THE 2001 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM AT THE NATURE RESERVE OF ORANGE COUNTY

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SUMMARY

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) Program, a cooperative effort among public and private agencies and individual bird banders in North America, to operate a continent-wide network of constant-effort mist-netting and banding stations. The purpose of the MAPS program is to provide annual indices of adult population size and post-fledging productivity, as well as estimates of adult survivorship and recruitment into the adult population, for various landbird species. Broad-scale data on productivity and survivorship are not obtained from any other avian monitoring program in North America and are needed to provide crucial information upon which to initiate research and management actions to reverse the recently-documented declines in North American landbird populations. A second objective of the MAPS program is to provide standardized population and demographic data for the landbirds found on federally managed public lands, such as national parks, national forests, military installations, and nature reserves.

We operated ten MAPS stations on The Nature Reserve of Orange County (NROC) in 2001. Six stations were established and operated at the same locations at which they were operated in 2000, and the remaining four were first established in 2001. Two of the six historical stations were first operated in 1998, two of them in 1999, and two of them were established in 1999 but, due to a shortage of volunteers in 1999, first underwent full operation in 2000. With few exceptions, the ten net sites per station were operated for six morning hours per day on one day per 10-day period for ten consecutive 10-day periods between May 3 and August 3. A total of 2150 birds of 53 species were banded at the ten stations during the summer of 2001, various individuals were recaptured a total of 563 times, and 688 birds were captured and released unbanded. Thus, a total of 3401 captures of 62 species was recorded.

Capture data on adult birds at NROC indicate that adult population sizes for all species pooled and for the majority of target species tended to be higher at coastal reserve than central reserve stations, both in 2001 and over the three-year period 1999-2001. In contrast, no consistent pattern of differences in adult population sizes were detected among core, road-edge, and housing-development stations in either reserve. Using 2001 data alone, both the two road-edge stations and the four housing-development stations had adult population sizes for all species pooled that averaged at least as high as those in the four core stations. These indices of adult population size at NROC stations generally compare rather favorably to those found at other MAPS stations across the United States, even those in forested areas.

Productivity indices in 2001, in contrast to adult population sizes, showed relatively small amounts of variation across the ten NROC stations. Indeed, logistic regression analyses of data from the six stations operated in both 2000 and 2001, when controlling for year and local landscape, revealed no significant differences in productivity between coastal and central reserve stations for all species pooled or for 11 of 12 target species. The only significant difference was that Spotted Towhee productivity was significantly greater at central than coastal reserve stations. Analogous logistic regression analyses controlling for year and geographic location, however, revealed that productivity was significantly greater at housing-development stations than at core stations for all species pooled and for both Spotted and California towhees, and nearly significantly greater for House Wren, but significantly less at housing-development stations than at core stations for Orange-crowned Warbler. No significant or even near-significant differences in productivity were detected by logistic regression between road-edge and core stations, although productivity at road-edge stations tended to be higher than at core stations for all species pooled and for eight of 12 target species. Thus, overall, productivity at both the housing-development and road-edge stations tended to be at least as high as that at the core stations. As with indices of adult population size, productivity indices at NROC stations tended to be at least as high as those found at other MAPS stations across the United States.

Adult population sizes at NROC decreased slightly between 2000 and 2001, but the decrease was limited primarily to the coastal reserve. These decreases were likely caused by decreased recruitment of young resulting from the relatively low productivity noted at the coastal stations in 2000. The opposite pattern was seen at the central reserve stations, where increased productivity in 2000 apparently led to increases in adult population sizes in 2001. Productivity followed the opposite pattern and increased slightly between 2000 and 2001, although the increases were again primarily limited to the coastal reserve stations; productivity at two of the central reserve stations decreased in 2001. Four years of data indicate that a regular alternating “productivity/ population” dynamic may be manifest at NROC, but that the cycles at the coastal and central reserve stations are offset by one year. Lower breeding populations and higher productivity tend to occur in odd-numbered years (such as 2001) at the coastal

stations, but the opposite pattern (higher breeding populations and lower productivity) occurs in those years at the central stations. We suggest that this pattern may be caused by a density-dependent effect on productivity along with low productivity of first-time breeders. If this pattern continues, we might expect higher breeding populations with lower reproductive success at the coastal stations in 2002, but lower breeding populations with higher reproductive success at the central stations.

This alternating "productivity/population" dynamic has been shown to be characteristic of MAPS data from regions that appear to lack dramatic interannual differences in weather. Disruptions of this alternating cycle at these other MAPS stations have appeared to be related to unusually favorable or unfavorable weather or to pronounced changes in the environment, such as fire or severe insect defoliation. Perhaps differences between the coastal and central reserves in fire history can explain why their productivity/population dynamics are out of phase. A highly significant negative correlation between productivity and adult population size was also found in 2001 for all species pooled for the five coastal reserve stations, and an analogous significant correlation was found for all ten stations. This provides further evidence for a density-dependent dynamic, at least for the coastal reserve stations. In contrast, however, no such correlation was found between productivity and adult population size in 2001 for all species pooled for the five central reserve stations.

Four-year trends in adult population size were determined from constant-effort changes in indices of adult population size obtained from mist net capture data for all species pooled and for 11 target species. Adult population sizes for all species pooled and for nine of the 11 species showed substantial decreases over the four years, with the declines for Bushtit and California Thrasher being statistically significant. Productivity, on the other hand, has shown a positive trend over the four years, with productivity increasing substantially for two species and showing non-substantial increasing trends for all species pooled and for five additional species. These increases in productivity resulted primarily from a recovery from the low productivity in 1999.
Using nine or ten years of data from other MAPS stations, we have examined relationships between productivity and various global climate cycles. We have found, for example, that productivity in western North America averages higher during El Niño conditions (such as those in 1998) than during La Niña conditions (such as those in 1999). Thus it is likely that the strong La Niña event of 1999 caused productivity to be lower than expected that year at NROC.

With four years of data from two stations, survival estimates were obtained for five species using a time-constant transient model which, by accounting for the effects of transient individuals, produces unbiased estimates of annual adult survival. In general, annual adult survival rate estimates for the five species were at least as high as analogous estimates from MAPS stations at other locations in the United States. The mean precision of survival-rate estimates for four species using four years of data (mean $CV(\varphi) = 26.4\%$) was vastly improved over that obtained last year for those species from three years of data (mean $CV(\varphi) = 50.1\%$). We expect to see substantial improvements in the precision of our survival estimates as additional years (up to about 12 years) of data accumulate from all ten stations. We expect to be able to estimate adult survival rates for as many as 14 target species at NROC once more years of data from all ten stations are available. Moreover, time-dependence in estimates of survivorship, recapture probability, and/or proportion of residents will also be available when at least five years of data have accumulated from six or more stations.

Results of the first four years of the MAPS Program at the NROC thus indicate that important information on the annual indices and estimates, between-year changes, and temporal trends in adult population size, productivity, and survivorship can be obtained for at least 14 key target species at NROC (and possibly for up to 20 species once data from all ten stations have accumulated for 8-10 years). In addition, MAPS data from NROC will provide an invaluable contribution to the determination of precise indices of adult population size and productivity and estimates of survivorship on a region-wide basis for landbirds of Southern California and for all of North America. As more years of MAPS data accumulate at NROC we are confident that we will be able to measure and assess the effects of productivity and survivorship as driving forces of population trends at NROC. In future analyses we also hope to add estimates of juvenal recruitment and indices of juvenile survival in order to fully understand which parameters are most affecting population changes in each target species. As a result, the indices and estimates of primary demographic parameters produced by MAPS will be extremely useful for the management and conservation of landbirds at NROC and, in combination with similar data from other areas, across all of North America. We conclude that the MAPS protocol is extremely well-suited as a component of NROC's long-term ecological monitoring program.

Finally, we have initiated two additional types of broad-scale analyses on longer time series of MAPS data from other locations to help us further understand the population dynamics of landbirds and potential management actions to reverse population declines. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we have been able to identify the proximate demographic causes of population decline for various species at multiple spatial scales. Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area of each station are good predictors not only of the numbers of birds of each species captured but, more importantly, their productivity levels as well. Based on these analyses, threshold values of critical habitat patch size can be determined that will maximize productivity, thereby providing an extremely powerful tool to aid in formulating management actions aimed at reversing landbird population declines. We plan to conduct analogous analyses on data from the NROC when eight or more years of data have accumulated from all ten stations.

Based on all the above information, it is recommended that the MAPS Program continue to be included as an integral part of NROC's long-term ecological monitoring program, and that operation of the ten currently active stations be sustained indefinitely into the future.

INTRODUCTION

The Nature Reserve of Orange County (NROC) is an extensive open space network consisting of relatively intact, coastal sage scrub plant communities. Due to the presence of federally-listed threatened species in this planning area, a Natural Community Conservation Plan (NCCP) and Habitat Conservation Plan have been developed to address Section 10 of the Endangered Species Act. The need for these plans was made apparent by a combination of cumulative impacts on coastal sage scrub resources and the legislative and regulatory responses to those impacts. The federal listing of the Coastal California Gnatcatcher and the potential listing of several additional species that depend upon coastal sage scrub habitat generated a need for a shift from single-species management and project-by-project decisions to conservation planning at the natural community level. The coastal sage scrub NCCP program was developed to address this need, with the goal of designating regional reserves to protect a wide range of species while allowing compatible land uses to occur within the reserves and appropriate growth and economic development outside the reserves.

The NROC Technical Advisory Committee is presently developing a comprehensive monitoring program to document baseline conditions within the Reserve during the initial years of the NCCP program, and to monitor population trends and ecological functions within the Reserve. It is anticipated that these monitoring results will be used to help guide NROC adaptive management activities, and to demonstrate the extent to which the NCCP program is successful in conserving coastal sage scrub habitat values for a variety of native plant and wildlife species.

The development of an effective long-term monitoring program at NROC can be of even wider importance than aiding in the managing of those resources. Studies conducted at NROC, when combined with those on other preserved and non-preserved areas, can provide invaluable information for monitoring natural ecological processes and for evaluating the effects of large-scale, even global, environmental changes. Thus, long-term monitoring data can provide information that is crucial for efforts to preserve natural resources and biodiversity on a continental or even global scale.

Landbirds

Landbirds, because of their high body temperature, rapid metabolism, and high trophic position on most food webs, may be excellent indicators of the effects of local, regional, and global environmental change in terrestrial ecosystems. Furthermore, their abundance and diversity in virtually all terrestrial habitats, diurnal nature, discrete reproductive seasonality, and intermediate longevity facilitate the monitoring of their population and demographic parameters. It is not surprising, therefore, that landbirds have been selected by many agencies to receive high priority for monitoring. Nor is it surprising that several large-scale monitoring programs that provide annual population estimates and long-term population trends for landbirds are already in place on this continent. They include the North American Breeding Bird Survey (BBS), the Breeding Bird Census, the Winter Bird Population Study, and the Christmas Bird Count.

Recent analyses of data from several of these programs, particularly the BBS, suggest that populations of many landbirds, including forest, scrubland, and grassland species, appear to be in serious decline (Peterjohn et al. 1995). Indeed, populations of most landbird species appear to be declining on a global basis. Nearctic-Neotropical migratory landbirds (those that breed in North America and winter in Central and South America and the West Indies; hereafter, Neotropical migratory birds) constitute one group for which pronounced population declines have been documented (Robbins et al. 1989, Terborgh 1989). In response to these declines, the Neotropical Migratory Bird Conservation Program, "Partners in Flight - Aves de las Americas," was initiated in 1991 (Finch and Stangel 1993). The major goal of Partners in Flight (PIF) is to reverse the declines in Neotropical migratory birds through a coordinated program of monitoring, research, management, education, and international cooperation. Recent analyses have also indicated that many resident North American species are also declining; thus, monitoring is needed of all North American landbirds, including both resident and migrant species.

Primary Demographic Parameters
Existing population-trend data on landbirds, while suggesting severe and sometimes accelerating declines, provide no information on primary demographic parameters (productivity and survivorship) of these birds. Thus, population-trend data alone provide no means for determining at what point(s) in the life cycles problems are occurring, or to what extent the observed population trends are being driven by causal factors that affect birth rates, death rates, or both (DeSante 1995). For example, large-scale North American avian monitoring programs that provide only population-trend data have been unable to determine to what extent forest fragmentation and deforestation on the temperate breeding grounds, versus that on the tropical wintering grounds, are causes for declining populations of Neotropical migrants. Without critical data on productivity and survivorship, it will be extremely difficult to identify effective management and conservation actions to reverse current population declines (DeSante 1992).

The ability to monitor primary demographic parameters of target species must also be an important component of any successful long-term inventory and monitoring program that aims to monitor the ecological processes leading from environmental stressors to population responses (DeSante and Rosenberg 1998). This is because environmental factors and management actions affect primary demographic parameters directly and these effects can be observed over a short time period (Temple and Wiens 1989). Because of the buffering effects of floater individuals and density-dependent responses of populations, there may be substantial timelags between changes in primary parameters and resulting changes in population size or density as measured by census or survey methods (DeSante and George 1994). Thus, a population could be in trouble long before this becomes evident from survey data. Moreover, because of the vagility of many animal species, especially birds, local variations in secondary parameters (e.g., population size or density) may be masked by recruitment from a wider region (George et al. 1992) or accentuated by lack of recruitment from a wider area (DeSante 1990). A successful monitoring program should be able to account for these factors.

MAPS
In 1989, The Institute for Bird Populations (IBP) established the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among public agencies, private organizations, and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting and banding stations to provide long-term demographic data on landbirds (DeSante et al. 1995). The design of the MAPS program was patterned after the very successful British Constant Effort Sites (CES) Scheme that has been operated by the British Trust for Ornithology since 1981 (Peach et al. 1996). The MAPS program was endorsed in 1991 by both the Monitoring Working Group of PIF and the USDI Bird Banding Laboratory, and a four-year pilot project (1992-1995) was approved by the USDI Fish and Wildlife Service and National Biological Service (now the Biological Resources Division [BRD] of the U.S. Geological Survey [USGS]) to evaluate its utility and effectiveness for monitoring demographic parameters of landbirds. A peer review of the MAPS program and evaluation of the pilot project were completed by a panel assembled by USGS/BRD, which concluded that: (1) MAPS is technically sound and is based on the best available biological and statistical methods; (2) it complements other landbird monitoring programs such as the BBS by providing useful information on landbird demographics that is not available elsewhere; and (3) it is the most important project in the nongame bird monitoring arena since the creation of the BBS (Geissler 1996).

Now in its thirteenth year (ninth year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to over 500 stations in 2002. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies, including the Department of Defense, Department of the Navy, Texas Army National Guard, National Park Service, USDA Forest Service, and US Fish and Wildlife Service, and private organizations in PIF. Within the past ten years, for example, IBP has been contracted to operate over 150 MAPS stations on federal lands, including stations on seven national forests, five national parks, and 21 military installations, as well as three stations on the Flathead Indian Reservation of the Confederated Salish and Kootenai Tribes and ten stations on the Nature Reserve of Orange County. Furthermore, many private organizations and individual bird banders and ornithologists interested in monitoring the vital rates of avian populations on federal, state, local government, and private lands, such as Audubon sanctuaries and nature preserves, have established and operated several hundred additional MAPS stations.

Goals and Objectives of MAPS

MAPS is organized to fulfill three tiers of goals and objectives: monitoring, research, and management.

The specific monitoring goals of MAPS are to provide, for over 100 target species, including many Neotropical-wintering migrants, temperate-wintering migrants, and permanent residents:

(A) annual indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured; and
(B) annual estimates of adult population size, adult survival rates, proportions of residents, recruitment rates into the adult population, and population growth rates from modified Cormack- Jolly-Seber analyses of mark-recapture data on adult birds.

The specific research goals of MAPS are to identify and describe:

(1) temporal and spatial patterns in these demographic indices and estimates at a variety of spatial scales ranging from the local landscape to the entire continent; and
(2) relationships between these patterns and ecological characteristics of the target species, population trends of the target species, station-specific and landscape-level habitat characteristics, and spatially-explicit weather variables.

The specific management goals of MAPS are to use these patterns and relationships, at the appropriate spatial scales, to:

(a) identify thresholds and trigger points to notify appropriate agencies and organizations of the need for further research and/or management actions;
(b) determine the proximate demographic cause(s) of population change;
(c) suggest management actions and conservation strategies to reverse population declines and maintain stable or increasing populations; and
(d) evaluate the effectiveness of the management actions and conservation strategies actually implemented through an adaptive management framework.

The overall objectives of MAPS are to achieve the above-outlined goals by means of long-term monitoring at two major spatial scales. The first is a very large scale — effectively the entire North American continent divided into eight geographical regions. It is envisioned that major nature preserves, along with national forests, national parks, DoD military installations, and other publicly owned lands and tribal reservations can provide a major subset of sites for this large-scale objective.

The second, smaller-scale but still long-term goal is to fulfill the above-outlined objectives for specific geographical areas (perhaps based on physiographic strata or Bird Conservation Regions) or specific locations (such as individual nature reserves, national forests, national parks, or military installations) to aid research and management efforts within the reserves, forests, parks, or installations to protect and enhance their avifauna and ecological integrity.

