relationships for assemblages dominated by chaparral-type species.

(2) Assemblages present in the northern, inland portion of the study region that were not particularly CSS-types (since DCA2 is largely uncorrelated with DCA axis 1) were associated with increasing proportion of urbanization in the landscape.

The foregoing suggests that we selected CSS-type sites that were in relatively good condition and, at least out to 500 m, not near sources of anthropogenic disturbance. In contrast, it appears that we were somewhat more constrained in our selection of points that were in shrublands other than CSS. This may represent the fact that the more chaparral-type sites were more often located in Orange or coastal San Diego counties, which are more urbanized than the inland areas.

Landscape Composition

Landscape components were correlated with a variety of local-level features (Table 13C). Some general patterns that emerged included:

(1) As landscape composition changed from domination by CSS to domination by other shrublands (LAFAC1), local species composition (DCA1) changed in parallel. This change was associated with an even more shrubland-like (as opposed to grassland-like) local structure.
(2) As the proportion of native grasslands and woodlands increased in the landscape (LAFAC2), there was more local grass coverage (PC_BNGRS) but reduced cryptogamic crust coverage (GC_CRYP). This change was also correlated with increasing shrubland (as opposed to grassland) local structure (STFAC1) and decreasing evidence of local disturbance (standing dead and *Brassica*, STFAC4).
(3) There was also greater local shrubland structural development (STFAC1) as the proportion of riparian woodlands and aquatic habitat in the landscape increased (LAFAC3).
(4) Increasing urbanization in the landscape (LAFAC4) was not associated with any local structural elements, but was correlated with a shift in local plant species composition, especially species other than those typical of CSS (DCA2).
(5) Increasing agriculture/exotic grasslands in the landscape (LAFAC5) was strongly associated with a shift in composition from CSS to other shrublands (DCA1).

The landscape distance measures were also associated with local features of points:

(1) The cover of grasses (PC_BNGRS) decreased away from habitat ecotones (EDGEDIST). Points farther from ecotones had more shrub cover (STFAC1), whereas those closer had more grass and litter cover (STFAC2).
(2) Points further from urban boundaries (URBDIST) had a more CSS-like assemblage of plant species (DCA1).

For the qualitative variables, we observed that cactus clumps and rock outcrops were strongly negatively associated, as were cactus clumps and trails. However, there was no association between rock outcrops and trails. Thus, to summarize these and other patterns (Table 13D):

(1) Large cactus clumps did not occur in rocky areas.
(2) Trails avoided areas with large cactus clumps, but not rock outcrops.
(3) At a local scale, large cactus clumps were associated with increasing shrubland-like structure (STFAC1), and at a landscape scale they were associated with increasing natural mosaic (LAFAC2). They were more prevalent closer to ecotones (EDGEDIST).
(4) At a local scale, rocky outcrops were associated with typical CSS plant species assemblage (DCA1), and was more likely to occur at points which were structurally shrublands rather than grasslands (STFAC1), containing more bare ground than litter (STFAC2). They were more common in landscapes dominated by CSS rather than chaparral (LAFAC1) and less common in natural mosaics (LAFAC2). They were less prevalent closer to ecotones (EDGEDIST).

V. VERTEBRATE DISTRIBUTION AND DIVERSITY IN COASTAL SAGE SCRUB

COMPOSITION OF ANIMAL COMMUNITIES

SPECIES DETECTED

Throughout the three-year period we detected a total of 108 bird and 13 small mammal species (Tables 14-16). Species varied substantially in their distribution and abundance as indexed by the number of points and the number of sites at which they were detected. We classed as rare 68 bird and 5 small mammal species that occurred on less than 4% of the total number of points surveyed for each taxon throughout the entire study (Tables 15, 16). Although we included rare species in estimating species richness at a point, we excluded them from further community-level analyses (e.g., DCA). Most of these species were truly rare; of them, 16 birds were only detected once, 10 only twice, 5 only three times, and 4 only four times out of 914 opportunities (Tables 17-21). Four mammal species were trapped at 7 or fewer points (out of 534 opportunities; Tables 22-25).

Because of the sampling technique employed, some finer resolution of the local abundance of small mammals was possible (Table 26). However, patterns in the absolute number of individuals captured closely mirrored patterns in presence/absence (compare Table 26 to Tables 22-25). Therefore further analyses of small mammal distributions were conducted on presence/absence data to be consistent with those undertaken for birds.

Species associated with urbanization (e.g., house mice, Rock Doves, European Starlings, House Sparrows) were rare in our samples, reflecting the fact that we endeavored to locate our points at some distance from human development. Several species of special concern in the region (e.g., Stephens kangaroo rat, Horned Lark, Bell s Vireo) were also rare in our samples, principally because their habitat affinities lie not with coastal sage scrub, our target vegetation type. Raptors and swallows were also uncommon in our samples, as these groups are poorly sampled by point counts such as ours.

Of the remaining species, 33 birds and 8 small mammals (indicated in Tables 15, 16) occurred on at least 10% of the points during at least one survey period (Tables 17-25). We retained these species for additional analysis of vertebrate habitat relationships. The remaining 7 bird species (which were detected at 5-10% of points surveyed) were included in community-level analyses, but had sample sizes insufficient to support analyses of habitat relationships.

Several species were widespread and quite abundant. California Towhees, for example, appeared on over 85% of our point surveys. Cactus mice, Wrentits, and Spotted Towhees occurred on almost two-thirds of our surveys, and San Diego woodrats, Bewick s Wrens, and House Finches on roughly one-half. Although not necessarily limited to coastal sage scrub vegetation type, these seven species can certainly be considered characteristic of it.

Of the common bird species, two were primarily fall-winter visitors, abundant only on fall surveys (Ruby-crowned Kinglet and Yellow-rumped Warbler). Thirteen were primarily spring-summer migrants, breeding in the region and commonly detected only on spring surveys (Ash-throated

Flycatcher, Black-chinned Sparrow, Black-headed Grosbeak, Canyon Wren, Common Yellowthroat, Costa s Hummingbird, Grasshopper Sparrow, House Wren, Lazuli Bunting, Mourning Dove, Phainopepla, Orange-crowned Warbler, and Song Sparrow).

Table 14. Codes, common names, and scientific names of all birds detected during NCCP surveys, 1995-1997. List is sorted in AOU checklist order.

Code	Common Name	Scientific Name
GTBH	Great Blue Heron	*Ardea herodias*
BCNH	Black-crowned Night Heron	*Nycticorax nycticorax*
TUVU	Turkey Vulture	*Cathartes aura*
SSHA	Sharp-shinned Hawk	*Accipiter striatus*
WTSW	White-throated Swift	*Aeronautes saxatalis*
COHA	Cooper's Hawk	*Accipiter cooperii*
RTHA	Red-tailed Hawk	*Buteo jamaicensis*
AMKE	American Kestrel	*Falco sparverius*
CAQU	California Quail	*Callipepla californica*
KILL	Killdeer	*Charadrius vociferus*
RODO	Rock Dove	*Columba livia*
BTPI	Band-tailed Pigeon	*Columba fasciata*
WWDO	White-winged Dove	*Zenaida asiatica*
MODO	Mourning Dove	*Zenaida macroura*
GRRO	Greater Roadrunner	*Geococcyx californianus*
LENI	Lesser Nighthawk	*Chordeiles acutipennis*
BCHU	Black-chinned Hummingbird	*Archilochus alexandri*
ANHU	Anna's Hummingbird	*Calypte anna*
COHU	Costa's Hummingbird	*Calypte costae*
RUHU	Rufous Hummingbird	*Selasphorus rufus*
ACWO	Acorn Woodpecker	*Melanerpes formicivorus*
NUWO	Nuttall's Woodpecker	*Picoides nuttallii*
NOFL	Northern Flicker	*Colaptes auratus*
WEWP	Western Wood-pewee	*Contopus sordidulus*
PSFL	Pacific-slope Flycatcher	*Empidonax difficilis*
BLPH	Black Phoebe	*Sayornis nigricans*
SAPH	Say's Phoebe	*Sayornis saya*
ATFL	Ash-throated Flycatcher	*Myiarchus cinerascens*
CAKI	Cassin's Kingbird	*Tyrannus vociferans*
WEKI	Western Kingbird	*Tyrannus verticalis*

Table 14. Continued.

Code	Common Name	Scientific Name
HOLA	Horned Lark	*Eremophila alpestris*
TRSW	Tree Swallow	*Tachycineta bicolor*
VGSW	Violet-green Swallow	*Tachycineta thalassina*
NRWS	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
BASW	Bank Swallow	*Riparia riparia*
CLSW	Cliff Swallow	*Hirundo pyrrhonota*
BARS	Barn Swallow	*Hirundo rustica*
SCJA	Western Scrub-Jay	*Aphelocoma californica*
AMCR	American Crow	*Corvus brachyrhynchos*
CORA	Common Raven	*Corvus corax*
PLTI	Plain Titmouse	*Parus inornatus*
COBU	Common Bushtit	*Psaltriparus minimus*
WBNU	White-breasted Nuthatch	*Sitta carolinensis*
CACW	Cactus Wren	*Campylorhynchus brunneicapillus*
ROWR	Rock Wren	*Salpinctes obsoletus*
CANW	Canyon Wren	*Catherpes mexicanus*
BEWR	Bewick's Wren	*Thryomanes bewickii*
HOWR	House Wren	*Troglodytes aedon*
WIWR	Winter Wren	*Troglodytes troglodytes*
RCKI	Ruby-crowned Kinglet	*Regulus calendula*
BGGN	Blue-gray Gnatcatcher	*Polioptila caerulea*
BTGN	Black-tailed Gnatcatcher	*Polioptila melanura*
CAGN	California Gnatcatcher	*Polioptila californica*
WEBL	Western Bluebird	*Sialia mexicana*
HETH	Hermit Thrush	*Catharus guttatus*
AMRO	American Robin	*Turdus migratorius*
WREN	Wrentit	*Chamaea fasciata*
NOMO	Northern Mockingbird	*Mimus polyglottos*
CATH	California Thrasher	*Toxostoma redivivum*
CEDW	Cedar Waxwing	*Bombycilla cedrorum*
PHAI	Phainopepla	*Phainopepla nitens*
LOSH	Loggerhead Shrike	*Lanius ludovicianus*
EUST	European Starling	*Sturnus vulgaris*

Table 14. Continued.

Code	Common Name	Scientific Name
BEVI	Bell's Vireo	*Vireo bellii*
SOVI	Solitary Vireo	*Vireo solitarius*
HUVI	Hutton's Vireo	*Vireo huttoni*
WAVI	Warbling Vireo	*Vireo gilvus*
OCWA	Orange-crowned Warbler	*Vermivora celata*
YWAR	Yellow Warbler	*Dendroica petechia*
YRWA	Yellow-rumped Warbler	*Dendroica coronata*
TOWA	Townsend's Warbler	*Dendroica townsendi*
COYE	Common Yellowthroat	*Geothlypis trichas*
WIWA	Wilson's Warbler	*Wilsonia pusilla*
YBCH	Yellow-breasted Chat	*Icteria virens*
WETA	Western Tanager	*Piranga ludoviciana*
BHGR	Black-headed Grosbeak	*Pheucticus melanocephalus*
BLGR	Blue Grosbeak	*Guiraca caerulea*
LAZB	Lazuli Bunting	*Passerina amoena*
SPTO	Spotted Towhee	*Pipilo maculatus*
CALT	California Towhee	*Pipilo crissalis*
RCSP	Rufous-crowned Sparrow	*Aimophila ruficeps*
CHSP	Chipping Sparrow	*Spizella passerina*
BRSP	Brewer's Sparrow	*Spizella breweri*
BCSP	Black-chinned Sparrow	*Spizella atrogularis*
LASP	Lark Sparrow	*Chondestes grammacus*
BTSP	Black-throated Sparrow	*Amphispiza bilineata*
SAGS	Sage Sparrow	*Amphispiza belli*
SAVS	Savannah Sparrow	*Passerculus sandwichensis*
GRSP	Grasshopper Sparrow	*Ammodramus savannarum*
FOSP	Fox Sparrow	*Passerella iliaca*
SOSP	Song Sparrow	*Melospiza melodia*
LISP	Lincoln's Sparrow	*Melospiza lincolnii*
GCSP	Golden-crowned Sparrow	*Zonotrichia atricapilla*
WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
DEJU	Dark-eyed Junco	*Junco hyemalis*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*

Table 14. Continued.

Code	Common Name	Scientific Name
WEME	Western Meadowlark	*Sturnella neglecta*
BRBL	Brewer's Blackbird	*Euphagus cyanocephalus*
BHCO	Brown-headed Cowbird	*Molothrus ater*
SCOR	Scott's Oriole	*Icterus parisorum*
HOOR	Hooded Oriole	*Icterus cucullatus*
NOOR	Bullock's Oriole	*Icterus bullockii*
PUFI	Purple Finch	*Carpodacus purpureus*
HOFI	House Finch	*Carpodacus mexicanus*
LEGO	Lesser Goldfinch	*Carduelis psaltria*
LAGO	Lawrence's Goldfinch	*Carduelis lawrencei*
AMGO	American Goldfinch	*Carduelis tristis*
HOSP	House Sparrow	*Passer domesticus*

Table 15. Codes and common names of all bird species detected during NCCP surveys, 1995-1997. List is sorted alphabetically by code, which is the order of their appearance in most tables. * denotes species that appeared on at least 10% of the points during any one census period. Italics denote rare species (appearing on < 4% of N = 915 total points).

Code	Common Name
ACWO	Acorn Woodpecker
AMCR	American Crow
AMGO	American Goldfinch
AMKE	*American Kestrel*
AMRO	*American Robin*
ANHU	Anna's Hummingbird *
ATFL	*Ash-throated Flycatcher*
BARS	*Barn Swallow*
BASW	*Bank Swallow*
BCHU	*Black-chinned Hummingbird*
BCNH	*Black-crowned Night Heron*
BCSP	Black-chinned Sparrow *
BEVI	Bell's Vireo
BEWR	Bewick's Wren *
BGGN	Blue-gray Gnatcatcher *
BHCO	Brown-headed Cowbird
BHGR	Black-headed Grosbeak *
BLGR	Blue Grosbeak
BLPH	*Black Phoebe*
BRBL	*Brewer's Blackbird*
BRSP	*Brewer's Sparrow*
BTGN	*Black-tailed Gnatcatcher*
BTPI	*Band-tailed Pigeon*
BTSP	*Black-throated Sparrow*
CACW	Cactus Wren *
CAGN	California Gnatcatcher *
CAKI	Cassin's Kingbird
CALT	California Towhee *
CANW	Canyon Wren *
CAQU	California Quail *

Table 15. Continued.

Code	Common Name
CATH	California Thrasher *
CEDW	Cedar Waxwing
CHSP	*Chipping Sparrow*
CLSW	*Cliff Swallow*
COBU	Common Bushtit *
COHA	Cooper's Hawk
COHU	Costa's Hummingbird *
CORA	Common Raven
COYE	Common Yellowthroat *
DEJU	Dark-eyed Junco
EUST	*European Starling*
FOSP	*Fox Sparrow*
GCSP	*Golden-crowned Sparrow*
GRRO	*Greater Roadrunner*
GRSP	Grasshopper Sparrow
GTBH	Great Blue Heron
HETH	*Hermit Thrush*
HOFI	House Finch *
HOLA	Horned Lark
HOOR	*Hooded Oriole*
HOSP	*House Sparrow*
HOWR	House Wren
HUVI	Hutton's Vireo
KILL	*Killdeer*
LAGO	*Lawrence's Goldfinch*
LASP	*Lark Sparrow*
LAZB	Lazuli Bunting *
LEGO	Lesser Goldfinch *
LENI	Lesser Nighthawk
LISP	*Lincoln's Sparrow*
LOSH	*Loggerhead Shrike*
MODO	Mourning Dove *
NOFL	Northern Flicker *

Table 15. Continued.

Code	Common Name
NOMO	Northern Mockingbird *
NOOR	Bullock's Oriole
NRWS	*Northern Rough-winged Swallow*
NUWO	*Nuttall's Woodpecker*
OCWA	Orange-crowned Warbler *
PHAI	Phainopepla *
PLTI	Plain Titmouse
PSFL	Pacific-slope Flycatcher
PUFI	*Purple Finch*
RCKI	Ruby-crowned Kinglet *
RCSP	Rufous-crowned Sparrow *
RODO	Rock Dove
ROWR	Rock Wren *
RTHA	Red-tailed Hawk
RUHU	*Rufous Hummingbird*
RWBL	*Red-winged Blackbird*
SAGS	Sage Sparrow *
SAPH	Say's Phoebe
SAVS	*Savannah Sparrow*
SCJA	Western Scrub-Jay *
SCOR	Scott's Oriole
SOSP	Song Sparrow *
SOVI	Solitary Vireo
SPTO	Spotted Towhee *
SSHA	Sharp-shinned Hawk
TOWA	*Townsend's Warbler*
TRSW	*Tree Swallow*
TUVU	*Turkey Vulture*
VGSW	*Violet-green Swallow*
WAVI	*Warbling Vireo*
WBNU	*White-breasted Nuthatch*
WCSP	White-crowned Sparrow *
WEBL	Western Bluebird

Table 15. Continued.

Code	Common Name
WEKI	Western Kingbird
WEME	Western Meadowlark *
WETA	Western Tanager
WEWP	*Western Wood-pewee*
WIWA	*Wilson's Warbler*
WIWR	*Winter Wren*
WREN	Wrentit *
WTSW	White-throated Swift
WWDO	*White-winged Dove*
YBCH	*Yellow-breasted Chat*
YRWA	Yellow-rumped Warbler *
YWAR	Yellow Warbler

Table 16. Codes, common names, and scientific names of all mammal species detected during NCCP surveys, 1995-1996. List is in alphabetical order by codes, which is their order of appearance in most tables. * denotes species that occurred on at least 10% of points during any sampling period. Remaining species were classed as rare (appearing on < 4% of N = 534 total points surveyed).

Code	Common Name	Scientific Name
CHCA	Dulzura pocket mouse	*Chaetodipus californicus femoralis*
CHFA	San Diego pocket mouse *	*Chaetodipus fallax fallax*
DIAG	Pacific kangaroo rat *	*Dipodomys agilis*
DIST	Stephens' kangaroo rat	*Dipodomys stephensi*
MICA	California vole	*Microtus californicus*
MUMU	House mouse	*Mus musculus*
NEFU	Dusky-footed woodrat *	*Neotoma fuscipes*
NELE	San Diego woodrat *	*Neotoma lepida intermedia*
PECA	California mouse *	*Peromyscus californicus*
PEER	Cactus mouse *	*Peromyscus eremicus*
PELO	Los Angeles pocket mouse	*Perognathus longimembris brevinasus*
PEMA	Deer mouse *	*Peromyscus maniculatus*
REME	Western harvest mouse *	*Reithrodontomys megalotis*

Table 17. Distribution of bird species among NCCP study sites, Spring 1995.

Species	Site											Number of Points	Number of Sites
	BLCA	DACA	LAPE	LICA	MRRE	PAVA	STRA	SWRI	SYCA	UCR	WAPA		
ACWO				+			+					12	2
AMGO			+									1	1
ANHU	+		+	+	+	+	+	+	+		+	29	9
ATFL			+	+		+	+					9	4
BCHU									+			1	1
BCNH								+				1	1
BCSP	+	+	+	+	+	+	+	+	+	+	+	79	11
BEWR	+	+	+	+	+	+	+	+	+	+		75	10
BGGN				+	+	+	+					7	4
BHCO			+	+	+							6	3
BHGR			+	+		+	+	+				12	5
BLGR				+			+	+				5	3
BLPH		+	+								+	5	3
CACW				+			+				+	28	3
CAGN		+		+	+		+	+			+	18	6
CALT	+	+	+	+	+	+	+	+	+	+	+	113	11
CANW			+		+				+			16	3
CAQU	+	+	+	+	+	+	+	+	+	+	+	74	11
CATH	+	+	+	+	+	+	+	+	+		+	61	10
CEDW									+			1	1
COBU	+		+	+	+	+	+	+	+	+	+	49	10
COHU	+	+	+	+	+	+	+	+	+	+	+	66	11
COYE				+				+				4	2
EUST			+									1	1
GCSP				+			+					3	2
GRRO		+	+		+			+				10	4
GRSP				+			+	+				11	3
HOFI		+	+	+	+		+	+	+	+	+	46	9
HOOR							+					1	1
HOWR				+			+		+			10	3
LAGO			+								+	4	2
LAZB	+	+	+	+	+	+	+	+	+	+	+	73	11
LEGO	+	+	+	+	+	+	+	+	+	+	+	60	11
LISP											+	1	1
LOSH			+									1	1
MODO	+	+	+	+	+	+	+	+	+	+	+	66	11
NOFL				+			+					5	2
NOMO			+	+	+		+	+	+	+	+	42	8
NOOR			+		+							4	2
NUWO				+			+	+				4	3
OCWA						+	+					3	2

Table 17. Continued.

Species	Site											Number of Points	Number of Sites
	BLCA	DACA	LAPE	LICA	MRRE	PAVA	STRA	SWRI	SYCA	UCR	WAPA		
PHAI				+		+	+	+			+	19	5
PLTI				+			+					4	2
RCSP		+	+	+	+		+	+	+	+	+	48	9
ROWR	+		+						+	+	+	10	5
RUHU				+								1	1
RWBL			+									1	1
SAGS	+	+	+		+	+		+	+	+		51	8
SCJA	+	+		+			+	+	+	+	+	35	8
SOSP	+	+	+	+	+	+	+	+	+		+	34	10
SPTO	+	+	+	+	+	+	+	+	+	+	+	103	11
WCSP			+		+		+	+	+	+	+	30	7
WEME		+	+	+	+	+		+	+	+		26	8
WETA							+					1	1
WIWA								+	+			2	2
WREN	+	+		+		+	+	+			+	81	7
YBCH								+				5	1
Number of Species	17	20	32	36	25	21	36	32	26	18	25		

Table 18. Distribution of bird species among NCCP study sites, Fall 1995.

Species	Site										Number of Points	Number of Sites
	BLCA	LAPE	LICA	MRRE	PAVA	STRA	SWRI	SYCA	UCR	WAPA		
ACWO			+		+						3	2
AMGO				+	+						3	2
AMRO						+					2	1
ANHU	+	+	+	+		+	+	+	+	+	49	9
BEWR	+	+	+	+	+	+	+	+	+	+	53	10
BGGN		+		+		+	+	+	+	+	23	7
BRBL			+								1	1
BTPI										+	1	1
CACW			+			+				+	12	3
CAGN			+	+		+	+			+	13	5
CAKI							+				2	1
CALT	+	+	+	+	+	+	+	+	+	+	97	10
CANW		+									1	1
CAQU	+	+	+	+	+	+	+	+		+	29	9
CATH	+	+	+	+		+	+	+			15	7
COBU	+	+	+	+	+	+	+	+	+	+	37	10
COHU							+				1	1
EUST		+									1	1
FOSP			+								2	1
GCSP							+				1	1
HETH							+				4	1
HOFI	+	+	+	+	+	+	+	+	+	+	70	10
HOWR						+					2	1
HUVI			+								1	1
LEGO	+	+	+	+	+	+	+	+	+	+	45	10
LOSH		+									2	1
MODO						+		+	+	+	4	4
NOFL	+	+	+	+	+	+	+	+	+	+	53	10
NOMO		+	+	+		+	+	+		+	33	7
NUWO			+			+					3	2
PLTI			+		+	+					12	3
RCKI			+		+	+	+	+		+	19	6
RCSP		+	+		+	+	+	+	+	+	16	8
ROWR	+	+		+	+		+	+	+		24	7
SPTO	+	+	+	+	+	+	+	+		+	49	9
SAGS	+	+		+	+			+	+		18	6
SAPH		+	+	+		+	+		+	+	9	7
SCJA	+		+		+	+	+			+	33	6
SCOR										+	1	1
SOSP	+			+		+	+	+			7	5

Table 18. Continued.

Species	Site										Number of Points	Number of Sites
	BLCA	LAPE	LICA	MRRE	PAVA	STRA	SWRI	SYCA	UCR	WAPA		
WCSP	+	+	+	+	+	+	+	+	+	+	66	10
WEME		+	+	+	+			+	+		16	6
WREN	+	+	+		+	+	+			+	78	7
YRWA		+	+		+	+	+			+	58	6
Number of Species	16	23	27	20	20	27	26	20	15	23		

Table 19. Distribution of bird species among NCCP study sites, Spring 1996.

Species	Site																					Number of Points	Number of Sites
	BLCA	BOSP	CHVI	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
ACWO						+	+					+		+	+			+				17	6
AMCR															+							2	1
AMGO	+						+															2	2
AMKE													+									1	1
AMRO																+						1	1
ANHU		+	+	+	+		+		+	+	+	+	+	+	+	+	+	+	+	+	+	83	18
ATFL		+		+						+		+						+				8	5
BASW			+										+									2	2
BCSP	+	+			+	+	+	+		+	+			+	+	+					+	83	12
BEWR	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	154	21
BGGN					+		+			+	+				+		+			+	+	13	8
BHCO				+	+		+						+									5	4
BHGR			+			+						+	+	+	+	+	+					29	8
BLGR													+									2	1
BLPH			+															+				2	2
BRBL					+																	3	1
CACW		+	+			+	+		+		+	+	+		+			+			+	65	11
CAGN				+			+	+	+				+		+	+		+			+	30	9
CAKI																+						1	1
CALT	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	206	21
CANW		+			+												+			+	+	18	5
CAQU	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	104	21
CATH	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	100	19
CEDW									+													2	1
CLSW			+			+							+									9	3
COBU	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	134	20
COHU	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	141	21
CORA								+							+							4	2

Table 19. Continued.

Species	Site																					Number of Points	Number of Sites
	BLCA	BOSP	CHVI	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
COYE			+		+	+	+					+	+		+	+	+	+			+	43	11
EUST		+	+		+					+	+			+			+	+				11	8
GRRO		+		+	+			+									+					10	5
GRSP		+				+	+						+	+	+	+		+			+	26	9
HOFI	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	117	20
HOLA				+																		3	1
HOOR														+								1	1
HOWR			+		+		+		+		+	+			+		+	+	+			24	10
KILL			+													+					+	4	3
LASP												+										1	1
LAZB	+				+	+	+			+		+			+	+					+	18	9
LEGO	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	95	20
LOSH		+		+																		2	2
MODO	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	137	20
NOFL							+		+	+					+	+	+		+		+	19	8
NOMO		+	+	+	+	+	+	+	+	+	+	+	+		+	+		+	+	+	+	102	18
NOOR	+	+		+														+				5	4
NUWO		+					+					+			+				+			5	5
OCWA					+		+	+			+	+			+	+			+		+	26	9
PHAI			+			+	+		+			+	+		+	+		+	+			23	10
PLTI	+						+					+			+	+			+			11	6
PSFL												+										1	1
RCKI						+									+							2	2
RCSP	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+	+	+	+	+	119	19
ROWR		+			+		+										+			+		16	5
RWBL				+	+																	5	2

Table 19. Continued.

Species	Site																					Number of Points	Number of Sites
	BLCA	BOSP	CHVI	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
SAGS	+	+		+	+			+		+						+	+			+		44	9
SAPH	+					+						+			+			+			+	8	6
SAVS																	+					2	1
SCJA	+	+	+	+		+	+		+	+	+	+	+	+	+	+		+	+		+	63	17
SOSP	+	+	+	+	+	+	+	+		+	+	+	+	+		+	+	+	+		+	68	18
SPTO	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	193	21
WAVI																		+				1	1
WCSP		+		+	+	+	+	+	+	+	+	+	+		+	+	+			+	+	66	16
WEKI				+	+						+		+	+		+		+				9	7
WEME		+		+	+	+	+	+	+	+		+	+		+	+	+	+		+		70	15
WIWA			+	+			+				+	+	+	+	+	+		+	+			16	11
WIWR																		+				1	1
WREN	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	157	19
YBCH													+									2	1
YRWA										+												1	1
Number of Species	21	30	27	27	32	28	36	22	22	26	24	33	31	22	37	34	26	33	22	18	29		

Table 20. Distribution of bird species among NCCP study sites, Fall 1996.

	Sites																					
Species	BLCA	BOSP	CHVI	DACA	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	Number of Points	Number of Sites
AMCR									+		+											3	2
AMGO							+															1	1
AMKE						+																1	1
AMRO												+			+	+						4	3
ANHU	+	+	+		+	+		+	+	+		+	+	+	+	+	+	+	+	+	+	88	18
BEWR		+	+		+	+		+	+		+	+	+	+	+	+	+	+	+	+		47	16
BGGN					+	+			+	+					+		+	+		+	+	21	9
BHGR			+																			1	1
BLPH			+	+		+								+					+	+		7	6
CACW			+							+						+			+			5	4
CAGN		+						+						+		+	+		+			14	6
CALT	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	142	20
CANW								+						+								4	2
CAQU	+	+				+		+	+					+	+		+	+		+		19	10
CATH			+		+			+	+	+	+		+	+	+	+	+			+		37	12
COBU		+	+		+	+		+	+			+			+	+	+	+	+	+		30	13
COHU		+				+								+								3	3
CORA		+				+		+	+		+									+		11	6
COYE			+																			2	1
DEJU											+					+						2	2
EUST												+										1	1
GCSP																+						1	1
GRSP													+									1	1
HETH								+														2	1
HOFI		+	+		+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	62	18

Table 20. Continued.

	Sites																					
Species	BLCA	BOSP	CHVI	DACA	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	Number of Points	Number of Sites
HOWR								+														2	1
LASP												+										2	1
LEGO			+	+		+		+	+					+	+	+	+		+			21	10
LOSH		+				+								+								6	3
MODO														+								1	1
NOFL		+			+	+		+	+		+			+	+	+	+			+	+	31	12
NOMO			+							+		+		+		+	+		+			15	7
NUWO						+			+													2	2
OCWA								+														1	1
PLTI																+						2	1
RCKI						+										+	+		+			21	4
RCSP	+	+			+	+		+					+		+	+	+					17	9
ROWR		+				+			+								+				+	14	5
RTHA																				+		1	1
SAGS		+				+			+								+					11	4
SAPH					+				+					+								3	3
SCJA			+				+	+			+		+		+	+	+	+	+	+		36	11
SOSP						+							+	+	+	+	+		+			10	7
SPTO	+		+					+	+		+	+	+	+	+	+	+		+	+		38	13
WCSP	+	+	+		+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	92	19
WEBL								+														1	1
WEKI		+																	+			2	2
WEME		+			+			+								+		+			+	11	6
WREN	+		+					+			+	+	+	+	+	+	+		+	+		104	12
YRWA								+		+	+				+	+	+		+	+		69	8
Number of Species	7	17	16	3	11	21	4	23	18	9	13	12	11	20	18	24	22	10	18	17	8		

Table 21. Distribution of bird species among NCCP study sites, Spring 1997.

Species	Site																						Number of Points	Number of Sites
	BLCA	BOSP	CHVI	DACA	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
ACWO								+			+		+		+	+							17	5
AMCR		+			+	+	+			+	+				+	+	+	+	+	+	+	+	52	14
AMGO						+								+								+	4	3
AMRO								+										+	+				4	3
ANHU	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	86	21
ATFL				+		+	+	+			+	+	+		+	+			+	+		+	57	12
YRWA						+		+	+							+	+		+	+			24	7
BARS								+					+										2	2
BASW								+				+											5	2
BCNH																						+	1	1
BCSP	+					+	+	+	+		+				+	+	+					+	67	10
BEVI																	+						3	1
BEWR	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	190	21
BGGN		+									+									+			4	3
BHCO	+	+			+	+		+	+		+				+								11	8
BHGR			+				+	+					+	+	+		+						22	7
BLGR				+	+	+	+										+						9	5
BLPH		+	+			+	+			+		+		+			+		+	+		+	19	11
BRSP	+				+	+	+	+														+	8	6
BTGN																			+				1	1
BTSP							+	+															2	2
CACW		+	+				+	+		+			+	+		+			+			+	68	10
CAGN		+	+		+		+	+	+	+				+		+	+		+			+	35	12
CAKI						+								+					+	+		+	8	5
CALT	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	227	22
CANW	+	+				+			+									+			+	+	26	7
CAQU	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	137	21

Table 21. Continued.

Species	Site																						Number of Points	Number of Sites
	BLCA	BOSP	CHVI	DACA	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
CATH	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	129	20
CHSP				+						+													2	2
CLSW			+					+					+			+	+		+	+		+	19	8
COBU						+	+	+	+	+	+	+	+	+	+		+		+	+	+	+	60	15
COHU	+	+				+	+	+	+	+	+		+		+	+	+				+	+	44	14
CORA	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	110	21
COYE			+				+	+					+	+			+		+	+		+	30	9
EUST		+	+			+		+				+	+	+	+	+			+				18	10
FOSP								+								+							2	2
GCSP								+							+					+			3	3
GRRO		+		+	+	+			+		+								+		+	+	14	9
GRSP							+	+					+			+							11	4
GTBH							+															+	2	2
HETH			+					+	+		+				+	+	+		+				18	8
HOFI	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	163	22
HOLA				+																			1	1
HOOR		+					+												+				4	3
HOSP						+																	1	1
HOWR	+	+					+	+		+	+		+	+	+	+	+	+	+				45	13
HUVI											+		+	+	+	+	+		+				13	7
KILL						+		+									+		+			+	9	5
LAGO					+	+		+	+				+									+	6	6
LASP				+				+	+		+		+	+	+							+	16	8
LAZB	+	+					+	+		+	+		+	+		+	+					+	34	11
LEGO	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	156	22
LISP					+	+		+				+			+		+					+	11	7

Table 21. Continued.

Species	Site																						Number of Points	Number of Sites
	BLCA	BOSP	CHVI	DACA	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
LOSH		+				+																	3	2
MODO	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	148	22
NOFL	+	+						+			+		+		+	+	+	+		+			41	10
NOMO		+	+		+	+		+	+	+		+	+	+		+	+		+	+	+	+	98	16
NOOR		+				+	+	+		+	+				+	+	+						18	9
NRWS			+														+						3	2
NUWO	+	+					+	+					+		+	+				+			22	8
OCWA	+		+					+			+	+	+	+	+	+	+		+	+			47	12
PHAI							+	+					+			+	+					+	19	6
PLTI	+							+			+		+		+	+							20	6
PSFL													+						+				4	2
PUFI								+								+							2	2
RCKI								+								+				+			6	3
RCSP	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	153	22
ROWR		+																+			+		4	3
RUHU								+															1	1
RWBL			+			+	+												+				5	4
SAGS	+	+			+	+	+		+		+						+	+			+		76	10
SAPH					+											+							2	2
SAVS					+																		1	1
SCJA	+	+	+				+	+		+	+	+	+		+	+	+		+	+	+		67	15
SOSP		+	+	+	+	+	+	+	+			+		+	+		+	+	+	+		+	58	16
SOVI																+							1	1
SPTO	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+	193	20
TOWA								+															4	1
TRSW																	+						1	1

Table 21. Continued.

Species	Site																						Number of Points	Number of Sites
	BLCA	BOSP	CHVI	DACA	KABI	LAPE	LASK	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
TUVU								+		+						+			+			+	9	5
VGSW						+											+					+	5	3
WAVI		+						+															6	2
WBNU								+															1	1
WCSP		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	107	20
WEKI			+	+	+	+							+	+	+	+	+				+	+	21	11
WEME		+		+	+	+	+		+		+	+	+	+				+			+	+	50	13
WETA										+													2	1
WEWP								+															2	1
WIWA								+		+									+				12	3
WREN	+		+				+	+		+	+	+	+	+	+	+	+		+	+		+	160	15
WTSW		+													+					+	+		5	4
WWDO																+							1	1
YBCH							+							+			+						16	3
YWAR								+															1	1
Number of species	25	37	28	20	27	40	40	60	26	27	34	24	39	32	36	44	44	21	40	31	19	42		

Table 22. Distribution of small mammal species among NCCP study sites, Spring 1995.

	Site									
Species	BLCA	LAPE	LICA	MRRE	PAVA	STRA	SWRI	WAPA	Number of Points	Number of Sites
CHCA					+				1	1
CHFA	+	+	+	+	+		+	+	31	7
DIAG		+		+	+		+	+	29	5
NEFU	+		+			+	+		11	4
NELE	+	+	+	+	+	+		+	42	7
PECA	+		+		+	+		+	24	5
PEER	+	+	+	+	+	+	+	+	48	8
PEMA		+		+			+	+	34	4
REME						+	+	+	8	3
Number of Species	5	5	5	5	6	5	6	7		

Table 23. Distribution of small mammal species among NCCP study sites, Fall 1995.

Species	Site											Number of Points	Number of Sites
	BLCA	LAPE	LICA	MRRE	PAVA	STRA	SWRI	SYCA	TPSP	UCR	WAPA		
CHFA	+	+	+	+			+	+	+	+	+	47	9
DIAG		+		+	+		+	+		+	+	40	7
MICA						+						2	1
MUMU							+		+			2	2
NEFU	+		+		+	+			+			32	5
NELE	+	+	+	+		+	+	+	+	+	+	54	10
PECA	+		+		+	+	+		+		+	49	7
PEER	+	+	+	+	+	+	+	+	+	+	+	87	11
PEMA		+		+			+	+	+	+	+	46	7
REME		+	+			+	+					18	4
Number of Species	5	6	6	5	4	6	8	5	7	5	6		

Table 24. Distribution of small mammal species among NCCP study sites, Spring 1996.

Species	Site																Number of Points	Number of Sites
	BLCA	KABI	LAPE	LICA	MRRE	PAVA	POLO	RMVI	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
CHCA	+																2	1
CHFA		+	+		+	+	+				+	+		+	+	+	61	10
DIAG		+	+		+	+					+	+			+	+	41	8
DIST												+					1	1
MICA		+															2	1
MUMU		+															1	1
NEFU				+		+	+	+	+	+			+	+		+	45	9
NELE	+		+	+	+		+	+		+	+	+	+	+	+	+	78	13
PECA	+			+		+	+	+	+	+	+		+	+		+	61	11
PEER	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	102	15
PELO			+														1	1
PEMA		+	+		+						+	+		+	+	+	50	8
REME		+	+	+	+			+	+	+	+	+	+	+			18	11
Number of Species	4	7	7	5	6	5	5	5	4	5	7	7	5	6	5	7		

Table 25. Distribution of small mammal species among NCCP study sites, Fall 1996.

Species	Site																			Number of Points	Number of Sites
	BLCA	BOSP	KABI	LAPE	LICA	MRRE	ORHI	PAVA	POLO	RMVI	SACA	SAMA	STRA	SWRI	SYCA	SYHI	TPSP	UCR	WAPA		
CHCA							+	+		+	+	+	+			+				13	7
CHFA	+	+	+	+		+		+	+				+	+	+		+	+	+	73	13
DIAG	+	+	+	+		+		+						+	+			+	+	48	10
DIST						+									+					3	2
MICA																+				1	1
MUMU			+														+			4	2
NEFU					+				+		+	+	+			+	+		+	31	8
NELE	+	+	+	+	+	+	+	+	+	+	+		+	+		+	+	+	+	67	17
PECA	+				+			+	+	+			+			+	+		+	43	9
PEER	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	103	18
PEMA	+	+	+	+		+	+	+	+		+	+	+	+		+		+	+	42	15
REME		+	+	+		+	+			+	+	+	+	+		+				24	11
Number of Species	6	6	7	6	4	7	5	7	6	5	6	5	8	6	3	8	6	5	7		

Table 26. Total numbers of small mammals (new captures only) captured at each site during each sampling period, NCCP project, 1995-1996. Note that numbers are not adjusted for differences in trapping effort (number of sample points) among sites.

Period	Site	Species												
		CHCA	CHFA	DIAG	DIST	MICA	MUMU	NEFU	NELE	PECA	PEER	PELO	PEMA	REME
Spring 1995	BLCA	0	2	0	0	0	0	2	1	5	5	0	0	0
	LAPE	0	20	23	0	0	0	0	21	0	35	0	54	0
	LICA	0	3	0	0	0	0	9	20	30	12	0	0	0
	MRRE	0	4	15	0	0	0	0	31	0	20	0	32	0
	PAVA	1	1	9	0	0	0	0	1	12	13	0	0	0
	STRA	0	0	0	0	0	0	17	25	18	27	0	0	4
	SWRI	0	8	3	0	0	0	1	0	0	5	0	7	11
	WAPA	0	9	4	0	0	0	0	12	3	15	0	11	1
	Total	1	47	54	0	0	0	29	111	68	132	0	104	16
Fall 1995	BLCA	0	3	0	0	0	0	1	1	3	11	0	0	0
	LAPE	0	60	29	0	0	0	0	18	0	70	0	64	3
	LICA	0	4	0	0	0	0	40	22	61	19	0	0	2
	MRRE	0	4	22	0	0	0	0	15	0	17	0	26	0
	PAVA	0	0	7	0	0	0	1	0	9	8	0	0	0
	STRA	0	0	0	0	2	0	17	31	49	47	0	0	15
	SWRI	0	5	3	0	0	1	0	3	1	49	0	16	12
	SYCA	0	12	10	0	0	0	0	1	0	2	0	6	0
	TPSP	0	3	0	0	0	1	13	23	100	9	0	8	0
	UCR	0	10	6	0	0	0	0	5	0	7	0	3	0
	WAPA	0	10	6	0	0	0	0	10	4	13	0	17	0
	Total	0	111	83	0	2	2	72	129	227	252	0	140	32

Table 26. Continued.

Period	Site	Species CHCA	CHFA	DIAG	DIST	MICA	MUMU	NEFU	NELE	PECA	PEER	PELO	PEMA	REME
Spring 1996	BLCA	2	0	0	0	0	0	0	1	2	5	0	0	0
	KABI	0	10	2	0	2	1	0	0	0	6	0	11	1
	LAPE	0	45	35	0	0	0	0	14	0	54	1	54	1
	LICA	0	0	0	0	0	0	26	24	66	12	0	0	1
	MRRE	0	14	36	0	0	0	0	33	0	39	0	20	2
	PAVA	0	2	4	0	0	0	1	0	7	9	0	0	0
	POLO	0	2	0	0	0	0	1	16	3	17	0	0	0
	RMVI	0	0	0	0	0	0	6	11	6	7	0	0	1
	SAMA	0	0	0	0	0	0	1	0	2	30	0	0	2
	STRA	0	0	0	0	0	0	16	36	38	25	0	0	5
	SWRI	0	10	1	0	0	0	0	1	2	35	0	11	4
	SYCA	0	6	8	2	0	0	0	1	0	1	0	2	1
	SYHI	0	0	0	0	0	0	10	32	24	8	0	0	3
	TPSP	0	5	0	0	0	0	54	9	56	0	0	2	1
	UCR	0	8	7	0	0	0	0	9	0	8	0	11	0
	WAPA	0	5	5	0	0	0	3	19	8	19	0	21	0
	Total	2	107	98	2	2	1	118	206	214	275	1	132	22
Fall 1996	BLCA	0	10	5	0	0	0	0	4	1	6	0	1	0
	BSPE	0	3	8	0	0	0	0	8	0	5	0	15	1
	BSPW	0	10	1	0	0	0	0	0	0	10	0	0	0
	KABI	0	8	2	0	0	2	0	1	0	5	0	4	5
	LAPE	0	25	14	0	0	0	0	3	0	16	0	6	1
	LICA	0	0	0	0	0	0	6	5	22	10	0	0	0
	MRRE	0	12	12	2	0	0	0	6	0	13	0	11	2
	ORHI	4	0	0	0	0	0	0	38	0	16	0	1	2
	PAVA	1	7	10	0	0	0	0	1	3	11	0	1	0
	POLO	0	3	0	0	0	0	3	12	12	25	0	2	0
	RMVI	5	0	0	0	0	0	0	10	9	11	0	0	2
	SACA	1	0	0	0	0	0	2	4	0	24	0	33	13
	SAMA	1	0	0	0	0	0	1	0	0	24	0	4	1
	STRA	1	1	0	0	0	0	3	16	9	21	0	1	1
	SWRI	0	16	5	0	0	0	0	2	0	8	0	9	3
	SYCA	0	4	9	1	0	0	0	0	0	0	0	0	0
	SYHI	3	0	0	0	1	0	18	20	26	9	0	4	6
	TPSP	0	9	0	0	0	4	31	16	53	10	0	0	0
	UCR	0	8	8	0	0	0	0	3	0	3	0	3	0
	WAPA	0	7	17	0	0	0	1	11	3	8	0	14	0
	Total	16	123	91	3	1	6	65	160	138	235	0	109	37

SITE ATTRIBUTES

Sites differed considerably with respect to the number of vertebrate species they supported, and, at least for birds, they also varied considerably between spring and fall surveys (Figs. 14, 15). Considering simply the total number of species detected at a site (Tables 27, 28), there was a clear association between site richness during a sample period and the number of points at a site (which roughly corresponds to site area). Such relationships between sampling effort and species richness commonly occur, but tell us little about community patterns or composition, other than that bigger sites have more species (Gotelli and Graves 1996). To avoid this problem, we described site richness as the average number of species seen per point, which is independent of the number of points at a site (i.e., site area).

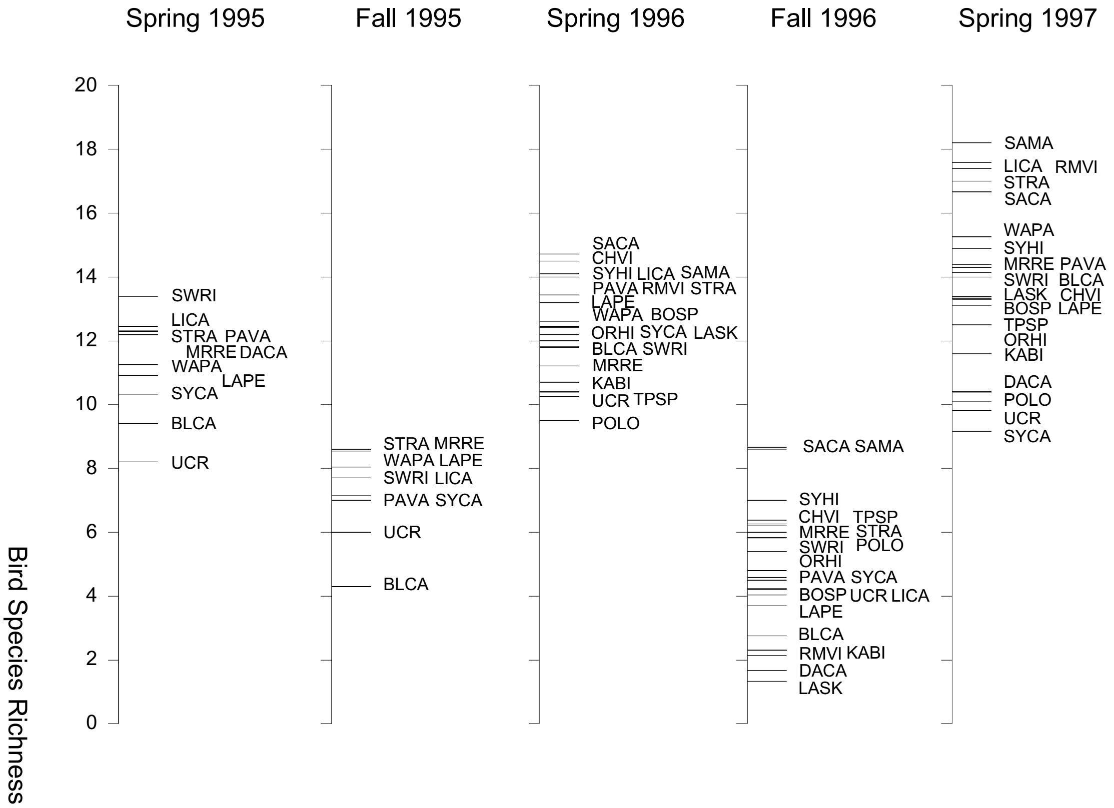


Figure 14. Mean bird species richness per point for NCCP study sites, by season of sampling. See Table 1 for site codes.

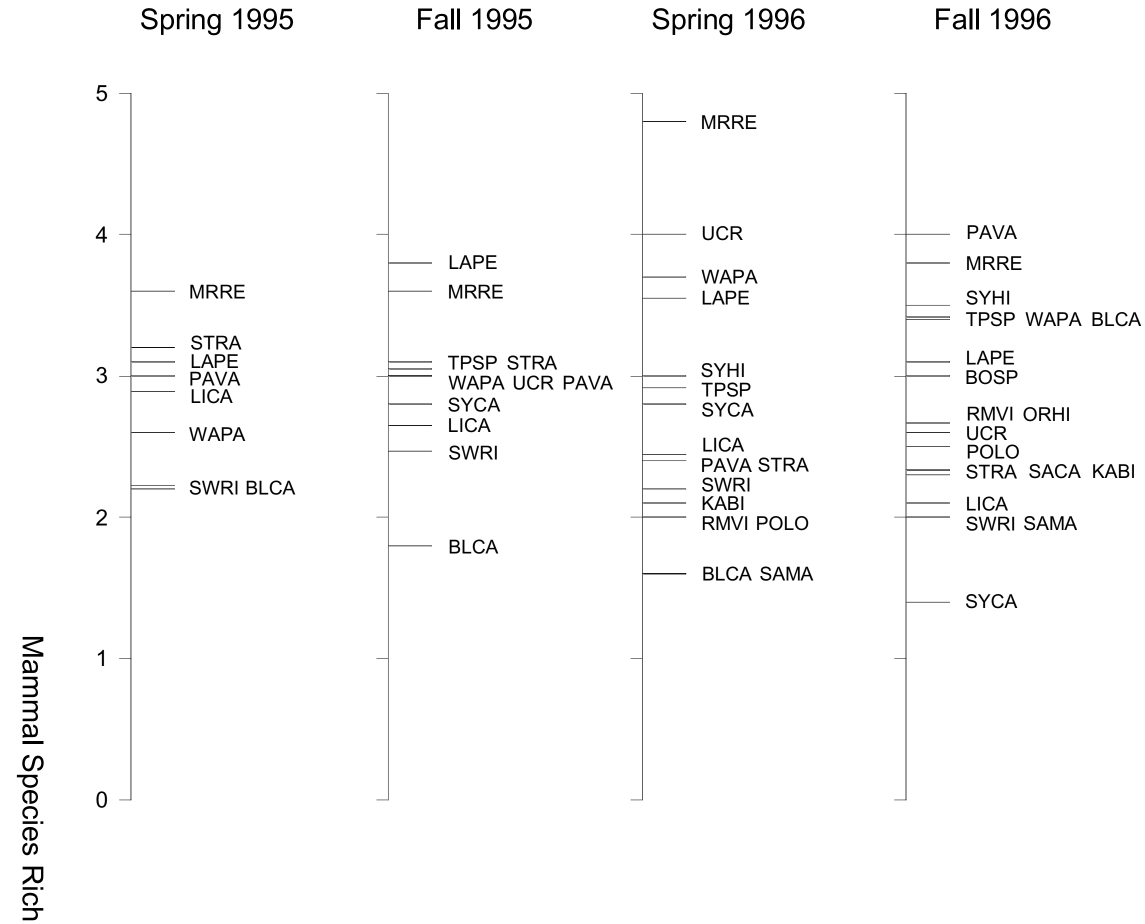


Figure 15. Mean mammal species richness per point for NCCP study sites, by season of sampling. See Table 1 for site codes.

In every sampling period and for both major taxa, average species richness per point varied significantly among sites (ANOVA, all $P < 0.05$). However, applying post hoc tests (Duncan s multiple range test; Zar 1984) to see which sites differed from others was generally uninformative; average richness graded relatively smoothly from one site to the next (Figs. 14, 15), and thus no site or group of sites was completely (or consistently) distinct from any other site or group.

Avian species richness at a point was significantly correlated across sample periods (Table 29). Thus, points with relatively high numbers of bird species detected during one period were likely to have relatively high numbers of bird species during any of the other periods. This was less true for small mammals. For example, although the number of species per point detected in spring 1995 was significantly correlated with the number detected in spring 1996, it was not so with either fall sample (Table 29). However, there was a significant correlation between mammal richness at a point in spring 1996 and both fall periods. Note also that the correlation coefficients for mammals are all positive and of similar magnitude to those of birds, which suggests that the lack of statistical significance is most likely a function of smaller maximum mammal richness.

At the site level, patterns of correlation were somewhat weaker, even when we changed alpha to 0.10 to compensate for the much smaller sample sizes (Table 29). Thus, although sites with relatively high richness of birds or small mammals (as measured by the average number of species per point) in one period were somewhat more likely to have relatively high richness in another period, this was slightly less consistent than for points. For birds, average richness of a site in any particular spring sample was significantly correlated with richness in the other spring samples, and likewise the fall samples were intercorrelated. Furthermore, high bird richness in a spring sample was associated with high richness in the subsequent fall, but a fall was not necessarily correlated with the spring following. Mammals differed in that richness in fall 1996 was not correlated with richness in any of the other sampling periods. We note that all correlations, whether statistically significant or not, had positive signs.

Cross-correlations between bird and small mammal richness were poor (Table 29). None were significant at the point-level, and only one of 20 at the site level (about that expected by chance alone). Thus, bird and small mammal richness did not covary at either the site or point level, and one was a poor predictor of the other. From a management perspective this implies that conservation of sites associated with, say, high avian biodiversity will not necessarily preserve high mammal biodiversity. We elaborate upon this theme in more detail in one of the manuscripts we have attached, Single species as indicators of species richness and composition in California coastal sage scrub bird and small mammal communities, authored by Chase et al., which is in press in the journal *Conservation Biology*.

Table 27. Bird species richness at NCCP sites, 1995 —1997. Entries are number of points, mean richness per point, and standard error of the mean.

Site	Spring 1995			Fall 1995			Spring 1996			Fall 1996			Spring 1997		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
BLCA	5	9.4	0.24	10	4.3	0.68	5	11.8	0.58	4	2.8	0.63	5	14.0	0.71
BOSP	-	-	-	-	-	-	9	12.4	0.87	9	4.2	0.49	9	13.3	0.97
CHVI	5	-	-	-	-	-	8	14.5	0.73	8	6.4	0.26	8	13.4	0.53
DACA	-	12.2	0.73	-	-	-	-	-	-	3	1.7	0.33	5	10.4	0.93
KABI	-	-	-	-	-	-	10	10.7	0.72	8	2.1	0.30	10	11.6	0.90
LAPE	20	10.9	0.61	20	7.7	0.47	21	12.6	0.53	23	3.7	0.32	23	13.3	0.53
LASK	-	-	-	-	-	-	10	12.2	0.92	3	1.3	0.33	10	13.4	1.31
LICA	20	12.5	0.49	20	8.1	0.77	20	14.0	0.50	23	4.0	0.51	24	17.6	0.69
MRRE	10	12.2	0.96	10	8.6	0.67	10	11.2	0.57	10	6.2	0.79	10	14.4	0.54
ORHI	-	-	-	-	-	-	6	12.0	0.73	5	4.8	0.58	6	12.5	1.43
PAVA	7	12.3	0.99	7	7.1	1.28	7	13.4	0.92	7	4.6	0.57	10	14.3	1.16
POLO	-	-	-	-	-	-	10	9.5	0.34	10	5.4	0.40	10	10.1	0.59
RMVI	-	-	-	-	-	-	10	13.2	1.00	10	2.3	0.40	10	17.4	0.67
SACA	-	-	-	-	-	-	6	14.7	0.68	6	8.7	1.23	6	16.7	0.61
SAMA	-	-	-	-	-	-	5	14.0	1.14	5	8.6	1.33	5	18.2	1.77
STRA	20	12.3	0.59	20	8.6	0.87	21	13.2	0.46	21	6.0	0.38	21	17.0	0.66
SWRI	15	13.4	0.55	15	8.5	0.52	20	11.8	0.59	23	5.8	0.51	24	14.1	0.54
SYCA	6	10.3	0.80	6	7.0	1.00	6	12.0	1.06	6	4.5	0.50	6	9.2	0.54
SYHI	-	-	-	-	-	-	10	14.1	0.64	10	7.0	0.60	10	14.9	0.66
TPSP	-	-	-	-	-	-	8	10.3	1.16	8	6.3	1.15	9	13.1	1.30
UCR	5	8.2	0.66	5	6.0	0.84	5	10.4	0.51	5	4.2	0.58	5	9.8	1.43
WAPA	12	11.3	0.58	12	8.6	0.68	12	12.4	0.75	-	-	-	12	15.3	0.80
Total	125	11.3	0.57	125	7.8	0.27	219	12.1	0.17	207	4.9	0.17	238	14.3	0.23

Table 28. Mammal species richness at NCCP sites, 1995 —1997. Entries are number of points, mean richness, and standard error of the mean.

Site	Spring 1995			Fall 1995			Spring 1996			Fall 1996		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
BLCA	5	2.2	0.49	5	1.8	0.49	5	1.6	0.24	5	3.4	0.75
BOSP	-	-	-	-	-	-	-	-	-	9	3.0	0.44
KABI	-	-	-	-	-	-	10	2.1	0.31	10	2.3	0.42
LAPE	20	3.1	0.19	20	3.8	0.20	20	3.6	0.22	10	3.1	0.38
LICA	9	2.9	0.42	20	2.7	0.32	18	2.4	0.26	10	2.1	0.38
MRRE	10	3.6	0.16	10	3.6	0.22	10	4.8	0.20	10	3.8	0.25
ORHI	-	-	-	-	-	-	-	-	-	6	2.7	0.49
PAVA	5	3.0	0.00	5	3.0	0.32	5	2.4	0.40	5	4.0	0.45
POLO	-	-	-	-	-	-	10	2.0	0.21	10	2.5	0.54
RMVI	-	-	-	-	-	-	9	2.0	0.29	9	2.7	0.17
SACA	-	-	-	-	-	-	-	-	-	6	2.3	0.21
SAMA	-	-	-	-	-	-	5	1.6	0.24	5	2.0	0.32
STRA	10	3.2	0.20	20	3.1	0.22	20	2.4	0.22	12	2.3	0.26
SWRI	9	2.2	0.28	15	2.5	0.36	15	2.2	0.28	14	2.0	0.18
SYCA	-	-	-	5	2.8	0.58	5	2.8	0.49	5	1.4	0.24
SYHI	-	-	-	-	-	-	10	3.0	0.21	10	3.5	0.31
TPSP	-	-	-	10	3.1	0.55	12	2.9	0.19	12	3.4	0.31
UCR	-	-	-	5	3.0	0.63	4	4.0	0.58	5	2.6	0.60
WAPA	10	2.6	0.37	10	3.0	0.21	10	3.7	0.47	10	3.4	0.43
Total	78	2.9	0.11	125	3.0	0.11	168	2.8	0.09	163	2.8	0.10

Table 29. Patterns of correlations of species richness (number of species detected at a point) within and between major taxa. Correlations based on points are above the diagonal, correlations based on sites (mean number of species detected at points) are below. Sample sizes in parentheses. * denotes P < 0.05, ** denotes P < 0.01, *** denotes P < 0.001. $^+$ denotes P < 0.10 (for sites only).

Taxon		Birds					Mammals			
		Spring 1995	Fall 1995	Spring 1996	Fall 1996	Spring 1997	Spring 1995	Fall 1995	Spring 1996	Fall 1996
Birds	Spring 1995	-	0.26** (125)	0.31** (107)	0.22* (109)	0.22** (124)	0.17 (78)	-0.09 (115)	-0.03 (109)	0.06 (86)
	Fall 1995	0.77** (10)	-	0.21* (107)	0.21* (109)	0.34*** (124)	0.07 (78)	0.03 (115)	0.07 (109)	0.07 (86)
	Spring 1996	0.58$^+$ (10)	0.34 (10)	-	0.16* (192)	0.44*** (215)	-0.11 (67)	-0.03 (108)	0.02 (154)	-0.01 (151)
	Fall 1996	0.35 (10)	0.79* (9)	0.35 (20)	-	0.14* (206)	0.24 (66)	0.06 (109)	0.02 (150)	0.02 (145)
	Spring 1997	0.55$^+$ (11)	0.46 (10)	0.71*** (21)	0.38$^+$ (21)	-	0.04 (78)	-0.27** (121)	-0.09 (164)	0.03 (159)
Mammals	Spring 1995	0.24 (8)	0.47 (8)	0.14 (8)	0.44 (7)	0.19 (8)	-	0.20 (78)	0.36** (74)	0.21 (60)
	Fall 1995	0.17 (10)	0.59$^+$ (10)	-0.04 (11)	0.40 (10)	-0.03 (11)	0.82* (8)	-	0.33*** (119)	0.13 (96)
	Spring 1996	-0.17 (10)	0.35 (10)	-0.21 (16)	0.11 (16)	-0.24 (16)	0.68$^+$ (8)	0.76** (11)	-	0.31*** (140)
	Fall 1996	-0.01 (10)	-0.12 (10)	-0.07 (19)	-0.07 (18)	0.07 (19)	0.29 (8)	0.24 (11)	0.40 (16)	-

COMMUNITY PATTERNS

We applied Detrended Correspondence Analysis to each sampling period separately for birds and mammals, to describe general patterns of community composition and variation (Table 30). Patterns were generally stronger (i.e., higher eigenvalues) in small mammals than in birds, and stronger in birds in fall than in spring. Higher eigenvalues indicate that species are somewhat more distinctly spaced with more distinct modes (i.e., peaks) in their distribution along ordination axes. To some degree this represents the fact that there were simply fewer species in the mammal and the fall bird data sets. In the more speciose spring bird samples, species were more broadly distributed and more widely overlapping in their occurrences, yielding a somewhat poorer fit (lower eigenvalue) to the basic DCA model (which assumes unimodal species distributions along environmental gradients).