The sampling strategy utilized at these smaller scales should be hypothesis-driven and should be integrated with other research and monitoring efforts.

Both long-term goals are in agreement with the NROC's integrated bird monitoring program as established by the NROC Technical Advisory Committee. Accordingly, a preliminary MAPS program was established at NROC in 1998, which was expanded in 1999 and 2000, and again in 2001. It is expected that the MAPS program will be capable of providing integrated data on avian population trends and vital rates, as well as information on the causes of population declines and potential management actions that can be undertaken to reverse the declines. This is some of the basic information that is required to drive the NROC's "adaptive management" program with the overall long-term goal of conserving avian biodiversity within the NROC.

SPECIFICS OF THE NROC MAPS PROGRAM

The NROC's coastal subregional reserve consists of 17,201 acres located primarily in and surrounding the San Joaquin Hills. It extends from the shoreline of Crystal Cove State Park northeast almost 7.5 miles inland, and from Upper Newport Bay southeast approximately 16 miles to the confluence of Oso and Trabuco creeks. The NROC's central subregional reserve comprises approximately 20,177 acres located south and west of the Cleveland National Forest in the foothills and southwestern slopes of the Santa Ana Mountains. From its western boundary at Santiago Oaks Regional Park in the City of Orange, the subarea extends east about 14 miles to El Toro Road. From its northernmost point in the Coal Canyon Preserve, it continues about 7.5 miles southwest to the southern edge of the Lomas de Santiago.

Ten MAPS stations were established and operated in NROC in 2001. Six of these stations were operated in the exact same locations where they were established and operated in 1998, 1999, or 2000, and four stations were newly established in 2001. Two stations (Little Sycamore Canyon and Weir Canyon) have been operated for four years (1998-2001). In 1999 four more stations were established, but due to a shortage of volunteers only two of them (Irvine Park and Upper Laurel Canyon) underwent full operation that year. In 2000 six stations were run, including two stations (Upper Wood Canyon and Upper Weir Canyon) that operated for their first full year. Four new stations (Emerald Canyon, Round Canyon, Sycamore Hills, and Whiting Ranch) were established in 2001. Five stations (Little Sycamore Canyon, Emerald Canyon, Upper Laurel Canyon, Upper Wood Canyon, and Sycamore Hills) are located in the NROC's coastal reserve and five stations (Weir Canyon, Round Canyon, Irvine Park, Upper Weir Canyon, and Whiting Ranch) are located in NROC's central reserve. Within each reserve, two stations are designated as the core stations (Little Sycamore Canyon and Emerald Canyon in the coastal reserve, and Weir Canyon and Round Canyon in the central reserve) and are located within central regions of the reserves; one station is designated as the "road-edge" station (Upper Laurel Canyon in the coastal reserve, and Irvine Park in the central reserve) and is located within 300 m of major transportation corridors; and two stations are designated as the housing stations (Upper Wood Canyon and Sycamore Hills in the coastal reserve, and Upper Weir Canyon and Whiting Ranch in the central reserve) and are located within 300 m of suburbs with houses. All ten stations were established in relatively mature, coastal sage scrub habitat; six of the stations contained scattered large shrubs and coast live oaks, whereas three of the four housing stations (Upper Wood Canyon, Upper Weir Canyon, and Sycamore Hills) and one of the core stations (Emerald Canyon) were in pure scrub or scrub/grassland, lacking oak woodland. A summary of the major habitats represented at each of the ten stations, along with the geographic location (coastal preserve, central preserve), local landscape type (core, road-edge, housing-development), latitude-longitude, and average elevation of the station, is presented in Table 1.

In 2001, the NROC stations were operated by MAPS field biologist interns as assisted by a number of trained volunteers. The 2001 NROC field biologist interns, Anni Bladh, Nick Meyer, Leslie Nelson, and Pauline Ridings, received 11 days of intensive training in a comprehensive course in mist netting and bird-banding techniques given by IBP biologists Julia Camp and Nicole Michel, which took place April 21 - May 2 at Starr Ranch, Trabuco Canyon, Orange County. Julia, Nicole, and the interns began to re-establish the six existing stations and to establish the four new stations during the training session, beginning on April 23. Data collection began on May 2, and all ten stations were established by May 3. Julia Camp then supervised the 2001 interns for the duration of the field work at the NROC.

All ten net sites at each of the six pre-existing stations were re-established without excessive difficulty at the exact same locations as in 2000, and ten net sites were established at each of the four new stations. All of the ten fixed net sites at each station were located within the interior eight ha of each station. On each day of operation, one 12-m long, 30-mm mesh, 4-tier, nylon mist net was erected at each of the ten net sites. These ten nets at each station were operated for six morning hours per day (beginning at local sunrise) on one day during each of ten consecutive 10-day periods between Period 1 (May 1-10) and Period 10 (July 30-August 8). With very few exceptions, the operation of all stations occurred on schedule in each of the ten 10-day periods.
A summary of the operation of the 2001 NROC MAPS Program at each of the ten stations, along with the number of years of operation at each station, is presented in Table 1.

METHODS

The operation of each of the ten stations during 2001 and during each of the preceding years followed MAPS protocol, as established for use by the MAPS Program throughout North America and spelled out in the MAPS Manual (DeSante et al. 2001a). An overview of both the field and analytical techniques is presented here.

Data Collection

With few exceptions, all birds captured during the course of the study were identified to species, age, and sex and, if unbanded, were banded with USGS/BRD numbered aluminum bands. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety would be comprised. Such situations involved exceptionally large numbers of birds being captured at once, or the sudden onset of adverse weather conditions such as high winds or sudden rainfall. The following data were taken on all birds captured, including recaptures, according to MAPS guidelines using standardized codes and forms:

(1) capture code (newly banded, recaptured, band changed, unbanded);
(2) band number;
(3) species;
(4) age and how aged;
(5) sex (if possible) and how sexed (if applicable);
(6) extent of skull pneumaticization;
(7) breeding condition of adults (i.e., presence or absence of a cloacal protuberance or brood patch);
(8) extent of juvenal plumage in young birds;
(9) extent of body and flight-feather molt;
(10) extent of primary-feather wear;
(11) fat class;
(12) wing chord and weight;
(13) date and time of capture (net-run time); and
(14) station and net site where captured.

Effort data, i.e., the number and timing of net-hours on each day (period) of operation, were also collected in a standardized manner. In order to allow constant-effort comparisons of data to be made, the times of opening and closing the array of mist nets and of beginning each net check were recorded to the nearest ten minutes. The breeding (summer residency) status (confirmed breeder, likely breeder, non-breeder) of each species seen, heard, or captured at each MAPS station on each day of operation was recorded using techniques similar to those employed for breeding bird atlas projects.

For each of the ten stations operated, simple habitat maps were prepared on which up to four major habitat types, as well as the locations of all structures, roads, trails, and streams, were identified and delineated; when suitable maps from previous years were available, these were used. The pattern and extent of cover of each major habitat type identified at each station, as well as the pattern and extent of cover of each of four major vertical layers of vegetation (upperstory, midstory, understory, and ground cover) in each major habitat type were classified into one of twelve pattern types and eleven cover categories according to guidelines spelled out in the MAPS Habitat Structure Assessment Protocol, developed by IBP Landscape Ecologist, M. Philip Nott and the IBP staff (Nott, 2001).

Computer Data Entry and Verification

The computer entry of all banding data was completed by John W. Shipman of Zoological Data Processing, Socorro, NM. The critical data for each banding record (capture code, band number, species, age, sex, date, capture time, station, and net number) were proofed by hand against the raw data and any computer-entry errors were corrected. Computer entry of effort and vegetation data was completed by IBP biologists using specially designed data entry programs. All banding data were then run through a series of verification programs as follows:

(1) Clean-up programs to check the validity of all codes entered and the ranges of all numerical data;
(2) Cross-check programs to compare station, date, and net fields from the banding data with those from the summary of mist netting effort data;
(3) Cross-check programs to compare species, age, and sex determinations against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), and extent of body and flight-feather molt, primary-feather wear, and juvenal plumage;
(4) Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species; and
(5) Verification programs to screen banding and recapture data from all years of operation for inconsistent species, age, or sex determinations for each band number.

Any discrepancies or suspicious data identified by any of these programs were examined manually and corrected if necessary. Wing chord, weight, station of capture, date, and any pertinent notes were used as supplementary information for the correct determination of species, age, and sex in all of these verification processes.

Data Analysis

To facilitate analyses, we first classified the landbird species captured in mist nets into five groups based upon their breeding or summer residency status. Each species was classified as one of the following: a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during all years* that the station was operated; a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during more than half but not all of the years* that the station was operated; an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during half or fewer of the years* that the station was operated; a transient (T) if the species was *never* a breeder or summer resident at the station, but the station was within the overall breeding range of the species; and a migrant (M) if the station was not located within the overall breeding range of the species. All data for a given species from a given station were included in year-specific (i.e., 2000 or 2001) or mean population size and productivity analyses for the species (e.g., Tables 3, 4 [in part], and 5-8; Figures 1-15) unless the species was classified as a migrant (M) at the station. For survivorship estimates (Table 9) and population size and productivity trends (Figures 16 and 17), data for a given species from a given station were included only if the species was classified as a regular (B) or usual (U) breeder and summer resident at the station. Thus, data from a station for a species classified as a migrant (M) at the station were included only in year-specific summaries of the total numbers of captures (Tables 2 and 4 [in part]).

A. Population-size and productivity analyses -- The proofed, verified, and corrected banding data from 2001 were run through a series of analysis programs that calculated for each species and for all species pooled at each station and for all stations pooled:

(1) the numbers of newly banded birds, recaptured birds, and birds released unbanded;
(2) the numbers and capture rates (per 600 net-hours) of first captures (in 2001) of individual adult and young birds; and
(3) the proportion of young in the catch.

Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach et al. 1996), the number of adult birds captured was used as an index of adult population size, and the proportion of young in the catch was used as an index of post-fledging productivity.

For each of the six stations that were operated during both the 2000 and 2001 season, we calculated percent changes between 2000 and 2001 in the numbers of adult and young birds captured, and actual changes in post-fledging productivity. These year-to-year comparisons were made in a "constant-effort" manner by means of a specially designed analysis program that used actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by- period basis to exclude captures that occurred in a given net in a given period in one year during the time when that net was not operated in that period in the other year. For species captured at several stations on the Nature Reserve of Orange County, we followed the methods developed by the BTO in their CES scheme (Peach et al. 1996) and inferred the statistical significance of reserve-wide changes in the indices of population size and productivity using confidence intervals derived from the standard errors of the mean percentage (or, for productivity, mean actual) changes. The statistical significance of the overall change at a given station was inferred from a one-sided binomial test on the proportion of species at that station that increased (or decreased). Throughout this report, we use an alpha level of 0.05 for statistical significance. For year-to-year comparisons, however, we use the term “near-significant” or “nearly significant” for differences for which $0.05 \leq P < 0.10$.

B. Logistic regression analyses of productivity -- The use of logistic regression provides an analytical framework for examining productivity in a multivariate manner as a function of year (in multi-year data sets) and various spatial variables, including geographic location, local landscape, and station. Logistic regression, when used in productivity analyses, estimates the probability of an individual bird captured at random being a young bird. The "odds ratio", the term used for the probability value produced by logistic regression, is the odds of a captured individual being a young bird after the variables incorporated into the model (e.g., year, geographic location, local landscape) have been accounted for. Assume, for example, that we are using a logistic regression model for productivity that incorporates the variables year, geographic location, and local landscape, and we have data from two geographic locations. If the odds ratio for the data from one geographic location was 1.2, then the probability of a captured bird at that location being a young bird was 1.2 times as great as the probability of being a young bird at the other location. In other words, one can infer that productivity at the first location is 1.2 as great as the productivity at the second location. Any number of variables can be incorporated into the logistic regression analyses, but here we concentrate on how productivity was affected by year, geographic location, local landscape, and station. We used data in these logistic regression analyses from the six stations that were operated in both 2000 and 2001.

Because geographic location, local landscape, and station are incorporated into the logistic regression model as non-continuous variables, the analysis format requires the designation of a reference station or reference group against which the odds ratios for the other stations or groups are compared. We chose 2001 as the reference year, coastal reserve as the reference geographic location, and core as the reference local landscape (as it has not been disturbed). Little Sycamore Canyon, the core coastal station, was chosen as the reference station.

In addition to providing logistic regression analyses for all species pooled, we attempted these analyses for those species for which the mean proportion of young over the two years was reasonably large, i.e., at least 0.30. Additionally, we required that the species be captured at two or more stations on Nature Reserve of Orange County. Using two years of data (2000 and 2001) from six stations, thirteen species (Bushtit, Bewick’s Wren, Wrentit, House Wren, California Thrasher, Orange-crowned Warbler, Common Yellowthroat, Spotted Towhee, California Towhee, Rufous-crowned Sparrow, Song Sparrow, House Finch, and Lesser Goldfinch) met these requirements.

Data preparation for the logistic regression analyses was completed using data-management programs in dBASE4. The logistic regression analyses themselves were completed using the statistical-analysis package STATA (Stata Corporation 1995). For all species pooled and for each of the thirteen individual species, we ran multivariate logistic regression analyses for productivity on the variables year, geographic location, and local landscape. Because each station has a unique combination of geographic location and local landscape, we could not also include the variable station in these multivariate logistic regression analyses. Rather, for all species pooled and for each of the individual species, we ran multivariate logistic regression analyses for productivity on the variables year and station (i.e., without controlling for geographic location or local landscape) to see if significant differences occurred among stations when controlling for year. Statistical significance in all these multivariate models was determined based on the z-statistic (or Wald Statistic) which equates to the maximum likelihood estimate based on the odds ratio divided by the standard error (Stata Corporation 1995).

C. Analyses of trends in adult population size and productivity -- We examined four-year (1998-2001) trends in indices of adult population size and productivity for target species for which we recorded an average of seven or more individual adult captures per year at the two stations combined that operated over those four years, Little Sycamore Canyon and Weir Canyon. For trends in adult population size, we first calculated adult population indices for each species for each of the four years based on an arbitrary starting index of 1.0 in 1998. Constant-effort changes (as defined above) were used to calculate these "chain" indices in each subsequent year by multiplying the proportional change (percent change divided by 100) between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

$$PSI_{i+1} = PSI_i + PSI_i * (d_i/100)$$

where PSI_i is the population size index for year i and d_i is the percentage change in constant- effort numbers from year i to year i+1. A regression analysis was then run to determine the slope of these indices over the four-years (*PT*). Because the indices for adult population size were based on percentage changes, we further calculated the annual percent change (*APC*), defined as the average change per year over the four-year period, to provide an estimate of the population trend for the species; *APC* was calculated as:

(actual 1998 value of *PSI* / predicted 1998 value of *PSI* based on the regression) * *PT*.

We present *APC*, the standard error of the slope (*SE),* the correlation coefficient (*r),* and the significance of the correlation (*P*) to describe each trend. Again, we use an alpha level of 0.05 for statistical significance. For purposes of discussion, however, we use the terms "nearly significant" or "near-significant" for trends for which $0.05 \leq P < 0.10$. Species for which $r > 0.5$ are considered to have a substantially increasing trend; those for which $r < -0.5$ are considered to have a substantially decreasing trend; those for which $-0.5 \leq r \leq 0.5$ and $SE \leq 0.219$ (for four-year trends) are considered to have a stable trend; and those for which $-0.5 \leq r \leq 0.5$ and $SE > 0.219$ (for ten-year trends) are considered to have widely fluctuating values but no substantial trend.

Trends in Productivity, *PrT*, were calculated in an analogous manner by starting with actual productivity values in 1998 and calculating each successive year's value based on the actual constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r),* and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends, except that productivity trends are considered to be highly fluctuating if the SE of the slope > 0.125 (for four-year productivity trends).

D. Survivorship analyses — Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) were conducted on select target species using four years (1998-2001) of capture histories of adult birds. Target species were those for which, on average, at least seven individual adults per year were recorded from those stations which were operated during each of the four years (Sycamore Canyon and Weir Canyon) and at which the species was a regular (B) or usual (U) breeder. Using the computer program SURVIV (White 1983), we calculated, for each target species, maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability (φ), adult recapture probability (p), and the proportion of residents among newly captured adults (τ) using both a between-year and within-year transient model (Pradel et al. 1997, Nott and DeSante 2002). Because four consecutive years of data are required in order to use the transient models, we were unable to employ them on MAPS data from the Nature Reserve of Orange County prior to this year. The use of the transient model ($\varphi p \tau$) accounts for the existence of transient adults (dispersing and floater individuals which are only captured once) in the sample of newly captured birds, and provides survival estimates that are unbiased with respect to these transient individuals (Pradel et al. 1997). Recapture probability is defined as the conditional probability of recapturing a bird in a subsequent year that was banded in a previous year, given that it survived and returned to the place it was originally banded.

Because we had only four years of data, we used a time-constant transient model for estimating survival and recapture probabilities and the proportion of residents among newly captured adults. We did not consider models that included time-dependence, as four years of data are generally insufficient to provide time-dependent estimates with any reasonable precision. We limited our consideration to models for species that produced estimates for both survival and recapture probability that were neither 0 nor 1 and to models that fit the data. The goodness of fit of the models was tested by using a Pearson's goodness-of-fit test. We calculated the Akaike Information Criterion

($QAIC_C$, which corrects for over-dispersion of data and is used with smaller sample sizes relative to the number of parameters examined) for each species. The $QAIC_C$ was calculated by multiplying the log-likelihood for the given model by -2, adding two times the number of estimable parameters in the model, and providing corrections for overdispersed data and small sample sizes.

RESULTS

A total of 5851.7 net-hours was accumulated at the ten MAPS stations operated in NROC in 2001 (Table 1). Because only six of the ten stations were operated in both years, data from only 3298.0 of these net-hours could be compared directly to 2000 data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

A. 2001 values — The 2001 capture summary of the numbers of newly-banded, unbanded, and recaptured birds is presented for each species and all species pooled at each of the five coastal reserve stations in Table 2a and for each of the five central reserve stations in Table 2b. The greatest number of total captures (430) was recorded at the Sycamore Hills station (in the coastal reserve), while Irvine Park (in the central reserve) produced the smallest number (234). The highest species richness, 40 species, was also recorded at the Sycamore Hills station, while species richness was also lowest at Irvine Park, with 25 species.

The capture rates (per 600 net-hours) of individual adult and young birds and the proportion of young in the catch during 2001 are presented for each species and for all species pooled at each of the coastal reserve (Table 3a) and central reserve (Table 3b) stations. We present capture rates (captures per 600 net-hours) of adults and young in these tables so that the data can be compared among stations which, because of the vagaries of weather and accidental net damage, can differ from one another in effort expended (see Table 1). These capture indices indicate that the total adult population size of all species pooled in 2001 was greatest at Upper Laurel Canyon, followed in descending order by Sycamore Hills, Whiting Ranch, Emerald Canyon, Upper Weir Canyon, Round Canyon, Weir Canyon, Little Sycamore Canyon, Upper Wood Canyon, and Irvine Park. The following is a list of the common breeding species (captured at a rate of at least 6.0 adults per 600 net-hours), in decreasing order, at each station in 2001 (see Table 3):

Coastal Reserve Stations:

Little Sycamore Canyon	Emerald Canyon	Upper Laurel Canyon
Wrentit	Wrentit	California Towhee
Spotted Towhee	Common Yellowthroat	Wrentit
Orange-crowned Warbler	Orange-crowned Warbler	Spotted Towhee
Bushtit	Spotted Towhee	Common Yellowthroat
Ash-throated Flycatcher	California Towhee	Bushtit
Bewick's Wren	Song Sparrow	Ash-throated Flycatcher
	Bushtit	Bullock's Oriole
Upper Wood Canyon		
Wrentit	Sycamore Hills	Sycamore Hills (cont.)
Bushtit	Wrentit	"Western" Flycatcher
Orange-crowned Warbler	Bushtit	Lesser Goldfinch
Spotted Towhee	Bewick's Wren	Yellow Warbler
	Spotted Towhee	

Central Reserve Stations:

Weir Canyon	Round Canyon	Irvine Park
Wrentit	Wrentit	Wrentit
California Towhee	Spotted Towhee	California Towhee
Lesser Goldfinch	Bewick's Wren	Bushtit
Bewick's Wren	Lesser Goldfinch	Spotted Towhee
House Wren	California Towhee	
	Bushtit	

Upper Weir Canyon	Whiting Ranch	Whiting Ranch (cont.)
Wrentit	Wrentit	California Towhee
Bushtit	Lesser Goldfinch	Bushtit
Lesser Goldfinch	Spotted Towhee	Bewick's Wren
House Finch	Song Sparrow	House Finch

Captures rates of young of all species pooled at each station in 2001 followed a different sequence to that of adults, being highest at Upper Weir Canyon, followed by Whiting Ranch, Upper Laurel Canyon, Little Sycamore Canyon, Upper Wood Canyon, Emerald Canyon, Sycamore Hills, Round Canyon, Weir Canyon, and Irvine Park. Due to the between-station variation in capture rates of adults and young, the index of productivity, as determined by the proportion of young in the catch, followed yet a different sequence. Productivity was highest at Upper Wood Canyon (0.56) followed by Little Sycamore Canyon (0.55), Upper Weir Canyon (0.51), Irvine Park (0.49), Whiting Ranch (0.48), Emerald Canyon and Weir Canyon (0.46 each), Upper Laurel Canyon and Round Canyon (0.45 each), and Sycamore Hills (0.42).

Table 4 summarizes the banding results at all ten 2001 NROC MAPS stations combined. Altogether, a total of 3401 birds of 62 species were captured during the 2001 breeding season. Newly-banded birds comprised 63.2% of the total captures. Overall, Wrentit was the most frequently captured, followed by Spotted Towhee, Anna's Hummingbird, Bushtit, Bewick's Wren, California Towhee, Common Yellowthroat, Orange-crowned Warbler, Song Sparrow, Costa's Hummingbird, Lesser Goldfinch, House Wren, and Rufous-crowned Sparrow. The 11 most abundant breeding species at the ten NROC MAPS stations in 2001 (as determined by adults captured per 600 net-hours), in decreasing order, were Wrentit, Bushtit, Spotted Towhee, California Towhee, Lesser Goldfinch, Bewick's Wren, Orange-crowned Warbler, Common Yellowthroat, Ash-throated Flycatcher, House Finch, Song Sparrow, and "Western" Flycatcher.

To see whether a density-dependent limitation on productivity might occur at the Nature Reserve of Orange County, we examined the relationship between productivity and adult population size at the ten MAPS stations operated in 2001. Figure 1 presents a regression of productivity indices (proportion of young in the catch) on indices of adult population size (number of adults captured per 600 net hours) for all species pooled at the ten stations operated on the Nature Reserve of Orange County during 2001. As shown in Figure 1, we found a highly significant negative correlation between productivity and adult population size (r = -0.974, P = 0.005) for the five coastal reserve stations pooled, and a significant negative correlation (r = -0.737, P = 0.015) for all ten stations pooled. We found no relationship, however, between productivity and adult population size (r = -0.068, P = 0.914) for the five central reserve stations pooled.

<u>B. Comparisons between 2000 and 2001</u> — Constant-effort comparisons between 2000 and 2001 were undertaken at six of the ten NROC MAPS stations (those operated during both 2000 and 2001) for numbers of adult birds captured (adult population size; Table 5), numbers of young birds captured (Table 6), and proportion of young in the catch (productivity; Table 7).

Adult population size for all species pooled for all stations combined decreased by a non-significant -4.0% between 2000 and 2001 (Table 5). Decreases were recorded for 20 of 41 species, a proportion not significantly greater than 0.50 (P = 0.622). The overall adult population size for all species pooled decreased at four of the six stations by amounts ranging from -1.9% at Upper Weir Canyon to -23.4% at Upper Laurel Canyon. The proportion of decreasing species was not significantly greater than 0.50 at any of the four stations. Increases in the adult population size for all species pooled were recorded at Irvine Park (+15.5%) and Weir Canyon (+80.4%). The proportion of increasing species was near-significantly (P = 0.095) greater than 0.50 at Weir Canyon. A highly significant decrease in the number of adults captured for all stations combined was recorded for Song Sparrow, and significant or near-significant decreases in the number of adults captured for all stations combined were recorded for Nuttall's Woodpecker, Spotted Towhee, Lazuli Bunting, and Lesser Goldfinch, while no such increases were recorded. The slight decrease in all species pooled and the five individual species that significantly or near-significantly decreased (compared with none that increased), indicates a decreasing tendency in adult populations over the entire reserve. However, as indicated by the decreases in all species pooled at the three coastal stations (as compared with one slight decrease and two increases in all species pooled at the central reserve stations) and the near-significant proportion of increasing species at Weir Canyon, the decrease in adult populations was primarily limited to the coastal reserve.

The number of young birds captured of all species pooled at all six stations combined increased between 2000 and 2001 by a fairly substantial but non-significant +20.8% (Table 6). Increases were recorded for 20 of 37 species, a proportion not significantly greater than 0.50. Captures of young for all species pooled increased at five of the six stations by amounts ranging from +2.7% at Upper Laurel Canyon to +164.3% at Little Sycamore Canyon, although a decrease of -12.6% was recorded at Upper Weir Canyon. The proportion of increasing species was not significantly greater than 0.50 at any of the six stations. A near-significant increase in the number of young captured for all stations combined was recorded for Common Yellowthroat, while significant decreases were recorded for Lazuli Bunting and House Finch, and a highly significant decrease was recorded for Lesser Goldfinch. Unlike the pattern seen in the between-year changes in adult populations, the changes in the number of young birds captured between 2000 and 2001 did not differ much between the coastal and central reserve stations.

With adult populations decreasing and numbers of young increasing, productivity (the proportion of young in the catch) showed a fairly substantial but non-significant increase of +0.057 (+13.1%) from 0.444 in 2000 to 0.502 in 2001 for all species pooled and all stations combined (Table 7). Increases in productivity were noted at four of the six stations, by values ranging from +0.045 at Irvine Park to +0.263 at Little Sycamore Canyon, while decreases were noted at Upper Weir Canyon (-0.029) and Weir Canyon (-0.073). The proportion of species with increasing productivity was not significantly greater than 0.50 at any of the six stations. Two species (Nuttall's Woodpecker and Bullock's Oriole) showed highly significant increases in productivity across all stations and four species (Hutton's Vireo, Orange-crowned Warbler, Song Sparrow, and Blue Grosbeak) showed significant or near-significant increases in productivity, while only one species (Ash-throated Flycatcher) showed even a near-significant decrease in productivity. In general, increases in productivity were greatest at the coastal reserve stations where the largest decreases in adult populations occurred.

C. Three-year mean population size and productivity values — Mean numbers of individual adults (an index of adult population size) and young captured per 600 net-hours, and proportion of young in the catch (an index of productivity), averaged over the three-year period 1999-2001, are presented in Table 8 for the four stations that operated for each of those four years. Examination of all-species-pooled values suggests that adult population sizes were substantially higher at the two coastal reserve stations (Little Sycamore Canyon and Upper Laurel Canyon; mean 153.3 adults captured) than at the two central reserve stations (Weir Canyon and Irvine Park; mean 104.6 adults captured). Additionally, adult population sizes tended to be somewhat higher at road-edge (Upper Laurel Canyon and Irvine Park; mean 141.3 adults captured) stations than at core (Little Sycamore Canyon and Weir Canyon; mean 127.9 adults captured) stations. The mean number of young birds captured followed the same pattern as adults, with mean captures at the coastal reserve stations (mean 75.2) tending to be higher than at the central reserve stations (mean 55.9). Similarly, road-edge stations tended to have higher mean captures of young birds (mean 71.7) than core stations (mean 59.4). Although the mean numbers of both adult and young birds were higher at the coastal reserve, productivity (the proportion of young in the catch) was slightly higher at the central reserve stations (mean 0.355 versus 0.325 at the coastal stations). This was due to the larger difference in mean captures of adults between the coastal and central stations than in mean captures of young birds. Mean productivity values were identical at the core and road-edge stations (mean 0.34).

Substantial differences in adult population size between coastal and central reserve stations were noted for several individual species as well. Among the eleven target species, seven species had larger adult population sizes at the coastal reserve stations: "Western" Flycatcher (coastal mean 8.3, central mean 6.6), Ash-throated Flycatcher (coastal mean 5.4, central mean 2.9), Bushtit (coastal mean 13.7, central mean 10.0), California Thrasher (coastal mean 4.0, central mean 2.0), Orange-crowned Warbler (coastal mean 7.5, central mean 1.6), Spotted Towhee (coastal mean 22.2, central mean 9.4), and Lesser Goldfinch (coastal mean 8.2, central mean 5.6). Two species had larger adult population sizes at the central reserve stations, House Wren (coastal mean 1.4, central mean 4.2) and Wrentit (coastal mean 16.6, central mean 23.3), while adult population sizes of Bewick's Wren (coastal mean 5.7, central mean 6.1) and California Towhee (coastal mean 15.5, central mean 15.8) did not differ much between coastal and central reserve stations. Of the six additional species that were present at all four stations, two species (Yellow Warbler and Common Yellowthroat) had larger adult population sizes at both the coastal reserve stations than at the central reserve stations, while two species (Bullock's Oriole, and House Finch) had larger adult populations at only one of the coastal reserve stations. One species, (Nuttall's Woodpecker) had larger adult population sizes at the two central reserve stations, and one species (Rufous-crowned Sparrow) had larger adult populations at only one of the central reserve stations.

D. Logistic Regression Analyses of Productivity — The odds ratios for productivity indices for all species pooled are presented in Figure 2, and the odds ratios are presented for 13 individual species, in phylogenetic order, in Figures 3-15. For all species pooled, productivity in 2000 was highly significantly lower ($P = 0.001$) than in 2001 when controlling for geographic location and local landscape. Productivity was lower in 2000 than 2001 for eight individual species (Bewick's Wren, House Wren, California Thrasher, Orange-crowned Warbler, Common Yellowthroat, Spotted Towhee, California Towhee, and Song Sparrow), with highly significant differences for three species (House Wren, Orange-crowned Warbler, Common Yellowthroat), and a significant difference for Song Sparrow. The remaining five species (Bushtit, Wrentit, Rufous-crowned Sparrow, House Finch, and Lesser Goldfinch) showed higher productivity in 2000 than in 2001, with no significant or near-significant differences.

Productivity tended to be higher in the central reserve than in the coastal reserve for all species pooled when controlling for year and local landscape, although the difference in productivity was not significant. Productivity for five species (Bushtit, House Wren, Spotted Towhee, California Towhee, and House Finch) tended to be higher in the central reserve than the coastal reserve with one species, Spotted Towhee, having highly significantly greater productivity in the central reserve than in the coastal reserve ($P = 0.000$). There was no difference in productivity between the central and coastal reserves for two species (California Thrasher and Common Yellowthroat). Five species (Bewick's Wren, Wrentit, Rufous-crowned Sparrow, Song Sparrow, and Lesser Goldfinch) tended to have somewhat lower productivity in the central reserve than in the coastal reserve, although no species showed significantly lower productivity in the central reserve. No probabilities were calculated for Orange-crowned Warblers as both of the stations included in the analysis for this species were located in the coastal reserve.

When controlling for year and geographic location, productivity for all species pooled was significantly higher (P=0.015) at stations bordering a housing development than at core stations. Productivity for all species pooled tended to be slightly, but not significantly, higher at road-edge than at core stations. Eight individual species (Bushtit, Bewick's Wren, Wrentit, House Wren, Spotted Towhee, California Towhee, House Finch, and Lesser Goldfinch) tended to have higher productivity at housing-development stations than at core stations, with a highly significant difference ($P = 0.008$) for Spotted Towhee, a significant difference ($P = 0.014$) for California Towhee, and a near-significant difference ($P = 0.056$) for House Wren. Productivity tended to be lower at housing-development stations than at core stations for four species (California Thrasher, Orange-crowned Warbler, Common Yellowthroat, Rufous-crowned Sparrow, and Song Sparrow); productivity for Orange-crowned Warbler was highly significantly lower at housing-development stations than at core stations ($P = 0.001$). Productivity at road-edge stations tended to be higher than at core stations for seven species (Bushtit, House Wren, California Thrasher, Common Yellowthroat, Spotted Towhee, Rufous-crowned Sparrow, and House Finch), with no significant differences for any species. Four species (Bewick's Wren, Wrentit, Song Sparrow, and Lesser Goldfinch) tended to have lower productivity at road-edge stations than at core stations, again with no significant differences. No probabilities were calculated for Orange-crowned Warblers as the species did not occur at any road-side station.

Figure 2 shows that productivity for all species pooled varied substantially among stations when controlling for year. Productivity for all species pooled was lowest at the reference station, Little Sycamore Canyon, and was significantly higher at Upper Wood Canyon ($P = 0.017$) and Upper Weir Canyon ($P = 0.014$) than at the reference station. Among individual species, productivity also varied substantially among stations when controlling for year. For Bushtit, productivity was significantly higher at Upper Laurel Canyon ($P = 0.015$), Upper Wood Canyon ($P = 0.035$), Weir Canyon ($P = 0.020$), and Upper Weir Canyon ($P = 0.046$), and slightly higher at Irvine Park, than at the reference station, Little Sycamore Canyon. Spotted Towhee productivity was highly significantly greater at Weir Canyon and Upper Weir Canyon (each $P = 0.000$), Upper Wood Canyon ($P = 0.004$), and Irvine Park ($P = 0.008$), and near-significantly greater at Upper Laurel Canyon ($P = 0.067$), than at the reference station, Little Sycamore Canyon. California Towhee had highly significantly greater productivity at Upper Weir Canyon ($P = 0.001$) and near-significantly greater productivity at Weir Canyon ($P = 0.061$) than at the reference station. Productivity for House Finch was near-significantly greater at Upper Wood Canyon ($P = 0.055$) and Weir Canyon ($P = 0.079$) than at the reference station. Productivity was significantly higher at the reference station, Little Sycamore Canyon, for only two species-station combinations, Orange-crowned Warbler at Upper Wood Canyon ($P = 0.001$) and Lesser

Goldfinch at Irvine Park (P = 0.000), and was near-significantly higher at the reference station than at Irvine Park for Bewick's Wren (P = 098) and than at Upper Laurel Canyon for Wrentit (P = 0.070).