In birds, the lengths of the axes (except for fall 1996) were relatively short (Table 30), again implying that many species were broadly overlapping in their distributions. In small mammals, however, the gradients were longer; that they approached or exceeded 4 suggests that species turnover between samples at opposite ends of the axis was complete. No point samples of birds were as distinct.

Table 30. Results of Detrended Correspondence Analysis of birds and small mammals, NCCP survey sites, 1995-1997.

Taxon	Sample	Axis 1		Axis 2		Axis 3	
		Eigenvalue	Length	Eigenvalue	Length	Eigenvalue	Length
Birds	Spring 1995	0.20	2.07	0.13	1.85	0.10	1.75
	Fall 1995	0.31	2.77	0.17	2.25	0.14	2.26
	Spring 1996	0.18	2.02	0.10	1.60	0.09	1.80
	Fall 1996	0.35	5.07	0.28	6.23	0.21	4.36
	Spring 1997	0.20	2.22	0.10	1.77	0.09	1.87
Mammals	Spring 1995	0.50	3.94	0.33	2.81	0.16	2.56
	Fall 1995	0.56	3.86	0.24	0.58	0.17	2.53
	Spring 1996	0.60	4.84	0.30	2.12	0.18	3.46
	Fall 1996	0.54	4.41	0.37	4.22	0.20	3.72

Although patterns in bird communities may have appeared weak, they were quite consistent among sample periods, at least with respect to the first DCA axis (Table 31). Both species scores and point scores were highly correlated across sampling periods, implying that species and point relationships remained similar, even though the ordinations were not particularly strong. All three spring samples were quite similar to one another, and to fall 1996. Fall 1997 was somewhat less similar to the other four, but still significantly related. However, the ordinations produced by second DCA axes were much less consistent and, except for spring 1996 and spring 1997, were not significant. Note that the directionality of a DCA axis (especially after the first) is arbitrary, so it is the absolute value, rather than the sign, of the correlation that is meaningful.

Table 31. Correlations among bird-based DCA scores for species and for points, NCCP surveys, 1995-1997. Correlations for DCA 1 above the diagonal; correlations for DCA 2 below. *** denotes $P < 0.001$, ** denotes $P < 0.01$, * denotes $P < 0.05$.

Species Scores

	Spring 1995	Fall 1995	Spring 1996	Fall 1996	Spring 1997
Spring 1995	-	0.84*** (28)	0.83*** (36)	0.35 (31)	0.83*** (36)
Fall 1995	-.04 (28)	-	0.86*** (30)	0.58** (29)	0.87*** (30)
Spring 1996	-0.16 (36)	0.17 (30)	-	0.50** (35)	0.86*** (40)
Fall 1996	-0.08 (31)	-0.17 (29)	0.33 (35)	-	0.53** (35)
Spring 1997	0.19 (36)	-0.37* (30)	0.57*** (40)	-0.10 (35)	-

Point Scores

	Spring 1995	Fall 1995	Spring 1996	Fall 1996	Spring 1997
Spring 1995	-	0.77*** (125)	0.83*** (107)	0.70*** (109)	0.80*** (124)
Fall 1995	-0.08 (125)	-	0.83*** (107)	0.71*** (109)	0.84*** (124)
Spring 1996	-0.18 (107)	-0.04 (107)	-	0.63*** (107)	0.84*** (215)
Fall 1996	0.03 (109)	-0.09 (109)	-0.04 (107)	-	0.68*** (205)
Spring 1997	0.16 (124)	-0.15 (124)	0.38*** (215)	-0.07 (205)	-

Relationships among species of small mammals, as described by DCA, were also highly consistent across sample periods (Table 32). Unlike birds, however, the second DCA axes of each mammal ordination also yielded similar species scores (all significant when alpha is adjusted to 0.10 for the small sample size). Although point scores were uncorrelated for second axes, they were highly correlated for first axes.

Table 32. Correlations among mammal-based DCA scores for species and for points, NCCP surveys, 1995-1997. Correlations for DCA 1 above the diagonal; correlations for DCA 2 below. *** denotes $P < 0.001$, ** denotes $P < 0.01$, * denotes $P < 0.05$. For small-sample tests, $^{+}$ denotes $P < 0.10$.

Species Scores

	Spring 1995	Fall 1995	Spring 1996	Fall 1996
Spring 1995	-	0.97*** (8)	0.89** (8)	0.94*** (8)
Fall 1995	0.69^{+} (8)	-	0.93*** (8)	0.91** (8)
Spring 1996	0.64^{+} (8)	0.93*** (8)	-	0.96*** (8)
Fall 1996	0.70^{+} (8)	0.64^{+} (8)	0.67^{+} (8)	-

Point Scores

	Spring 1995	Fall 1995	Spring 1996	Fall 1996
Spring 1995	-	0.83*** (76)	0.71*** (74)	0.61*** (60)
Fall 1995	0.14 (76)	-	0.81*** (118)	0.78*** (95)
Spring 1996	-0.09 (74)	0.17 (118)	-	0.76*** (139)
Fall 1996	0.22 (60)	0.05 (95)	0.06 (139)	-

Rather than present more detailed results of each of the DCAs for each taxon for each time period, because of the relatively consistent among-samples patterns (especially for first DCA axes) we selected three: fall 1996 and spring 1997 birds, and fall 1996 mammals. These were chosen based on their general representativeness (i.e., correlations in Tables 31 and 32) and their large sample sizes, which were inclusive of most sites we surveyed.

In fall birds, three loose groups of species appeared, and Orange-crowned Warblers were distinct from all others (Fig. 16). However, no distinguishing characteristics of members within these loose groups (other than that they shared patterns of co-occurrence) were apparent. In spring, the species previously identified as characteristic (California Towhee, Wrentit, Spotted Towhee, Bewick s Wren, and House Finch) appeared in the center of the ordination, intermingled with other species that shared an overall similar distributional pattern, but simply at reduced incidence of occurrence. Thus species such as Grasshopper Sparrow, Common Bushtit, Anna s Hummingbird, California Thrasher, Lesser Goldfinch, White-crowned Sparrow, Common Raven, California Quail, Blue-gray Gnatcatcher, Mourning Dove, Costa s Hummingbird, and Rufous-crowned Sparrow may also be considered characteristic of our samples. That species such as Sage Sparrow and California Gnatcatcher, two well-known CSS-associated species, were somewhat peripheral in their appearance in the ordination diagram likely reflects the distribution of our sampling points with respect to their habitat affinities, and not necessarily an overall reduced incidence of occurrence region-wide.

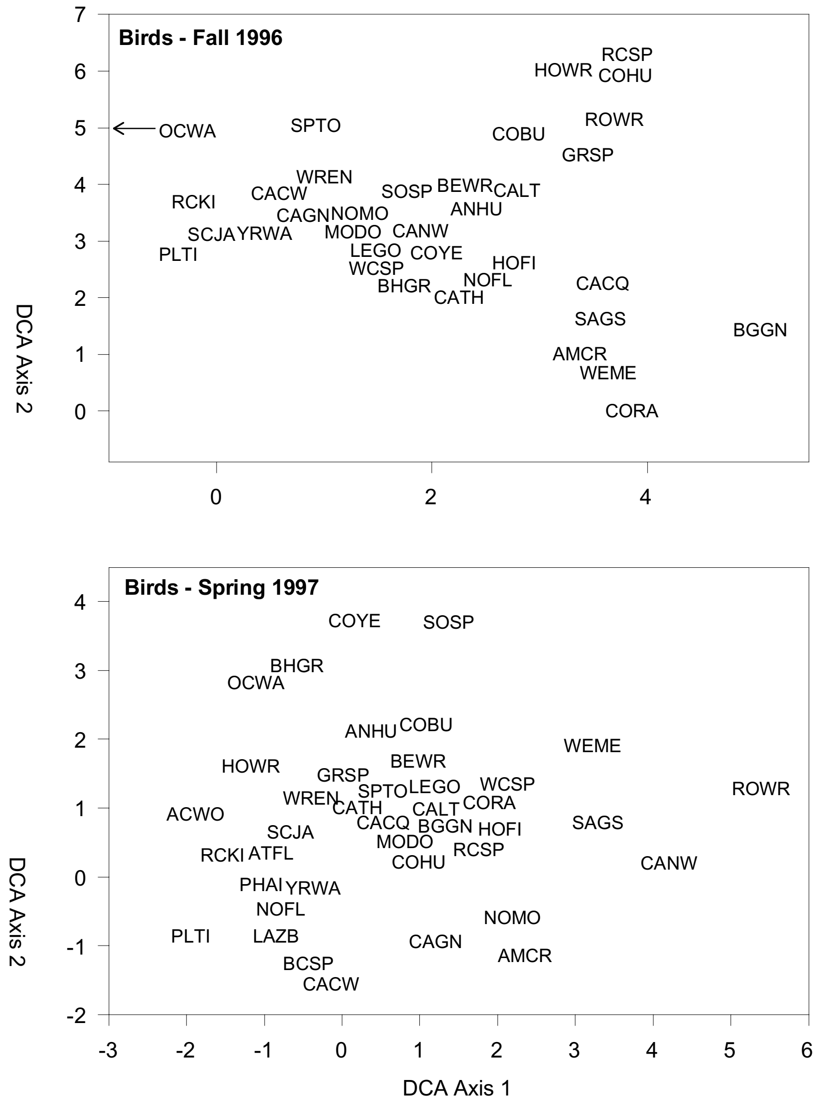


Figure 16. Bird species scores on Detrended Correspondence Analysis axes based on bird species composition, fall 1996 and spring 1997. See Table 14 for species codes.

As with birds, the most commonly-detected small mammal species, cactus mouse and San Diego woodrat (PEER and NELE), occupied the center of the mammal ordination diagram (Fig. 17). Otherwise, species were somewhat uniformly and widely dispersed, consistent with the relatively high eigenvalues associated with this DCA.

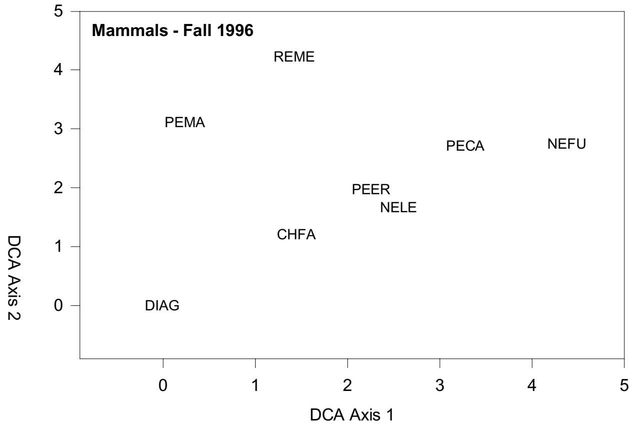


Figure 17. Mammal species scores on Detrended Correspondence Analysis axes based on mammal species composition, fall 1996. See Table 15 for species codes.

The ordination of sites based on the fall bird species revealed that the northeastern-most sites, in Riverside County, hosted an avian community somewhat distinct from the other sites during that period (Fig. 18). Although they contained Common Bushtits, California Towhees, and House Finches in common with many of the other sites, they also contained those species lying to the right of those three (DCA axis 1 > 2.5) in the species ordination diagram (Fig. 16), which were infrequent at the other sites.

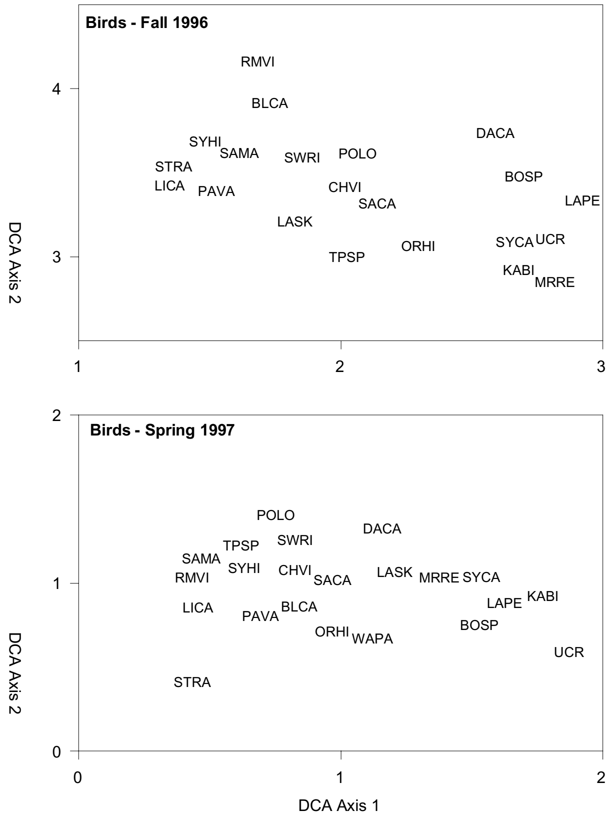


Figure 18. NCCP site mean scores on Detrended Correspondence Analysis axes based on bird species composition, fall 1996 and spring 1997. See Table 1 for site codes.

That avian community distinctness in the fall had a geographical component was readily apparent when DCA axis 1 was contoured onto a map of the sites (Fig. 19). It was also apparent that most of the separation was due to the first DCA axis, as a contour map of DCA axis 2 only served to highlight those widely scattered sites with the extreme scores on that axis (Fig. 20).

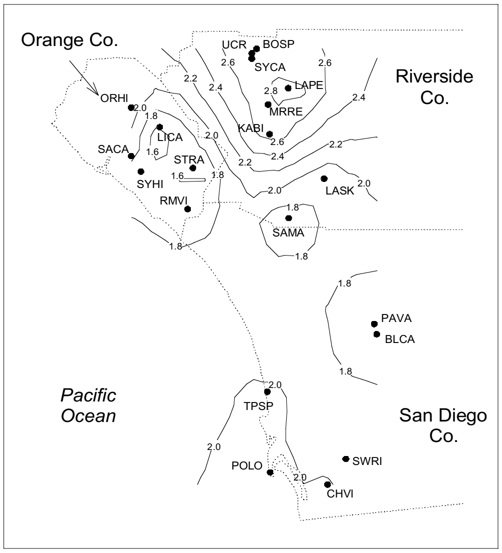


Figure 19. Contour map of NCCP site mean scores on fall 1996 bird species Detrended Correspondence Analysis axis 1. See Table 1 for site codes.

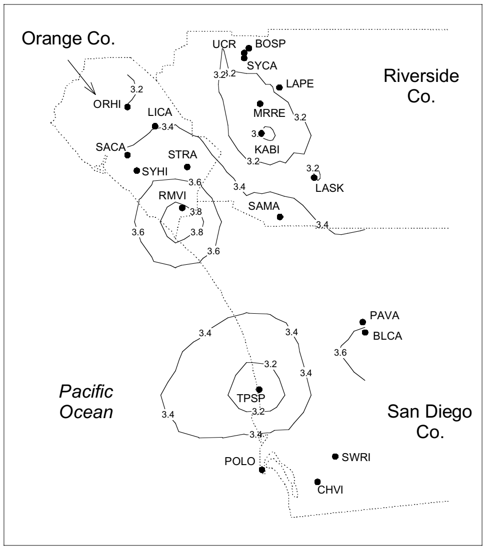


Figure 20. Contour map of NCCP site mean scores on fall 1996 bird species Detrended Correspondence Analysis axis 2. See Table 1 for site codes.

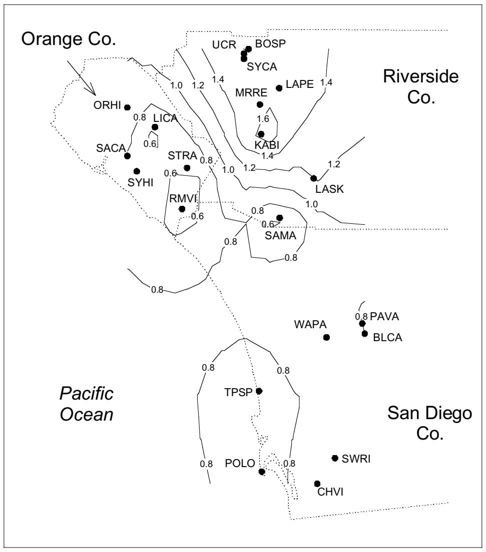
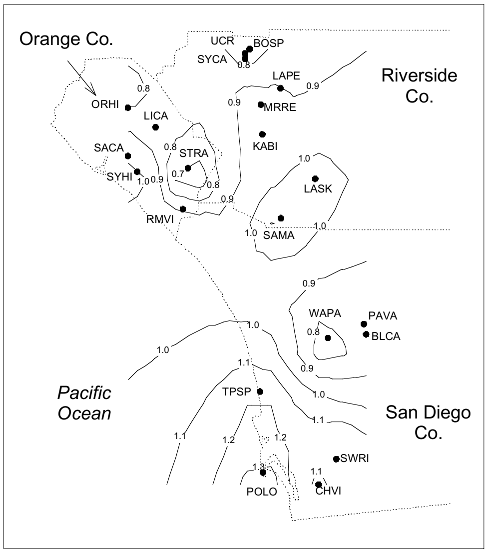


Figure 21. Contour map of NCCP site mean scores on spring 1997 bird species Detrended Correspondence Analysis axis 1. See Table 1 for site codes.

The same Riverside County sites also appeared to the right of the mean in the spring bird-based ordination, although somewhat less distinctly separated than in fall (Fig. 18). Diagnostic species were Canyon and Rock wrens, Western Meadowlarks, and Sage Sparrows, the latter three of which also helped distinguish the fall samples (Fig. 16). As before, the ordination was geographically distinct for the first DCA axis (Fig. 21), but not the second (Fig. 22).

Means of site scores, however, can hide a substantial amount of within-site variation (Fig. 23). Lake Skinner, for example, had a standard deviation on fall DCA 1 that encompassed all other site means, implying considerable point-to-point variation in avian species composition at this site. Torrey Pines was also quite variable, with comparatively large standard deviations along both fall DCA axes. Although sites were still variable for spring samples, the standard deviations were substantially smaller than in fall. We think the differences are due to the presence of more individuals (incoming fall/winter migrants and dispersing young-of-the-year that were locally produced) more broadly scattered and, perhaps, less closely tied to site-specific details of local vegetation and landscape structure when not breeding.



. Contour map of NCCP site mean scores on spring 1997 bird etrended Correspondence Analysis axis 2. See Table 1 for site

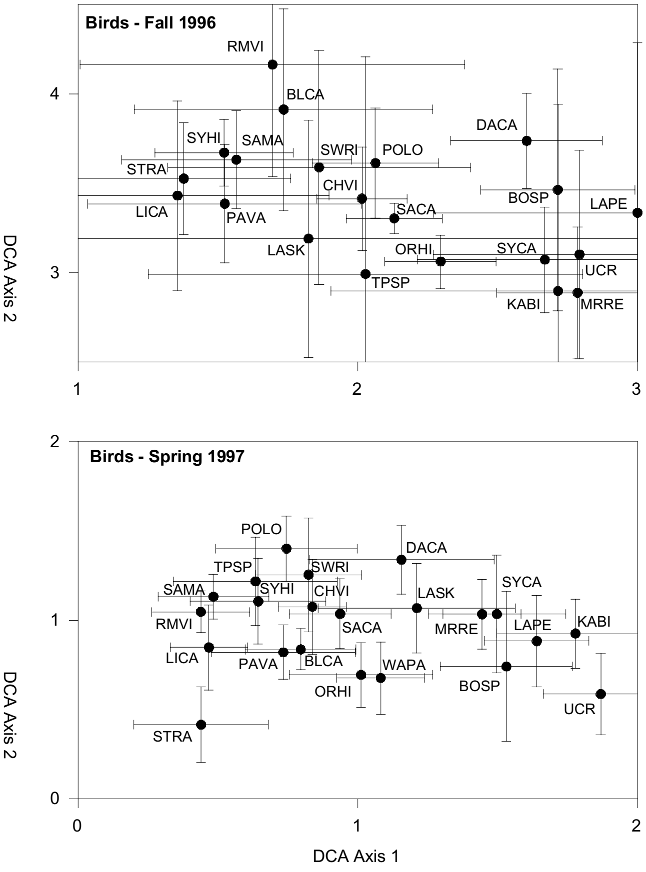


Figure 23. NCCP site mean scores and standard deviations on Detrended Correspondence Analysis axes based on bird species composition, fall 1996 and spring 1997. See Table 1 for site codes.

The mammal ordination produced one very tight cluster of sites, with the remainder scattered throughout the ordination space (Fig. 24). In addition to the regionally common species (cactus mice and San Diego woodrats), these sites were also characterized by San Diego pocket mice and Pacific kangaroo rats (Fig. 17). This ordination also contained a strong geographical component, in that all inland sites (regardless of north-south orientation) had mean scores on DCA axis 1 < 2.0, whereas all coastal ones had scores > 2.0 (Fig. 25). This also implies that San Diego pocket mice, Pacific kangaroo rats, deer mice, and western harvest mice (whose scores on axis 1 are < 2; Fig. 17) are primarily inland species, whereas California mice and dusky-footed woodrats are mainly coastal ones. DCA 2 also had a strong east-west separation at 2.0, but with an inland bulge that incorporated Kabian Park and Santa Margarita (KABI and SAMA; Fig. 26).

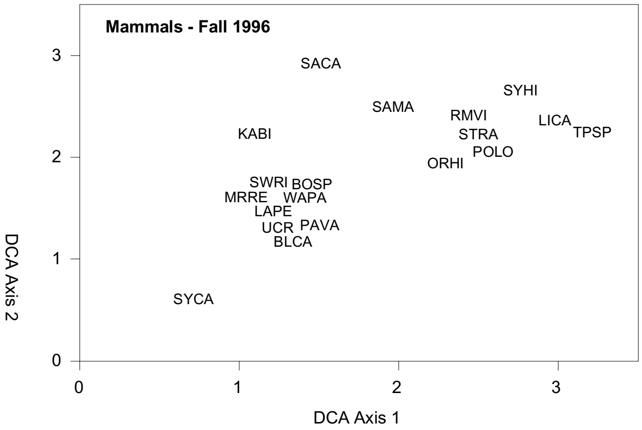


Figure 24. NCCP site mean scores on Detrended Correspondence Analysis axes based on mammal species composition, fall 1996. See Table 1 for site codes.

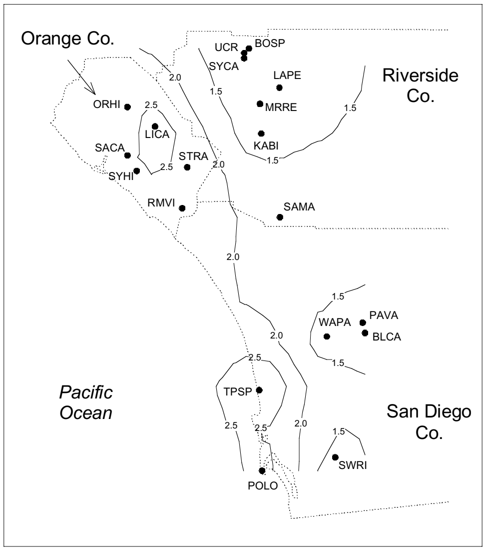


Figure 25. Contour map of NCCP site mean scores on fall 1996 mammal species Detrended Correspondence Analysis axis 1. See Table 1 for site codes.

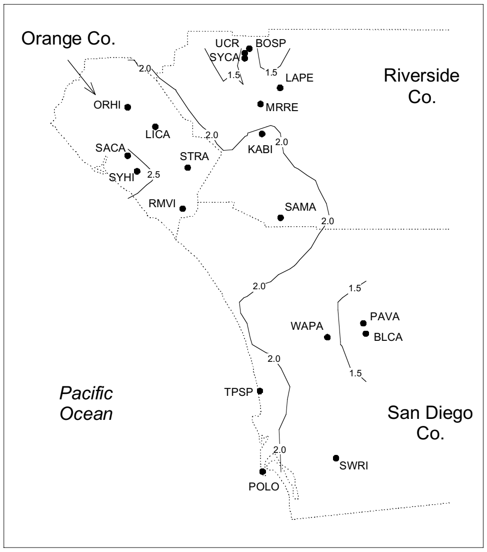


Figure 26. Contour map of NCCP site mean scores on fall 1996 mammal species Detrended Correspondence Analysis axis 2. See Table 1 for site codes.

As for birds, site mean ordination scores based on small mammals also concealed a substantial amount of within-site variation (Fig. 27). However, examination of this variation served to reinforce the distinctness between the inland and coastal sites, as it was apparent that standard deviations of the two groups overlapped little. It was also apparent that Sycamore Canyon (SYCA) was yet even more distinct among the inland sites.

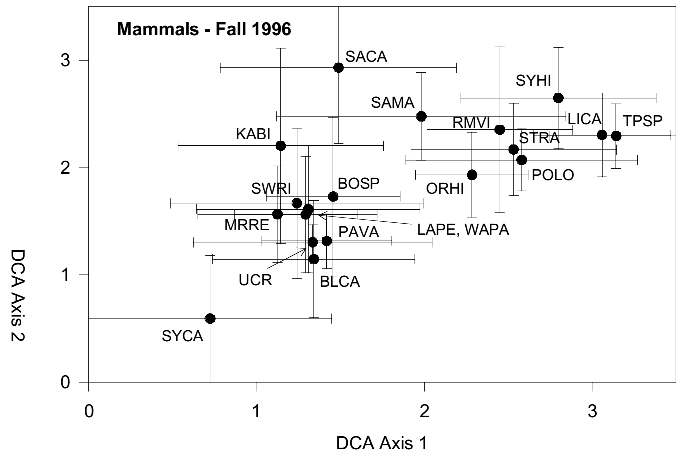


Figure 27. NCCP site mean scores and standard deviations on Detrended Correspondence Analysis axes based on mammal species composition, fall 1996. See Table 1 for site codes.

Community ordinations were similar for both birds and small mammals; the scores of the first axis generated from bird-based DCA were significantly correlated with scores of the first axis obtained from mammal-based DCA for the four seasons in which the two taxa were co-sampled (Table 33). Thus the major gradient in species change for birds in each sampling period was paralleled by changes for mammals. This reflects the major gradient in vegetation and landscape structure and composition that underlies species distributional patterns in this system, which will be developed in greater detail below.

Table 33. Patterns of intercorrelations among bird-based and mammal-based DCA scores for points, NCCP surveys, 1995-1996. DCAs based on presence/absence.

Season	Number of co-Sampled points	Bird DCA 1 Mammal DCA 1	Bird DCA 2 Mammal DCA 2	Bird DCA 1 Mammal DCA 2	Bird DCA 2 Mammal DCA 1
Spring 1995	78	-0.49***	-0.21	-0.41***	0.33**
Fall 1995	113	-0.64***	-0.16	-0.13	-0.09
Spring 1996	154	-0.72***	-0.01	0.08	-0.09
Fall 1996	144	-0.43***	0.14	-0.24**	0.20*

TEMPORAL VARIATION

ANNUAL CHANGES IN ABUNDANCE

Several species underwent statistically detectable changes in their abundance (as indicated by the number of points occupied) between sampling periods (Tables 34, 35). Between spring 1995 and spring 1996, six bird species increased while two decreased, whereas between spring 1996 and spring 1997, 10 increased and seven decreased (Table 34). Northern Flickers, Rufous-crowned Sparrows, and White-crowned Sparrows increased in both springs, whereas no species decreased in both. A spring decrease in Sage Sparrows in the first comparison was followed by an increase in the second, and the reverse (increase followed by decrease) was true for Common Yellowthroats and Common Bushtits. No species appeared to be in consistent decline throughout our relatively short span of sampling, which in any event was not designed to detect long-term trends in population abundance.

Compared to birds, mammals varied much less between samples (Table 35). One species increased and one decreased significantly during the interval between fall 1996 and fall 1997, whereas a third increased between the two spring sampling periods. This increase was sandwiched around a decrease in the intervening fall.

Table 34. Significant changes in bird species detections between sampling periods. + denotes increase from first to second period; - denotes decrease. Comparisons made using chi-square test of presence/absence at points in each period. N = number of points in common across sampling periods compared. Blanks denote no significant change; * denotes $P < 0.05$; ** denotes $P < 0.01$; *** denotes $P < 0.001$.

Species	Comparison		
	Spring 1995-1996 (N = 107)	Spring 1996-1997 (N = 215)	Fall 1995-1996 (N = 109)
ANHU			
BCSP		- **	
BEWR		+ *	- **
BGGN			
BHGR			
CACW			- *
CAGN			
CALT	+ *		
CANW			
CAQU		+ *	- *
CATH			
COBU	+ ***	- ***	- ***
COHU		- ***	
COYE	+ ***	- *	
HOFI		+ ***	- ***
LAZB	- ***		
LEGO		+ ***	- ***
MODO			
NOFL	+ *	+ **	- ***
NOMO			- ***
OCWA		+ *	
PHAI	- **		
RCKI			
RCSP	+ ***	+ *	
ROWR		- **	- **
SAGS	- *	+ **	
SCJA			
SOSP			
SPTO		- *	- ***
WCSP	+ *	+ ***	
WEME		- *	- *
WREN			- *
YRWA		+ ***	

Table 35. Significant changes in mammal species detections between sampling periods. + denotes increase from first to second period; - denotes decrease. Comparisons made using chi-square test of presence/absence at points in each period. N = number of points in common across sampling periods compared. Blanks denote no significant change; * denotes P < 0.05; *** denotes P < 0.001.