E. Four-year trends in adult population size-- "Chain" indices of adult population size are presented in Figure 16 for 11 target species (those with an average of at least seven individual adults captured per year) and for all species pooled at the two stations operated for four years, Little Sycamore Canyon and Weir Canyon. See Methods for an explanation of the calculations used to obtain the indices. We used the slope of the regression line for each species to calculate the Annual Percentage Change (*APC*) for the population. *APC* along with the standard error of the slope (SE), the correlation coefficient (*r)*, and the significance of the correlation (P) for each target species and all species pooled are included in Figure 1.

Population trends for nine species ("Western" Flycatcher, Ash-throated Flycatcher, Bushtit, Bewick's Wren, House Wren, Wrentit, California Thrasher, Spotted Towhee, and California Towhee) and all species pooled showed substantial decreases ($r < -0.5$) over the four years 1998-2001. Of these, California Thrasher showed a highly significant decline, and Bushtit showed a significant decline. The remaining two species, Orange-crowned Warbler and Lesser Goldfinch, showed stable populations but no definite trend (absolute $r < 0.5$, $SE \leq 0.219$). Overall, as indicated by *APC* values, population trends for ten species and all species pooled were negative, whereas only one species (Orange-crowned Warbler) showed a slightly positive trend. The annual percentage change (*APC*) in population between 1998 and 2001 varied from -21.6% for California Thrasher to +1.0% for Orange-Crowned Warbler, and was -10.9% for all species pooled.

In contrast to generally declining trends in numbers of adult birds, Figure 17 indicates generally stable to increasing trends in productivity during the four-year period 1998-2001. Trends for three species (Ash-throated Flycatcher, Bushtit and Bewick's Wren) and all species pooled were fairly stable, with absolute $r < 0.5$ and $SE \leq 0.125$ in all cases. Productivity trends for four additional species (House Wren, Wrentit, Spotted Towhee, and California Towhee) showed erratic fluctuations, but no definite trend (absolute $r < 0.5$ and $SE > 0.125$). Productivity trends for two species (California Thrasher and Orange-crowned Warbler) showed substantial increases ($r > 0.5$), with that of California Thrasher being nearly significant, while productivity trends for the remaining two species, "Western" Flycatcher and Lesser Goldfinch, showed substantial ($r <$
-0.5), but non-significant, declines. The annual change in the index of productivity (*PrT*) between 1998 and 2001 varied between -0.072 for Lesser Goldfinch to +0.161 for Orange-crowned Warbler, and was +0.048 for all species pooled. Overall, as indicated by *PrT* values, productivity trends for seven species and all species pooled were positive, where as trends for four species were negative.

Estimates of Adult Survivorship

Using four years of data (1998-2001) from the two long-running stations (Little Sycamore Canyon and Weir Canyon), estimates of adult survival and recapture probabilities could be obtained for five of the 11 target species breeding at NROC. Maximum-likelihood estimates of annual adult survival probability, recapture probability, and proportion of residents among newly captured adults from the time-constant transient model are presented in Table 9 for each of the five species. Annual adult survival-rate estimates ranged from a low of 0.405 for Bushtit to a high of 0.660 for California Towhee, with a mean of 0.538 for the five species. Estimates of recapture probability for the five species varied from 0.203 for Spotted Towhee to 0.697 for Bewick's Wren, with a mean of 0.379. Estimates of the proportion of residents among newly captured adults ranged from 0.571 for Wrentit to 1.000 for Bushtit and Spotted Towhee, with a mean of 0.780. Based on data from other MAPS stations in California, these survival-rate estimates from NROC appear to be at least as high, if not higher, than those from other locations, particularly for Bushtit. These initial estimates, therefore, suggest that adult survival rates at NROC are generally quite good. The mean coefficient of variation of the annual adult survival-rate estimate, CV(φ), for the five species was 29.3%. Survival rate estimates were also obtained from three years (1998-2000) of data for four of these five species (all but Bushtit). The mean CV(φ) for those four species from four years of data (26.4%) was much less than the mean CV(φ) for those four species from three years of data (50.1%), indicating a very pronounced improvement in precision as a result of the additional year of data.

DISCUSSION OF RESULTS

It should be noted at the onset that the staggered starting years for the various MAPS stations on the NROC (two started in 1998, two more in 1999, two more in 2000, and four more in 2001) add a confounding influence to the data and make it difficult to separate temporal and spatial differences in adult population size and productivity. This difficulty will, of course, become lessened as more years of data from all ten stations accumulate.

In general, capture data from the four stations that were operated for three consecutive years (1999-2001) suggests that adult population sizes for all species pooled and for seven of 11 target species tended to be higher at the two coastal reserve stations (Little Sycamore Canyon and Upper Laurel Canyon) than at the two central reserve stations (Weir Canyon and Irvine Park). House Wren and Wrentit were the only target species for which adult populations tended to be substantially higher at the two central reserve stations. Capture data during 2001 at all ten NROC stations showed the same general pattern, with capture rates for all species pooled averaging slightly higher at the five coastal reserve stations (117.3 adults per 600 net hours) than at the five central reserve stations (109.0 adults per 600 net hours), and seven of 11 target species tending to have higher adult populations at coastal reserve stations. Bewick's and House wrens and Lesser Goldfinch were the only target species for which adult populations tended to be substantially higher at the five central reserve stations.

No consistent patterns of difference in adult population sizes were noted among core, road-edge, and housing-development stations in the two reserves. Using three years of data from four stations, the coastal reserve road-edge station (Upper Laurel Canyon) had a much higher adult population size for all species pooled than the coastal reserve core station (Little Sycamore Canyon), but the adult population size for all species pooled at the central reserve road-edge station (Irvine Park) was similar to that at the central reserve core station (Weir Canyon). Using 2001 data only, the coastal reserve road-edge station (Upper Laurel Canyon) again had a higher adult population size for all species pooled than either of the coastal reserve core stations, but the central reserve road-edge station (Irvine Park) had a lower adult population size for all species pooled than either of the central reserve core stations. In the coastal reserve, one housing-development station (Sycamore Hills) had higher adult population sizes than either core station, while the other housing-development station (Upper Wood Canyon) had lower adult population sizes than either core station. In the central reserve, both housing-development stations (Upper Weir Canyon and Whiting Ranch) had higher adult population sizes than either the core station.
Despite the inconsistencies in these results, it is clear that, on average, both the two road-edge stations (mean adult population size for all species pooled 113.0 birds per 600 net hours) and the four housing-development stations (mean 117.5) had adult population sizes at least as high as the four core stations (mean 108.9).

It should also be noted that the adult population sizes for all species pooled recorded on NROC stations compare rather favorably to those found at other MAPS stations elsewhere in North America. For example, adult population sizes for all species pooled at the ten NROC stations in 2001 (113.2 birds per 600 net hours) compares to 140.9 birds per 600 net hours at 36 stations on six national forest in Oregon and Washington, 120.8 at eight stations on the Flathead National Forest and Flathead Indian Reservation in Montana, 122.8 at six stations in Denali National Park in Alaska, and 100.4 at six stations in Shenandoah National Park in Virginia.

Productivity in 2001, in contrast to adult population sizes, showed relatively small amounts of variation across the ten NROC stations. Nevertheless, productivity at two of the coastal reserve stations, Upper Wood Canyon and Little Sycamore Canyon, 0.56 and 0.55, respectively, was notably higher than at the other three coastal reserve stations where it varied between 0.42 and 0.46. In contrast, productivity was more constant at the five central reserve stations, where it varied between 0.45 and 0.51. Similarly, mean productivity over the four stations operated for three years (1999-2001) varied only between 0.32 and 0.36. The three-year mean productivity indices were much lower than those in 2001 because of the very low productivity recorded in 1999. Despite the low values in 1999, mean productivity indices at NROC were quite high compared to other locations at similar latitudes.

Logistic regression analyses on data from the six stations operated during both 2000 and 2001 revealed no significant differences in productivity between coastal and central reserve stations when controlling for year and local landscape for all species pooled and for 11 of 12 species, although productivity did tend to be higher on central than coastal reserve stations for all species pooled. Spotted Towhee was the only species that showed a significant difference between productivity on the central and coastal reserves when controlling for year and local landscape;

productivity was highly significantly greater on central than coastal reserve stations.

Logistic regression analyses on data from the same six stations, however, revealed that productivity, when controlled for year and geographic location, was significantly greater at housing-development stations than at core stations for all species pooled and for both Spotted and California towhees, and nearly significantly greater for House Wren. In contrast, Orange-crowned Warbler showed highly significantly lower productivity at the one housing-development station at which it was found than at the one core station at which it was found. Analogous logistic regression analyses revealed no significant or even near-significant differences between productivity at road-edge and core stations either for all species pooled or for any individual species. However, productivity at road-edge stations did tend to be higher than at core stations for all species pooled and for eight of 12 individual species. Thus, overall, it is clear that productivity at both the housing-development and road-edge stations was at least as high as at the core stations during 2000 and 2001.

It should also be noted that the productivity indices for all species pooled recorded on NROC stations in 2001 were generally higher than those found at other MAPS stations elsewhere in North America, especially at such low latitudes. For example, the productivity index (proportion of young in the catch) of 0.48 for all species pooled at the ten NROC stations in 2001 compares to 0.30 at 36 stations on six national forest in Oregon and Washington, 0.35 at eight stations on the Flathead National Forest and Flathead Indian Reservation in Montana, 0.59 at six stations in Denali National Park in Alaska, and 0.39 at six stations in Shenandoah National Park in Virginia.
It should be emphasized that all of the results discussed above are based on data from, at most, only three years of operation of a variable number of stations. Data from other longer-running groups of MAPS stations indicate that variation among stations in adult population size and productivity can itself vary substantially from year to year, apparently due to habitat-specific effects of local weather on food, water, or cover resources. Thus, more years of data from all ten of the NROC MAPS stations will be needed to confirm these initial findings.

Despite this variation among stations, landbird population dynamics at NROC appeared to have shown some generally station-wide and even rather species-wide patterns. Adult breeding populations decreased slightly between 1998 and 1999 (as based on only two stations), decreased significantly between 1999 and 2000 (as based on four stations), and decreased slightly again between 2000 and 2001 (as based on six stations). Interestingly, the decrease between 1999 and 2000 was most substantial at the central reserve stations (Weir Canyon and Irvine Park), while the decrease between 2000 and 2001 was limited primarily to the coastal stations, and increases were noted at two central reserve stations (Weir Canyon and Irvine Park). In contrast, productivity generally followed the opposite pattern and declined substantially between 1998 and 1999, increased substantially and significantly between 1999 and 2000, and increased slightly between 2000 and 2001. Analogous (but opposite) to the trend in adult populations, the increase in productivity between 1999 and 2000 was most substantial at the two central reserve stations (Weir Canyon and Irvine Park), while the increase between 2000 and 2001 was primarily limited to the coastal stations, and decreases were noted at two central reserve stations (Weir Canyon and Upper Weir Canyon).

This alternating, two-year population dynamic has been noted at other MAPS stations, and we believe it relates to density-dependent effects on productivity and recruitment along with lower productivity of first-time breeders. Thus, the low productivity in 1999, particularly at the central reserve stations, led to the significantly decreased adult population sizes in 2000, particularly at the central reserve stations. We suggest that these low population sizes in 2000, which were presumably comprised of a low proportion of inexperienced first-time breeders, were subjected to relatively little intra- and inter-specific competition in 2000 and, as a result, had good reproductive success. Similarly, we suggest that this increased productivity in 2000, particularly at the central stations, and the subsequent increase in recruitment of first-year birds in 2001 was likely a primary factor leading to the increase in adult populations noted at the central stations in 2001, and helped to counteract the declines in adult populations seen at the coastal reserve. The higher adult breeding populations at the central reserve in 2001, which were likely comprised of a high proportion of inexperienced breeders and which probably suffered from higher levels of both intra- and inter-specific competition, in turn, showed relatively low reproductive success. The opposite pattern was seen at the coastal reserve, where the relatively low productivity in 2000 led to a low proportion of inexperienced breeders in 2001, which in turn led to a generally higher reproductive success in 2001 than seen at the central reserve stations. If this pattern continues, we might expect to see higher breeding populations with lower reproductive success at the coastal stations, and smaller breeding populations with higher reproductive success at the central stations, in 2002.

Results of a regression of productivity on adult population size for all species pooled at each of the ten stations in 2001 confirm that a density-dependent dynamic in breeding success may be operating at the NROC, at least at coastal reserve stations. A highly significant negative correlation between productivity and adult population size was found for the five coastal reserve stations, which drove an analogous significant negative correlation for all ten stations considered together, but no relationship was found between productivity and adult population size for the central reserve stations.

We have found the alternating "productivity/population" dynamic described above at other groups of MAPS stations, especially those in geographic areas that appear to lack dramatic interannual changes in weather (e.g., extreme droughts or excessive snowpack accumulations). Disruptions of this alternating cycle at these other MAPS stations have generally appeared to be related to unusually favorable or unfavorable weather or to pronounced changes in the environment (perhaps caused by fire or severe insect defoliation). We do not understand why the coastal and central reserve stations at NROC appear to be on different productivity/population cycles, or why productivity at the two reserves appears to respond differently to population density, except to note that each reserve has recently been greatly effected by fire but in different years. The Santiago Canyon Fire burned 38% of the central reserve in 1998 while the Laguna Breach Fire burned 75% of the coastal reserve in 1993 (R. Hamilton, pers. comm.).

The overall trends in bird populations at the Nature Reserve of Orange County over the past four years, as indicated by data from the two MAPS stations, Little Sycamore Canyon and Weir Canyon, operated for each of those years, have been negative. Indeed, adult population sizes for all species pooled, as well as for nine of 11 target species, have decreased substantially from 1998 to 2001, with the declines for Bushtit and California Thrasher being significant and highly significant, respectively. Adult populations of the remaining two species were essentially stable, with Lesser Goldfinch showing a slight declining tendency and Orange-crowned Warbler showing a slight increasing tendency. In contrast, over the past four years, productivity for two species (California Thrasher and Orange-crowed Warbler) showed substantial increases, with that for the thrasher being nearly significant; productivity for all species pooled and for five other target species showed non-substantial increases; and productivity for only four species showed decreases, with two species ("Western" Flycatcher and Lesser Goldfinch) showing substantial, but non-significant, decreases and two species showing non-substantial decreases.

Using nine or ten years of data from other MAPS stations, (Nott et al. 2002), we have been able to examine relationships between global climate cycles (such as the El Niño/Southern Oscillation and the North Atlantic Oscillation) and productivity and have found significant correlations. In particular, we have found that productivity in the Pacific Northwest and most other locations in western and southern United States is strongly related to the mean monthly El Niño/Southern Oscillation Precipitation Index (ESPI; a measure of the effects of El Niños and La Niñas) in such a manner that productivity averages higher during El Niño conditions (such as those in 1998) than during La Niña conditions (such as those in 1999). Thus it is likely that the La Niña event of 1999, resulting in one of the lowest ESPI values during the past decade, caused productivity to be very low that year at NROC. Indeed, most of the increases in productivity recorded at NROC during the past four years have resulted from the recovery from the low productivity in 1999. Once more years of data have accumulated at NROC we will be able to better understand avian population dynamics on NROC and in the Southern California region generally and their relationship to global climate cycles.

With four years of data (1998-2001) from two stations, survival estimates were obtained for five species using modified (CJS) mark-recapture models. The fourth year of data also enabled us to use a transient model, which produces an unbiased (with respect to transients) estimate of adult survivorship. In general, annual adult survival rate estimates for the five species were at least as high, if not higher, than analogous estimates from MAPS stations at other locations in the United States. The mean precision of survival-rate estimates for four species using four years of data (mean CV(φ) = 26.4%) was vastly improved over that obtained last year from three years of data (mean CV(φ) = 50.1%) for those four species (survival-rate estimates were not obtained last year for Bushtit). We have noted substantial improvements in precision with each additional year of data (so far, up to ten years) at other MAPS stations. These predictions are in agreement with simulations of MAPS data completed by Dan Rosenberg as part of his evaluation of the statistical properties of the MAPS Program (Rosenberg et al. 1996, 1999). We expect to be able to estimate adult survival rates for as many as 14 target species at NROC once more years of data from all ten stations are available. Time-dependence in estimates of survivorship, recapture probability, and/or proportion of residents will also be available when at least five years of data have accumulated from six or more stations.

We must emphasize that the population trend, productivity trend, and survival rate results presented here are based on only four years of data from two stations. Thus, the short-term patterns identified may not be representative of the true long-term, large-scale population dynamics. Moreover, the indices and estimates of primary demographic parameters presented here have relatively low precision and statistical power because of the limited number of years and small number of stations. This, of course, will improve dramatically as more years of data accumulate from all ten stations now being operated on the NROC.

Previous extensive analyses conducted on 1992-1996 data (DeSante et al. 1997) indicated that the indices and estimates of primary demographic parameters (productivity and survivorship) of common landbird species produced by the MAPS Programs could adequately predict the relative short-term population trends of those species (DeSante et al. 1999). In addition, late-summer mist netting has been shown to provide accurate indices of region-wide productivity in targeted endangered species suggesting that "mist-netting programs like MAPS and the Constant Effort Sites used in Britain can provide useful measures of temporal patterns, large-scale spatial patterns, and year-specific patterns in avian productivity" (Bart et al. 1999). As a result, the indices and estimates of primary demographic parameters produced by MAPS are proving to be extremely useful for the management and conservation of landbirds at specific locations and, in combination with similar data from other areas, across all of North America. We conclude that the MAPS protocol is very well-suited to provide one component of NROC's long-term ecological monitoring efforts, and can provide critical data to aid in resolving problems associated with declining landbird populations in Southern California.

Finally, in addition to the analyses involving climate cycles, we have initiated two broad-scale analyses to help us further understand the population dynamics of landbirds and to allow us to identify potential management actions to reverse population declines and maintain stable or increasing populations. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we are beginning to determine the proximate demographic causes of population trends for species at multiple spatial scales (DeSante et al. 2001b). Among Gray Catbird populations, for example, we found that adult survival-rate estimates varied appropriately between areas of increasing vs. decreasing population trends while productivity indices were independent of area, suggesting that low survivorship was driving the declining population in this species. Second, by modeling vital rates as a function of landscape-level habitat characteristics, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area of each station are good predictors not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well (Nott 2000). That study revealed the existence of threshold values of critical habitat patch size above which productivity levels could be maximized, thus providing an extremely powerful tool to identify and formulate management actions aimed at increasing landbird populations. With additional funding from a variety of sources, we hope to undertaking such analyses with data from NROC as well as with data from all 500 stations that are now being operated across North America. We also hope to include estimates of juvenile recruitment and first-year survival in future analyses in order to fully understand what parameters are most affecting population changes in each target species. We are excited by the prospect of conducting these analyses on data from NROC in upcoming years.

CONCLUSIONS AND RECOMMENDATIONS

(1) Capture data on adult birds generally indicate that adult population sizes for all species pooled and for the majority of target species tended to be higher at stations in NROC's coastal reserve than at stations in NROC's central reserve, both in 2001 and over the three-year period 1999-2001. In contrast, no consistent pattern of differences in adult population sizes were detected among core, road-edge, and housing-development stations in either reserve. Using 2001 data alone, both the two road-edge stations and the four housing-development stations had adult population sizes for all species pooled that averaged at least as high as those in the four core stations. These adult population size indices from NROC stations in 2001 generally compare rather favorably with analogous measures from other MAPS stations across North America.

(2) Productivity indices in 2001, in contrast to adult population sizes, showed relatively small amounts of variation

across the ten NROC stations. Indeed, logistic regression analyses of data from the six stations operated in both 2000 and 2001 revealed no significant differences in productivity between coastal and central reserve stations when controlling for year and local landscape for all species pooled or for 11 of 12 target species. The only significant difference was for Spotted Towhee for which productivity was significantly greater at central than coastal reserve stations.

(3) Analogous logistic regression analyses controlling for year and geographic location, however, revealed that productivity was significantly greater at housing-development stations than at core stations for all species pooled and for both Spotted and California towhees, and nearly significantly greater for House Wren, but significantly less at housing-development stations than at core stations for Orange-crowned Warbler. No significant or even near-significant differences in productivity were detected by logistic regression between road-edge and core stations, although productivity at road-edge stations tended to be higher than at core stations for all species pooled and for eight of 12 target species. Thus, overall, productivity at both the housing-development and road-edge stations tended to be at least as high as that at the core stations.

(4) Adult population sizes at NROC decreased slightly between 2000 and 2001, but the decrease was limited primarily to the coastal reserve. These decreases are likely attributable to decreased recruitment of young resulting from the relatively low productivity noted at the coastal stations in 2000. The opposite pattern was seen at the central reserve stations, where increased productivity in 2000 apparently led to increases in adult population sizes in 2001. Productivity followed the opposite pattern and increased slightly between 2000 and 2001, although the increases were primarily limited to the coastal reserve stations; productivity at two of the central reserve stations decreased in 2001. It is likely that the combination of smaller adult population sizes in 2001, leading to less competition for food resources among breeding individuals, and a larger proportion of experienced breeders resulted in the slight increase in productivity in 2001 at the coastal stations; and that the larger population sizes producing greater competition for resources among breeding individuals, along with the smaller proportion of experienced breeders, led to the decrease in productivity in 2001 at two of the central reserve stations.

(5) Four years of data indicate that an alternating, “productivity/population” dynamic may be manifest at NROC, but that the cycles at the coastal and central reserve stations are offset by one year. Lower breeding populations and higher productivity tends to occur in odd-numbered years (such as 2001) at the coastal stations, but the opposite pattern (higher breeding populations and lower productivity) occurs in those years at the central stations. We suggest that this pattern may be caused by a density-dependent effect on productivity along with low productivity of first-time breeders. If this pattern continues, we might expect higher breeding populations with lower reproductive success at the coastal stations in 2002, but lower breeding populations with higher reproductive success at the central stations.

(6) This, alternating “productivity/population” dynamic has been shown to be characteristic of MAPS data from regions that appear to lack dramatic interannual differences in weather. Disruptions of this alternating cycle at these other MAPS stations have appeared to be related to unusually favorable or unfavorable weather or to pronounced changes in the environment, such as fire or severe insect defoliation. Perhaps differences between the two reserves in fire history can explain why their productivity/population dynamics are out of phase.

(7) A highly significant negative correlation between productivity and adult population size in 2001 for all species pooled for the five coastal reserve stations, and an analogous significant correlation for all ten stations, provide further evidence for this density-dependent dynamic, at least for the coastal reserve stations. In contrast, however, no correlation was found between productivity and adult population size in 2001 for all species pooled for the five central reserve stations.

(8) Four-year trends in adult population size were determined from constant-effort changes in indices of adult population size obtained from mist net capture data for all species pooled and for 11 target species. Adult population sizes for all species pooled and for nine of the 11 species showed substantial decreases over the four years, with the declines for Bushtit and California Thrasher being statistically significant. Productivity, on the other hand, has shown a positive trend over the four years, with productivity increasing substantially for two species and showing non-substantial increasing trends for all species pooled and for five additional species. These increases in productivity resulted primarily from a recovery from the low productivity in 1999.

(9) Using nine or ten years of data from other MAPS stations, we have been able to examine relationships between productivity and various global climate cycles. We have found, for example, that productivity in western North America averages higher during El Niño conditions (such as those in 1998) than during La Niña conditions (such as those in 1999). Thus it is likely that the strong La Niña event of 1999 caused productivity to be low that year at NROC.

(10) With four years of data from two stations, survival estimates were obtained for five species using a time-constant transient model which, by accounting for the effects of transient individuals, produces unbiased estimates of annual adult survival. In general, annual adult survival rate estimates for the five species were at least as high as analogous estimates from MAPS stations at other locations in the United States. The mean precision of survival-rate estimates for four species using four years of data (mean CV(φ) = 26.4%) was vastly improved over that obtained last year for those species from three years of data (mean CV(φ) = 50.1%). We expect to see substantial improvements in the precision of our survival estimates as additional years (up to about 12 years) of data accumulate from all ten stations. We expect to be able to estimate adult survival rates for as many as 14 target species at NROC once more years of data from all ten stations are available. Moreover, time-dependence in estimates of survivorship, recapture probability, and/or proportion of residents will also be available when at least five years of data have accumulated from six or more stations.

(11) Results for ten stations operated on NROC during 2001 indicate that productivity indices and adult annual survival-rate estimates generally averaged at least as high or higher than analogous measures from MAPS stations elsewhere in North America.

(12) Results of the first four years of the MAPS Program at the NROC indicate that important information on the annual indices and estimates, between-year changes, and temporal trends in adult population size, productivity, and survivorship can be obtained for at least 14 key target species at NROC (and possibly for up to 20 species once data from all ten stations have accumulated for 8-10 years). In addition, MAPS data from NROC will provide an invaluable contribution to the determination of precise indices of adult population size and productivity and estimates of survivorship on a region-wide basis for landbirds of Southern California and for all of North America.

(13) As more years of MAPS data accumulate at NROC we are confident that we will be able to measure and assess the effects of productivity and survivorship as driving forces of population trends at NROC. In future analyses we also hope to add estimates of juvenal recruitment and indices of juvenile survival in order to fully understand which parameters are most affecting population changes in each target species. As a result, the indices and estimates of primary demographic parameters produced by MAPS will be extremely useful for the management and conservation of landbirds at NROC and, in combination with similar data from other areas, across all of North America. We conclude that the MAPS protocol is extremely well-suited as a component of NROC's long-term ecological monitoring program.

(14) Finally, we have initiated two additional types of broad-scale analyses on longer time series of MAPS data from other locations to help us further understand the population dynamics of landbirds and potential management actions to reverse population declines. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we have been able to identify the proximate demographic causes of population decline for various species at multiple spatial scales. Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area of each station are good predictors not only of the numbers of birds of each species captured but, more importantly, their productivity levels as well. Based on these analyses, threshold values of critical habitat patch size can be determined that will maximize productivity, thereby providing an extremely powerful tool to aid in formulating management actions aimed at reversing landbird population declines. We plan to conduct analogous analyses on data from the NROC when eight or more years of data have accumulated from all ten stations.

(15) Based on the above information, it is recommended that the MAPS Program continue to be included as an integral part of NROC's long-term ecological monitoring program, and that operation of the ten currently active stations be sustained indefinitely into the future.

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Table 1. Summary of the 2001 MAPS program on the Nature Reserve of Orange County.

Station Name	Station Code	Station No.	Major Habitat Type	Latitude-longitude	Avg. Elev. (m)	Number years of operation	2001 operation: Total number of net-hours[1]	2001 operation: No. of periods	2001 operation: Inclusive dates
Coastal Reserve Sites:									
Little Sycamore Canyon	LISY	12269	coastal sage scrub, scrub oak woodland, core	33º36'48"N,117º46'09"W	176	4	589.3 (556.3)	10	5/07-8/02
Emerald Canyon	EMCA	12308	coastal sage scrub in a steep canyon, core	33º34'15"N,117º46'51"W	264	1	563.8 (0.0)	10	5/04-7/30
Upper Laurel Canyon	UPLA	12293	coastal sage scrub, coast live oak woodland, road-edge	33º35'48"N,117º46'33"W	195	3	596.7 (596.7)	10	5/04-8/03
Upper Wood Canyon	UPWO	12294	coastal sage scrub, bordering housing development	33º35'30"N,117º44'41"W	140	2	562.7 (527.3)	10	5/06-8/01
Sycamore Hills	SYHI	12310	coastal sage scrub, bordering housing development	33º36'04"N,117º45'07"W	186	1	599.7 (0.0)	10	5/08-8/01
Central Reserve Sites:									
Weir Canyon	WEIR	12270	coastal sage scrub, coast live oak woodland, core	33º48'54"N,117º44'52"W	220	4	600.0 (555.0)	10	5/03-7/31
Round Canyon	ROCA	12309	coastal sage scrub, oak woodland, core	33º42'20"N,117º41'34"W	217	1	587.7 (0.0)	10	5/05-7/31
Irvine Park	IRPA	12292	coastal sage scrub, coast live oak woodland, road-edge	33º47'35"N,117º44'07"W	223	3	592.0 (546.7)	10	5/08-8/03
Upper Weir Canyon	UPWE	12295	coastal sage scrub, grassland, bordering housing development	33º50'20"N,117º44'22"W	329	2	559.8 (516.0)	10	5/06-7/30

Table 1. (cont.) Summary of the 2001 MAPS program on the Nature Reserve of Orange County.

Station Name	Station Code	Station No.	Major Habitat Type	Latitude-longitude	Avg. Elev. (m)	Number years of operation	2001 operation: Total number of net-hours[1]	2001 operation: No. of periods	2001 operation: Inclusive dates
Whiting Ranch	WHRA	12311	coastal sage scrub, oak woodland, bordering housing development	33º40'59"N,117º38'51"W	276	1	600.0 (0.0)	10	5/07-8/02
ALL STATIONS COMBINED							5851.7 (3298.0)	10	5/03-8/03

[1] Total net-hours in 2001. Net-hours in 2001 that could be compared in a constant-effort manner to 2000 are shown in parentheses. Emerald Canyon, Round Canyon, Sycamore Hills, and Whiting Ranch began operation in 2001 and therefore have no comparable hours in 2000.

Table 2a. Capture summary for the five coastal reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	L. Sycamore Can. (core)			Emerald Canyon (core)			U. Laurel Canyon (road-edge)			U. Wood Canyon (housing)			Sycamore Hills (housing)		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Cooper's Hawk		1													
California Quail		4						7						1	
Mourning Dove		1													
Common Ground-Dove														1	
Black-chinned Hummingbird		1						1			1			5	
Anna's Hummingbird		37			75			14			11			44	
Costa's Hummingbird		1			31			4			2			3	
Rufous Hummingbird		2			1			1						2	
Allen's Hummingbird		2			6			1			1			5	
Unidentified Selasphorus		1			5			2			1			4	
Unidentified Hummingbird											1				
Acorn Woodpecker															
Nuttall's Woodpecker	1		2							1			1		
Western Wood-Pewee													1		
"Traill's" Flycatcher	1						1								
Hammond's Flycatcher				1									1		
Dusky Flycatcher													1		
"Western" Flycatcher	4			1						5			7		
Unidentified Empidonax											1				
Black Phoebe	1						2						1		
Say's Phoebe															
Ash-throated Flycatcher	5		2	2			9						3		
Cassin's Kingbird							9								
Western Kingbird							1								
Hutton's Vireo	1						2			2		1			
Warbling Vireo	9	1	1							4		1	2		2

Table 2a. (cont.) Capture summary for the five coastal reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	L. Sycamore Can. (core)			Emerald Canyon (core)			U. Laurel Canyon (road-edge)			U. Wood Canyon (housing)			Sycamore Hills (housing)		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Western Scrub-Jay	2						3	1		1			2		
Northern Rough-winged Swallow							1			1					
Cliff Swallow										3					
Oak Titmouse															
Bushtit	6	3	3	15	3	1	13	1	1	17	2	4	53	8	17
Cactus Wren															
Canyon Wren															
Bewick's Wren	16	1	6	5		2	7	1		2			23		6
House Wren	2			11	1		3			1			4	2	
Blue-gray Gnatcatcher	7		5												
California Gnatcatcher						1	1						1		
Swainson's Thrush	9			1			6			1			1		
Wrentit	35	2	32	61	2	22	29	2	26	65	3	52	80		54
Northern Mockingbird				1											
California Thrasher	5			5	1	1	15	2	4	5			5		1
Phainopepla															
Orange-crowned Warbler	49		6	26	1	16	2		1	13		5	4	1	
Yellow Warbler	3			2			2			1			6		1
Townsend's Warbler	6			1			2			1			2		
Hermit Warbler	2		1										1		
MacGillivray's Warbler	1							1					2		
Common Yellowthroat	3			29		10	47		15	11		3	2		
Wilson's Warbler	6	1		5			10			7		1	2	1	
Yellow-breasted Chat							4		1						
Western Tanager													1		
Spotted Towhee	11		6	15		5	21	1	15	15	1	4	23	1	6
California Towhee	7	2	3	15		3	25	1	10	3	1		6		1

Table 2a. (cont.) Capture summary for the five coastal reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	L. Sycamore Can. (core)			Emerald Canyon (core)			U. Laurel Canyon (road-edge)			U. Wood Canyon (housing)			Sycamore Hills (housing)		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Rufous-crowned Sparrow	14	2	7	3			1	1		1			1		1
Song Sparrow				12	1	4	14	2	13	9		7	4		
Golden-crowned Sparrow				3	1										
Unidentified Sparrow															
Black-headed Grosbeak	1						2								
Blue Grosbeak							1		1	1		1			
Lazuli Bunting				1									1		
Hooded Oriole										1			1		
Bullock's Oriole	1			2			10	2					1		
Purple Finch															
House Finch	4	1		3			3			5			9		1
Lesser Goldfinch	1			2			5		1	3			10		
House Sparrow					1										
ALL SPECIES POOLED	213	63	74	222	129	65	251	45	88	179	25	79	262	78	90
TOTAL NUMBER OF CAPTURES		350			416			384			283			430	
NUMBER OF SPECIES	29	16	12	24	12	10	30	17	11	26	8	10	33	12	10
TOTAL NUMBER OF SPECIES		37			30			37			30			40	

Table 2b. Capture summary for the five central reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Weir Canyon (core)			Round Canyon (core)			Irvine Park (road-edge)			U. Weir Canyon (housing)			Whiting Ranch (housing)		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Cooper's Hawk															
California Quail											3				
Mourning Dove					1										
Common Ground-Dove															
Black-chinned Hummingbird		7			9						4			7	
Anna's Hummingbird		16			2			8			31			17	
Costa's Hummingbird		2			10			1						33	
Rufous Hummingbird		2									4				
Allen's Hummingbird															
Unidentified Selasphorus		2						1						3	
Unidentified Hummingbird					1						1			1	
Acorn Woodpecker							3		4						
Nuttall's Woodpecker	2		1	4	1		1		1	2					
Western Wood-Pewee				1											
"Traill's" Flycatcher															
Hammond's Flycatcher															
Dusky Flycatcher															
"Western" Flycatcher	5	1		2			1			4	2		2		
Unidentified Empidonax								1							
Black Phoebe										3			1		
Say's Phoebe										1					
Ash-throated Flycatcher	3			6		2	3		3	3		2	2	1	
Cassin's Kingbird															
Western Kingbird															
Hutton's Vireo	1												3		
Warbling Vireo										2			1		