Species	Comparison				
	Fall 1995-1996	Spring 1995-1996	Spring 1995-Fall 1995	Fall 1995-Spring 1996	Spring 1996-Fall 1996
	(N = 96)	(N = 74)	(N = 78)	(N = 119)	(N = 140)
CHFA	+ ***				
DIAG					
NEFU					
NELE					
PECA					
PEER		+ ***	- *		
PEMA	- *				
REME					

Concordance of Species Distributions Among Years

Species varied considerably in the concordance of their distribution among points between sampling periods (Tables 36, 37). Birds were particularly variable, displaying both the highest (Wrentit near 0.9) and lowest concordances (many species around 0.0) observed (Table 36).

Table 36. Concordance in bird species distributions between sampling periods. Comparisons made using point-biserial correlation of presence/absence at points in each period. N = number of points in common across sampling periods compared. * denotes P < 0.05; ** denotes P < 0.01; *** denotes P < 0.001. Under Asymmetry, 00 denotes >80% of observations in cell 0,0; ++ denotes > 80% of observations in cell 1,1 (see Fig. 13); + denotes increase from first to second period; - denotes decrease (Table 34).

Species	Comparison					
	Spring 1995-1996 (N = 107)		Spring 1996-1997 (N = 215)		Fall 1995-1996 (N = 109)	
	Correlation	Asymmetry	Correlation	Asymmetry	Correlation	Asymmetry
ANHU	0.167		0.320***		0.227*	
BCSP	0.464***		0.635***	-	-	
BEWR	0.311**		0.310***	+	-0.066	-
BGGN	0.085	00	0.124	00	0.303**	
BHGR	-0.003	00	0.338***	00	-	
CACW	0.662***		0.738***		-0.025	00, -
CAGN	0.572***	00	0.295***		0.121	00
CALT	-0.055	++, +	0.147*	++	0.084*	

Table 36. Continued.

Species	Comparison					
	Spring 1995-1996 (N = 107)		Spring 1996-1997 (N = 215)		Fall 1995-1996 (N = 109)	
	Correlation	Asymmetry	Correlation	Asymmetry	Correlation	Asymmetry
CANW	0.325***		0.373***	00	-	
CAQU	0.162		0.260***	+	0.157	-
CATH	0.327***		0.388***		0.099	
COBU	0.186	+	0.144*	-	0.159	-
COHU	0.200*		0.006	-	-	
COYE	0.366***	00, -	0.468***	-	-	
HOFI	0.252**		0.304***	+	0.245*	-
LAZB	0.262**	-	0.282***	00	-	
LEGO	0.308**		0.215**	+	0.198*	-
MODO	0.102		0.279***		-	
NOFL	0.031	00, +	0.113	+	0.111	-
NOMO	0.213*		0.454***		0.186	-
OCWA	0.153	00	0.385***	+	-	
PHAI	0.184	00, -	0.074	00	-	
RCKI	-		-		0.126	
RCSP	0.278**	+	0.303***	+	0.128	
ROWR	0.093	00	0.486***	00, -	0.368***	-
SAGS	0.591***	-	0.667***	+	-0.044	
SCJA	0.348**		0.252***		0.437***	
SOSP	0.295**		0.378***		-	
SPTO	0.552***		0.523***	-	-0.009	-
WCSP	-0.098	-	0.184**	+	-0.239*	
WEME	0.466***		0.613***	-	0.209*	00, -
WREN	0.885***		0.872***		0.716***	-
YRWA	-		-0.023	+	0.670***	

Eighteen bird species were significantly concordant in their distributional patterns during both spring comparisons (1995-1996, 1996-1997), whereas ten were concordant in one or the other, but not both. Low concordance can occur for a variety of reasons, such as true shifts in distribution among points, but also can be an artifact of either low or high overall abundance, or of changes in abundance among sampling periods. Of the ten species not concordant in one or the other season, concordance in three species was likely reduced because of relative rareness, reduced in one because it was very common, and reduced in another four because of significant inter-sample changes in abundance (Table 34). Northern Flickers and Blue-gray Gnatcatchers were never concordant in consecutive spring samples. Concordances were highly correlated across the two spring comparisons ($r = 0.76$, $N = 30$, $P < 0.001$), although neither set of spring concordances was correlated with the fall set ($r = 0.28, 0.24$, respectively; $N = 21$; $P > 0.05$).

A smaller proportion of birds were significantly concordant across the two fall sampling periods (11 of 23 tested; Table 36). Of the 12 that lacked concordance, four (California Thrasher, Rufous-crowned Sparrow, Ruby-crowned Kinglet, and Sage Sparrow) were not associated with significant asymmetry due to any detectable cause.

Consistent with the lower vagility of mammals compared to birds, mammals were significantly concordant in almost all comparisons examined (Table 37). Western harvest mice had two non-significant concordances, the pattern of which suggested that the change in distribution that produced the deviance occurred in spring 1996, and may have been associated with low numbers of occupied points (more than 80% of points lacked harvest mice). San Diego pocket mice had one instance of non-concordance, and it could not be attributed to asymmetry (Table 37). There were too few degrees of freedom (df = 6) to make a meaningful search for correlations in concordances across comparisons.

Table 37. Concordance in mammal species distributions between sampling periods. Comparisons made using point-biserial correlation of presence/absence at points in each period. N = number of points in common across sampling periods compared. * denotes $P < 0.05$; ** denotes $P < 0.01$; *** denotes $P < 0.001$. Under Asymmetry, 00 denotes >80% of observations in cell 0,0 (see Fig. 13); + denotes increase from first to second period; - denotes decrease (Table 35).

	Comparison									
Species	Fall 1995-1996 (N = 96)		Spring 1995-1996 (N = 74)		Spring 1995-Fall 1995 (N = 78)		Fall 1995-Spring 1996 (N = 119)		Spring 1996-Fall 1996 (N = 140)	
	Correlation	Asymmetry	Correlation	Asymmetry	Correlation	Asymmetry	Correlation	Asymmetry	Correlation	Asymmetry
CHFA	0.234*	+	0.165		0.448***		0.480***		0.537***	
DIAG	0.554***		0.559***		0.653***		0.648***		0.585***	
NEFU	0.700***		0.406***		0.616***	00	0.590***		0.491***	
NELE	0.413***		0.539***		0.467***		0.509***		0.409***	
PECA	0.657***		0.742***		0.787***		0.668***		0.649***	
PEER	0.360***		0.435***	+	0.349**	-	0.461***		0.265**	
PEMA	0.320**	-	0.611***		0.615***		0.632***		0.397***	
REME	0.259*		0.056	00	0.274*	00	0.153		0.184*	

COMMUNITY PATTERNS OF ANNUAL VARIATION

Overall community patterns were highly significantly concordant among all periods and all taxonomic groupings compared for both the first DCA axis and the Mantel statistic (Table 38). Likewise, the average difference in DCA axis 1 scores of points between periods compared was near zero, and in any event was always ≤ 5% of the total length of the axis. Correlations for DCA axis 2 scores, however, were not always significantly correlated, and some average differences were 12-19% of the total length of the axis (although most were ~ 2%). This suggests that whatever annual redistribution of animals occurs accounts for a relatively small proportion of the patterns detected by DCA, and is relegated primarily to second and subsequent axes.

Community patterns also reflected patterns of individual taxa noted above. Spring samples were more consistent between years than fall samples, and mammals were more consistent than birds. Apparently, the lesser concordance for springs based on all taxa represented the dominance of those samples by the more variable birds.

Table 38. Community-level concordances between various sampling periods. N is the number of points common to both periods being compared. Correlation refers to the correlation between scores of points between periods compared on a common axis. Average difference refers to the mean difference of points between periods compared on a common axis. *** denotes P < 0.001; * denotes P < 0.05.

Taxon	Periods Compared	N	DCA Axis 1				DCA Axis 2				Mantel r
			Correlation	Average Difference	Eigenvalue	Length	Correlation	Average Difference	Eigenvalue	Length	
Birds and Small Mammals	Spring 1995 — Spring 1996	66	0.91***	0.05	0.26	2.38	0.65***	-0.24	0.12	1.91	0.50***
	Fall 1995 — Fall 1996	67	0.81***	0.08	0.33	3.28	0.11	-0.20	0.20	2.83	0.34***
Birds	Spring 1995 — Spring 1996	107	0.86***	-0.01	0.23	2.29	0.63***	0.02	0.14	1.97	0.38***
	Spring 1996 — Spring1997	215	0.84***	-0.08	0.22	2.32	0.43***	-0.39	0.13	2.03	0.43***
	Fall 1995 — Fall 1996	109	0.73***	0.07	0.36	4.21	0.14	0.09	0.25	4.28	0.25***
Mammals	Spring 1995 — Spring 1996	74	0.78***	-0.09	0.54	4.61	0.14	0.00	0.31	3.44	0.41***
	Fall 1995 — Fall 1996	95	0.78***	0.18	0.56	4.05	0.25*	0.03	0.26	1.20	0.39***
	Spring 1995 — Fall 1995	76	0.83***	-0.04	0.52	3.91	0.56***	0.02	0.28	3.45	0.42***
	Fall 1995 — Spring 1996	118	0.83***	-0.03	0.58	4.44	0.22*	0.03	0.27	1.58	0.49***
	Spring 1996 — Fall 1996	139	0.78***	0.25	0.58	4.69	0.40***	-0.04	0.34	3.63	0.36***

HABITAT RELATIONSHIPS

We were able to use 208 points for birds and 168 points for small mammals that had been sampled from 1-2 times in fall and 1-3 times in spring, and which also included a complete set of habitat variables, in ordinal logistic regressions. The number of times each species was detected at a point varied widely (Tables 39, 40), and we excluded from our analyses any species that was detected on less than 10% of the total number of points in a sample in a season. For most species, especially those that occurred only infrequently, these logistic regressions mainly contrasted habitat measurements associated with presence/absence. However, for species like California and Spotted towhees that occurred virtually everywhere (in > 90% of points), regressions mainly assessed habitat values associated with the likelihood of detecting them repeatedly at a point.

Table 39. Number of occurrences of different count categories (number of sampling periods in which a species was detected at a point) used in logistic regressions of bird species distribution on habitat variables. N = 208; thus no species sample with a 0 count category containing >187 counts (208 x 90%) was analyzed. * denote species with < 10% (21) in 0 count category.

Species	Season	Count Category			
		0	1	2	3
ANHU	Spring	85	73	42	8
	Fall	93	96	19	
BCSP	Spring	109	32	30	37
BEWR	Spring	23	42	97	46
	Fall	120	80	8	
BGGN	Fall	171	29	8	
BHGR	Spring	165	32	11	
CACW	Spring	134	23	31	20
CAGN	Spring	156	34	13	5
	Fall	184	23	1	
CALT	Spring*	1	13	101	93
	Fall	40	106	62	
CANW	Spring	171	21	14	2

Table 39. Continued.

Species	Season	Count Category			
		0	1	2	3
CAQU	Spring	52	61	66	29
	Fall	167	36	5	
CATH	Spring	59	62	61	26
	Fall	162	40	6	
COBU	Spring	56	93	46	13
	Fall	148	54	6	
COHU	Spring	51	102	41	14
COYE	Spring	163	29	13	3
HOFI	Spring	40	63	82	23
	Fall	95	98	15	
LAZB	Spring	121	66	13	8
LEGO	Spring	48	78	52	30
	Fall	154	47	7	
MODO	Spring	32	61	92	23
NOFL	Spring	158	40	9	1
	Fall	138	58	12	
NOMO	Spring	77	54	61	16
	Fall	164	41	3	
OCWA	Spring	156	36	16	
PHAI	Spring	160	40	8	
RCKI	Fall	176	29	3	
RCSP	Spring	46	68	66	28
	Fall	178	27	3	

Table 39. Continued.

Species	Season	Count Category			
		0	1	2	3
ROWR	Spring	184	20	2	2
	Fall	180	21	7	
SAGS	Spring	137	18	30	23
	Fall	181	26	1	
SCJA	Spring	106	60	34	8
	Fall	156	40	12	
SOSP	Spring	112	56	36	4
SPTO	Spring*	15	17	103	73
	Fall	127	75	6	
WCSP	Spring	83	70	50	5
	Fall	72	122	14	
WEME	Spring	135	34	27	12
	Fall	184	21	3	
WREN	Spring	56	10	77	65
	Fall	79	82	47	
YRWA	Spring	185	23		
	Fall	122	46	40	

Table 40. Number of occurrences of different count categories (number of sampling periods in which a species was detected at a point) used in logistic regressions of mammal species distribution on habitat variables. N = 168; thus no species sample with a 0 count category containing >151 counts (168 x 90%) was analyzed.

Species	Season	Count Category				
		0	1	2	3	4
CHFA	All	76	28	33	21	10
	Spring	96	54	18		
	Fall	86	57	25		

Table 40. Continued.

Species	Season	Count Category				
		0	1	2	3	4
DIAG	All	106	21	13	16	12
	Spring	122	29	17		
	Fall	114	28	26		
NEFU	All	105	27	21	12	3
	Spring	119	43	6		
	Fall	122	30	16		
NELE	All	63	30	37	29	9
	Spring	82	54	32		
	Fall	82	63	23		
PECA	All	90	20	29	20	9
	Spring	101	51	16		
	Fall	101	43	24		
PEER	All	30	37	44	34	23
	Spring	62	64	42		
	Fall	41	83	44		
PEMA	All	94	26	18	21	9
	Spring	110	34	24		
	Fall	106	45	17		
REME	All	117	41	8	1	1
	Spring	142	25	1		
	Fall	134	31	3		

It was clear that variation in the distribution of bird and small mammal species was significantly associated with the habitat variables we measured and generated; that is, these variables appear relevant to the distribution of these species, at least in a correlational context. Virtually all of the logistic regressions we fitted (by species, season, and scale) were statistically significant (Tables 41, 42). Note, however, that because birds were sampled using slightly different methods in fall vs. spring, and because detectablities of birds may change substantially between seasons, the regressions combining detections across all seasons (all ; Table 41) may not be reliable. We present them (Tables 41, 43), but do not discuss them further. No such problems arise, however, with the combined small mammal data (Tables 42, 44).

Below we highlight some of the general patterns obtained from our analyses. Discussion of individual species habitat relationships is presented in Section VII. SPECIES SUMMARIES.

THE RELATIVE IMPORTANCE OF LOCAL AND LANDSCAPE VARIABLES

It was clear that the contribution of local and landscape variables differed from species to species and season to season. More than half of the best bird-season and mammal-season regressions included both local and landscape variables (Tables 41, 42). Thus, landscape variables appeared to play an important role in determining the distribution of these taxa in this ecosystem. Of the models that were deemed either local-only or landscape-only, the preponderance were local-only; this preponderance was particularly apparent in spring birds (11 local vs. 2 landscape), although it occurred in fall as well (7 vs. 3). Mammals had a higher proportion of local-only models compared to birds (13/24 = 54% vs. 18/52 = 35%), likely a reflection of their lower vagility.

Of 28 bird and mammal species for which we generated spring and fall regressions, four birds and three mammals had best models that were local-only in both seasons; none had landscape-only in both seasons (Tables 41, 42). Two species (Common Bushtit and White-crowned Sparrows) shifted from local-only in one season to landscape-only in the other. Eight species were local-only in one season and both in the other, whereas only four were landscape-only in one season and both in the other. Six birds and one mammal had best models that incorporated both sets of variables in both seasons.

When we examined the statistically significant ($P < 0.05$) regression coefficients associated with the best models for all species, every variable appeared in at least one model (Tables 43, 44). As a reminder, this significance evaluates the contribution of a variable to a model given that other variables are also present in the model, and that it is possible that even a significant overall regression model (e.g., Common Bushtit, spring; Table 41) may have no significant individual variables (Table 43). Bearing this caveat in mind, we can now examine what species appear to be associated with different local and landscape variables.

Some variables were significantly associated with only a few of the best species-season models. For example, the presence of trails (TRAIL) appeared only once for birds, where it seemed Rock Wrens in spring had a negative association (Table 43). It appeared only twice for mammals, where it was positively associated with all dusky-footed woodrats and fall California mice (Table 44). Likewise, no small mammals were associated with variation in tree coverage (PC_TREE), although it appeared in four bird models (positive for spring Lazuli Buntings, spring California Thrashers, and fall Western Scrub-jays, and negative for fall California Towhees).

We considered five variables to be representative of increasing human disturbance and/or urbanization at either local or landscape scales: habitat structural factor 1 (STFAC4, disturbed), distance to an urban boundary (URBDIST), presence of roads or trails (TRAIL) , and landscape factors 4 (LAFAC4, urban) and 5 (LAFAC5, ag/exotic). These variables appeared in the best model for several species (although, as noted above, TRAIL did so only infrequently), and these species may therefore be considered especially sensitive to disturbance and/or urbanization (some negatively so, but some positive as well). For example, Pacific kangaroo rats and deer mice were in all seasons positively associated with agriculture and exotic grasslands in the landscape within 500 m of a point (LAFAC5), as were California Quail, Common Yellowthroats, Mourning Doves, Northern Mockingbirds, and Western Meadowlarks in spring, and Bewick s Wrens and White-crowned Sparrows in fall. Only Orange-crowned Warblers were negatively associated. Increasing exotic grasses and forbs at the local level (STFAC4) was positively associated with San Diego woodrats, Bewick s Wrens, California Thrashers, Common Yellowthroats, and Song Sparrows in spring, and Spotted Towhees both seasons, and negatively with western harvest mice, Rufous-crowned Sparrows, and White-crowned Sparrows in spring, and House Finches and Northern Flickers in fall. The latter five species could be considered to be intolerant of local scale disturbance.

A suite of species were associated with local and landscape measures of urbanization. Anna s Hummingbirds, California Towhees, and House Finches were all more likely to occur in both seasons at points increasingly close to urban boundaries, as were Common Yellowthroats and White-crowned Sparrows in spring. In contrast, California mice, cactus mice, and Western Meadowlarks were less likely to occur in all seasons close to urban boundaries, as were Black-chinned Sparrows, Blue-gray Gnatcatchers, Lazuli Buntings, Mourning Doves, Northern Flickers, Western Scrub-jays, and Yellow-rumped Warblers in spring, and Wrentits and Spotted Towhees in fall. At the landscape level, Pacific pocket mice, Anna s Hummingbirds, House Finches, and Northern Mockingbirds in spring, and dusky-footed woodrats, Cactus Wrens, California Towhees, Sage Sparrows, and White-crowned Sparrows in fall, and San Diego pocket mice and Wrentits in both seasons were more likely to be detected in more urbanized landscapes, whereas Lazuli Buntings and Western Meadowlarks in the spring and California Quail in the fall were detected more frequently in less urban settings.

We also had two variables that represented variation in habitat heterogeneity, STFAC3 (forbs/patchy) and EDGEDIST. The former variable was associated with increasing number of changes from grass to shrub and back along a 50-m transect, while the latter represented the distance to the nearest habitat type other than CSS, and thus was an index of CSS patch size (which is smaller in more heterogeneous or fragmented landscapes). Species positively associated with EDGEDIST (i.e., more likely to occur farther from other habitats or in larger patches of CSS) included Pacific kangaroo rats, deer mice, western harvest mice, and California Thrashers in all seasons, and Sage Sparrows and Anna s Hummingbirds in spring. Species occurring under more fragmented conditions were California mice in all seasons, Cactus Wrens, Northern Mockingbirds, and Orange-crowned Warblers in spring, and Rufous-crowned Sparrows and Rock Wrens in fall. At the point level (STFAC3), cactus mice and western harvest mice in all seasons, and Cactus

Wrens, California Gnatcatchers, and Costa's Hummingbirds in spring were associated with increasing local-scale heterogeneity, whereas Anna's Hummingbirds and Song Sparrows in the spring and Lesser Goldfinches in the fall showed the opposite trend.

Two species lived up to their names. Cactus Wrens were positively associated with CACTUS, and House Finches were more abundant closer to urban areas (URBDIST, mainly suburban housing). However, Rock Wrens were not associated with ROCK, nor cactus mice with CACTUS (at least not over and above variation in their occurrence accounted for by other variables).