Table 2b. (cont.) Capture summary for the five central reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Weir Canyon (core)			Round Canyon (core)			Irvine Park (road-edge)			U. Weir Canyon (housing)			Whiting Ranch (housing)		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Western Scrub-Jay				5						6		4	2		
Northern Rough-winged Swallow															
Cliff Swallow															
Oak Titmouse	4	1	2	5	1	1	4		1	2			6		
Bushtit	8	1	2	7	1	2	12		6	26	2	7	18		4
Cactus Wren	1			1									7		
Canyon Wren				1											
Bewick's Wren	26	1	13	22	1	15	3	1	6	13	1	6	25	3	7
House Wren	14		4	9		2	7		1	12	1	4	5		
Blue-gray Gnatcatcher	6	1	1												
California Gnatcatcher	1			1											
Swainson's Thrush	1			1			5			5			1		
Wrentit	42	2	31	40	4	10	37		28	26	2	30	54		24
Northern Mockingbird	1									4			1		
California Thrasher	2			3			3			5	1		7		
Phainopepla	2						1						2		
Orange-crowned Warbler				4			4			3			2		
Yellow Warbler	3			1						2					
Townsend's Warbler				1											
Hermit Warbler															
MacGillivray's Warbler	1						1			1					
Common Yellowthroat				8			2			11		2	5		
Wilson's Warbler	2			5			4			10			2	1	
Yellow-breasted Chat															
Western Tanager															
Spotted Towhee	11	2	5	35	2	10	17	1	3	17	1	1	39	4	5
California Towhee	20	2	9	12	1	1	17		5	15	2	3	15		1

Table 2b. (cont.) Capture summary for the five central reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	Weir Canyon (core)			Round Canyon (core)			Irvine Park (road-edge)			U. Weir Canyon (housing)			Whiting Ranch (housing)		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Rufous-crowned Sparrow	5			6			22	1	8	4	1	1	2		1
Song Sparrow				7			1			6		1	19	2	5
Golden-crowned Sparrow															
Unidentified Sparrow								1							
Black-headed Grosbeak				5	1		1			5			1		
Blue Grosbeak	1												4		
Lazuli Bunting	3			2			2								
Hooded Oriole										2			1		
Bullock's Oriole															
Purple Finch													1		
House Finch	4			5						18	3	1	9		
Lesser Goldfinch	12			12	1	1	2			13	1	2	18		3
House Sparrow													2		
ALL SPECIES POOLED	181	40	68	211	36	44	153	15	66	221	60	64	257	72	50
TOTAL NUMBER OF CAPTURES		289			291			234			345			379	
NUMBER OF SPECIES	26	12	9	28	13	9	23	5	11	28	15	13	30	8	8
TOTAL NUMBER OF SPECIES		30			32			25			32			33	

Table 3a. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the five coastal reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.

	Little Sycamore Canyon (core)			Emerald Canyon (core)			Upper Laurel Canyon (road-edge)			Upper Wood Canyon (housing)			Sycamore Hills (housing)		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Acorn Woodpecker															
Nuttall's Woodpecker	1.0	1.0	0.50							0.0	1.1	1.00	0.0	1.0	1.00
Western Wood-Pewee													1.0	0.0	0.00
"Western" Flycatcher	4.1	0.0	0.00	1.1	0.0	0.00				5.3	0.0	0.00	7.0	0.0	0.00
Black Phoebe	0.0	1.0	1.00				0.0	2.0	1.00				1.0	0.0	0.00
Say's Phoebe															
Ash-throated Flycatcher	6.1	0.0	0.00	2.1	0.0	0.00	9.0	0.0	0.00				3.0	0.0	0.00
Cassin's Kingbird							5.0	4.0	0.44						
Western Kingbird							0.0	1.0	1.00						
Hutton's Vireo	1.0	0.0	0.00				1.0	1.0	0.50	1.1	1.1	0.50			
Western Scrub-Jay	1.0	1.0	0.50				0.0	3.0	1.00	0.0	1.1	1.00	2.0	0.0	0.00
N. Rough-winged Swallow							1.0	0.0	0.00	0.0	1.1	1.00			
Cliff Swallow										3.2	0.0	0.00			
Oak Titmouse															
Bushtit	7.1	2.0	0.22	8.5	7.4	0.47	10.1	3.0	0.23	9.6	8.5	0.47	38.0	12.0	0.24
Cactus Wren															
Canyon Wren															
Bewick's Wren	6.1	12.2	0.67	2.1	3.2	0.60	2.0	5.0	0.71	0.0	2.1	1.00	10.0	13.0	0.57
House Wren	1.0	1.0	0.50	2.1	9.6	0.82	1.0	2.0	0.67				1.0	3.0	0.75
Blue-gray Gnatcatcher	3.1	4.1	0.57												
California Gnatcatcher				0.0	1.1	1.00	1.0	0.0	0.00				0.0	1.0	1.00
Wrentit	19.3	27.5	0.59	26.6	38.3	0.59	20.1	15.1	0.43	30.9	51.2	0.62	43.0	35.0	0.45
Northern Mockingbird				0.0	1.1	1.00									
California Thrasher	2.0	3.1	0.60	1.1	4.3	0.80	5.0	11.1	0.69	1.1	4.3	0.80	1.0	4.0	0.80
Phainopepla															
Orange-crowned Warbler	10.2	39.7	0.80	16.0	11.7	0.42	3.0	0.0	0.00	9.6	5.3	0.36	1.0	3.0	0.75

Table 3a. (cont.) Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the five coastal reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.

	Little Sycamore Canyon (core)			Emerald Canyon (core)			Upper Laurel Canyon (road-edge)			Upper Wood Canyon (housing)			Sycamore Hills (housing)		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Yellow Warbler	3.1	0.0	0.00	2.1	0.0	0.00	2.0	0.0	0.00	1.1	0.0	0.00	6.0	0.0	0.00
Common Yellowthroat	1.0	2.0	0.67	18.1	13.8	0.43	15.1	32.2	0.68	4.3	7.5	0.64	0.0	2.0	1.00
Yellow-breasted Chat							4.0	0.0	0.00						
Spotted Towhee	11.2	4.1	0.27	14.9	1.1	0.07	20.1	7.0	0.26	8.5	9.6	0.53	8.0	15.0	0.65
California Towhee	5.1	4.1	0.44	12.8	3.2	0.20	21.1	11.1	0.34	2.1	1.1	0.33	4.0	2.0	0.33
Rufous-crowned Sparrow	5.1	11.2	0.69	3.2	0.0	0.00	0.0	1.0	1.00	0.0	1.1	1.00	1.0	0.0	0.00
Song Sparrow				9.6	3.2	0.25	5.0	11.1	0.69	2.1	9.6	0.82	0.0	4.0	1.00
Black-headed Grosbeak	1.0	0.0	0.00				2.0	0.0	0.00						
Blue Grosbeak							1.0	1.0	0.50	0.0	1.1	1.00			
Lazuli Bunting				0.0	1.1	1.00							1.0	0.0	0.00
Hooded Oriole										0.0	1.1	1.00	1.0	0.0	0.00
Bullock's Oriole	1.0	0.0	0.00	2.1	0.0	0.00	8.0	2.0	0.20				1.0	0.0	0.00
Purple Finch															
House Finch	4.1	1.0	0.20	1.1	2.1	0.67	1.0	2.0	0.67	3.2	2.1	0.40	4.0	5.0	0.56
Lesser Goldfinch	1.0	0.0	0.00	0.0	2.1	1.00	4.0	2.0	0.33	3.2	0.0	0.00	7.0	3.0	0.30
House Sparrow															
ALL SPECIES POOLED	94.7	115.0	0.55	123.4	103.2	0.46	141.8	116.6	0.45	85.3	108.8	0.56	141.1	103.1	0.42
NUMBER OF SPECIES	21	15		16	15		22	19		14	17		20	14	
TOTAL NUMBER OF SPECIES		22			20			26			21			24	

Table 3b. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the five central reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.

	Weir Canyon (core)			Round Canyon (core)			Irvine Park (road-edge)			Upper Weir Canyon (housing)			Whiting Ranch (housing)		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Acorn Woodpecker							5.1	0.0	0.00						
Nuttall's Woodpecker	2.0	1.0	0.33	3.1	1.0	0.25	1.0	1.0	0.50	0.0	2.1	1.00			
Western Wood-Pewee				1.0	0.0	0.00									
"Western" Flycatcher	5.0	0.0	0.00	2.0	0.0	0.00	1.0	0.0	0.00	4.3	0.0	0.00	2.0	0.0	0.00
Black Phoebe										0.0	3.2	1.00	1.0	0.0	0.00
Say's Phoebe										0.0	1.1	1.00			
Ash-throated Flycatcher	3.0	0.0	0.00	4.1	2.0	0.33	4.1	0.0	0.00	3.2	1.1	0.25	2.0	0.0	0.00
Cassin's Kingbird															
Western Kingbird															
Hutton's Vireo	1.0	0.0	0.00										1.0	2.0	0.67
Western Scrub-Jay				5.1	0.0	0.00				2.1	5.4	0.71	2.0	0.0	0.00
N. Rough-winged Swallow															
Cliff Swallow															
Oak Titmouse	4.0	1.0	0.20	4.1	1.0	0.20	2.0	3.0	0.60	0.0	2.1	1.00	3.0	3.0	0.50
Bushtit	5.0	2.0	0.29	6.1	1.0	0.14	10.1	2.0	0.17	18.2	11.8	0.39	7.0	7.0	0.50
Cactus Wren	1.0	0.0	0.00	0.0	1.0	1.00							3.0	4.0	0.57
Canyon Wren				0.0	1.0	1.00									
Bewick's Wren	9.0	17.0	0.65	9.2	12.3	0.57	4.1	2.0	0.33	5.4	8.6	0.62	7.0	18.0	0.72
House Wren	6.0	9.0	0.60	5.1	4.1	0.44	1.0	5.1	0.83	3.2	8.6	0.73	3.0	2.0	0.40
Blue-gray Gnatcatcher	1.0	5.0	0.83												
California Gnatcatcher	0.0	1.0	1.00	0.0	1.0	1.00									
Wrentit	29.0	20.0	0.41	25.5	16.3	0.39	16.2	30.4	0.65	19.3	17.1	0.47	32.0	22.0	0.41
Northern Mockingbird	0.0	1.0	1.00							3.2	1.1	0.25	1.0	0.0	0.00
California Thrasher	0.0	2.0	1.00	2.0	1.0	0.33	0.0	2.0	1.00	2.1	3.2	0.60	4.0	2.0	0.33
Phainopepla	2.0	0.0	0.00				1.0	0.0	0.00				2.0	0.0	0.00
Orange-crowned Warbler				3.1	1.0	0.25	4.1	0.0	0.00	0.0	3.2	1.00	2.0	0.0	0.00

Table 3b. (cont.) Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the five central reserve MAPS stations operated on the Nature Reserve of Orange County in 2001.

	Weir Canyon (core)			Round Canyon (core)			Irvine Park (road-edge)			Upper Weir Canyon (housing)			Whiting Ranch (housing)		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Yellow Warbler	3.0	0.0	0.00	1.0	0.0	0.00				2.1	0.0	0.00			
Common Yellowthroat				2.0	6.1	0.75	1.0	1.0	0.50	5.4	6.4	0.54	1.0	4.0	0.80
Yellow-breasted Chat															
Spotted Towhee	4.0	9.0	0.69	16.3	19.4	0.54	10.1	8.1	0.44	5.4	13.9	0.72	11.0	29.0	0.73
California Towhee	12.0	14.0	0.54	7.1	5.1	0.42	14.2	5.1	0.26	4.3	15.0	0.78	10.0	4.0	0.29
Rufous-crowned Sparrow	3.0	2.0	0.40	0.0	6.1	1.00	5.1	19.3	0.79	3.2	1.1	0.25	0.0	2.0	1.00
Song Sparrow				2.0	5.1	0.71	0.0	1.0	1.00	3.2	3.2	0.50	11.0	7.0	0.39
Black-headed Grosbeak				0.0	4.1	1.00	0.0	1.0	1.00	3.2	2.1	0.40	0.0	1.0	1.00
Blue Grosbeak	0.0	1.0	1.00										2.0	2.0	0.50
Lazuli Bunting	2.0	1.0	0.33	2.0	0.0	0.00	2.0	0.0	0.00						
Hooded Oriole										2.1	0.0	0.00	1.0	0.0	0.00
Bullock's Oriole															
Purple Finch													1.0	0.0	0.00
House Finch	2.0	2.0	0.50	3.1	2.0	0.40				10.7	8.6	0.44	6.0	3.0	0.33
Lesser Goldfinch	10.0	1.0	0.09	9.2	3.1	0.25	2.0	0.0	0.00	13.9	2.1	0.13	12.0	6.0	0.33
House Sparrow													2.0	0.0	0.00
ALL SPECIES POOLED	104.0	89.0	0.46	113.3	93.9	0.45	84.1	81.1	0.49	114.7	121.1	0.51	129.0	118.0	0.48
NUMBER OF SPECIES	19	17		20	20		17	13		19	21		25	17	
TOTAL NUMBER OF SPECIES		23			25			20			24			27	

Table 4. Summary of results for all ten Nature Reserve of Orange County MAPS stations combined in 2001.

	Birds captured			Birds/600 net-hours		
Species	Newly banded	Un-banded	Recap-tured	Adults	Young	Prop. Young
Cooper's Hawk		1				
California Quail		15				
Mourning Dove		2				
Common Ground-Dove		1				
Black-chinned Hummingbird		35				
Anna's Hummingbird		255				
Costa's Hummingbird		87				
Rufous Hummingbird		12				
Allen's Hummingbird		15				
Unidentified Selasphorus		19				
Unidentified Hummingbird		4				
Acorn Woodpecker	3		4	0.5	0.0	0.00
Nuttall's Woodpecker	12	1	4	0.7	0.8	0.53
Western Wood-Pewee	2			0.2	0.0	0.00
"Traill's" Flycatcher	2					
Hammond's Flycatcher	2					
Dusky Flycatcher	1					
"Western" Flycatcher	31	3		3.2	0.0	0.00
Unidentified Empidonax		2				
Black Phoebe	8			0.2	0.6	0.75
Say's Phoebe	1			0.0	0.1	1.00
Ash-throated Flycatcher	36	1	9	3.6	0.3	0.08
Cassin's Kingbird	9			0.5	0.4	0.44
Western Kingbird	1			0.0	0.1	1.00
Hutton's Vireo	9		1	0.5	0.4	0.44
Warbling Vireo	18	1	4			
Western Scrub-Jay	21	1	4	1.2	1.0	0.46
Northern Rough-winged Swa	2			0.1	0.1	0.50
Cliff Swallow	3			0.3	0.0	0.00
Oak Titmouse	21	2	4	1.3	1.0	0.44
Bushtit	175	21	47	12.0	5.6	0.32
Cactus Wren	9			0.4	0.5	0.56
Canyon Wren	1			0.0	0.1	1.00
Bewick's Wren	142	9	61	5.5	9.4	0.63
House Wren	68	4	11	2.4	4.4	0.65
Blue-gray Gnatcatcher	13	1	6	0.4	0.9	0.69
California Gnatcatcher	4		1	0.1	0.4	0.80
Swainson's Thrush	31					
Wrentit	469	17	309	26.2	27.1	0.51
Northern Mockingbird	7			0.4	0.3	0.43
California Thrasher	55	4	6	1.8	3.7	0.67
Phainopepla	5			0.5	0.0	0.00

Table 4.(cont.) Summary of results for all ten Nature Reserve of Orange County MAPS stations combined in 2001.

Species	Birds captured: Newly banded	Un-banded	Recap-tured	Birds/600net-hours: Adults	Young	Prop. Young
Orange-crowned Warbler	107	2	28	4.8	6.4	0.57
Yellow Warbler	20		1	2.1	0.0	0.00
Townsend's Warbler	13					
Hermit Warbler	3		1			
MacGillivray's Warbler	6	1				
Common Yellowthroat	118		30	4.7	7.5	0.61
Wilson's Warbler	53	3	1			
Yellow-breasted Chat	4		1	0.4	0.0	0.00
Western Tanager	1					
Spotted Towhee	204	13	60	11.0	11.6	0.51
California Towhee	135	9	36	9.3	6.5	0.41
Rufous-crowned Sparrow	59	5	18	2.1	4.4	0.68
Song Sparrow	72	5	30	3.3	4.4	0.57
Golden-crowned Sparrow	3	1				
Unidentified Sparrow		1				
Black-headed Grosbeak	15	1		0.6	0.8	0.57
Blue Grosbeak	7		2	0.3	0.5	0.63
Lazuli Bunting	9			0.7	0.2	0.22
Hooded Oriole	5			0.4	0.1	0.20
Bullock's Oriole	14	2		1.2	0.2	0.14
Purple Finch	1			0.1	0.0	0.00
House Finch	60	4	2	3.5	2.8	0.44
Lesser Goldfinch	78	2	7	6.3	1.9	0.24
House Sparrow	2	1		0.2	0.0	0.00
ALL SPECIES POOLED	2150	563	688	113.2	104.7	0.48
TOTAL NUMBER OF CAPTURES		3401				
NUMBER OF SPECIES	53	34	27	39	33	
TOTAL NUMBER OF SPECIES		62			42	

Table 5. Percentage changes between 2000 and 2001 in the numbers of individual ADULT birds captured at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	n[1]	All six stations combined: No. adults 2000	All six stations combined: No. adults 2001	All six stations combined: % change	All six stations combined: SE[2]
Acorn Woodpecker					+400.0		1	1	5	+400.0	
Nuttall's Woodpecker	++++ [3]	-100.0	-100.0	+100.0	-66.7	-100.0	6	10	4	-60.0	26.5*
Downy Woodpecker		-100.0					1	1	0	-100.0	
Western Wood-Pewee	-100.0		-100.0			-100.0	3	3	0	-100.0	88.9
"Western" Flycatcher	-70.0	-100.0	+150.0	+33.3	-50.0	0.0	6	27	17	-37.0	27.5
Black Phoebe							0	0	0		
Say's Phoebe							0	0	0		
Ash-throated Flycatcher	++++	+350.0	-100.0	0.0	+300.0	+200.0	6	8	25	+212.5	133.3
Cassin's Kingbird		-16.7					1	6	5	-16.7	
Western Kingbird		-100.0					1	1	0	-100.0	
Hutton's Vireo	++++	++++ [3]	0.0	-50.0			4	3	4	+33.3	85.1
Western Scrub-Jay	++++	-100.0				-60.0	3	8	3	-62.5	23.1
Northern Rough-winged Swallow	-100.0	++++					2	1	1	0.0	200.0
Cliff Swallow			++++[3]				1	0	3	++++[3]	
Oak Titmouse				+300.0	+100.0	-100.0	3	3	6	+100.0	115.5
Bushtit	-56.3	-9.1	+28.6	+150.0	+900.0	+60.0	6	47	57	+21.3	37.9
Cactus Wren		-100.0		0.0			2	2	1	-50.0	50.0
Bewick's Wren	+20.0	+100.0	-100.0	+60.0	0.0	+66.7	6	21	25	+19.0	23.5
House Wren	++++	++++		-14.3	0.0	+200.0	5	9	12	+33.3	49.7
Blue-gray Gnatcatcher	+200.0			++++[3]			2	1	4	+300.0	200.0
California Gnatcatcher		++++					1	0	1	++++	
Wrentit	+137.5	+100.0	-9.7	+211.1	0.0	-5.6	6	92	128	+39.1	30.9
Northern Mockingbird		-100.0				++++[3]	2	1	3	+200.0	600.0
California Thrasher	0.0	0.0	-66.7	-100.0	-100.0	0.0	6	16	10	-37.5	20.9
Phainopepla	-100.0			++++	0.0		3	2	3	+50.0	156.1
Orange-crowned Warbler	+42.9	-50.0	+12.5		++++[3]		4	21	26	+23.8	34.0

Table 5. (cont.) Percentage changes between 2000 and 2001 in the numbers of individual ADULT birds captured at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	n[1]	All six stations combined: No. adults 2000	No. adults 2001	% change	SE[2]
Yellow Warbler	-50.0	-33.3	-50.0	++++		++++	5	11	11	0.0	49.8
Common Yellowthroat	-75.0	+7.1	-60.0		++++	++++	5	28	26	-7.1	32.3
Yellow-breasted Chat		++++					1	0	4	++++	
Spotted Towhee	-42.1	-25.9	-52.9	-33.3	+11.1	+25.0	6	82	58	-29.3	8.5**
California Towhee	-54.5	+31.3	0.0	+50.0	+27.3	-42.9	6	55	58	+5.5	18.9
Rufous-crowned Sparrow	++++			++++	+25.0	++++	4	4	16	+300.0	369.7
Black-chinned Sparrow						-100.0	1	1	0	-100.0	
Lark Sparrow		-100.0					1	1	0	-100.0	
Song Sparrow	-100.0	-64.3	-66.7			0.0	4	24	10	-58.3	9.8***
Black-headed Grosbeak	0.0	0.0	-100.0		-100.0	+200.0	5	7	6	-14.3	46.2
Blue Grosbeak		-75.0				-100.0	2	5	1	-80.0	8.0
Lazuli Bunting		-100.0		++++	-66.7	-100.0	4	11	3	-72.7	26.9*
Hooded Oriole						++++	1	0	2	++++	
Bullock's Oriole	++++	+100.0		-100.0			3	5	9	+80.0	54.1
House Finch	-20.0	-50.0	++++	++++	-100.0	-44.4	6	28	20	-28.6	20.0
Lesser Goldfinch	-85.7	-81.0	-40.0	+150.0	-71.4	-38.1	6	65	33	-49.2	18.7**
Lawrence's Goldfinch		-100.0					1	14	0	-100.0	
ALL SPECIES POOLED	-13.2	-23.4	-21.8	+80.4	+15.5	-1.9	6	625	600	-4.0	11.2

Table 5. (cont.) Percentage changes between 2000 and 2001 in the numbers of individual ADULT birds captured at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	All six stations combined
No. species that increased[4]	11(7)	11(5)	5(2)	14(6)	9(2)	11(5)	19(4)
No. species that decreased[5]	12(4)	19(10)	12(5)	5(2)	7(3)	11(6)	20(6)
No. species remained same	2	2	2	2	4	3	2
TOTAL NUMBER OF SPECIES	25	32	19	21	20	25	41
Proportion of increasing (decreasing) species	(0.480)	(0.594)	(0.632)	0.667	0.450	(0.440)	(0.488)
Sig. of increase (decrease)[6]	(0.655)	(0.189)	(0.180)	0.095	0.748	(0.788)	(0.622)
				*			

[1] Number of stations at which at least one adult bird was captured in either year.
[2] Standard error of the % change in the number of adult birds captured.
[3] Increase indeterminate (infinite) because no adult was captured during 2000.
[4] No. of species for which adults were captured in 2001 but not in 2000 are in parentheses.
[5] No. of species for which adults were captured in 2000 but not in 2001 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** *P* < 0.01; ** 0.01 # *P* < 0.05; * 0.05 # *P* < 0.10.

Table 6. Percentage changes between 2000 and 2001 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	n[1]	All six stations combined: No. adults 2000	No. adults 2001	% change	SE[2]
Acorn Woodpecker					-100.0		1	1	0	-100.0	
Nuttall's Woodpecker	++++[3]		++++[3]	++++[3]	++++[3]	++++[3]	5	0	6	++++[3]	
Downy Woodpecker							0	0	0		
Western Wood-Pewee							0	0	0		
"Western" Flycatcher				-100.0			1	1	0	-100.0	
Black Phoebe	++++	0.0			-100.0	++++	4	3	6	+100.0	163.3
Say's Phoebe						++++	1	0	1	++++	
Ash-throated Flycatcher				-100.0		0.0	2	3	1	-66.7	44.4
Cassin's Kingbird		-42.9					1	7	4	-42.9	
Western Kingbird		0.0					1	1	1	0.0	
Hutton's Vireo		++++[3]	++++				2	0	2	++++	
Western Scrub-Jay	++++	++++	-50.0			+66.7	4	5	10	+100.0	103.3
Northern Rough-winged Swallow			++++				1	0	1	++++	
Cliff Swallow							0	0	0		
Oak Titmouse				0.0	0.0	++++	3	4	6	+50.0	78.1
Bushtit	-33.3	-80.0	+100.0	-66.7	-50.0	+83.3	6	38	28	-26.3	34.2
Cactus Wren				-100.0			1	1	0	-100.0	
Bewick's Wren	+120.0	+66.7	-50.0	+325.0	0.0	-11.1	6	27	45	+66.7	55.4
House Wren	++++	++++		++++	++++	+133.3	5	3	24	+700.0	745.4
Blue-gray Gnatcatcher	++++			++++			2	0	8	++++	
California Gnatcatcher				++++			1	0	1	++++	
Wrentit	+125.0	+114.3	-15.8	-4.8	+86.7	-44.8	6	141	154	+9.2	22.5
Northern Mockingbird			-100.0	++++		0.0	3	2	2	0.0	86.6
California Thrasher	-25.0	-8.3	+300.0	0.0	+100.0	-57.1	6	27	25	-7.4	19.6
Phainopepla			-100.0				1	1	0	-100.0	
Orange-crowned Warbler	+875.0		+150.0			+200.0	3	7	47	+571.4	266.7

Table 6. (cont.) Percentage changes between 2000 and 2001 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	n[1]	All six stations combined: No. adults 2000	No. adults 2001	% change	SE[2]
Yellow Warbler							0	0	0		
Common Yellowthroat	0.0	+100.0	+600.0	-100.0	++++	++++	6	20	48	+140.0	58.2*
Yellow-breasted Chat							0	0	0		
Spotted Towhee	+300.0	-46.2	-35.7	+12.5	+33.3	+44.4	6	51	50	-2.0	20.1
California Towhee	+300.0	-35.3	-50.0	+100.0	-37.5	-17.6	6	52	49	-5.8	21.1
Rufous-crowned Sparrow	+120.0	0.0	++++	-50.0	+183.3	-66.7	6	19	33	+73.7	55.4
Black-chinned Sparrow				-100.0		-100.0	2	2	0	-100.0	88.9
Lark Sparrow				-100.0			1	1	0	-100.0	
Song Sparrow	-100.0	+10.0	+60.0		++++	-25.0	5	20	23	+15.0	17.8
Black-headed Grosbeak					0.0	++++	2	1	3	+200.0	400.0
Blue Grosbeak		++++	++++	++++			3	0	3	++++	
Lazuli Bunting		-100.0		-50.0	-100.0		3	9	1	-88.9	13.4**
Hooded Oriole			++++				1	0	1	++++	
Bullock's Oriole		++++					1	0	2	++++	
House Finch	0.0	++++	-33.3	0.0	-100.0	-65.0	6	31	14	-54.8	13.8**
Lesser Goldfinch	-100.0	-50.0		-50.0		-84.6	4	22	5	-77.3	8.9***
Lawrence's Goldfinch							0	0	0		
ALL SPECIES POOLED	+164.3	+2.7	+4.1	+34.8	+38.2	-12.6	6	500	604	+20.8	17.4

Table 6. (cont.) Percentage changes between 2000 and 2001 in the numbers of individual YOUNG birds captured at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	All six stations combined
No. species that increased[4]	11(5)	10(6)	11(6)	9(6)	8(4)	11(6)	20(9)
No. species that decreased[5]	4(2)	7(1)	8(2)	11(6)	6(4)	9(1)	15(6)
No. species remained same	2	3	0	3	3	2	2
TOTAL NUMBER OF SPECIES	17	20	19	23	17	22	37
Proportion of increasing (decreasing) species	0.647	0.500	0.579	0.391	0.471	(0.409)	0.541
Sig. of increase (decrease)[6]	0.166	0.588	0.324	0.895	0.685	(0.857)	0.371

[1] Number of stations at which at least one young bird was captured in either year.
[2] Standard error of the % change in the number of young birds captured.
[3] Increase indeterminate (infinite) because no young was captured during 2000.
[4] No. of species for which young were captured in 2001 but not in 2000 are in parentheses.
[5] No. of species for which young were captured in 2000 but not in 2001 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** 0.01 # P < 0.05; * 0.05 # P < 0.10

Table 7. Changes between 2000 and 2001 in the PROPORTION OF YOUNG in the catch at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	n[1]	All six stations combined: No. adults 2000	2001	% change	SE[2]
Acorn Woodpecker					-0.500		1	0.500	0.000	-0.500	
Nuttall's Woodpecker	+-+-+ [3]	+-+-+ [3]	+1.000	+0.333	+0.500	+1.000	6	0.000	0.600	+0.600	0.135***
Downy Woodpecker		+-+-+					1	0.000	------ [4]	+-+-+ [3]	
Western Wood-Pewee	+-+-+		+-+-+ [3]			+-+-+ [3]	3	0.000	------	+-+-+	
"Western" Flycatcher	0.000	+-+-+	0.000	-0.250	0.000	0.000	6	0.036	0.000	-0.036	0.038
Black Phoebe	+-+-+	0.000			+-+-+ [3]	+-+-+	4	1.000	1.000	0.000	0.000
Say's Phoebe						+-+-+	1	------ [4]	1.000	+-+-+	
Ash-throated Flycatcher	+-+-+	0.000	+-+-+	-0.400	0.000	-0.250	6	0.273	0.039	-0.234	0.110*
Cassin's Kingbird		-0.094					1	0.539	0.444	-0.094	
Western Kingbird		+0.500					1	0.500	1.000	+0.500	
Hutton's Vireo	+-+-+	+-+-+	+0.500	0.000			4	0.000	0.333	+0.333	0.128*
Western Scrub-Jay	+-+-+	+1.000	0.000			+0.339	4	0.385	0.769	+0.385	0.174
Northern Rough-winged Swallow	+-+-+	+-+-+	+-+-+				3	0.000	0.500	+0.500	0.433
Cliff Swallow			+-+-+				1	------	0.000	+-+-+	
Oak Titmouse				-0.300	-0.150	+1.000	3	0.571	0.500	-0.071	0.250
Bushtit	+0.064	-0.346	+0.107	-0.464	-0.633	+0.032	6	0.447	0.329	-0.118	0.107
Cactus Wren		+-+-+		-0.500			2	0.333	0.000	-0.333	0.222
Bewick's Wren	+0.147	-0.036	+0.429	+0.236	0.000	-0.135	6	0.563	0.643	+0.080	0.077
House Wren	+-+-+	+-+-+		+0.600	+0.833	-0.050	5	0.250	0.667	+0.417	0.253
Blue-gray Gnatcatcher	+0.500			+-+-+ [3]			2	0.000	0.667	+0.667	0.167
California Gnatcatcher		+-+-+		+-+-+			2	------	0.500	+-+-+	
Wrentit	-0.013	+0.017	-0.016	-0.283	+0.153	-0.132	6	0.605	0.546	-0.059	0.054
Northern Mockingbird		+-+-+	+-+-+	+-+-+		-0.750	4	0.667	0.400	-0.267	0.370
California Thrasher	-0.067	-0.018	+0.550	+0.600	+0.500	-0.178	6	0.628	0.714	+0.086	0.080
Phainopepla	+-+-+		+-+-+	+-+-+	0.000		4	0.333	0.000	-0.333	0.314
Orange-crowned Warbler	+0.432	0.000	+0.157		+-+-+	0.000	5	0.250	0.644	+0.394	0.164*

Table 7. (cont.) Changes between 2000 and 2001 in the PROPORTION OF YOUNG in the catch at six constant-effort MAPS stations on the Nature Reserve of Orange County.

							All six stations combined				
							No. adults				
Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	n[1]	2000	2001	% change	SE[2]
Yellow Warbler	0.000	0.000	0.000	+-+-+		+-+-+	5	0.000	0.000	0.000	0.000
Common Yellowthroat	+0.333	+0.148	+0.546	+-+-+	+-+-+	+-+-+	6	0.417	0.649	+0.232	0.119
Yellow-breasted Chat		+-+-+					1	------	0.000	+-+-+	
Spotted Towhee	+0.217	-0.066	+0.078	+0.121	+0.044	+0.030	6	0.384	0.463	+0.079	0.112
California Towhee	+0.361	-0.171	-0.167	+0.072	-0.158	+0.069	6	0.486	0.458	-0.028	0.112
Rufous-crowned Sparrow	-0.313	0.000	+-+-+	-0.600	+0.173	-0.750	6	0.826	0.674	-0.153	0.141
Black-chinned Sparrow				+-+-+		+-+-+	2	0.667	------	+-+-+	
Lark Sparrow		+-+-+		+-+-+			2	0.500	------	+-+-+	
Song Sparrow	+-+-+	+0.271	+0.346		+-+-+	-0.071	5	0.455	0.697	+0.242	0.063**
Black-headed Grosbeak	0.000	0.000	+-+-+		+0.667	+0.400	5	0.125	0.333	+0.208	0.164
Blue Grosbeak		+0.500	+-+-+	+-+-+		+-+-+	4	0.000	0.750	+0.750	0.177**
Lazuli Bunting		+-+-+		-0.667	-0.400	+-+-+	4	0.450	0.250	-0.200	0.147
Hooded Oriole			+-+-+			+-+-+	2	------	0.333	+-+-+	
Bullock's Oriole	+-+-+	+0.200		+-+-+			3	0.000	0.182	+0.182	0.029***
House Finch	+0.033	+0.667	-0.600	-0.500	+-+-+	-0.115	6	0.525	0.412	-0.114	0.071
Lesser Goldfinch	-0.300	+0.173	0.000	-0.242	0.000	-0.249	6	0.253	0.132	-0.121	0.080
Lawrence's Goldfinch		+-+-+					1	0.000	------	+-+-+	
ALL SPECIES POOLED	+0.263	+0.071	+0.071	-0.073	+0.045	-0.029	6	0.444	0.502	+0.057	0.044

Table 7. (cont.) Changes between 2000 and 2001 in the PROPORTION OF YOUNG in the catch at six constant-effort MAPS stations on the Nature Reserve of Orange County.