Table 41. Logistic regression of bird presence/absence on local and landscape habitat variables, by season, and test of significance of addition of variables of one scale to those of the other scale. * denotes best model for spring or fall; ? denotes ambiguity in best model. Int. only is total Chi-square; Int. + cov. is Chi-square with covariates fitted; Cov. is reduction in Chi-square due to fitting covariates, which is the test of the significance of the regression.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
ANHU	All	208	Local	626.253	566.950	59.303	15	< 0.001	70.9%	14.101	5	0.015
			Landscape	626.253	601.218	25.035	6	< 0.001	64.7%	48.369	14	< 0.001
			Both	626.253	552.849	73.404	20	< 0.001	73.0%			
	Spring	208	Local	491.523	453.342	38.180	15	0.001	69.5%	17.696	5	0.003
			Landscape	491.523	463.749	27.774	6	< 0.001	66.6%	28.103	14	0.014
			Both*	491.523	435.646	55.876	20	< 0.001	72.7%			
	Fall	208	Local*	389.109	314.803	74.306	15	< 0.001	78.6%	2.420	5	0.788
			Landscape	389.109	370.888	18.221	6	0.006	64.1%	58.505	14	< 0.001
			Both	389.109	312.383	76.726	20	< 0.001	78.9%			
BCSP	Spring	208	Local*	504.615	318.443	186.172	15	< 0.001	87.8%	8.919	5	0.112
			Landscape	504.615	387.901	116.714	6	< 0.001	82.0%	78.377	14	< 0.001
			Both	504.615	309.524	195.091	20	< 0.001	88.4%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results -2 LOG L Int. only	 Int.+cov.	 Chi-sq. Cov.	 df	 P	 Regression Concordance	Test of Addition of Other Variable Set Chi-sq.	 df	 P
BEWR	All	208	Local	639.077	560.897	78.180	15	< 0.001	75.0%	9.765	5	0.082
			Landscape	639.077	576.053	63.024	6	< 0.001	71.7%	24.921	14	0.035
			Both	639.077	551.132	87.945	20	< 0.001	76.1%			
	Spring	208	Local*	522.490	445.286	77.204	15	< 0.001	75.7%	8.531	5	0.129
			Landscape	522.490	473.444	49.046	6	< 0.001	69.5%	36.689	14	0.001
			Both	522.490	436.755	85.735	20	< 0.001	75.8%			
	Fall	208	Local	337.022	306.579	30.443	15	0.010	71.4%	8.319	5	0.140
			Landscape	337.022	313.678	23.344	6	0.001	67.8%	15.418	14	0.350
			Both*	337.022	298.260	38.763	20	0.007	74.2%			
BGGN	Fall	208	Local	233.393	165.535	67.857	15	< 0.001	86.8%	11.595	5	0.041
			Landscape	233.393	181.892	51.500	6	< 0.001	82.2%	27.952	14	0.014
			Both*	233.393	153.940	79.453	20	< 0.001	89.1%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
BHGR	Spring	208	Local	260.893	245.084	15.809	15	0.395	68.3%	31.983	5	< 0.001
			Landscape*	260.893	236.454	24.439	6	< 0.001	72.0%	23.353	14	0.055
			Both	260.893	213.101	47.792	20	< 0.001	79.8%			
CACW	Fall	208	Local	117.718	88.149	29.569	15	0.014	86.0%	15.468	5	0.009
			Landscape	117.718	100.777	16.941	6	0.010	78.4%	28.096	14	0.014
			Both*	117.718	72.681	45.037	20	0.001	91.8%			
CAGN	All	208	Local	383.086	346.652	36.434	15	0.002	72.9%	18.730	5	0.002
			Landscape	383.086	360.005	23.081	6	0.001	65.6%	32.083	14	0.004
			Both	383.086	327.922	55.164	20	< 0.001	77.8%			
	Spring	208	Local	322.285	285.576	36.709	15	0.001	75.2%	16.904	5	0.005
			Landscape	322.285	306.682	15.604	6	0.016	63.0%	38.010	14	0.001
			Both*	322.285	268.672	53.613	20	< 0.001	79.5%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
CAGN	Fall	208	Local	157.087	138.818	18.269	15	0.249	74.8%	8.500	5	0.131
			Landscape	157.087	146.454	10.633	6	0.100	68.4%	16.136	14	0.305
			Both	157.087	130.318	26.769	20	0.142	79.8%			
CALT	All	208	Local	601.307	343.809	257.498	15	< 0.001	72.6%	13.223	5	0.021
			Landscape	601.307	380.376	220.931	6	< 0.001	74.3%	49.790	14	< 0.001
			Both	601.307	330.586	270.721	20	< 0.001	73.3%			
	Spring	208	Local*	378.409	139.739	238.670	15	< 0.001	65.0%	7.119	5	0.212
			Landscape?	378.409	164.891	213.519	6	< 0.001	85.0%	32.271	14	0.004
			Both	378.409	132.620	245.789	20	< 0.001	55.5%			
	Fall	208	Local	424.892	290.002	134.890	15	< 0.001	85.1%	15.013	5	0.010
			Landscape	424.892	308.479	116.413	6	< 0.001	84.3%	33.490	14	0.002
			Both*	424.892	274.989	149.903	20	< 0.001	87.0%			
CANW	Spring	208	Local	257.431	161.505	95.926	15	< 0.001	93.0%	27.084	5	< 0.001
			Landscape	257.431	170.371	87.060	6	< 0.001	89.8%	35.950	14	0.001
			Both*	257.431	134.421	123.009	20	< 0.001	94.7%			
CAQU	All	208	Local	643.376	573.670	69.706	15	< 0.001	72.7%	12.378	5	0.030
			Landscape	643.376	604.349	39.028	6	< 0.001	68.1%	43.057	14	< 0.001
			Both	643.376	561.292	82.085	20	< 0.001	74.5%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
CAQU	Spring	208	Local	559.622	494.405	65.217	15	< 0.001	72.6%	13.982	5	0.016
			Landscape	559.622	522.466	37.157	6	< 0.001	67.2%	42.043	14	< 0.001
			Both*	559.622	480.423	79.199	20	< 0.001	74.7%			
	Fall	208	Local	236.898	202.813	34.085	15	0.003	76.6%	10.849	5	0.054
			Landscape	236.898	214.149	22.749	6	0.001	72.8%	22.185	14	0.075
			Both*	236.898	191.964	44.935	20	0.001	80.6%			
CATH	All	208	Local	643.698	556.754	86.943	15	< 0.001	75.6%	20.057	5	0.001
			Landscape	643.698	597.578	46.120	6	< 0.001	69.7%	60.881	14	< 0.001
			Both	643.698	536.697	107.000	20	< 0.001	78.6%			
	Spring	208	Local	556.554	472.689	83.865	15	< 0.001	76.7%	15.127	5	0.010
			Landscape	556.554	516.465	40.089	6	< 0.001	69.3%	58.903	14	< 0.001
			Both*	556.554	457.562	98.992	20	< 0.001	78.6%			
	Fall	208	Local*	255.423	198.008	57.415	15	< 0.001	81.0%	8.268	5	0.142
			Landscape	255.423	224.094	31.329	6	< 0.001	75.2%	34.354	14	0.002
			Both	255.423	189.740	65.683	20	< 0.001	82.8%			
COBU	All	208	Local	590.664	552.732	37.932	15	0.001	68.1%	5.513	5	0.357
			Landscape	590.664	564.589	26.075	6	< 0.001	64.8%	17.370	14	0.237
			Both	590.664	547.219	43.445	20	0.002	69.2%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
COBU	Spring	208	Local*	507.589	476.919	30.670	15	0.010	67.0%	6.087	5	0.298
			Landscape	507.589	492.904	14.685	6	0.023	62.6%	22.072	14	0.077
			Both	507.589	470.832	36.757	20	0.013	68.3%			
	Fall	208	Local	288.930	275.809	13.121	15	0.593	65.8%	10.793	5	0.056
			Landscape*	288.930	271.098	17.831	6	0.007	66.7%	6.082	14	0.964
			Both	288.930	265.016	23.914	20	0.246	70.2%			
COHU	Spring	208	Local*	497.469	439.223	58.245	15	< 0.001	73.0%	2.568	5	0.766
			Landscape	497.469	459.198	38.270	6	< 0.001	68.9%	22.543	14	0.068
			Both	497.469	436.655	60.813	20	< 0.001	73.8%			
COYE	Spring	208	Local	291.270	260.398	30.871	15	0.009	72.1%	16.138	5	0.006
			Landscape	291.270	284.100	7.170	6	0.305	60.9%	39.840	14	< 0.001
			Both*	291.270	244.260	47.009	20	0.001	77.5%			
HOFI	All	208	Local	661.190	588.962	72.228	15	< 0.001	71.8%	39.652	5	< 0.001
			Landscape	661.190	588.773	72.417	6	< 0.001	71.8%	39.463	14	< 0.001
			Both	661.190	549.310	111.880	20	< 0.001	77.4%			
	Spring	208	Local	536.336	478.141	58.194	15	< 0.001	72.7%	37.719	5	< 0.001
			Landscape	536.336	478.332	58.003	6	< 0.001	71.9%	37.910	14	0.001
			Both*	536.336	440.422	95.914	20	< 0.001	78.3%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results -2 LOG L Int. only	 Int.+cov.	 Chi-sq. Cov.	 df	 P	 Regression Concordance	Test of Addition of Other Variable Set Chi-sq.	 df	 P
HOFI	Fall	208	Local	375.284	327.335	47.949	15	< 0.001	73.6%	9.316	5	0.097
			Landscape	375.284	339.757	35.527	6	< 0.001	70.4%	21.738	14	0.084
			Both*	375.284	318.019	57.265	20	< 0.001	76.0%			
LAZB	Spring	208	Local	406.840	316.799	90.041	15	< 0.001	80.8%	7.181	5	0.208
			Landscape	406.840	327.532	79.309	6	< 0.001	79.4%	17.914	14	0.211
			Both*	406.840	309.618	97.222	20	< 0.001	81.9%			
LEGO	All	208	Local	649.278	597.013	52.265	15	< 0.001	70.7%	22.871	5	< 0.001
			Landscape	649.278	597.333	51.945	6	< 0.001	69.8%	23.191	14	0.057
			Both	649.278	574.142	75.136	20	< 0.001	73.9%			
	Spring	208	Local	554.133	510.383	43.750	15	< 0.001	70.1%	17.168	5	0.004
			Landscape*	554.133	515.031	39.102	6	< 0.001	68.1%	21.816	14	0.082
			Both	554.133	493.215	60.918	20	< 0.001	72.5%			
	Fall	208	Local	279.878	242.819	37.059	15	0.001	74.4%	10.472	5	0.063
			Landscape	279.878	255.917	23.961	6	0.001	68.8%	23.570	14	0.052
			Both*	279.878	232.347	47.531	20	< 0.001	77.4%			
MODO	Spring	208	Local	520.840	482.828	38.012	15	0.001	69.0%	13.184	5	0.022
			Landscape	520.840	502.600	18.240	6	0.006	63.0%	32.956	14	0.003
			Both*	520.840	469.644	51.196	20	< 0.001	71.3%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results: -2 LOG L		Chi-sq.			Regression Concordance	Test of Addition of Other Variable Set		
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
NOFL	All	208	Local	462.496	372.293	90.204	15	< 0.001	78.9%	9.051	5	0.107
			Landscape	462.496	394.658	67.838	6	< 0.001	77.1%	31.416	14	0.005
			Both	462.496	363.242	99.255	20	< 0.001	80.5%			
	Spring	208	Local*	285.975	237.102	48.873	15	< 0.001	77.8%	9.988	5	0.076
			Landscape	285.975	251.067	34.908	6	< 0.001	74.7%	23.953	14	0.046
			Both	285.975	227.114	58.862	20	< 0.001	81.4%			
	Fall	208	Local*	329.845	253.677	76.168	15	< 0.001	81.9%	6.822	5	0.234
			Landscape	329.845	276.305	53.539	6	< 0.001	78.6%	29.450	14	0.009
			Both	329.845	246.855	82.989	20	< 0.001	83.3%			
NOMO	All	208	Local	607.815	527.130	80.685	15	< 0.001	75.9%	16.987	5	0.005
			Landscape	607.815	571.500	36.315	6	< 0.001	67.9%	61.357	14	< 0.001
			Both	607.815	510.143	97.672	20	< 0.001	78.7%			
	Spring	208	Local	530.410	451.018	79.392	15	< 0.001	76.0%	14.600	5	0.012
			Landscape	530.410	489.863	40.547	6	< 0.001	69.9%	53.445	14	< 0.001
			Both*	530.410	436.418	93.992	20	< 0.001	78.3%			
	Fall	208	Local*	236.555	190.781	45.774	15	< 0.001	80.6%	8.496	5	0.131
			Landscape	236.555	221.022	15.533	6	0.016	67.5%	38.737	14	< 0.001
			Both	236.555	182.285	54.270	20	< 0.001	83.1%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results: -2 LOG L Int. only	Int.+cov.	Chi-sq. Cov.	df	P	Regression Concordance	Test of Addition of Other Variable Set: Chi-sq.	df	P
OCWA	Spring	208	Local	298.125	210.144	87.981	15	< 0.001	85.7%	18.712	5	0.002
			Landscape	298.125	237.282	60.843	6	< 0.001	80.4%	45.850	14	< 0.001
			Both*	298.125	191.432	106.692	20	< 0.001	87.8%			
PHAI	Spring	208	Local*	267.979	225.841	42.138	15	< 0.001	77.6%	5.930	5	0.313
			Landscape	267.979	251.842	16.137	6	0.013	69.1%	31.931	14	0.004
			Both	267.979	219.911	48.068	20	< 0.001	78.9%			
RCKI	Fall	208	Local	198.511	164.845	33.666	15	0.004	77.8%	16.757	5	0.005
			Landscape	198.511	173.083	25.427	6	< 0.001	76.9%	24.995	14	0.035
			Both*	198.511	148.088	50.423	20	< 0.001	83.9%			
RCSP	All	208	Local	617.223	549.008	68.214	15	< 0.001	73.4%	10.038	5	0.074
			Landscape	617.223	568.964	48.259	6	< 0.001	69.5%	29.994	14	0.008
			Both	617.223	538.970	78.253	20	< 0.001	74.9%			
	Spring	208	Local	554.690	484.213	70.477	15	< 0.001	74.3%	12.573	5	0.028
			Landscape	554.690	499.690	55.000	6	< 0.001	71.7%	28.050	14	0.014
			Both*	554.690	471.640	83.049	20	< 0.001	76.1%			
	Fall	208	Local*	191.134	162.940	28.194	15	0.020	77.7%	1.086	5	0.955
			Landscape	191.134	180.029	11.105	6	0.085	66.7%	18.175	14	0.199
			Both	191.134	161.854	29.280	20	0.082	78.0%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
ROWR	All	208	Local	287.944	134.041	153.903	15	< 0.001	96.5%	3.759	5	0.585
			Landscape	287.944	202.427	85.518	6	< 0.001	88.8%	72.145	14	< 0.001
			Both	287.944	130.282	157.662	20	< 0.001	96.6%			
	Spring	208	Local*	175.945	83.994	91.951	15	< 0.001	97.0%	7.210	5	0.205
			Landscape	175.945	134.409	41.536	6	< 0.001	85.6%	57.625	14	< 0.001
			Both	175.945	76.784	99.161	20	< 0.001	97.5%			
	Fall	208	Local*	195.839	86.719	109.120	15	< 0.001	96.7%	7.782	5	0.169
			Landscape	195.839	123.330	72.509	6	< 0.001	91.2%	44.393	14	< 0.001
			Both	195.839	78.937	116.902	20	< 0.001	97.8%			
SAGS	All	208	Local	466.707	316.311	150.396	15	< 0.001	89.8%	52.136	5	< 0.001
			Landscape	466.707	296.836	169.872	6	< 0.001	91.2%	32.661	14	0.003
			Both	466.707	264.175	202.532	20	< 0.001	93.5%			
	Spring	208	Local	419.983	272.786	147.197	15	< 0.001	90.1%	48.080	5	< 0.001
			Landscape	419.983	260.920	159.063	6	< 0.001	91.0%	36.214	14	0.001
			Both*	419.983	224.706	195.277	20	< 0.001	93.5%			
	Fall	208	Local	169.139	97.577	71.561	15	< 0.001	93.1%	31.107	5	< 0.001
			Landscape*	169.139	86.217	82.922	6	< 0.001	94.5%	19.747	14	0.138
			Both	169.139	66.470	102.669	20	< 0.001	96.9%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
SCJA	All	208	Local	571.327	471.707	99.620	15	< 0.001	79.6%	20.865	5	0.001
			Landscape	571.327	491.700	79.627	6	< 0.001	77.9%	40.858	14	< 0.001
			Both	571.327	450.842	120.485	20	< 0.001	81.4%			
	Spring	208	Local	467.382	396.733	70.649	15	< 0.001	77.0%	18.035	5	0.003
			Landscape	467.382	403.354	64.028	6	< 0.001	76.9%	24.656	14	0.038
			Both*	467.382	378.698	88.684	20	< 0.001	79.5%			
	Fall	208	Local	290.113	224.542	65.570	15	< 0.001	83.1%	28.566	5	< 0.001
			Landscape	290.113	231.589	58.524	6	< 0.001	81.1%	35.613	14	0.001
			Both*	290.113	195.976	94.136	20	< 0.001	88.0%			
SOSP	Spring	208	Local	443.529	408.484	35.045	15	0.002	70.3%	13.685	5	0.018
			Landscape	443.529	430.757	12.772	6	0.047	56.8%	35.958	14	0.001
			Both*	443.529	394.799	48.730	20	< 0.001	73.2%			
SPTO	All	208	Local	632.849	468.929	163.919	15	< 0.001	80.9%	4.272	5	0.511
			Landscape	632.849	532.218	100.631	6	< 0.001	77.8%	67.561	14	< 0.001
			Both	632.849	464.657	168.192	20	< 0.001	81.6%			
	Spring	208	Local*	461.684	293.564	168.120	15	< 0.001	87.4%	5.479	5	0.360
			Landscape	461.684	353.059	108.625	6	< 0.001	82.9%	64.974	14	< 0.001
			Both	461.684	288.085	173.598	20	< 0.001	87.7%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
SPTO	Fall	208	Local*	320.868	253.686	67.182	15	< 0.001	79.8%	4.954	5	0.422
			Landscape	320.868	275.406	45.462	6	< 0.001	75.6%	26.674	14	0.021
			Both	320.868	248.732	72.136	20	< 0.001	81.0%			
WCSP	All	208	Local	616.491	519.533	96.958	15	< 0.001	76.5%	9.025	5	0.108
			Landscape	616.491	548.941	67.550	6	< 0.001	73.2%	38.433	14	< 0.001
			Both	616.491	510.508	105.983	20	< 0.001	77.4%			
	Spring	208	Local*	484.802	406.684	78.118	15	< 0.001	77.5%	3.591	5	0.610
			Landscape	484.802	437.864	46.939	6	< 0.001	72.0%	34.771	14	0.002
			Both	484.802	403.093	81.709	20	< 0.001	77.6%			
	Fall	208	Local	358.501	310.544	47.957	15	< 0.001	74.3%	17.139	5	0.004
			Landscape*	358.501	316.449	42.052	6	< 0.001	72.5%	23.044	14	0.060
			Both?	358.501	293.405	65.096	20	< 0.001	78.0%			
WEME	All	208	Local	477.396	417.070	60.326	15	< 0.001	75.6%	19.256	5	0.002
			Landscape	477.396	433.313	44.083	6	< 0.001	72.8%	35.499	14	0.001
			Both	477.396	397.814	79.582	20	< 0.001	79.4%			
	Spring	208	Local	418.586	364.086	54.500	15	< 0.001	75.5%	18.580	5	0.002
			Landscape	418.586	373.232	45.354	6	< 0.001	74.1%	27.726	14	0.015
			Both*	418.586	345.506	73.080	20	< 0.001	79.4%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
WEME	Fall	208	Local*	166.858	116.000	50.858	15	< 0.001	87.0%	0.819	5	0.976
			Landscape	166.858	141.245	25.613	6	< 0.001	78.5%	26.064	14	0.025
			Both	166.858	115.181	51.677	20	< 0.001	87.3%			
WREN	All	208	Local	685.417	460.859	224.558	15	< 0.001	86.5%	30.067	5	< 0.001
			Landscape	685.417	570.346	115.071	6	< 0.001	78.3%	139.554	14	< 0.001
			Both	685.417	430.792	254.625	20	< 0.001	88.4%			
	Spring	208	Local	511.908	280.004	231.905	15	< 0.001	91.7%	23.990	5	< 0.001
			Landscape	511.908	396.679	115.230	6	< 0.001	81.5%	140.665	14	< 0.001
			Both*	511.908	256.014	255.894	20	< 0.001	93.2%			
	Fall	208	Local	445.427	267.342	178.085	15	< 0.001	88.9%	19.281	5	0.002
			Landscape	445.427	351.922	93.505	6	< 0.001	79.0%	103.861	14	< 0.001
			Both*	445.427	248.061	197.366	20	< 0.001	90.5%			
YRWA	All	208	Local	466.238	370.219	96.020	15	< 0.001	79.8%	12.495	5	0.029
			Landscape	466.238	409.285	56.954	6	< 0.001	73.3%	51.561	14	< 0.001
			Both	466.238	357.724	108.514	20	< 0.001	81.3%			
	Spring	208	Local*	144.651	110.483	34.169	15	0.003	82.3%	5.456	5	0.363
			Landscape	144.651	128.301	16.350	6	0.012	74.3%	23.274	14	0.056
			Both	144.651	105.027	39.624	20	0.006	84.4%			

Table 41. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
YRWA	Fall	208	Local	400.889	290.440	110.450	15	< 0.001	82.4%	16.901	5	0.005
			Landscape	400.889	332.437	68.453	6	< 0.001	76.8%	58.898	14	< 0.001
			Both*	400.889	273.539	127.350	20	< 0.001	84.6%			

Table 42. Logistic regression of mammal presence/absence on local and landscape habitat variables, by season, and test of significance of addition of variables of one scale to those of the other scale. * denotes best model. Int. only is total Chi-square; Int. + cov. is Chi-square with covariates fitted; Cov. is reduction in Chi-square due to fitting covariates, which is the test of the significance of the regression.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
CHFA	All	168	Local	472.086	336.088	135.998	15	< 0.001	86.1%	42.592	5	< 0.001
			Landscape	472.086	321.945	150.141	6	< 0.001	86.9%	28.449	14	0.012
			Both*	472.086	293.496	178.590	20	< 0.001	89.6%			
	Spring	168	Local*	310.433	196.203	114.231	15	< 0.001	88.6%	27.017	5	< 0.001
			Landscape	310.433	192.790	117.643	6	< 0.001	88.9%	23.604	14	0.051
			Both	310.433	169.186	141.247	20	< 0.001	91.9%			
	Fall	168	Local	333.653	220.349	113.303	15	< 0.001	87.6%	36.275	5	< 0.001
			Landscape	333.653	216.874	116.778	6	< 0.001	87.7%	32.801	14	0.003
			Both*	333.653	184.074	149.579	20	< 0.001	91.4%			
DIAG	All	168	Local	390.084	220.101	169.983	15	< 0.001	92.9%	24.996	5	< 0.001
			Landscape	390.084	241.373	148.710	6	< 0.001	90.3%	46.269	14	< 0.001
			Both*	390.084	195.105	194.979	20	< 0.001	94.9%			
	Spring	168	Local	257.838	127.048	130.791	15	< 0.001	94.0%	24.672	5	< 0.001
			Landscape	257.838	138.842	118.996	6	< 0.001	92.5%	36.467	14	0.001
			Both*	257.838	102.376	155.463	20	< 0.001	96.2%			
	Fall	168	Local	285.774	145.842	139.932	15	< 0.001	93.5%	23.851	5	< 0.001
			Landscape	285.774	167.270	118.504	6	< 0.001	91.2%	45.279	14	< 0.001
			Both*	285.774	121.991	163.783	20	< 0.001	95.9%			

Table 42. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
NEFU	All	168	Local*	372.246	247.498	124.747	15	< 0.001	89.0%	10.650	5	0.059
			Landscape	372.246	333.644	38.601	6	< 0.001	72.0%	96.796	14	< 0.001
			Both	372.246	236.848	135.397	20	< 0.001	89.8%			
	Spring	168	Local*	239.256	151.822	87.434	15	< 0.001	88.8%	2.640	5	0.755
			Landscape	239.256	219.324	19.932	6	0.003	72.0%	70.142	14	< 0.001
			Both	239.256	149.182	90.074	20	< 0.001	89.2%			
	Fall	168	Local	256.676	154.482	102.194	15	< 0.001	90.6%	20.995	5	0.001
			Landscape	256.676	211.457	45.219	6	< 0.001	74.8%	77.970	14	< 0.001
			Both*	256.676	133.487	123.189	20	< 0.001	92.9%			
NELE	All	168	Local	493.484	415.489	77.995	15	< 0.001	77.4%	14.385	5	0.013
			Landscape	493.484	460.759	32.725	6	< 0.001	68.6%	59.655	14	< 0.001
			Both*	493.484	401.104	92.380	20	< 0.001	79.6%			
	Spring	168	Local	346.333	269.874	76.459	15	< 0.001	80.4%	13.566	5	0.019
			Landscape	346.333	295.842	50.491	6	< 0.001	75.1%	39.534	14	< 0.001
			Both*	346.333	256.308	90.025	20	< 0.001	83.4%			
	Fall	168	Local*	332.682	279.120	53.562	15	< 0.001	76.9%	10.213	5	0.069
			Landscape	332.682	320.950	11.733	6	0.068	60.9%	52.042	14	< 0.001
			Both	332.682	268.907	63.775	20	< 0.001	78.4%			

Table 42. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
PECA	All	168	Local*	437.174	264.315	172.860	15	< 0.001	90.6%	8.021	5	0.155
			Landscape	437.174	374.080	63.095	6	< 0.001	77.6%	117.786	14	< 0.001
			Both	437.174	256.294	180.881	20	< 0.001	91.1%			
	Spring	168	Local*	299.628	185.884	113.745	15	< 0.001	89.1%	6.532	5	0.258
			Landscape	299.628	256.390	43.239	6	< 0.001	77.2%	77.037	14	< 0.001
			Both	299.628	179.352	120.276	20	< 0.001	89.2%			
	Fall	168	Local*	313.388	146.959	166.429	15	< 0.001	93.7%	8.411	5	0.135
			Landscape	313.388	252.381	61.007	6	< 0.001	79.5%	113.833	14	< 0.001
			Both	313.388	138.548	174.840	20	< 0.001	94.5%			
PEER	All	168	Local*	533.338	433.472	99.866	15	< 0.001	77.8%	2.170	5	0.825
			Landscape	533.338	476.840	56.498	6	< 0.001	70.3%	45.538	14	< 0.001
			Both	533.338	431.302	102.036	20	< 0.001	78.3%			
	Spring	168	Local*	363.586	268.513	95.073	15	< 0.001	81.9%	2.115	5	0.833
			Landscape	363.586	297.021	66.565	6	< 0.001	74.2%	30.623	14	0.006
			Both	363.586	266.398	97.188	20	< 0.001	82.5%			
	Fall	168	Local*	350.603	287.812	62.790	15	< 0.001	78.1%	2.605	5	0.761
			Landscape	350.603	322.479	28.124	6	< 0.001	68.9%	37.272	14	0.001
			Both	350.603	285.207	65.396	20	< 0.001	78.6%			

Table 42. Continued.

Species	Season	N	Scale	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
PEMA	All	168	Local	426.618	317.886	108.732	15	< 0.001	84.6%	27.958	5	< 0.001
			Landscape	426.618	314.363	112.255	6	< 0.001	85.3%	24.435	14	0.041
			Both*	426.618	289.928	136.690	20	< 0.001	88.1%			
	Spring	168	Local	295.207	184.672	110.535	15	< 0.001	89.3%	59.782	5	< 0.001
			Landscape	295.207	160.429	134.778	6	< 0.001	92.6%	35.539	14	0.001
			Both*	295.207	124.890	170.317	20	< 0.001	95.2%			
	Fall	168	Local	294.074	221.594	72.480	15	< 0.001	83.8%	15.381	5	0.009
			Landscape*	294.074	228.805	65.268	6	< 0.001	81.2%	22.593	14	0.067
			Both?	294.074	206.213	87.861	20	< 0.001	85.6%			
REME	All	168	Local*	269.519	220.101	49.418	15	< 0.001	80.5%	7.819	5	0.166
			Landscape	269.519	244.397	25.122	6	< 0.001	72.3%	32.115	14	0.004
			Both	269.519	212.282	57.237	20	< 0.001	82.1%			
	Spring	168	Local*	153.253	120.044	33.209	15	0.004	82.7%	6.474	5	0.263
			Landscape	153.253	139.886	13.367	6	0.038	70.7%	26.316	14	0.024
			Both	153.253	113.570	39.683	20	0.005	85.3%			
	Fall	168	Local*	189.532	151.752	37.780	15	0.001	82.4%	6.979	5	0.222
			Landscape	189.532	171.777	17.755	6	0.007	72.8%	27.004	14	0.019
			Both	189.532	144.773	44.759	20	0.001	84.6%			

Table 43. Standardized logistic regression coefficients for bird presence/absence on local and landscape habitat variables, by season. See Tables 3, 4, 8, and 12 for descriptions of structural and landscape variables and principal components; see Figs. 6 and 7 for description of plant species DCAs. Only statistically significant (P < 0.05) coefficients shown. * denotes best regression model (see Table 41).

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
ANHU	All	Local			0.16		0.23	-0.18			0.23	0.19	-0.49								
		Landscape																		0.32	
		Both			0.17		0.29				0.22	0.18	-0.45							0.28	
	Spring	Local					0.21	-0.16			0.17	0.21	-0.26								
		Landscape																		0.30	
		Both*					0.26	-0.16				0.18	-0.20							0.30	
	Fall	Local*									0.28		-1.02								
		Landscape																		0.23	
		Both									0.29		-1.03								
BCSP	Spring	Local*					-0.42		-0.37	-0.34			0.55		-0.38						
		Landscape															0.52	0.18		-0.32	
		Both					-0.46		-0.46	-0.28			0.50		-0.30		0.29				
BEWR	All	Local	0.16	-0.18		0.22															
		Landscape																-0.21	0.15		
		Both																			

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
BEWR	Spring	Local*		-0.17		0.30					-0.21			-0.23							
		Landscape															0.16	-0.25			
		Both				0.30					-0.19				0.25			-0.20			
	Fall	Local	0.18																		
		Landscape																			
		Both*	0.18																		0.23
BGGN	Fall	Local								0.46				0.36							
		Landscape															-0.52	-0.28			0.33
		Both*										0.41		0.48					0.33		0.39

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
BHGR	Spring	Local																			
		Landscape*																0.33			
		Both					-0.62			-0.33				-0.34				0.57	-0.60		0.32
CACW	Spring	Local						0.38		-0.30		-0.28		0.51							
		Landscape															0.26	0.42			
		Both*						0.36		-0.42		-0.32		0.49					-0.36		
CAGN	All	Local						0.24	-0.23			0.22		0.39							
		Landscape																	-0.40		
		Both						0.26						0.37			-0.43		-0.46		
	Spring	Local						0.32				0.22		0.37							
		Landscape																	-0.35		
		Both*						0.35						0.36			-0.45				

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
CAGN	Fall	Local	0.23											0.33							
		Landscape																			
		Both																			
CALT	All	Local	0.18		-0.22						0.26		-0.46								
		Landscape															-0.28	-0.17		0.29	
		Both	0.22		-0.25						0.24		-0.39							0.32	
	Spring	Local*	0.53										-0.34		0.47						
		Landscape															-0.28				
		Both	0.64										-0.35						-0.28		
	Fall	Local			-0.20						0.23		-0.38								
		Landscape															-0.21			0.33	
		Both*			-0.22								-0.32							0.38	
CANW	Spring	Local								0.63											
		Landscape															-0.86	-1.62			0.38
		Both*								0.54								-1.86			
CACQ	All	Local	0.18								-0.44				0.22						
		Landscape																			
		Both	0.17							-0.25	-0.43			0.21	0.22						0.22

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
CAQU	Spring	Local	0.20								-0.40										
		Landscape																	-0.18		
		Both*	0.21							-0.27	-0.41								-0.18		0.24
	Fall	Local									-0.43				0.42						
		Landscape																			
		Both*									-0.44				0.49					-0.40	
CATH	All	Local					0.20		-0.23	-0.42		0.33			0.24						
		Landscape																	-0.27		-0.18
		Both				0.24				-0.54		0.25							-0.38		
	Spring	Local			0.21				-0.18	-0.35		0.29			0.21						
		Landscape																	-0.24	-0.16	-0.19
		Both*			0.19	0.26				-0.42		0.22							-0.34		
	Fall	Local*								-0.43	0.28	0.28									
		Landscape																			
		Both		-0.24						-0.61	0.32										
COBU	All	Local																			
		Landscape																			
		Both																			

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
COBU	Spring	Local*																			
		Landscape																			
		Both												-0.19							
	Fall	Local																			
		Landscape*															-0.24				
		Both																			
COHU	Spring	Local*						0.17			-0.21										
		Landscape															0.18				
		Both									-0.20										
COYE	Spring	Local	-0.55				0.33						-0.43								
		Landscape																			
		Both*	-0.58			0.35				-0.45			-0.55				-0.42				0.27
HOFI	All	Local	0.20							0.32			-0.36			0.16					
		Landscape															-0.24	-0.39	-0.16	0.36	0.23
		Both	0.20										-0.34	0.21				-0.42	-0.16	0.30	0.21
	Spring	Local	0.19							0.38			-0.33								
		Landscape																-0.35	-0.15	0.37	0.21
		Both*								0.31			-0.28		-0.24			-0.43	-0.16	0.30	

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
HOFI	Fall	Local				-0.27							-0.35			0.17					
		Landscape															-0.30	-0.25		0.18	
		Both*				-0.25							-0.29								
LAZB	Spring	Local			0.21								0.24								
		Landscape																		-0.31	
		Both*			0.19								0.19							-0.26	
LEGO	All	Local																			
		Landscape															0.15		-0.31		
		Both								-0.24							0.18		-0.27		
	Spring	Local												-0.18							
		Landscape*																	-0.26		
		Both												-0.22					-0.22		
	Fall	Local	0.18							-0.29				0.28							
		Landscape																	-0.35		
		Both*	0.20					-0.31		-0.33				0.27					-0.43		
MODO	Spring	Local					-0.18						0.18	0.24							
		Landscape															0.17	0.15			0.16
		Both*					-0.23						0.19	0.26							0.24

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
NOFL	All	Local		0.32	0.21	-0.23							0.28								
		Landscape																0.27			
		Both			0.22	-0.28							0.28					0.32			
	Spring	Local*		0.36					-0.34				0.24								
		Landscape															0.20	0.28			
		Both			0.21				-0.35				0.23				0.29	0.33			
	Fall	Local*				-0.33					0.28										
		Landscape																			
		Both	0.22			-0.31					0.29										
NOMO	All	Local					-0.30			0.36	0.22	-0.21	-0.28	0.31							
		Landscape															-0.17			0.33	0.22
		Both					-0.32			0.21	0.24	-0.28		0.30					-0.22	0.20	0.17
	Spring	Local					-0.31			0.44	0.20		-0.30	0.22							
		Landscape															-0.20			0.34	0.24
		Both*					-0.33			0.31	0.20	-0.21		0.20					-0.18	0.20	0.17
	Fall	Local*												0.55							
		Landscape																0.22			
		Both												0.59							0.32

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
OCWA	Spring	Local		0.37				-0.32		-0.93	0.35	-0.61									
		Landscape															0.37	0.36	0.32	-0.29	-0.24
		Both*								-0.71	0.36	-0.55			-0.46						-0.44
PHAI	Spring	Local*					0.41		-0.39	-0.46											
		Landscape																0.21			
		Both					0.38		-0.33	-0.48											
RCKI	Fall	Local					0.42														
		Landscape																0.37	-0.46		
		Both*					0.41												-0.79		
RCSP	All	Local				-0.19															
		Landscape															-0.21				
		Both				-0.23		0.16										0.26			
	Spring	Local				-0.19															
		Landscape															-0.24				
		Both*				-0.23												0.29			
	Fall	Local*										-0.32									
		Landscape																			
		Both										-0.36									

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
ROWR	All	Local	0.33				-0.65			0.80		-0.31									
		Landscape															-0.67	-1.01		0.42	0.26
		Both	0.29							0.86		-0.44									
	Spring	Local*								0.89						-0.47					
		Landscape															-0.43	-1.03		0.40	
		Both								1.29						-0.41					
	Fall	Local*	0.38				-1.04			0.55		-0.44									
		Landscape															-2.37	-0.79		0.62	0.44
		Both	0.62									-0.69									
SAGS	All	Local								0.40	-0.46	0.41		-0.41							
		Landscape															-1.00	-2.86	-0.84		
		Both									-0.48	0.29					-0.83	-2.62	-0.61		
	Spring	Local								0.44	-0.50	0.45		-0.39							
		Landscape															-0.99	-2.84	-0.81		
		Both*									-0.55	0.33					-0.77	-2.53	-0.58		
	Fall	Local	0.37								-0.45	0.18	-0.04	-0.37	0.05	-0.15					
		Landscape*															-1.34	-2.87	-0.95	0.50	
		Both	0.61	2.45													-2.33	-3.80		1.52	

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
SCJA	All	Local				0.22				-0.23			0.22								
		Landscape															0.51	0.46			
		Both			0.20								0.20				0.33	0.32			
	Spring	Local				0.26							0.17								
		Landscape															0.32	0.51	0.16		
		Both*											0.20					0.41			
	Fall	Local								-0.32											
		Landscape															0.58	0.23			
		Both*			0.23												0.52				
SOSP	Spring	Local						-0.18						-0.26	0.25						
		Landscape																-0.26			
		Both*	-0.21			0.24		-0.19		-0.30	0.18						-0.27	-0.36			
SPTO	All	Local				0.31	0.28		-0.20	-0.42			0.27								
		Landscape															0.28	0.25	0.15		
		Both				0.29	0.25		-0.20	-0.47			0.27								
	Spring	Local*				0.30			-0.22	-0.58											
		Landscape															0.26	0.18		-0.24	
		Both				0.34			-0.25	-0.63											

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
SPTO	Fall	Local*				0.26	0.30						0.28								
		Landscape															0.26	0.25			
		Both					0.31						0.28		0.31						
WCSP	All	Local				-0.39			0.22		0.24		-0.32	-0.23							
		Landscape															-0.35	-0.25			
		Both				-0.37			0.24	-0.23	0.23	-0.18	-0.25	-0.23			-0.26				
	Spring	Local*				-0.40							-0.19	-0.21							
		Landscape															-0.35	-0.21			
		Both				-0.35							-0.18	-0.22							
	Fall	Local							0.35		0.31		-0.26								
		Landscape*																-0.25	0.18	0.26	0.17
		Both							0.35	-0.30	0.31									0.31	0.21
WEME	All	Local				-0.24				0.33	-0.36		0.27								
		Landscape															-0.41			-0.22	0.20
		Both								0.26	-0.33		0.31				-0.26			-0.29	0.22
	Spring	Local				-0.25				0.30	-0.28		0.22								
		Landscape															-0.49			-0.22	0.21
		Both*											0.26				-0.32			-0.25	0.21

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
WEME	Fall	Local*								0.43	-0.62		0.38								
		Landscape															-0.30	-0.48			
		Both									-0.62		0.40								
WREN	All	Local				0.23				-1.08	0.43		0.25		-0.35						
		Landscape															0.62	0.42			-0.31
		Both								-1.15	0.42		0.34		-0.38		0.28	0.21		0.35	
	Spring	Local								-1.22	0.54				-0.45						
		Landscape															0.61	0.50			-0.32
		Both*								-1.26	0.58				-0.52			0.38	-0.20	0.23	
	Fall	Local				0.32				-1.01	0.37		0.31								
		Landscape															0.60	0.35			-0.29
		Both*								-1.02	0.35		0.41				0.29			0.36	
YRWA	All	Local			0.20				-0.33	-0.32											
		Landscape																0.43			-0.20
		Both							-0.23	-0.37								0.22			
	Spring	Local*											0.40								
		Landscape																0.33		-0.47	
		Both						-0.63					0.32								

Table 43. Continued.

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
YRWA	Fall	Local							-0.33	-0.49											
		Landscape																0.43			-0.30
		Both*								-0.64					-0.31		-0.28	0.27			

Table 44. Standardized logistic regression coefficients for small mammal presence/absence on local and landscape habitat variables, by season. See Tables 3, 4, 8, and 12 for descriptions of structural and landscape variables and principal components; see Figs. 6 and 7 for description of plant species DCAs. Only statistically significant ($P < 0.05$) coefficients shown. * denotes best regression model (see Table 42).

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
CHFA	All	Local		-0.21		-0.32				0.24											
		Landscape															-0.77	-1.12	0.18	0.38	
		Both*				-0.35											-0.46	-0.96	0.34	0.34	
	Spring	Local*				-0.45															
		Landscape															-0.89	-0.95		0.32	
		Both				-0.45											-0.51	-0.75	0.28	0.30	
	Fall	Local		-0.26			-0.33		0.22	0.28											
		Landscape															-0.63	-1.18		0.37	
		Both*	-0.34															-0.99	0.35	0.46	
DIAG	All	Local	0.51	-0.23						0.46	-0.39	0.40				0.27					
		Landscape															-0.80	-1.31	-1.11	0.29	0.39
		Both*	0.49									0.37					-0.60	-0.72	-0.87		0.52
	Spring	Local	0.40							0.73	-0.62	0.48									
		Landscape															-1.18	-1.91	-1.09	0.50	0.48
		Both*	0.40								-0.71	0.48					-1.09	-1.22	-0.75	0.46	0.68
	Fall	Local	0.76	-0.25		-0.41					-0.38	0.29	0.32			0.31					
		Landscape															-0.54	-1.21	-1.51		0.37
		Both*	0.77	-0.31														-0.73	-1.44		0.50

Table 44. Continued

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
NEFU	All	Local*		-0.28		1.06				-0.46	-0.24				-0.53	0.28					
		Landscape															0.33	0.22	0.38		
		Both				1.11				-0.46	-0.32				-0.48				0.32		
	Spring	Local*				0.99															
		Landscape															0.31	0.22	0.23		
		Both				1.04				-0.52					-0.44						
	Fall	Local		-0.29		0.88				-0.51					-0.66	0.33					
		Landscape															0.31	0.21	0.52	0.23	
		Both*				1.03					-0.41				-0.62				0.50	0.43	
NELE	All	Local				0.57			0.19					0.33	0.42						
		Landscape																0.17	0.19		
		Both*				0.68								0.35	0.39						
	Spring	Local				0.45								0.29							
		Landscape																0.22	0.20		
		Both*				0.56			0.24					0.30			-0.30				
	Fall	Local*				0.58								0.35	0.50						
		Landscape																	0.17		
		Both				0.69								0.37	0.50						-0.29

Table 44. Continued

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
PECA	All	Local*	0.24			0.77	0.39			-0.81		-0.52	0.25		-0.58						
		Landscape															0.52	0.41	0.29		
		Both	0.25			0.67	0.49			-0.96		-0.50	0.38		-0.46					0.26	
	Spring	Local*				0.53				-0.61			0.32		-0.46						
		Landscape															0.46	0.39	0.20		
		Both				0.46	0.31			-0.82			0.44								
	Fall	Local*	0.32			0.98	0.40			-0.91		-0.58			-0.41	0.31					
		Landscape															0.50	0.39	0.34		
		Both	0.34			0.90	0.51			-0.90	-0.32	-0.58		0.40						0.36	
PEER	All	Local*				0.35		0.20					0.31		0.47						
		Landscape																			
		Both				0.38		0.20					0.36		0.48						
	Spring	Local*				0.32		0.19							0.39						
		Landscape																			
		Both				0.32		0.22							0.40						
	Fall	Local*				0.25	-0.24						0.31		0.44						
		Landscape																			
		Both				0.29	-0.24						0.32		0.43						

Table 44. Continued

			Standardized Regression Coefficients																		
			Local														Landscape				
Species	Season	Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
PEMA	All	Local				-0.32						0.20	-0.36								
		Landscape															-0.87	-0.78		0.23	0.21
		Both*										0.22					-0.86	-0.63			0.35
	Spring	Local	0.26			-0.45							-0.38								
		Landscape															-2.30	-0.91	0.28	0.33	
		Both*	0.50														-3.79	-1.01	0.59		0.51
	Fall	Local																			
		Landscape*															-0.58	-0.58			0.23
		Both															-0.60	-0.53			0.38
REME	All	Local*				-0.28	0.50	0.31	-0.37			0.26									
		Landscape															-0.25	0.35	-0.35		
		Both					0.47	0.26													
	Spring	Local*					0.66		-0.46												
		Landscape																0.39			
		Both					0.78														
	Fall	Local*					0.35	0.42													
		Landscape																	-0.51		
		Both					0.32	0.29													

GEOGRAPHICAL VARIATION IN HABITAT ASSOCIATIONS

We noted previously the presence of statistically significant geographical variation in local and landscape habitat variables observed at the site level (e.g., Figs. 8, 9), and presume that most of it reflects region-wide physical gradients in maximum and minimum temperatures, precipitation, and elevation (which are also intercorrelated among themselves). However, since our habitat regression analyses were conducted at the point-scale rather than the site-scale, we should confirm whether such geographical variation is still present at that level. Indeed, all but two (STFAC4 and URBDIST) of the 19 local and landscape habitat variables showed significant geographical variation, both from east to west and from north to south (Table 45). The strongest coastal-inland biotic gradients (i.e., significant correlations with EAST) included decreasing cactus and increasing rocky outcrops and edginess at the local scale, and a shift from fewer woodlands to more grasslands at the landscape scale. At a local scale, the plant community showed highly significant north-south variation with respect to both plant species DCA axes (Table 45; Figs. 8, 9), whereas at the landscape level our northern points were more likely to have higher values for LAFAC1 (i.e., more exotic grasslands and agriculture) and lower ones for LAFAC2 (i.e., less urbanization).

Table 45. Geographic variation in habitat variables. Entries are correlations between each habitat variable and east and north UTMs (N = 224). * denotes P < 0.05, ** denotes P < 0.01, *** denotes P < 0.001.

Scale	Variable	EAST	NORTH
Local	GC_CRYP	0.22***	-0.09
	PC_BNGRS	-0.29***	0.12
	PC_TREE	-0.27***	0.11
	STFAC1	-0.31***	-0.18**
	STFAC2	-0.31***	-0.08
	STFAC3	-0.26***	0.30***
	STFAC4	0.07	0.07
	DCA1	0.04	0.44***
	DCA2	0.17**	-0.51***
	EDGEDIST	0.41***	-0.15*
	URBDIST	0.06	0.02
	CACTUS	-0.39***	-0.02
	ROCK	0.43***	0.09
	TRAIL	0.04	-0.18**
Landscape	LAFAC1	-0.20**	-0.05
	LAFAC 2	-0.34***	-0.04
	LAFAC 3	-0.03	-0.15*
	LAFAC 4	0.08	-0.25***
	LAFAC 5	-0.11	0.32***

It is clear that, for many species of birds and small mammals, geography and habitat combine to account for their current distribution among our sampling points (Tables 46, 47). Of 52 bird-season regressions, in nearly half (24) the addition of UTMs provided a statistically significant increase over a pure habitat logistic model. In 16 mammal-season regressions 8 included UTMs in the best model. For neither taxon, however, did UTMs by themselves represent the best model.

Because we always included a covariate (number of surveys conducted at a point) in every regression, it was possible for a geographical model to appear significant even though a species did not vary in its distribution (i.e., statistical significance was strictly due to the effect of the covariate). So, we designated a species distribution as significantly associated with geography only if one or both of the UTMs had a statistically significant regression coefficient. Thus although Bewick s Wren had a highly significant geographical regression (Table 46), neither EAST nor NORTH were significant (Table 48), and we conclude that it displays no spatial clines in distribution within the survey region. In many cases, however, EAST and NORTH were significant, implying that, for whatever reason (we presume variation in habitat is the principal factor), most species were not uniformly distributed among our sampling points.

Of the 19 bird species analyzed for both spring and fall, 7 (California Gnatcatcher, California Towhee, Common Bushtit, House Finch, Lesser Goldfinch, Rock Wren, and Spotted Towhee) did not include a geographical component for either season in their best model. Of the eight small mammals, the distributions of California mice, deer mice, and western harvest mice seemed to be best determined by habitat independent of geography in both seasons. For birds, geography appeared more important in the spring; 16 of 30 (54%) of spring models included UTMs compared to only 7 of 26 (27%) fall ones. We suspect that this in part reflects the general redistribution of birds throughout the region that occurs during the fall, which is influenced by the influx of migrant individuals and the movement of dispersing young-of-the-year.

In some cases for small mammals, there appeared to be an instability as to which was the best model across spring-fall comparisons (e.g., San Diego pocket mouse, dusky-footed woodrat; Table 47). This is unexpected for non-migratory animals with relatively stable home ranges; the importance of geography should not differ for spring vs. fall samples. We expect that this may be a consequence of differences in the array of sites included in the samples for the two seasons. We continued to add sites for small mammal sampling each season (Table 2), and it seems possible that this affected the results. It also implies that our test is somewhat conservative, so that mammal species that appeared consistent across seasons really were consistent.

Inclusion of geographical coordinates can, in some cases, alter our perception of habitat associations (compare which variables have significant regression coefficients in Tables 43 and 44 with those in Tables 48 and 49). For example, when UTMs are added to the best habitat model for Anna s Hummingbirds in spring, STFAC2, STFAC3, and URBDIST are no longer statistically significant, whereas DCA1, ROCK, and LAFAC3 become so. For other species, such as Black-chinned Sparrows, however, although inclusion of UTMs adds significantly to the purely habitat model, no additional variables enter or exit.

All habitat variables changed (i.e., entered or exited a model) at least once when comparing a significant habitat + geography model to a pure habitat model (Tables 48, 49). However, by far the most labile were the two plant species DCAs; with the addition of UTMs, DCA1 dropped out of 9 bird models and entered 4, and DCA2 dropped out of 8 and entered 3. No other variable entered and exited more than 6 times, out of 25 significant models in total. In mammal models (of which only 14 were significant for habitat + geography) landscape variables LAFAC1 and LAFAC2 were the most labile, dropping out of 6 each. All four of these habitat variables were among the most highly correlated with NORTH and EAST (Table 45).

In some cases, addition of UTMs clarified species associations. For example, CACTUS was significant in the best Cactus Wren habitat model (Table 43). However, both CACTUS (Table 45) and Cactus Wrens (Table 48, pure Geography model) show a strong coastal bias (i.e., a negative association with EAST). And while it is certainly plausible that the bird species is associated with its namesake plant, the possibility exists that the association in Table 43 is spurious, due only to covariation with a third feature, distance from coast (for which EAST is a surrogate). However, CACTUS remains a significant feature of Cactus Wren distribution even when geography is taken into account (Table 48, H + G model), implying that the association is not trivial. In general, then, we assume that a variable that remains significant in both pure Habitat and H + G models is likely a robust associate of a species distributional pattern.

We also note that in many cases (e.g., Cactus Wrens in Table 48, deer mice in Table 49) UTMs remain individually significant in an H + G model. This implies that there remains geographical variation in the distribution of such a species over and beyond that associated with any of the habitat variables we have considered.

Table 46. Logistic regression of bird presence/absence on habitat and geographical variables, by season, and test of significance of addition of variables of one scale to those of the other scale. Best habitat scale from Table 41. H + G = combined habitat + geographical variables. * denotes best model for spring or fall. Int. only is total Chi-square; Int. + cov. is Chi-square with covariates fitted; Cov. is reduction in Chi-square due to fitting covariates, which is the test of the significance of the regression.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
ANHU	Spring	Both	Habitat	491.523	435.646	55.876	20	<0.001	72.7%	29.871	2	<0.001
			Geography	491.523	462.144	29.379	3	<0.001	66.6%	56.369	19	<0.001
			H + G *	491.523	405.775	85.747	22	<0.001	77.9%			
	Fall	Local	Habitat	389.109	314.803	74.306	15	<0.001	78.6%	9.731	2	0.008
			Geography	389.109	382.987	6.121	3	0.106	55.0%	77.915	14	<0.001
			H + G *	389.109	305.072	84.037	17	<0.001	80.9%			
BCSP	Spring	Local	Habitat *	504.615	318.443	186.172	15	<0.001	87.8%	1.769	2	0.413
			Geography	504.615	433.184	71.431	3	<0.001	73.9%	116.510	14	<0.001
			H + G	504.615	316.674	187.941	17	<0.001	88.3%			
BEWR	Spring	Local	Habitat	522.49	445.286	77.204	15	<0.001	75.7%	9.671	2	0.008
			Geography	522.49	491.656	30.834	3	<0.001	64.4%	56.041	14	<0.001
			H + G *	522.49	435.615	86.875	17	<0.001	76.1%			
	Fall	Both	Habitat *	337.022	298.26	38.763	20	0.007	74.2%	0.319	2	0.853
			Geography	337.022	317.016	20.007	3	<0.001	66.2%	19.075	19	0.452
			H + G	337.022	297.941	39.082	22	0.014	74.3%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
BGGN	Fall	Local	Habitat	233.393	165.535	67.857	15	<0.001	86.8%	6.462	2	0.040
			Geography	233.393	186.68	46.712	3	<0.001	79.5%	27.607	14	0.016
			H + G *	233.393	159.073	74.32	17	<0.001	88.2%			
BHGR	Spring	Landscape	Habitat	260.893	236.454	24.439	6	<0.001	72.0%	8.405	2	0.015
			Geography	260.893	256.518	4.375	3	0.224	58.5%	28.469	5	<0.001
			H + G *	260.893	228.049	32.844	8	<0.001	75.8%			
CACW	Spring	Both	Habitat	430.826	319.311	111.514	20	<0.001	85.0%	12.404	2	0.002
			Geography	430.826	362.618	68.207	3	<0.001	77.8%	55.711	19	<0.001
			H + G *	430.826	306.907	123.919	22	<0.001	86.5%			
CAGN	Spring	Both	Habitat *	322.285	268.672	53.613	20	<0.001	79.5%	0.855	2	0.652
			Geography	322.285	318.808	3.477	3	0.324	56.6%	50.991	19	<0.001
			H + G	322.285	267.817	54.468	22	<0.001	79.4%			
	Fall	Both (NS)	Habitat	157.087	130.318	26.769	20	0.142	79.8%	2.709	2	0.258
			Geography	157.087	155.301	1.786	3	0.618	51.0%	27.692	19	0.090
			H + G	157.087	127.609	29.478	22	0.132	82.5%			
CALT	Spring	Local	Habitat *	378.409	139.739	238.67	15	<0.001	65.0%	4.207	2	0.122
			Geography	378.409	172.245	206.164	3	<0.001	84.0%	36.713	14	0.001
			H + G	378.409	135.532	242.877	17	<0.001	62.7%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
CALT	Spring	Landscape	Habitat *	378.409	164.891	213.519	6	<0.001	85.0%	2.381	2	0.304
			Geography	378.409	172.245	206.164	3	<0.001	84.0%	9.735	5	0.083
			H + G	378.409	162.51	215.899	8	<0.001	83.4%			
	Fall	Both	Habitat	389.109	312.383	76.726	20	<0.001	78.9%	13.243	2	0.001
			Geography	389.109	382.987	6.121	3	0.106	55.0%	83.847	19	<0.001
			H + G *	389.109	299.14	89.969	22	<0.001	81.7%			
CANW	Spring	Both	Habitat	257.431	134.421	123.009	20	<0.001	94.7%	13.021	2	0.001
			Geography	257.431	152.733	104.698	3	<0.001	92.2%	31.333	19	0.037
			H + G *	257.431	121.4	136.031	22	<0.001	95.3%			
CAQU	Spring	Both	Habitat	559.622	480.423	79.199	20	<0.001	74.7%	10.535	2	0.005
			Geography	559.622	521.315	38.307	3	<0.001	67.6%	51.427	19	<0.001
			H + G *	559.622	469.888	89.734	22	<0.001	76.2%			
	Fall	Both	Habitat *	236.898	191.964	44.935	20	0.001	80.6%	4.382	2	0.112
			Geography	236.898	216.072	20.827	3	<0.001	70.2%	28.490	19	0.074
			H + G	236.898	187.582	49.316	22	0.001	81.8%			
CATH	Spring	Both	Habitat	556.554	457.562	98.992	20	<0.001	78.6%	7.070	2	0.029
			Geography	556.554	530.866	25.688	3	<0.001	63.9%	80.374	19	<0.001
			H + G *	556.554	450.492	106.062	22	<0.001	79.2%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results: -2 LOG L Int. only	-2 LOG L Int.+cov.	Chi-sq. Cov.	df	P	Regression Concordance	Test of Addition of Other Variable Set: Chi-sq.	df	P
CATH	Fall	Local	Habitat	255.423	198.008	57.415	15	<0.001	81.0%	9.025	2	0.011
			Geography	255.423	218.973	36.45	3	<0.001	73.3%	29.990	14	0.008
			H + G *	255.423	188.983	66.44	17	<0.001	83.9%			
COBU	Spring	Local	Habitat *	507.589	476.919	30.67	15	0.010	67.0%	1.266	2	0.531
			Geography	507.589	496.992	10.597	3	0.014	57.0%	21.339	14	0.093
			H + G	507.589	475.653	31.936	17	0.015	67.1%			
	Fall	Landscape	Habitat *	288.93	271.098	17.831	6	0.007	66.7%	2.364	2	0.307
			Geography	288.93	278.87	10.059	3	0.018	61.2%	10.136	5	0.071
			H + G	288.93	268.734	20.196	8	0.010	66.9%			
COHU	Spring	Local	Habitat *	497.469	439.223	58.245	15	<0.001	73.0%	1.333	2	0.514
			Geography	497.469	461.801	35.668	3	<0.001	66.9%	23.911	14	0.047
			H + G	497.469	437.89	59.578	17	<0.001	73.2%			
COYE	Spring	Both	Habitat *	291.27	244.26	47.009	20	0.001	77.5%	5.505	2	0.064
			Geography	291.27	279.56	11.709	3	0.008	65.3%	40.805	19	0.003
			H + G	291.27	238.755	52.515	22	<0.001	79.3%			
HOFI	Spring	Both	Habitat *	536.336	440.422	95.914	20	<0.001	78.3%	4.716	2	0.095
			Geography	536.336	523.197	13.139	3	0.004	58.9%	87.491	19	<0.001
			H + G	536.336	435.706	100.629	22	<0.001	79.3%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
HOFI	Fall	Both	Habitat *	375.284	318.019	57.265	20	<0.001	76.0%	4.651	2	0.098
			Geography	375.284	366.942	8.342	3	0.039	60.3%	53.574	19	<0.001
			H + G	375.284	313.368	61.916	22	<0.001	76.9%			
LAZB	Spring	Both	Habitat *	406.84	309.618	97.222	20	<0.001	81.9%	0.200	2	0.905
			Geography	406.84	336.846	69.995	3	<0.001	76.5%	27.428	19	0.095
			H + G	406.84	309.418	97.422	22	<0.001	82.0%			
LEGO	Spring	Landscape	Habitat *	554.133	515.031	39.102	6	<0.001	68.1%	3.444	2	0.179
			Geography	554.133	530.043	24.09	3	<0.001	62.6%	18.456	5	0.002
			H + G	554.133	511.587	42.546	8	<0.001	68.8%			
	Fall	Both	Habitat *	279.878	232.347	47.531	20	<0.001	77.4%	2.680	2	0.262
			Geography	279.878	264.272	15.606	3	0.001	64.2%	34.605	19	0.016
			H + G	279.878	229.667	50.211	22	0.001	77.7%			
MODO	Spring	Both	Habitat *	520.84	469.644	51.196	20	<0.001	71.3%	1.611	2	0.447
			Geography	520.84	512.935	7.905	3	0.048	56.0%	44.902	19	0.001
			H + G	520.84	468.033	52.807	22	<0.001	71.7%			
NOFL	Spring	Local	Habitat	285.975	237.102	48.873	15	<0.001	77.8%	13.247	2	0.001
			Geography	285.975	261.836	24.139	3	<0.001	69.1%	37.981	14	0.001
			H + G *	285.975	223.855	62.12	17	<0.001	81.1%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
NOFL	Fall	Local	Habitat *	329.845	253.677	76.168	15	<0.001	81.9%	1.498	2	0.473
			Geography	329.845	278.371	51.474	3	<0.001	77.2%	26.192	14	0.024
			H + G	329.845	252.179	77.665	17	<0.001	82.3%			
NOMO	Spring	Both	Habitat	530.41	436.418	93.992	20	<0.001	78.3%	11.345	2	0.003
			Geography	530.41	527.384	3.026	3	0.388	55.1%	102.311	19	<0.001
			H + G *	530.41	425.073	105.337	22	<0.001	79.7%			
	Fall	Local	Habitat *	236.555	190.781	45.774	15	<0.001	80.6%	0.573	2	0.751
			Geography	236.555	228.127	8.428	3	0.038	62.0%	37.919	14	0.001
			H + G	236.555	190.208	46.347	17	<0.001	80.6%			
OCWA	Spring	Both	Habitat	298.125	191.432	106.692	20	<0.001	87.8%	11.445	2	0.003
			Geography	298.125	240.306	57.818	3	<0.001	79.8%	60.319	19	<0.001
			H + G *	298.125	179.987	118.137	22	<0.001	89.4%			
PHAI	Spring	Local	Habitat	267.979	225.841	42.138	15	<0.001	77.6%	10.664	2	0.005
			Geography	267.979	242.443	25.536	3	<0.001	68.6%	27.266	14	0.018
			H + G *	267.979	215.177	52.802	17	<0.001	80.3%			
RCKI	Fall	Both	Habitat *	198.511	148.088	50.423	20	<0.001	83.9%	0.783	2	0.676
			Geography	198.511	176.259	22.252	3	<0.001	72.3%	28.954	19	0.067
			H + G	198.511	147.305	51.206	22	<0.001	84.3%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
RCSP	Spring	Both	Habitat	554.69	471.64	83.049	20	<0.001	76.1%	19.854	2	<0.001
			Geography	554.69	492.383	62.307	3	<0.001	73.4%	40.597	19	0.003
			H + G *	554.69	451.786	102.904	22	<0.001	79.3%			
	Fall	Local	Habitat *	191.134	162.94	28.194	15	0.020	77.7%	4.341	2	0.114
			Geography	191.134	174.375	16.759	3	0.001	72.4%	15.776	14	0.327
			H + G	191.134	158.599	32.535	17	0.013	79.1%			
ROWR	Spring	Local	Habitat *	175.945	83.994	91.951	15	<0.001	97.0%	1.773	2	0.412
			Geography	175.945	117.799	58.146	3	<0.001	89.5%	35.578	14	0.001
			H + G	175.945	82.221	93.724	17	<0.001	97.1%			
	Fall	Local	Habitat *	195.839	86.719	109.12	15	<0.001	96.7%	0.263	2	0.877
			Geography	195.839	126.111	69.728	3	<0.001	89.7%	39.655	14	<0.001
			H + G	195.839	86.456	109.383	17	<0.001	96.7%			
SAGS	Spring	Both	Habitat	419.983	224.706	195.277	20	<0.001	93.5%	21.766	2	<0.001
			Geography	419.983	277.358	142.626	3	<0.001	88.3%	74.418	19	<0.001
			H + G *	419.983	202.94	217.043	22	<0.001	94.4%			
	Fall	Landscape	Habitat *	169.139	86.217	82.922	6	<0.001	94.5%	3.923	2	0.141
			Geography	169.139	106.746	62.393	3	<0.001	88.5%	24.452	5	<0.001
			H + G	169.139	82.294	86.845	8	<0.001	95.3%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
SCJA	Spring	Both	Habitat	467.382	378.698	88.684	20	<0.001	79.5%	7.497	2	0.024
			Geography	467.382	421.14	46.242	3	<0.001	70.4%	49.939	19	<0.001
			H + G *	467.382	371.201	96.181	22	<0.001	80.1%			
	Fall	Both	Habitat *	290.113	195.976	94.136	20	<0.001	88.0%	1.910	2	0.385
			Geography	290.113	264.818	25.295	3	<0.001	69.0%	70.752	19	<0.001
			H + G	290.113	194.066	96.047	22	<0.001	88.2%			
SOSP	Spring	Both	Habitat *	443.529	394.799	48.73	20	<0.001	73.2%	5.764	2	0.056
			Geography	443.529	423.039	20.49	3	<0.001	64.3%	34.004	19	0.018
			H + G	443.529	389.035	54.494	22	<0.001	74.8%			
SPTO	Spring	Local	Habitat *	461.684	293.564	168.12	15	<0.001	87.4%	5.924	2	0.052
			Geography	461.684	360.249	101.435	3	<0.001	80.7%	72.609	14	<0.001
			H + G	461.684	287.64	174.044	17	<0.001	88.0%			
	Fall	Local	Habitat *	320.868	253.686	67.182	15	<0.001	79.8%	1.322	2	0.516
			Geography	320.868	289.497	31.371	3	<0.001	70.8%	37.133	14	0.001
			H + G	320.868	252.364	68.504	17	<0.001	80.0%			
WCSP	Spring	Local	Habitat	484.802	406.684	78.118	15	<0.001	77.5%	7.347	2	0.025
			Geography	484.802	430.995	53.807	3	<0.001	73.5%	31.658	14	0.004
			H + G *	484.802	399.337	85.465	17	<0.001	77.8%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results: -2 LOG L Int. only	Int.+cov.	Chi-sq. Cov.	df	P	Regression Concordance	Test of Addition of Other Variable Set: Chi-sq.	df	P
WCSP	Fall	Landscape	Habitat *	358.501	316.449	42.052	6	<0.001	72.5%	3.450	2	0.178
			Geography	358.501	339.703	18.798	3	<0.001	65.1%	26.704	5	<0.001
			H + G	358.501	312.999	45.502	8	<0.001	73.6%			
	Fall	Both	Habitat *	358.501	293.405	65.096	20	<0.001	78.0%	0.007	2	0.997
			Geography	358.501	339.703	18.798	3	<0.001	65.1%	46.305	19	<0.001
			H + G	358.501	293.398	65.103	22	<0.001	77.9%			
WEME	Spring	Both	Habitat	418.586	345.506	73.08	20	<0.001	79.4%	25.967	2	<0.001
			Geography	418.586	362.502	56.084	3	<0.001	73.3%	42.963	19	0.001
			H + G *	418.586	319.539	99.047	22	<0.001	83.5%			
	Fall	Local	Habitat	166.858	116	50.858	15	<0.001	87.0%	9.439	2	0.009
			Geography	166.858	134.658	32.2	3	<0.001	82.4%	28.097	14	0.014
			H + G *	166.858	106.561	60.297	17	<0.001	90.4%			
WREN	Spring	Both	Habitat	511.908	256.014	255.894	20	<0.001	93.2%	117.632	2	<0.001
			Geography	511.908	299.809	212.1	3	<0.001	90.8%	161.427	19	<0.001
			H + G *	511.908	138.382	373.526	22	<0.001	84.1%			
	Fall	Both	Habitat	445.427	248.061	197.366	20	<0.001	90.5%	85.549	2	<0.001
			Geography	445.427	297.04	148.387	3	<0.001	84.6%	134.528	19	<0.001
			H + G *	445.427	162.512	282.915	22	<0.001	93.3%			

Table 46. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
YRWA	Spring	Local	Habitat *	144.651	110.483	34.169	15	0.003	82.3%	3.356	2	0.187
			Geography	144.651	138.852	5.8	3	0.122	62.9%	31.725	14	0.004
			H + G	144.651	107.127	37.524	17	0.003	83.4%			
	Fall	Both	Habitat	400.889	273.539	127.35	20	<0.001	84.6%	23.556	2	<0.001
			Geography	400.889	296.137	104.753	3	<0.001	81.4%	46.154	19	<0.001
			H + G *	400.889	249.983	150.906	22	<0.001	87.1%			

Table 47. Logistic regression of mammal presence/absence on habitat and geographical variables, by season, and test of significance of addition of variables of one scale to those of the other scale. Best habitat scale from Table 42. H + G = combined habitat + geographical variables. * denotes best model for spring or fall. Int. only is total Chi-square; Int. + cov. is Chi-square with covariates fitted; Cov. is reduction in Chi-square due to fitting covariates, which is the test of the significance of the regression.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
CHFA	All	Both	Habitat	472.086	293.496	178.590	20	<0.001	89.6%	7.531	2	0.023
			Geography	472.086	351.118	120.968	3	<0.001	84.1%	65.153	19	<0.001
			H + G *	472.086	285.965	186.121	22	<0.001	90.2%			
	Spring	Local	Habitat *	310.433	196.203	114.231	15	<0.001	88.6%	5.009	2	0.082
			Geography	310.433	226.499	83.935	3	<0.001	84.7%	35.305	14	0.001
			H + G	310.433	191.194	119.239	17	<0.001	89.5%			
	Fall	Both	Habitat	333.653	184.074	149.579	20	<0.001	91.4%	12.313	2	0.002
			Geography	333.653	219.185	114.467	3	<0.001	87.4%	47.424	19	<0.001
			H + G *	333.653	171.761	161.892	22	<0.001	92.9%			
DIAG	All	Both	Habitat	390.084	195.105	194.979	20	<0.001	94.9%	23.430	2	<0.001
			Geography	390.084	254.313	135.770	3	<0.001	89.3%	82.638	19	<0.001
			H + G *	390.084	171.675	218.409	22	<0.001	95.8%			
	Spring	Both	Habitat	491.523	435.646	55.876	20	<0.001	72.7%	29.871	2	<0.001
			Geography	491.523	462.144	29.379	3	<0.001	66.6%	56.369	19	<0.001
			H + G *	491.523	405.775	85.747	22	<0.001	77.9%			

Table 47. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
DIAG	Fall	Both	Habitat	285.774	121.991	163.783	20	<0.001	95.9%	16.828	2	<0.001
			Geography	285.774	168.168	117.606	3	<0.001	90.3%	63.005	19	<0.001
			H + G *	285.774	105.163	180.611	22	<0.001	96.9%			
NEFU	All	Local	Habitat	372.246	247.498	124.747	15	<0.001	89.0%	11.757	2	0.003
			Geography	372.246	301.152	71.094	3	<0.001	81.2%	65.411	14	<0.001
			H + G *	372.246	235.741	136.505	17	<0.001	89.7%			
	Spring	Local	Habitat *	239.256	151.822	87.434	15	<0.001	88.8%	5.664	2	0.059
			Geography	239.256	192.524	46.732	3	<0.001	79.8%	46.366	14	<0.001
			H + G	239.256	146.158	93.098	17	<0.001	89.4%			
	Fall	Both	Habitat	256.676	133.487	123.189	20	<0.001	92.9%	11.021	2	0.004
			Geography	256.676	188.425	68.251	3	<0.001	84.2%	65.959	19	<0.001
			H + G *	256.676	122.466	134.21	22	<0.001	94.1%			
NELE	All	Both	Habitat	493.484	401.104	92.38	20	<0.001	79.6%	19.627	2	<0.001
			Geography	493.484	452.502	40.982	3	<0.001	69.3%	71.025	19	<0.001
			H + G *	493.484	381.477	112.007	22	<0.001	82.3%			
	Spring	Both	Habitat	346.333	256.308	90.025	20	<0.001	83.4%	25.785	2	<0.001
			Geography	346.333	278.003	68.329	3	<0.001	78.3%	47.480	19	<0.001
			H + G *	346.333	230.523	115.809	22	<0.001	86.7%			

Table 47. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results: -2 LOG L Int. only	Int.+cov.	Chi-sq. Cov.	df	P	Regression Concordance	Test of Addition of Other Variable Set: Chi-sq.	df	P
NELE	Fall	Local	Habitat	332.682	279.12	53.562	15	<0.001	76.9%	7.563	2	0.023
			Geography	332.682	321.695	10.987	3	0.012	62.0%	50.138	14	<0.001
			H + G *	332.682	271.557	61.125	17	<0.001	78.0%			
PECA	All	Local	Habitat *	437.174	264.315	172.86	15	<0.001	90.6%	1.371	2	0.504
			Geography	437.174	352.895	84.28	3	<0.001	79.0%	89.951	14	<0.001
			H + G	437.174	262.944	174.23	17	<0.001	90.8%			
	Spring	Local	Habitat *	299.628	185.884	113.745	15	<0.001	89.1%	0.548	2	0.760
			Geography	299.628	245.121	54.508	3	<0.001	76.1%	59.785	14	<0.001
			H + G	299.628	185.336	114.293	17	<0.001	89.0%			
	Fall	Local	Habitat *	313.388	146.959	166.429	15	<0.001	93.7%	1.490	2	0.475
			Geography	313.388	236.14	77.248	3	<0.001	79.2%	90.671	14	<0.001
			H + G	313.388	145.469	167.919	17	<0.001	93.5%			
PEER	All	Local	Habitat *	533.338	433.472	99.866	15	<0.001	77.8%	0.075	2	0.963
			Geography	533.338	477.354	55.985	3	<0.001	70.1%	43.957	14	<0.001
			H + G	533.338	433.397	99.942	17	<0.001	77.8%			
	Spring	Local	Habitat *	363.586	268.513	95.073	15	<0.001	81.9%	1.087	2	0.581
			Geography	363.586	296.183	67.403	3	<0.001	74.5%	28.757	14	0.011
			H + G	363.586	267.426	96.16	17	<0.001	82.1%			

Table 47. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results						Test of Addition of Other Variable Set		
				-2 LOG L		Chi-sq.			Regression Concordance			
				Int. only	Int.+cov.	Cov.	df	P		Chi-sq.	df	P
PEER	Fall	Local	Habitat *	350.603	287.812	62.79	15	<0.001	78.1%	1.054	2	0.590
			Geography	350.603	326.404	24.199	3	<0.001	66.5%	39.646	14	<0.001
			H + G	350.603	286.758	63.845	17	<0.001	78.4%			
PEMA	All	Both	Habitat	426.618	289.928	136.69	20	<0.001	88.1%	26.916	2	<0.001
			Geography	426.618	330.564	96.054	3	<0.001	82.9%	67.552	19	<0.001
			H + G *	426.618	263.012	163.606	22	<0.001	91.2%			
	Spring	Both	Habitat	295.207	124.89	170.317	20	<0.001	95.2%	23.079	2	<0.001
			Geography	295.207	208.896	86.311	3	<0.001	85.6%	107.085	19	<0.001
			H + G *	295.207	101.811	193.397	22	<0.001	97.0%			
	Fall	Landscape	Habitat	294.074	228.805	65.268	6	<0.001	81.2%	20.006	2	<0.001
			Geography	294.074	227.049	67.025	3	<0.001	82.3%	18.250	5	0.003
			H + G *	294.074	208.799	85.275	8	<0.001	85.9%			
		Both	Habitat	294.074	206.213	87.861	20	<0.001	85.6%	21.952	2	<0.001
			Geography	294.074	227.049	67.025	3	<0.001	82.3%	42.788	19	0.001
			H + G	294.074	184.261	109.813	22	<0.001	82.9%			
REME	All	Local	Habitat *	269.519	220.101	49.418	15	<0.001	80.5%	1.182	2	0.554
			Geography	269.519	266.8	2.72	3	0.437	56.3%	47.881	14	<0.001
			H + G	269.519	218.919	50.6	17	<0.001	80.7%			

Table 47. Continued.

Species	Season	Best Habitat Scale	Feature	Logistic Regression Results: -2 LOG L: Int. only	Int.+cov.	Chi-sq.: Cov.	df	P	Regression Concordance	Test of Addition of Other Variable Set: Chi-sq.	df	P
REME	Spring	Local	Habitat *	153.253	120.044	33.209	15	0.004	82.7%	1.664	2	0.435
			Geography	153.253	148.628	4.625	3	0.201	59.5%	30.248	14	0.007
			H + G	153.253	118.38	34.873	17	0.006	83.1%			
	Fall	Local	Habitat *	189.532	151.752	37.78	15	0.001	82.4%	0.482	2	0.786
			Geography	189.532	185.601	3.931	3	0.269	59.6%	34.331	14	0.002
			H + G	189.532	151.27	38.262	17	0.002	82.3%			

Table 48. Standardized logistic regression coefficients for bird presence/absence on local and landscape habitat variables and geographical coordinates, by season. See Tables 3, 4, 8, and 12 for descriptions of structural and landscape variables and principal components; see Figs. 6 and 7 for description of plant species DCAs. Only models for which the addition of geographical coordinates was statistically significant (see Table 46) are shown. Only statistically significant ($P < 0.05$) coefficients shown. No regression included TRAIL as significant.

			Standardized Regression Coefficients																			
			Local													Landscape					Geography	
Species	Season	Best Habitat Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5	EAST	NORTH
ANHU	Spring	Both								0.31		0.26			0.34			-0.18	0.30		-0.82	-1.08
	Fall	Local								0.44			-0.92									-0.58
BEWR	Spring	Local		-0.18		0.38				-0.32				-0.21							0.35	0.53
BGGN	Fall	Local										0.30		0.39								0.73
BHGR	Spring	Landscape															0.35			0.28		-0.35
CACW	Spring	Both								-0.41				0.46				-0.39			-0.59	
CALT	Fall	Both								0.51			-0.91								-0.41	-0.74
CANW	Spring	Both									0.85		-0.97					-0.95				2.01
CAQU	Spring	Both	0.19							-0.49	-0.26							-0.21		0.17	0.45	0.55
CATH	Spring	Both			0.22	0.28					-0.32							-0.32				
	Fall	Local		-0.26								0.35			0.39						-0.80	-0.66
NOFL	Spring	Local		0.40	0.18				-0.38		-0.38		0.35									-0.89

Table 48. Continued

			Standardized Regression Coefficients																		
			Local													Landscape					Geography	
Species	Season	Best Habitat Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5	EAST	NORTH
NOMO	Spring	Both					-0.46			0.40								-0.19	0.22	0.21	-0.55	
OCWA	Spring	Both										-0.78			-0.63				-0.63			-1.20
PHAI	Spring	Local					0.40		-0.45													-0.84
RCSP	Spring	Both															0.42			-0.24	0.72	0.64
SAGS	Spring	Both										0.41				-0.65	-1.67	-0.80			1.27	1.48
SCJA	Spring	Both											0.25				0.38					-0.57
WCSP	Spring	Local				-0.34							-0.23								0.36	
WEME	Spring	Both							0.21							-0.38	0.27				0.43	1.11
	Fall	Local										0.42	0.54									1.62
WREN	Spring	Both						0.61			-0.52	-0.42	0.88		-0.82	0.93	0.41	-0.51	0.36		-1.42	-3.88
	Fall	Both	0.35					0.54			-0.62		1.01			0.68			0.50	0.28		-2.55
YRWA	Fall	Both							-0.30		-0.45										-0.50	-1.12

Table 49. Standardized logistic regression coefficients for mammal presence/absence on local and landscape habitat variables and geographical coordinates, by season. See Tables 3, 4, 8, and 12 for descriptions of structural and landscape variables and principal components; see Figs. 6 and 7 for description of plant species DCAs. Only models for which the addition of geographical coordinates was statistically significant (see Table 47) are shown. Only statistically significant ($P < 0.05$) coefficients shown. No regression included PC_BNGRS or LAFAC5 as significant.

			Standardized Regression Coefficients																		
			Local													Landscape				Geography	
Species	Season	Best Habitat Scale	GC_CRYP	PC_TREE	STFAC1	STFAC2	STFAC3	STFAC4	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC 1	LAFAC 2	LAFAC 3	LAFAC 4	EAST	NORTH
CHFA	All	Both							0.38							-0.44	-0.68	0.35		0.72	
	Fall	Both	-0.36														-0.54	0.44	0.35	1.13	0.59
DIAG	All	Both	0.47								0.42				0.38	-0.49		-1.63		2.71	2.38
	Spring	Both							0.31		0.26			0.34				-0.18	0.30	0.82	1.08
	Fall	Both	0.71												0.49			-2.27		2.75	2.26
NEFU	All	Local			1.01					-0.52										-0.72	-1.01
	Fall	Both			0.92					-0.54							-0.67	0.52	0.54	-1.47	-1.35
NELE	All	Both		-0.21	0.52	-0.23		0.28		0.35			0.27	0.51						-0.66	
	Spring	Both						0.35		0.32				0.40						-0.99	
	Fall	Local			0.51	-0.23							0.28	0.59						-0.45	
PEMA	All	Both				0.49	-0.32					-0.30				-0.96				1.52	1.26
	Spring	Both	0.64				-0.53									-4.66		1.28		3.24	1.83
	Fall	Landscape														-0.52				0.90	
	Fall	Both				0.59	-0.34									-0.73				1.55	1.09

COMMUNITY PATTERNS

We followed a similar statistical process to detect relationships between overall bird or mammal community variation and major habitat features. As an index to community composition, we used each point s score on each of the first two DCA axis for birds or mammals for each year and season of sampling (scores summarized in Figs. 18, 23, 24, and 27). These scores were first regressed on local and landscape habitat variables (using linear multiple regression since scores were continuous rather than dichotomous or ordinal variables) to determine the best fitting model. The scores were then regressed on the best habitat model and UTM coordinates to determine the extent of geographic variation.

In all but one case examined (Birds, Fall 1996, DCA2) local variables generated a higher R^2 than landscape variables (Table 50). However, in about half of the remaining cases, landscape variables did, indeed, contribute to explaining a statistically significant amount of remaining variation in animal-habitat relationships. There was a greater tendency for landscape variables to be involved with first DCAs; they appeared as significant in only two of nine models of second DCAs.

For both birds and small mammals, first DCAs invariably had higher R^2 for best models than did second DCAs (Table 50), and usually had more significant habitat variables associated with them (Table 51). For birds, both plant species DCAs, ROCK, and LAFAC2 appeared most often to be significant, whereas for mammals, STFAC1 appeared most often (Table 51).

Inclusion of UTMs to the best habitat model explained an additional statistically significant amount of variation in community composition in about half the cases, slightly more so for birds than mammals (Table 52). In all cases, however, habitat generated a higher R^2 than geography did. Geography occurred as important in spring DCAs about the same as fall ones, but far more for first DCAs than second ones (8 vs. 1).

For birds, although some individual habitat variables were significant, none seemed to show up more frequently than others (Table 53). However, UTMs were significant for first DCAs in all five sampling periods, implying that avian community composition continued to vary geographically over and above variation accounted for by our habitat variables. Likewise for mammals, UTMs were significant for first DCAs in three out of four periods. STFAC1 also appeared somewhat more often than other habitat variables.

Table 50. Multiple regression of bird and mammal community Detrended Correspondence Analysis scores on local and landscape habitat variables, by season, and test of significance of addition of variables of one scale to those of the other scale. * denotes best model.

Taxon	Season	Axis	Total df	Scale	Multiple Regression Results							Test of Addition of Other variable set	
					Total SS	Model SS	Error SS	Model df	F	P	R^2	F-to-enter	P
Bird	Spring 1995	DCA1	118	Local	28.03635	19.61536	8.421	14	17.304	<0.001	70.0%	3.685	0.004
			118	Landscape	28.03635	17.38843	10.648	5	36.907	<0.001	62.0%	3.534	0.006
			118	Both *	28.03635	20.93661	7.100	19	15.365	<0.001	74.7%		
Bird	Spring 1995	DCA2	118	Local *	17.15528	6.511917	10.643	14	4.545	<0.001	38.0%	3.108	0.012
			118	Landscape	17.15528	5.280296	11.875	5	10.049	<0.001	30.8%	2.057	0.077
			118	Both	17.15528	7.955944	9.199	19	4.506	<0.001	46.4%		
Bird	Fall 1995	DCA1	118	Local *	49.784	36.671	13.113	14	20.773	<0.001	73.7%	2.254	0.055
			118	Landscape	49.784	29.755	20.030	5	33.573	<0.001	59.8%	4.959	<0.001
			118	Both	49.784	38.011	11.773	19	16.823	<0.001	76.4%		
Bird	Fall 1995	DCA2	118	Local	22.60814	3.031053	19.577	14	1.150	0.325	13.4%	1.824	0.115
			118	Landscape	22.60814	1.29072	21.317	5	1.368	0.242	5.7%	1.338	0.255
			118	Both	22.60814	4.682171	17.926	19	1.361	0.165	20.7%		
Bird	Spring 1996	DCA1	106	Local	24.02754	17.29004	6.737	14	16.864	<0.001	72.0%	3.991	0.003
			106	Landscape	24.02754	14.71786	9.310	5	31.935	<0.001	61.3%	4.342	0.001
			106	Both *	24.02754	18.54711	5.480	19	15.496	<0.001	77.2%		
Bird	Spring 1996	DCA2	106	Local *	10.69623	3.234694	7.462	14	2.849	0.001	30.2%	1.396	0.234
			106	Landscape	10.69623	1.96359	8.733	5	4.542	0.001	18.4%	1.642	0.157
			106	Both	10.69623	3.788958	6.907	19	2.512	0.002	35.4%		
Bird	Fall 1996	DCA1	104	Local	82.006	48.962	33.045	14	9.525	<0.001	59.7%	3.358	0.008
			104	Landscape	82.006	40.37397	41.632	5	19.202	<0.001	49.2%	3.089	0.013
			104	Both *	82.006	54.412	27.594	19	8.822	<0.001	66.4%		

Table 50. Continued.

Taxon	Season	Axis	Total df	Scale	Multiple Regression Results							Test of Addition of Other variable set	
					Total SS	Model SS	Error SS	Model df	F	P	R^2	F-to-enter	P
Bird	Fall 1996	DCA2	104	Local	45.89542	7.409272	38.486	14	1.238	0.263	16.1%	3.209	0.011
			104	Landscape*	45.89542	8.301518	37.594	5	4.372	0.001	18.1%	0.979	0.436
			104	Both	45.89542	13.52064	32.375	19	1.868	0.028	29.5%		
Bird	Spring 1997	DCA1	117	Local	33.15999	26.1188	7.041	14	27.291	<0.001	78.8%	8.740	<0.001
			117	Landscape	33.15999	24.60561	8.554	5	64.431	<0.001	74.2%	5.297	<0.001
			117	Both *	33.15999	28.29032	4.870	19	29.965	<0.001	85.3%		
Bird	Spring 1997	DCA2	117	Local	14.72855	7.16032	7.568	14	6.961	<0.001	48.6%	3.474	0.006
			117	Landscape	14.72855	2.06617	12.662	5	3.655	0.004	14.0%	6.788	<0.001
			117	Both *	14.72855	8.299847	6.429	19	6.659	<0.001	56.4%		
Mammal	Spring 1995	DCA1	75	Local	52.86117	33.77896	19.082	14	7.713	<0.001	63.9%	5.248	0.001
			75	Landscape	52.86117	30.55941	22.302	5	19.184	<0.001	57.8%	2.865	0.023
			75	Both *	52.86117	39.8674	12.994	19	9.043	<0.001	75.4%		
Mammal	Spring 1995	DCA2	75	Local *	25.0372	9.069416	15.968	14	2.475	0.008	36.2%	0.310	0.905
			75	Landscape	25.0372	3.465105	21.572	5	2.249	0.059	13.8%	1.553	0.188
			75	Both	25.0372	9.499381	15.538	19	1.802	0.046	37.9%		
Mammal	Fall 1995	DCA1	106	Local *	10.69623	3.234694	7.462	14	2.849	0.001	30.2%	1.396	0.234
			106	Landscape	10.69623	1.96359	8.733	5	4.542	0.001	18.4%	1.642	0.157
			106	Both	10.69623	3.788958	6.907	19	2.512	0.002	35.4%		
Mammal	Fall 1995	DCA2	111	Local *	0.554999	0.127588	0.427	14	2.068	0.020	23.0%	1.292	0.274
			111	Landscape	0.554999	0.054456	0.501	5	2.306	0.049	9.8%	1.665	0.151
			111	Both	0.554999	0.155623	0.399	19	1.887	0.024	28.0%		

Table 50. Continued.

Taxon	Season	Axis	Total df	Scale	Multiple Regression Results							Test of Addition of Other variable set	
					Total SS	Model SS	Error SS	Model df	F	P	R^2	F-to-enter	P
Mammal	Spring 1996	DCA1	107	Local	103.4483	69.17008	34.278	14	13.405	<0.001	66.9%	6.162	<0.001
			107	Landscape	103.4483	57.92383	45.525	5	25.956	<0.001	56.0%	4.985	<0.001
			107	Both *	103.4483	78.05868	25.390	19	14.239	<0.001	75.5%		
Mammal	Spring 1996	DCA2	107	Local *	6.849492	1.690567	5.159	14	2.177	0.014	24.7%	1.668	0.151
			107	Landscape	6.849492	0.485737	6.364	5	1.557	0.179	7.1%	2.203	0.061
			107	Both	6.849492	2.137279	4.712	19	2.101	0.011	31.2%		
Mammal	Fall 1996	DCA1	84	Local *	70.97316	41.72137	29.252	14	7.131	<0.001	58.8%	1.482	0.208
			84	Landscape	70.97316	27.61301	43.360	5	10.062	<0.001	38.9%	3.024	0.016
			84	Both	70.97316	44.71405	26.259	19	5.825	<0.001	63.0%		
Mammal	Fall 1996	DCA2	84	Local *	35.27624	14.15012	21.126	14	3.349	<0.001	40.1%	1.406	0.234
			84	Landscape	35.27624	8.435574	26.841	5	4.966	0.001	23.9%	1.894	0.107
			84	Both	35.27624	16.212	19.064	19	2.909	0.001	46.0%		

Table 51. Significant coefficients for multiple regression of bird and mammal community Detrended Correspondence Analysis scores on local and landscape habitat variables, by season, for best fitting habitat models (Table 50). STFAC4 did not appear in any model. * denotes P < 0.05, ** denotes P < 0.01, *** denotes P < 0.001. Parentheses denote a negative relationship.

				Significant Regression Coefficients																	
				Local													Landscape				
Taxon	Season	Axis	Best Habitat Scale	GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
Bird	Spring 1995	DCA1	Both							***	(*)	*						(***)			
	Spring 1995	DCA2	Local								(**)		***	(*)							
	Fall 1995	DCA1	Local	**	(*)					***	(**)				*						
	Fall 1995	DCA2	none																		
	Spring 1996	DCA1	Both	**						***	(***)	*			*	(*)	(*)	(***)		*	
	Spring 1996	DCA2	Local									(*)									
	Fall 1996	DCA1	Both					(*)							**			(*)			*
	Fall 1996	DCA2	Landscape														**		*		(**)
	Spring 1997	DCA1	Both							***					**		(***)	(***)		***	*
	Spring 1997	DCA2	Both							(**)			(***)	(***)						(**)	
Mammal	Spring 1995	DCA1	Both			*					(*)						***	***		(*)	
	Spring 1995	DCA2	Local	(*)						(**)	*										
	Fall 1995	DCA1	Local									(*)									
	Fall 1995	DCA2	Local				(**)														

Table 51. Continued.

Taxon	Season	Axis	Best Habitat Scale	Significant Regression Coefficients																	
				Local													Landscape				
				GC_CRYP	PC_BNGRS	PC_TREE	STFAC1	STFAC2	STFAC3	DCA1	DCA2	EDGEDIST	URBDIST	CACTUS	ROCK	TRAIL	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	LAFAC 5
Mammal	Spring 1996	DCA1	Both		(*)	*	*					(**)					***	***		(***)	
	Spring 1996	DCA2	Local																		
	Fall 1996	DCA1	Local			*	*		*			(**)									
	Fall 1996	DCA2	Local				*	*						*							

Table 52. Multiple regression of bird and mammal community Detrended Correspondence Analysis scores on habitat and geographical variables, by season, and test of significance of addition of variables of one scale to those of the other scale. Best habitat scale from Table 50. H + G = combined habitat + geographical variables. * denotes best model.

Taxon	Season	Axis	Best Habitat Scale	Multiple Regression Results									Test of Addition of Other Variable Set	
				Total df	Feature	Total SS	Model SS	Error SS	Model df	F	P	R^2	F-to-enter	P
Bird	Spring 1995	DCA1	Both	118	Habitat	28.036	20.937	7.100	19	15.365	<0.001	74.7%	14.156	<0.001
				118	Geography	28.036	18.295	9.742	2	108.925	<0.001	65.3%	3.944	<0.001
				118	H + G *	28.036	22.541	5.496	21	18.945	<0.001	80.4%		
Bird	Spring 1995	DCA2	Local	118	Habitat	17.155	6.512	10.643	14	4.545	<0.001	38.0%	10.201	<0.001
				118	Geography	17.155	2.054	15.101	2	7.890	0.001	12.0%	5.119	<0.001
				118	H + G *	17.155	8.286	8.869	16	5.956	<0.001	48.3%		
Bird	Fall 1995	DCA1	Local	118	Habitat	49.784	36.671	13.113	14	20.773	<0.001	73.7%	14.067	<0.001
				118	Geography	49.784	32.242	17.542	2	106.599	<0.001	64.8%	5.149	<0.001
				118	H + G *	49.784	39.506	10.278	16	24.503	<0.001	79.4%		
Bird	Fall 1995	DCA2	none	118	Habitat	22.608	4.682	17.926	19	1.361	0.165	20.7%	1.952	0.147
				118	Geography	22.608	0.435	22.173	2	1.137	0.324	1.9%	1.464	0.116
				118	H + G	22.608	5.376	17.232	21	1.441	0.119	23.8%		
Bird	Spring 1996	DCA1	Both	106	Habitat	24.028	18.547	5.480	19	15.496	<0.001	77.2%	13.291	<0.001
				106	Geography	24.028	16.445	7.583	2	112.771	<0.001	68.4%	3.652	<0.001
				106	H + G *	24.028	19.853	4.175	21	19.248	<0.001	82.6%		
Bird	Spring 1996	DCA2	Local	106	Habitat *	10.696	3.235	7.462	14	2.849	0.001	30.2%	1.683	0.192
				106	Geography	10.696	0.426	10.270	2	2.158	0.121	4.0%	2.751	0.002
				106	H + G	10.696	3.504	7.192	16	2.740	0.001	32.8%		
Bird	Fall 1996	DCA1	Both	104	Habitat	82.006	54.412	27.594	19	8.822	<0.001	66.4%	3.866	0.025
				104	Geography	82.006	43.873	38.133	2	58.677	<0.001	53.5%	2.231	0.007
				104	H + G *	82.006	56.764	25.242	21	8.888	<0.001	69.2%		

Table 52. Continued.

Taxon	Season	Axis	Best Habitat Scale	Multiple Regression Results									Test of Addition of Other Variable Set	
				Total df	Feature	Total SS	Model SS	Error SS	Model df	F	P	R^2	F-to-enter	P
Bird	Fall 1996	DCA2	Landscape	104	Habitat *	45.895	8.302	37.594	5	4.372	0.001	18.1%	1.315	0.273
				104	Geography	45.895	2.806	43.090	2	3.321	0.040	6.1%	3.439	0.007
				104	H + G	45.895	9.294	36.601	7	3.519	0.002	20.3%		
Bird	Spring 1997	DCA1	Both	117	Habitat	33.160	28.290	4.870	19	29.965	<0.001	85.3%	21.850	<0.001
				117	Geography	33.160	25.245	7.915	2	183.411	<0.001	76.1%	6.897	<0.001
				117	H + G *	33.160	29.814	3.346	21	40.728	<0.001	89.9%		
Bird	Spring 1997	DCA2	Both	117	Habitat *	14.729	8.300	6.429	19	6.659	<0.001	56.4%	0.152	0.860
				117	Geography	14.729	1.479	13.250	2	6.418	0.002	10.0%	5.394	<0.001
				117	H + G	14.729	8.320	6.408	21	5.935	<0.001	56.5%		
Mammal	Spring 1995	DCA1	Both	75	Habitat *	52.861	39.867	12.994	19	9.043	<0.001	75.4%	0.619	0.542
				75	Geography	52.861	15.061	37.801	2	14.542	<0.001	28.5%	5.615	<0.001
				75	H + G	52.861	40.159	12.703	21	8.129	<0.001	76.0%		
Mammal	Spring 1995	DCA2	Local	75	Habitat *	25.037	9.069	15.968	14	2.475	0.008	36.2%	2.949	0.060
				75	Geography	25.037	7.424	17.614	2	15.383	<0.001	29.6%	0.899	0.564
				75	H + G	25.037	10.521	14.517	16	2.672	0.003	42.0%		
Mammal	Fall 1995	DCA1	Local	111	Habitat	104.763	69.181	35.582	14	13.471	<0.001	66.0%	6.866	0.002
				111	Geography	104.763	51.736	53.027	2	53.173	<0.001	49.4%	4.789	<0.001
				111	H + G *	104.763	73.675	31.088	16	14.071	<0.001	70.3%		
Mammal	Fall 1995	DCA2	Local	111	Habitat *	0.555	0.128	0.427	14	2.068	0.020	23.0%	0.506	0.605
				111	Geography	0.555	0.015	0.540	2	1.513	0.225	2.7%	1.879	0.038
				111	H + G	0.555	0.132	0.423	16	1.854	0.035	23.8%		

Table 52. Continued.

Taxon	Season	Axis	Best Habitat Scale	Multiple Regression Results									Test of Addition of Other Variable Set	
				Total df	Feature	Total SS	Model SS	Error SS	Model df	F	P	R^2	F-to-enter	P
Mammal	Spring 1996	DCA1	Both	107	Habitat	103.448	78.059	25.390	19	14.239	<0.001	75.5%	3.251	0.044
				107	Geography	103.448	54.867	48.581	2	59.293	<0.001	53.0%	4.789	<0.001
				107	H + G *	103.448	79.843	23.605	21	13.852	<0.001	77.2%		
Mammal	Spring 1996	DCA2	Local	107	Habitat *	6.849	1.691	5.159	14	2.177	0.014	24.7%	0.764	0.469
				107	Geography	6.849	0.431	6.419	2	3.523	0.033	6.3%	1.723	0.064
				107	H + G	6.849	1.776	5.074	16	1.991	0.022	25.9%		
Mammal	Fall 1996	DCA1	Local	84	Habitat	70.973	41.721	29.252	14	7.131	<0.001	58.8%	9.936	<0.001
				84	Geography	70.973	33.304	37.669	2	36.249	<0.001	46.9%	3.225	0.001
				84	H + G *	70.973	48.337	22.637	16	9.075	<0.001	68.1%		
Mammal	Fall 1996	DCA2	Local	84	Habitat *	35.276	14.150	21.126	14	3.349	<0.001	40.1%	1.872	0.162
				84	Geography	35.276	9.916	25.361	2	16.030	<0.001	28.1%	1.295	0.234
				84	H + G	35.276	15.253	20.024	16	3.237	<0.001	43.2%		

Table 53. Significant coefficients for multiple regression of bird and mammal community Detrended Correspondence Analysis scores on local and landscape habitat variables and geographical coordinates, by season. See Tables 3, 4, 8, and 12 for descriptions of structural and landscape variables and principal components; see Figs. 6 and 7 for description of plant species DCAs. Only models for which the addition of geographical coordinates was statistically significant (see Table 52) are shown. PC_TREE, STFAC4, DCA2, ROCK, TRAIL, and LAFAC5 did not appear significant in any model. * denotes P < 0.05, ** denotes P < 0.01, *** denotes P < 0.001. Parentheses denote a negative relationship.

				Significant Regression Coefficients														
				Local									Landscape				Geography	
Taxon	Season	Axis	Best Habitat Scale	GC_CRYP	PC_BNGRS	STFAC1	STFAC2	STFAC3	DCA1	EDGEDIST	URBDIST	CACTUS	LAFAC1	LAFAC 2	LAFAC 3	LAFAC 4	EAST	NORTH
Bird	Spring 1995	DCA1	Both							*							***	***
	Spring 1995	DCA2	Local						(**)		**	(***)						**
	Fall 1995	DCA1	Local	*					*								**	***
	Spring 1996	DCA1	Both	*						*							**	***
	Fall 1996	DCA1	Both				(*)										*	**
	Spring 1997	DCA1	Both								(*)		(***)	(*)	(*)	*	***	***
Mammal	Fall 1995	DCA1	Local			***					*						(***)	(**)
	Spring 1996	DCA1	Both		(**)	*				(*)			**	*		(*)	(*)	
	Fall 1996	DCA1	Local			*		*		(**)	*						(***)	(*)

VI. CONCLUSIONS

SUMMARY OF RESULTS

Our surveys and analyses have yield several general results:

1. California coastal sage scrub, while distinct at a regional level (i.e., compared to other southern California major vegetation types), is a heterogeneous vegetation type.
2. Within CSS there are geographical gradients in local vegetation structure and composition, mainly reflecting north-south and east-west gradients in climate and topography.
3. Likewise, there is geographical variation in landscape-level vegetation and land-use classification.
4. Both local and landscape level attributes include patterns induced by human activities (e.g., increased coverage of exotic forbs and grasses, increased urbanization).
5. Both bird and small mammal species respond to these gradients, with virtually all taxa showing statistically significant regressions of presence/absence with local, landscape, or geographical variables.
6. Species are generally concordant in their distributions between years. This suggests that the point samples of birds and small mammals are generating consistent estimates of species presence/absence.
7. Patterns of bird and/or mammal community variation are associated with habitat variables, and are correlated with each other.
8. Species richness (biodiversity) of birds and small mammals is uncorrelated.

MANAGEMENT IMPLICATIONS

1. A <u>regional</u> reserve system that spans the range of CSS conditions and geographical areas will be necessary if we hope to preserve CSS species diversity.

CSS *is* a heterogeneous vegetation type; it varies floristically, structurally, and geographically. Likewise, the land-use contexts of CSS are also geographically variable. More importantly, CSS is also highly variable from the perspective of birds and small mammals; all taxa showed significant variation in distribution with respect to at least some feature of the system. Bird and mammal inhabitants of CSS respond in species-specific ways to the variation in habitat, both in time (i.e., seasonally) and in space.

2. Any system of reserves cannot rely on the local diversity of any single taxonomic group as an indicator of appropriate design. Instead, design must be based on meeting the needs of multiple, independent species criteria.

Community ordinations were similar for both birds and small mammals; the scores of the first axis generated from bird-based DCA were significantly correlated with scores of the first axis obtained from mammal-based DCA for the four seasons in which the two taxa were co-sampled (Table 33). Thus the major gradient in species change for birds in each sampling period was paralleled by changes for mammals. This reflects the major gradient in vegetation and landscape structure and composition that underlies species distributional patterns in this system. However, despite this correlation in composition, cross-correlations between bird and small mammal richness were poor (Table 29). None were significant at the point-level, and only one of 20 at the site level (about that expected by chance alone). Thus, bird and small mammal richness did not covary at either the site or point level, and one was a poor predictor of the other. From a management perspective this implies that conservation of sites associated with, say, high avian biodiversity will not necessarily preserve high mammal biodiversity.

FUTURE RESEARCH DIRECTIONS

Our data yield a baseline description of current patterns of distribution of CSS birds and small mammals, and provide some indication of important environmental features that are associated with the presence of individual species. As such, they will be useful in developing a reserve system. However, in order to manage such a system once it is in place we need a much better understanding of individual species local and metapopulation dynamics and extinction risks if we are to maintain current levels of species diversity. Likewise, we need to understand more about how a species interacts with its surrounding landscape (e.g., its use of dispersal or movement corridors), and how that landscape in turn impinges directly upon a species (e.g., edge effects).

It is also likely that human impacts will continue, on both local and global scales. Exotic organisms (plant and animal) continue to be introduced to and spread within southern California, and their effects on species and ecosystems remains to be fully documented. Additionally, regional enrichment of soil nutrients due to the deposition of atmospheric nitrogen from automobiles and industrial activities is likely to produce changes in plant communities. These community changes will likely be further enhanced by changes in climate, which is also a product of human alteration of atmospheric composition. Understanding where and how these changes will take place will be crucial to the long-term success of any reserve system.

SPECIES SUMMARIES

BIRDS

The following summaries are only for those bird species with sufficient number of detections for analysis (i.e., they occurred on at least 10% of the points surveyed during at least one sampling period). See Table 13 for scientific names of bird species. Sites in which species occurred found in Tables 16-20.

Abundances are taken from Table 37, and are classified using the following criteria:

>80% of points = very abundant
80-65% = abundant
65-35% = common
35-20% = uncommon
20-10% = very uncommon

Significant changes in bird species detections between sampling periods are taken from Table 32. None denotes no statistically significant change. Concordances in presence/absence at a point between sampling periods are taken from Table 34. Yes denotes statistically significant concordance. Concordances >0.500 are denoted as high.

Regression statistics are taken from Table 39 for habitat models (local + landscape variables) and Table 44 for habitat + geography models. All are statistically significant ($P < 0.05$) unless noted otherwise. Only best model (based on the significance of the addition of one set of variables to a model already containing the other) shown. Regression coefficients are taken from Table 41 for habitat models and Table 46 for habitat + geography models. All are statistically significant ($P < 0.05$). Significant geographical variation describes regional distributional trends independent of habitat.

Detailed descriptions of habitat variables appear in Tables 3 and 6 (local structural variables and principal components), Tables 4 and 10 (landscape variables and principal components), and discussion of Figures 4 and 5 (local plant species DCAs). To recapitulate briefly:

Component	Interpretation
STFAC1	shrubland vs. grassland local structure
STFAC2	high litter coverage vs. bare ground
STFAC3	increasing forbs/patchy
STFAC4	increasing disturbed
LAFAC1	chaparral vs. CSS landscape
LAFAC2	increasing native mosaic
LAFAC3	increasing aquatic/riparian
LAFAC4	urban
LAFAC5	increasing ag/exotic
DCA1	CSS vs. chaparral plant species
DCA2	south coastal vs. northern inland plant species

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Abundance and Variation

- Abundance: common spring, common fall
- Concordance: non-concordant spring1995 —spring 1996
- Annual Changes: none

Habitat Associations

- Spring: Best Habitat Model: Local + Landscape
  - Significant Habitat Variables: +STFAC2, -STFAC3, +EDGEDIST, -URBDIST, +LAFAC4
  - Significant Geographical Variation: -NORTH
  - Significant Habitat + UTM Variables: +DCA1, +EDGEDIST, +ROCK, -LAFAC3, +LAFAC4, -EAST, -NORTH
- Fall: Best Habitat Model: Local
  - Significant Habitat Variables: +DCA2, -URBDIST
  - Significant Geographical Variation: no
  - Significant Habitat + UTM Variables: +DCA1, -URBDIST, -NORTH

BCSP —BLACK-CHINNED SPARROW

Abundance and Variation

- Abundance: common spring
- Concordance: high
- Annual Changes: declined spring 1996 —spring 1997

Habitat Associations

- Spring: Best Habitat Model: Local
  - Significant Habitat Variables: -STFAC2, -STFAC4, -DCA1, +URBDIST, -ROCK
  - Significant Geographical Variation: -EAST, -NORTH
  - Significant Habitat + UTM Variables: H + G model not significant
- Fall: absent

BEWR —BEWICK S WREN

Abundance and Variation

- Abundance: very abundant spring, common fall
- Concordance: non-concordant fall 1995 —fall 1996
- Annual Changes: declined fall 1995 —fall 1996, increased spring 1996 —spring 1997

Habitat Associations

- Spring: Best Habitat Model: Local
  - Significant Habitat Variables: -PC_BNGRS, +STFAC1, -DCA2, -CACTUS
  - Significant Geographical Variation: +EAST, +NORTH
  - Significant Habitat + UTM Variables: -PC_BNGRS, +STFAC1, -CACTUS, +EAST, +NORTH
- Fall: Best Habitat Model: Local + Landscape
  - Significant Habitat Variables: +GC_CRYP, +LAFAC5
  - Significant Geographical Variation: none
  - Significant Habitat + UTM Variables: H + G model not significant

BGGN — BLUE-GRAY GNATCATCHER
Abundance and Variation
Abundance: very uncommon fall
Concordance: non-concordant spring 1995 — spring 1996, spring 1996 — spring 1997
Annual Changes: none
Habitat Associations
Spring: absent
Fall: Best Habitat Model: Local
Significant Habitat Variables: +DCA1, +CACTUS
Significant Geographical Variation: no
Significant Habitat + UTM Variables: +EDGEDIST, +CACTUS, +NORTH

BHGR — BLACK-HEADED GROSBEAK
Abundance and Variation
Abundance: uncommon spring
Concordance: non-concordant spring 1995 — spring 1996
Annual Changes: none
Habitat Associations
Spring: Best Habitat Model: Landscape
Significant Habitat Variables: +LAFAC2
Significant Geographical Variation: no
Significant Habitat + UTM Variables: +LAFAC2, +LAFAC5, -NORTH
Fall: absent

CACW — CACTUS WREN
Abundance and Variation
Abundance: common spring
Concordance: high concordances in spring
Annual Changes: none
Habitat Associations
Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +STFAC3, -DCA1, -EDGEDIST, +CACTUS, -LAFAC3
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: -DCA1, +CACTUS, -LAFAC3, -EAST
Fall: absent

CAGN — California Gnatcatcher
Abundance and Variation
Abundance: uncommon spring, very uncommon fall
Concordance: non-concordant fall 1995 — fall 1996; high concordances in spring
Annual Changes: none
Habitat Associations
Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +STFAC3, +CACTUS, -LAFAC1
Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: none significant
Significant Habitat Variables: --
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant

CALT — CALIFORNIA TOWHEE

Abundance and Variation

Abundance: very abundant spring, very abundant fall
Concordance: non-concordant spring1995 — spring 1996
Annual Changes: increased spring 1995 — spring 1996

Habitat Associations

Spring: Best Habitat Model: Local (Landscape)
Significant Habitat Variables: +GC_CRYP, -URBDIST, +ROCK (-LAFAC1)
Significant Geographical Variation: +EAST
Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local + Landscape
Significant Habitat Variables: -PC_TREE, -URBDIST, +LAFAC4
Significant Geographical Variation: +EAST
Significant Habitat + UTM Variables: H + G model not significant

Remarks: In spring, local habitat model was best statistically, but landscape model gave much better concordances; probably due to near saturation of points by this species

CANW — CANYON WREN

Abundance and Variation

Abundance: very uncommon spring
Concordance: yes
Annual Changes: none

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +DCA1, -LAFAC2
Significant Geographical Variation: +EAST, +NORTH
Significant Habitat + UTM Variables: +DCA2, -URBDIST, -LAFAC3, +NORTH

Fall: absent

CAQU — CALIFORNIA QUAIL

Abundance and Variation

Abundance: abundant spring, uncommon fall
Concordance: non-concordant spring1995 — spring 1996, fall 1995 — fall 1996
Annual Changes: declined fall 1995 — fall 1996, increased spring 1996 — spring 1997

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +GC_CRYP, -DCA1, -DCA2, -LAFAC3, +LAFAC5
Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +GC_CRYP, -DCA1, -DCA2, -LAFAC3, +LAFAC5, +EAST, +NORTH

Fall: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -DCA2, +ROCK, -LAFAC4

Significant Geographical Variation: +NORTH

Significant Habitat + UTM Variables: H + G model not significant

CATH —CALIFORNIA THRASHER

Abundance and Variation

Abundance: abundant spring, uncommon fall

Concordance: non-concordant fall 1995 —fall 1996

Annual Changes: none

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +PC_TREE, +STFAC1, -DCA1, +EDGEDIST, -LAFAC3

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: +PC_TREE, +STFAC1, -DCA2, -LAFAC3

Fall: Best Habitat Model: Local

Significant Habitat Variables: -DCA1, +DCA2, +EDGEDIST

Significant Geographical Variation: -NORTH

Significant Habitat + UTM Variables: -PC_BNGRS, +EDGEDIST, +ROCK, -EAST, -NORTH

COBU —COMMON BUSHTIT

Abundance and Variation

Abundance: abundant spring, uncommon fall

Concordance: non-concordant spring1995 —spring 1996, fall 1995 —fall 1996

Annual Changes: increased spring 1995 —spring 1996; declined fall 1995 —fall 1996, spring 1996 spring 1997

Habitat Associations

Spring: Best Habitat Model: Local

Significant Habitat Variables: none

Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Landscape

Significant Habitat Variables: -LAFAC1

Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

COHU —COSTA S HUMMINGBIRD

Abundance and Variation

Abundance: abundant spring

Concordance: non-concordant spring 1996 —spring 1997

Annual Changes: declined spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Local

Significant Habitat Variables: +STFAC3, -DCA2

Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

Fall: absent

COYE — COMMON YELLOWTHROAT

Abundance and Variation

Abundance: uncommon spring

Concordance: yes

Annual Changes: increased spring 1995 — spring 1996; declined spring 1996 — spring 1997

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -GC_CRYP, +STFAC1, -DCA1, -URBDIST, -LAFAC1, +LAFAC5

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: H + G model not significant

Fall: absent

HOFI — HOUSE FINCH

Abundance and Variation

Abundance: very abundant spring, common fall

Concordance: yes

Annual Changes: declined fall 1995 — fall 1996; increased spring 1996 — spring 1997

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +DCA1, -URBDIST, -ROCK, -LAFAC2, -LAFAC3, +LAFAC4

Significant Geographical Variation: +NORTH

Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -STFAC1, -URBDIST

Significant Geographical Variation: +EAST

Significant Habitat + UTM Variables: H + G model not significant

LAZB — LAZULI BUNTING

Abundance and Variation

Abundance: common spring

Concordance: yes

Annual Changes: declined spring 1995 — spring 1996

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +PC_TREE, +URBDIST, -LAFAC4
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant
Fall: absent

LEGO —LESSER GOLDFINCH

Abundance and Variation

Abundance: abundant spring, uncommon fall
Concordance: yes
Annual Changes: declined fall 1995 —fall 1996; increased spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Landscape
Significant Habitat Variables: -LAFAC3
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant
Fall: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +GC_CRYP, -STFAC3, -DCA1, +CACTUS, -LAFAC3
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant

MODO —MOURNING DOVE

Abundance and Variation

Abundance: very abundant spring
Concordance: non-concordant spring1995 —spring 1996
Annual Changes: none

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: -STFAC2, +URBDIST, +CACTUS, +LAFAC5
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant
Fall: absent

NOFL —Northern Flicker

Abundance and Variation

Abundance: uncommon spring, common fall
Concordance: non-concordant fall 1995 —fall 1996, spring1995 —spring 1996, spring 1996 —spring 1997
Annual Changes: declined fall 1995 —fall 1996; increased spring1995 —spring 1996, spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Local
Significant Habitat Variables: +PC_BNGRS, -STFAC4, +URBDIST
Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: +PC_BNGRS, +PC_TREE, -STFAC4, -DCA2, +URBDIST, -NORTH

Fall: Best Habitat Model: Local

Significant Habitat Variables: -STFAC1, +DCA2

Significant Geographical Variation: -NORTH

Significant Habitat + UTM Variables: H + G model not significant

NOMO —NORTHERN MOCKINGBIRD

Abundance and Variation

Abundance: common spring, uncommon fall

Concordance: non-concordant fall 1995 —fall 1996

Annual Changes: declined fall 1995 —fall 1996

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -STFAC2, +DCA1, +DCA2, -EDGEDIST, +CACTUS, -LAFAC3, +LAFAC4, +LAFAC5

Significant Geographical Variation: no

Significant Habitat + UTM Variables: -STFAC2, +DCA1, -LAFAC3, +LAFAC4, +LAFAC5, -EAST

Fall: Best Habitat Model: Local

Significant Habitat Variables: +CACTUS

Significant Geographical Variation: -EAST

Significant Habitat + UTM Variables: H + G model not significant

OCWA —ORANGE-CROWNED WARBLER

Abundance and Variation

Abundance: uncommon spring

Concordance: non-concordant spring1995 —spring 1996

Annual Changes: increased spring1995 —spring 1996

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -DCA1, +DCA2, -EDGEDIST, -ROCK, -LAFAC5

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: -EDGEDIST, -ROCK, -LAFAC4, -NORTH

Fall: absent

PHAI —PHAINOPEPLA

Abundance and Variation

Abundance: uncommon spring

Concordance: non-concordant spring 1995 —spring 1996

Annual Changes: decreased spring 1995 —spring 1996

Habitat Associations

Spring: Best Habitat Model: Local

Significant Habitat Variables: +STFAC2, -STFAC4, -DCA1

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: +STFAC2, -STFAC4, -NORTH

Fall: absent

RCKI — RUBY-CROWNED KINGLET

Abundance and Variation

Abundance: very uncommon fall

Concordance: non-concordant fall 1995 — fall 1996

Annual Changes: none

Habitat Associations

Spring: absent

Fall: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +STFAC2, -LAFAC3

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: H + G model not significant

RCSP — RUFOUS-CROWNED SPARROW

Abundance and Variation

Abundance: very abundant spring, very uncommon fall

Concordance: non-concordant fall 1995 — fall 1996

Annual Changes: increased spring 1995 — spring 1996, spring 1996 — spring 1997

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -STFAC1, +LAFAC2

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +LAFAC2, -LAFAC5, +EAST, +NORTH

Fall: Best Habitat Model: Local

Significant Habitat Variables: -EDGEDIST

Significant Geographical Variation: +EAST

Significant Habitat + UTM Variables: H + G model not significant

ROWR — ROCK WREN

Abundance and Variation

Abundance: very uncommon spring, very uncommon fall

Concordance: non-concordant spring 1995 — spring 1996

Annual Changes: declined fall 1995 — fall 1996, spring 1996 — spring 1997

Habitat Associations

Spring: Best Habitat Model: Local

Significant Habitat Variables: +DCA1, -TRAIL

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local

Significant Habitat Variables: +GC_CRYP, -STFAC2, +DCA1, -EDGEDIST

Significant Geographical Variation: +EAST, +NORTH
Significant Habitat + UTM Variables: H + G model not significant

SAGS —SAGE SPARROW

Abundance and Variation

Abundance: common spring, very uncommon fall
Concordance: non-concordant fall 1995 —fall 1996; high concordances in spring
Annual Changes: declined spring 1995 —spring 1996; increased spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: -DCA2, +EDGEDIST, -LAFAC1, -LAFAC2, -LAFAC3
Significant Geographical Variation: +EAST, +NORTH
Significant Habitat + UTM Variables: +EDGEDIST, -LAFAC1, -LAFAC2, -LAFAC3, +EAST, +NORTH

Fall: Best Habitat Model: Landscape
Significant Habitat Variables: -LAFAC1, -LAFAC2, -LAFAC3, +LAFAC4
Significant Geographical Variation: +EAST, +NORTH
Significant Habitat + UTM Variables: H + G model not significant

SCJA —WESTERN SCRUB-JAY

Abundance and Variation

Abundance: common spring, uncommon fall
Concordance: yes
Annual Changes: none

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +URBDIST, +LAFAC2
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: +URBDIST, +LAFAC2, -NORTH

Fall: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +PC_TREE, +LAFAC1
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant

SOSP —SONG SPARROW

Abundance and Variation

Abundance: common spring
Concordance: yes
Annual Changes: none

Habitat Associations

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: -GC_CRYP, +STFAC1, -STFAC3, -DCA1, +DCA2, -LAFAC1, -LAFAC2
Significant Geographical Variation: +EAST
Significant Habitat + UTM Variables: H + G model not significant
Fall: absent

SPTO —SPOTTED TOWHEE

Abundance and Variation

Abundance: very common spring, common fall
Concordance: non-concordant fall 1995 —fall 1996; high concordances in spring
Annual Changes: declined fall 1995 —fall 1996, spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, -STFAC4, -DCA1
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant
Fall: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, +STFAC2, +URBDIST
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant

WCSP —WHITE-CROWNED SPARROW

Abundance and Variation

Abundance: common spring, common fall
Concordance: non-concordant spring1995 —spring 1996
Annual Changes: increased spring1995 —spring 1996, spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Local
Significant Habitat Variables: -STFAC1, -URBDIST, -CACTUS
Significant Geographical Variation: +EAST, +NORTH
Significant Habitat + UTM Variables: -STFAC1, -URBDIST, +EAST
Fall: Best Habitat Model: Landscape (Local + Landscape)
Significant Habitat Variables: -LAFAC2, +LAFAC3, +LAFAC4, +LAFAC5 (+STFAC4, -DCA1, +DCA2, +LAFAC4, +LAFAC5)
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant

Remarks: In fall, landscape habitat model was best statistically, but local + landscape model gave much better concordances

WEME —WESTERN MEADOWLARK

Abundance and Variation

Abundance: common spring, very uncommon fall
Concordance: high concordances in spring
Annual Changes: declined fall 1995 —fall 1996, spring 1996 —spring 1997

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +URBDIST, -LAFAC1, -LAFAC4, +LAFAC5

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +STFAC4, -LAFAC1, +LAFAC2, +EAST, +NORTH

Fall: Best Habitat Model: Local

Significant Habitat Variables: +DCA1, -DCA2, +URBDIST

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +EDGEDIST, +URBDIST, +NORTH

WREN —WRENTIT

Abundance and Variation

Abundance: abundant spring, common fall

Concordance: very high concordances in all seasons

Annual Changes: declined fall 1995 —fall 1996

Habitat Associations

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -DCA1, +DCA2, -ROCK, +LAFAC2, -LAFAC3, +LAFAC4

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: +STFAC1, -DCA2, -EDGEDIST, +URBDIST, -ROCK, +LAFAC1, +LAFAC2, -LAFAC3, +LAFAC4, -EAST, -NORTH

Fall: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -DCA1, +DCA2, +URBDIST, +LAFAC1, +LAFAC4

Significant Geographical Variation: -EAST, -NORTH

Significant Habitat + UTM Variables: +GC_CRYP, +STFAC3, -DCA2, +URBDIST, +LAFAC1, +LAFAC4, +LAFAC5, -NORTH

YRWA —YELLOW-RUMPED WARBLER

Abundance and Variation

Abundance: very uncommon spring, common fall

Concordance: high concordances in fall, non-concordant spring 1996 —spring 1997

Annual Changes: increased spring 1996 —spring 1997 (absent spring 1995)

Habitat Associations

Spring: Best Habitat Model: Local
Significant Habitat Variables: +URBDIST
Significant Geographical Variation: -EAST
Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local + Landscape
Significant Habitat Variables: -DCA1, -ROCK, -LAFAC1, +LAFAC2
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: -STFAC4, -DCA2, -EAST, -NORTH

SMALL MAMMALS

The following summaries are only for those mammal species with sufficient number of detections for analysis (i.e., they occurred on at least 10% of the points surveyed during at least one sampling period). See Table 15 for scientific names of mammal species. Sites in which species occurred are found in Tables 21-24.

Abundances are taken from Table 38, and are classified using the following criteria:

>65% of points = very abundant
65-50% = abundant
50-35% = common
35-20% = uncommon
20-10% = very uncommon

Significant changes in mammal species detections between sampling periods are taken from Table 33. None denotes no statistically significant change. Concordances in presence/absence at a point between sampling periods are taken from Table 35. Yes denotes statistically significant concordance. Concordances >0.500 are denoted as high.

Regression statistics are taken from Table 40 for habitat models (local + landscape variables) and Table 45 for habitat + geography models. All are statistically significant ($P < 0.05$) unless noted otherwise. Only best model (based on the significance of the addition of one set of variables to a model already containing the other) shown. Regression coefficients are taken from Table 42 for habitat models and Table 47 for habitat + geography models. All are statistically significant ($P < 0.05$). Significant geographical variation describes regional distributional trends independent of habitat.

Detailed descriptions of habitat variables appear in Tables 3 and 6 (local structural variables and principal components), Tables 4 and 10 (landscape variables and principal components), and discussion of Figures 4 and 5 (local plant species DCAs). To recapitulate briefly:

Component	Interpretation
STFAC1	shrubland vs. grassland local structure
STFAC2	high litter coverage vs. bare ground
STFAC3	increasing forbs/patchy
STFAC4	increasing disturbed
LAFAC1	chaparral vs. CSS landscape
LAFAC2	increasing native mosaic
LAFAC3	increasing aquatic/riparian
LAFAC4	urban
LAFAC5	increasing ag/exotic
DCA1	CSS vs. chaparral plant species
DCA2	south coastal vs. northern inland plant species

CHFA - SAN DIEGO POCKET MOUSE

Abundance and Variation

Abundance: common

Concordance: non-concordant spring 1995 —spring 1996

Annual Changes: increased fall 1995 —fall 1996

Habitat Associations

All: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -STFAC1, -LAFAC1, -LAFAC2, +LAFAC3, +LAFAC4

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +DCA1, -LAFAC1, -LAFAC2, +LAFAC3, +EAST

Spring: Best Habitat Model: Local

Significant Habitat Variables: -STFAC1

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local + Landscape

Significant Habitat Variables: -GC_CRYP, -LAFAC2, +LAFAC3, +LAFAC4

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: -GC_CRYP, -LAFAC2, +LAFAC3, +LAFAC4, +EAST, +NORTH

DIAG - PACIFIC KANGAROO RAT

Abundance and Variation

Abundance: uncommon

Concordance: yes

Annual Changes: none

Habitat Associations

All: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +GC_CRYP, +EDGEDIST, -LAFAC1, -LAFAC2, -LAFAC3, +LAFAC5

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +GC_CRYP, +EDGEDIST, +TRAIL, -LAFAC1, -LAFAC3, +EAST, +NORTH

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +GC_CRYP, -DCA2, +EDGEDIST, -LAFAC1, -LAFAC2, -LAFAC3, +LAFAC4, +LAFAC5

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +DCA1, +EDGEDIST, +ROCK, -LAFAC3, +LAFAC4, +EAST, +NORTH

Fall: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +GC_CRYP, -PC_BNGRS, -LAFAC2, -LAFAC3, +LAFAC5

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +GC_CRYP, +TRAIL, -LAFAC3, +EAST, +NORTH

NEFU - DUSKY-FOOTED WOODRAT

Abundance and Variation

Abundance: uncommon
Concordance: yes
Annual Changes: none

Habitat Associations

All: Best Habitat Model: Local
Significant Habitat Variables: -PC_BNGRS, +STFAC1, -DCA1, -DCA2, -ROCK, +TRAIL
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: +STFAC1, -DCA2, -EAST, -NORTH

Spring: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +STFAC1, -DCA2, -ROCK, +LAFAC3, +LAFAC4
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: +STFAC1, -DCA2, -LAFAC2, +LAFAC3, +LAFAC4, -EAST, -NORTH

NELE - SAN DIEGO WOODRAT

Abundance and Variation

Abundance: abundant
Concordance: yes
Annual Changes: none

Habitat Associations

All: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +STFAC1, +CACTUS, +ROCK
Significant Geographical Variation: -EAST
Significant Habitat + UTM Variables: -PC_TREE, +STFAC1, -STFAC2, +STFAC4, +DCA2, +CACTUS, +ROCK, -EAST

Spring: Best Habitat Model: Local + Landscape
Significant Habitat Variables: +STFAC1, +STFAC4, +CACTUS, -LAFAC1
Significant Geographical Variation: -EAST
Significant Habitat + UTM Variables: +STFAC4, +DCA2, +ROCK, -EAST

Fall: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, +CACTUS, +ROCK
Significant Geographical Variation: -EAST
Significant Habitat + UTM Variables: +STFAC1, -STFAC2, +CACTUS, +ROCK, -EAST

PECA - CALIFORNIA MOUSE

Abundance and Variation

Abundance: common
Concordance: yes
Annual Changes: none

Habitat Associations

All: Best Habitat Model: Local
Significant Habitat Variables: +GC_CRYP, +STFAC1, +STFAC2, -DCA1, -EDGEDIST, +URBDIST, -ROCK
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant

Spring: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, -DCA1, +URBDIST, -ROCK
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local
Significant Habitat Variables: +GC_CRYP, +STFAC1, +STFAC2, -DCA1, -EDGEDIST, -ROCK, +TRAIL
Significant Geographical Variation: -EAST, -NORTH
Significant Habitat + UTM Variables: H + G model not significant

PEER - CACTUS MOUSE

Abundance and Variation

Abundance: very abundant
Concordance: yes
Annual Changes: decreased spring 1995 —fall 1995; increased spring 1995 —spring 1996

Habitat Associations

All: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, +STFAC3, +URBDIST, +ROCK
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant

Spring: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, +STFAC3, +ROCK
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local
Significant Habitat Variables: +STFAC1, -STFAC2, +URBDIST, +ROCK
Significant Geographical Variation: no
Significant Habitat + UTM Variables: H + G model not significant

PEMA - DEER MOUSE

Abundance and Variation

Abundance: uncommon

Concordance: yes

Annual Changes: declined fall 1995 — fall 1996

Habitat Associations

All: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +EDGEDIST, -LAFAC1, -LAFAC2, +LAFAC5

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +STFAC2, -STFAC3, -URBDIST, -LAFAC1, +EAST, +NORTH

Spring: Best Habitat Model: Local + Landscape

Significant Habitat Variables: +GC_CRYP, -LAFAC1, -LAFAC2, +LAFAC3, +LAFAC5

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: +GC_CRYP, -STFAC3, -LAFAC1, +LAFAC3, +EAST, +NORTH

Fall: Best Habitat Model: Landscape (Local + Landscape)

Significant Habitat Variables: -LAFAC1, -LAFAC2, +LAFAC5 (-LAFAC1, -LAFAC2, +LAFAC5)

Significant Geographical Variation: +EAST, +NORTH

Significant Habitat + UTM Variables: -LAFAC1, +EAST (+STFAC2, -STFAC3, -LAFAC1, +EAST, +NORTH)

Remarks: In fall, landscape habitat model was best statistically, but local + landscape model gave much better concordances

REME - WESTERN HARVEST MOUSE

Abundance and Variation

Abundance: very uncommon

Concordance: non-concordant spring 1995 — spring 1996, fall 1995 — fall 1996

Annual Changes: none

Habitat Associations

All: Best Habitat Model: Local

Significant Habitat Variables: -STFAC1, +STFAC2, +STFAC3, -STFAC4, +EDGEDIST

Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

Spring: Best Habitat Model: Local

Significant Habitat Variables: +STFAC2, -STFAC4

Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

Fall: Best Habitat Model: Local

Significant Habitat Variables: +STFAC2, +STFAC3

Significant Geographical Variation: no

Significant Habitat + UTM Variables: H + G model not significant

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APPENDIX - ADDITIONAL PAPERS RESULTING FROM THIS PROJECT

Is the California Gnatcatcher an indicator of bird-species richness in coastal sage scrub?
Mary K. Chase, John T. Rotenberry, and Michael D. Misenhelter.
Western Birds 29:468-474. 1998.

Biology of the California Gnatcatcher—filling in the gaps.
John T. Rotenberry and Thomas A. Scott.
Western Birds 29:1-8. 1998.

Single species as indicators of species richness and composition in California coastal sage scrub bird and small mammal communities.
Mary K. Chase, William B. Kristan, III, Anthony J. Lynam, Mary V. Price, and John T. Rotenberry.
Conservation Biology. In press.

Living on the edge: evaluating alternative processes producing edge effects in California coastal sage scrub bird and small mammal communities.
William B. Kristan, III, Anthony J. Lynam, Mary V. Price, Kevin Crooks, and John T. Rotenberry.
Ecological Applications. In Preparation.