Species	L. Syca. Canyon (coastal) (core)	U. Laurel Canyon (coastal) (road-edge)	U. Wood Canyon (coastal) (housing)	Weir Canyon (central) (core)	Irvine Park (central) (road-edge)	U. Weir Canyon (central) (housing)	All six stations combined
No. species that increased	8	9	9	6	7	7	16
No. species that decreased	4	6	3	10	5	10	15
No. species remained same	3	6	4	1	5	2	2
TOTAL NUMBER OF SPECIES[5]	15	21	16	17	17	19	33
Proportion of increasing (decreasing) species	0.533	0.429	0.563	(0.588)	0.412	(0.526)	0.485
Sig. of increase (decrease)[6]	0.500	0.808	0.402	(0.315)	0.834	(0.500)	0.636

[1] Number of stations at which at least one aged bird was captured in either year.
[2] Standard error of the change in the proportion of young.
[3] The change in the proportion of young is undefined at this station because no aged individual of the species was captured in one of the two years.
[4] Proportion of young not given because no aged individual of the species was captured in the year shown.
[5] Species for which the change in the proportion of young is undefined are not included.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** 0.01 # $P < 0.05$; * 0.05 # $P < 0.10$

Table 8. Mean numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the four individual MAPS stations operated on the Nature Reserve of Orange County averaged over the three years. Data are included only from stations that lie within the breeding range of the target species.

	L. Sycamore Canyon (coastal / core)			Upper Laurel Canyon (coastal / road-edge)			Weir Canyon (central / core)			Irvine Park (central / road-edge)			All stations pooled		
Species	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.
Acorn Woodpecker										2.0	0.3	0.25	0.5	0.1	0.25
Nuttall's Woodpecker	1.3	0.3	0.25	1.3	0.3	0.25	1.7	0.3	0.11	2.0	0.3	0.17	1.6	0.3	0.18
Downy Woodpecker				0.3	0.0	0.00							0.1	0.0	0.00
Western Wood-Pewee	0.3	0.0	0.00										0.1	0.0	0.00
"Western" Flycatcher	13.0	0.3	0.02	3.6	0.3	0.10	8.8	0.3	0.08	4.4	0.7	0.06	7.4	0.4	0.04
Black Phoebe	0.0	0.3	1.00	0.0	1.3	1.00				0.0	0.3	1.00	0.0	0.5	1.00
Ash-throated Flycatcher	4.0	0.0	0.00	6.7	0.0	0.00	3.4	1.3	0.19	2.4	0.0	0.00	4.1	0.3	0.12
Cassin's Kingbird				3.6	3.6	0.49							0.9	0.9	0.49
Western Kingbird				0.3	0.7	0.75							0.1	0.2	0.75
Hutton's Vireo	1.0	0.0	0.00	1.7	0.3	0.25	1.7	0.0	0.00				1.1	0.1	0.08
Western Scrub-Jay	0.3	0.3	0.50	1.3	1.0	0.33	0.3	0.0	0.00				0.5	0.3	0.27
N. Rough-winged Swallow	0.3	0.0	0.00	0.3	0.0	0.00							0.2	0.0	0.00
Cliff Swallow				3.3	0.0	0.00							0.8	0.0	0.00
Oak Titmouse							2.3	0.7	0.23	2.3	2.7	0.53	1.2	0.8	0.42
Bushtit	13.4	1.7	0.12	14.0	7.3	0.32	8.8	4.0	0.38	11.1	2.0	0.28	11.8	3.8	0.26
Cactus Wren				0.3	0.0	0.00	0.7	0.3	0.25				0.3	0.1	0.17
Bewick's Wren	8.7	6.4	0.43	2.7	2.7	0.49	7.4	8.4	0.48	4.7	2.3	0.33	5.9	4.9	0.44
House Wren	0.7	0.3	0.25	2.0	1.0	0.42	6.7	4.0	0.30	1.7	1.7	0.28	2.8	1.8	0.29
Blue-gray Gnatcatcher	2.0	2.0	0.36				0.3	1.7	0.83				0.6	0.9	0.40
California Gnatcatcher				0.7	0.0	0.00	0.0	0.3	1.00				0.2	0.1	0.25
Wrentit	19.1	13.2	0.40	14.0	8.0	0.33	23.1	14.3	0.39	23.5	17.1	0.42	19.9	13.1	0.39
Northern Mockingbird				0.3	0.0	0.00	1.0	0.3	0.50				0.3	0.1	0.33
California Thrasher	4.0	6.0	0.62	4.0	10.0	0.71	2.0	1.3	0.47	2.0	1.3	0.47	3.0	4.7	0.62
Phainopepla	0.3	0.0	0.00				1.3	0.0	0.00	0.7	0.0	0.00	0.6	0.0	0.00

Table 8. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the four individual MAPS stations operated on the Nature Reserve of Orange County averaged over the three years 1999-2001. Data are included only from stations that lie within the breeding range of the target species.

	L. Sycamore Canyon (coastal / core)			Upper Laurel Canyon (coastal / road-edge)			Weir Canyon (central / core)			Irvine Park (central / road-edge)			All stations pooled		
Species	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.	Ad.	Yg.	Prop.[1] Yg.
Orange-crowned Warbler	6.7	14.9	0.40	8.3	0.0	0.00	0.7	0.0	0.00	2.4	0.0	0.00	4.5	3.7	0.32
Yellow Warbler	3.7	0.0	0.00	2.7	0.0	0.00	1.0	0.0	0.00	0.3	0.0	0.00	1.9	0.0	0.00
Common Yellowthroat	4.7	1.3	0.33	16.6	20.3	0.53	0.0	0.3	1.00	0.7	0.3	0.25	5.5	5.6	0.49
Yellow-breasted Chat	0.3	0.0	0.00	1.3	0.0	0.00							0.4	0.0	0.00
Spotted Towhee	22.1	2.4	0.12	22.2	7.6	0.23	8.4	6.0	0.44	10.4	5.4	0.32	15.8	5.3	0.26
California Towhee	9.7	1.7	0.18	21.3	9.3	0.29	13.8	7.0	0.32	17.8	5.0	0.23	15.6	5.8	0.27
Rufous-crowned Sparrow	2.7	5.4	0.56	1.0	0.7	0.67	2.0	2.0	0.47	7.1	10.4	0.56	3.2	4.6	0.56
Black-chinned Sparrow	0.3	0.0	0.00				0.0	0.3	1.00				0.1	0.1	0.50
Lark Sparrow				0.3	0.0	0.00	0.0	0.3	1.00				0.1	0.1	0.50
Song Sparrow	1.3	0.7	0.33	13.6	7.6	0.40				0.0	0.3	1.00	3.8	2.2	0.41
Black-headed Grosbeak	0.7	0.0	0.00	1.3	0.0	0.00				1.0	0.7	0.63	0.8	0.2	0.20
Blue Grosbeak				3.7	0.7	0.21	0.0	0.3	1.00				0.9	0.3	0.27
Lazuli Bunting				1.6	2.0	0.55	0.7	1.0	0.67	2.0	0.7	0.13	1.1	0.9	0.25
Bullock's Oriole	0.7	0.0	0.00	4.7	0.7	0.07	0.3	0.0	0.00	0.7	0.0	0.00	1.6	0.2	0.06
House Finch	3.7	1.3	0.27	1.3	0.7	0.22	1.3	1.3	0.50	1.3	1.7	0.31	1.9	1.3	0.34
Lesser Goldfinch	4.7	3.0	0.27	11.6	2.7	0.22	5.7	1.0	0.14	5.4	1.3	0.12	6.8	2.0	0.22
Lawrence's Goldfinch				4.6	0.0	0.00							1.2	0.0	0.00
ALL SPECIES POOLED	129.9	61.7	0.32	176.7	88.7	0.33	103.3	57.1	0.36	105.8	54.7	0.35	129.1	65.6	0.34
NUMBER OF SPECIES	27	18		34	22		24	23		22	19		40	33	
TOTAL NUMBER OF SPECIES		28			35			29			24			41	

[1] Years for which the proportion of young was undefined (no aged birds were captured in the year) are not included in the mean proportion of young.

Table 9. Estimates of adult survival and recapture probabilities and proportion of residents using for a time-constant model for five species breeding at two MAPS stations (Little Sycamore Canyon and Weir Canyon) on the Nature Reserve of Orange County obtained from four years (1998-2001) of mark-recapture data.

Species	Num. sta[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	$QAIC_C$[5]	Survival probability[6]	Surv. C.V.[7]	Recapture probability[8]	Proportion of residents[9]
Bushtit	2	90	118	13	28.9	0.405 (0.165)	40.6	0.284 (0.177)	1.000 (0.612)
Bewick's Wren	2	58	109	17	22.2	0.473 (0.111)	23.5	0.697 (0.172)	0.585 (0.244)
Wrentit	2	151	253	34	31.3	0.597 (0.102)	17.2	0.428 (0.113)	0.571 (0.168)
Spotted Towhee	2	102	129	16	23.7	0.553 (0.202)	36.5	0.203 (0.136)	1.000 (0.655)
California Towhee	2	80	115	17	34.1	0.660 (0.188)	28.5	0.284 (0.137)	0.744 (0.350)

[1] Number of stations where the species was a regular or usual breeder at which adults of the species were captured.
[2] Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).
[3] Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.
[4] Total number of returns. A return is the first recapture in a given year of a bird originally banded at the same station in a previous year.
[5] Akaike Information Criterion ($QAIC_C$) given as -2(log-likelihood) + 2(number of estimable parameters) with corrections for small sample size and overdispersion of data.
[6] Survival probability presented as the maximum likelihood estimate (standard error of the estimate).
[7] The coefficient of variation for survival probability.
[8] Recapture probability presented as the maximum likelihood estimate (standard error of the estimate).
[9] The proportion of residents among newly captured adults presented as the maximum likelihood estimate (standard error of the estimate).

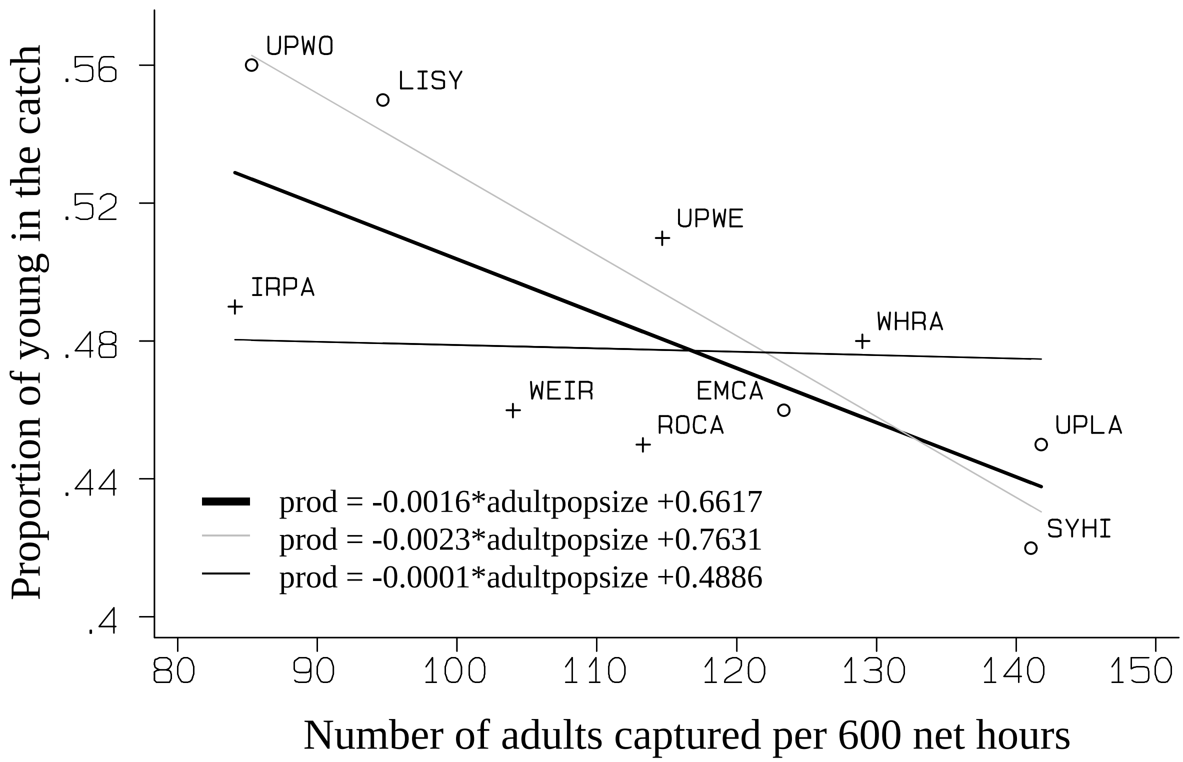

Figure 1. Regression of productivity indices (proportion of young in the catch) on indices of adult population size (number of adults captured per 600 net hours) for all species pooled at the ten MAPS stations operated on the Nature Reserve of Orange County during 2001. Correlations are shown for all ten stations (thick black line) (*r*= -0.737, *P*=0.015), the five coastal reserve stations (open circles, thin gray line) (*r*= -0.974, *P*=0.005), and the five central reserve stations (plus signs, thin black line) (*r*= -0.068, *P*=0.914).

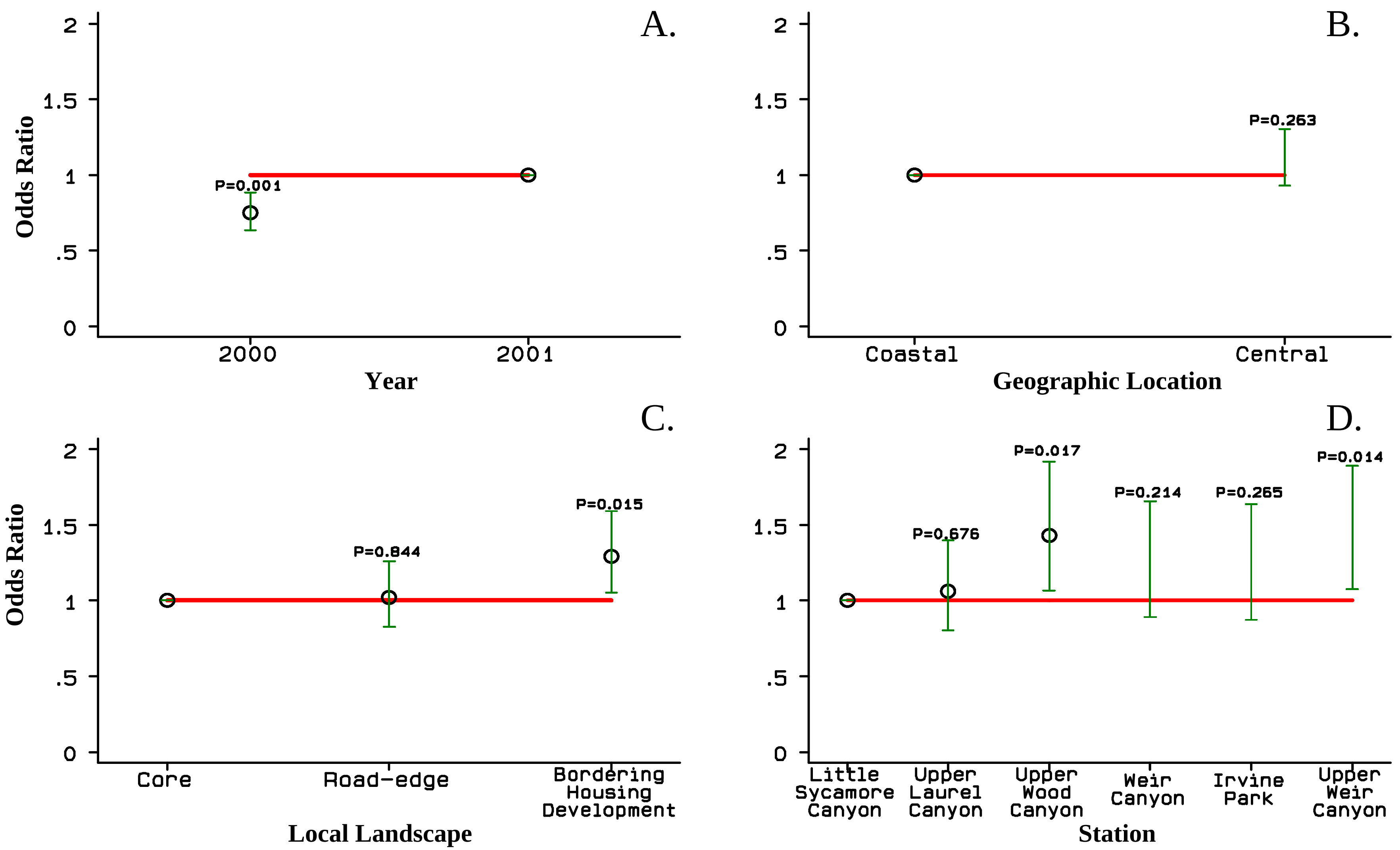

Figure 2. The odds ratios for productivity indices (with 95% confidence intervals) for **all species pooled** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

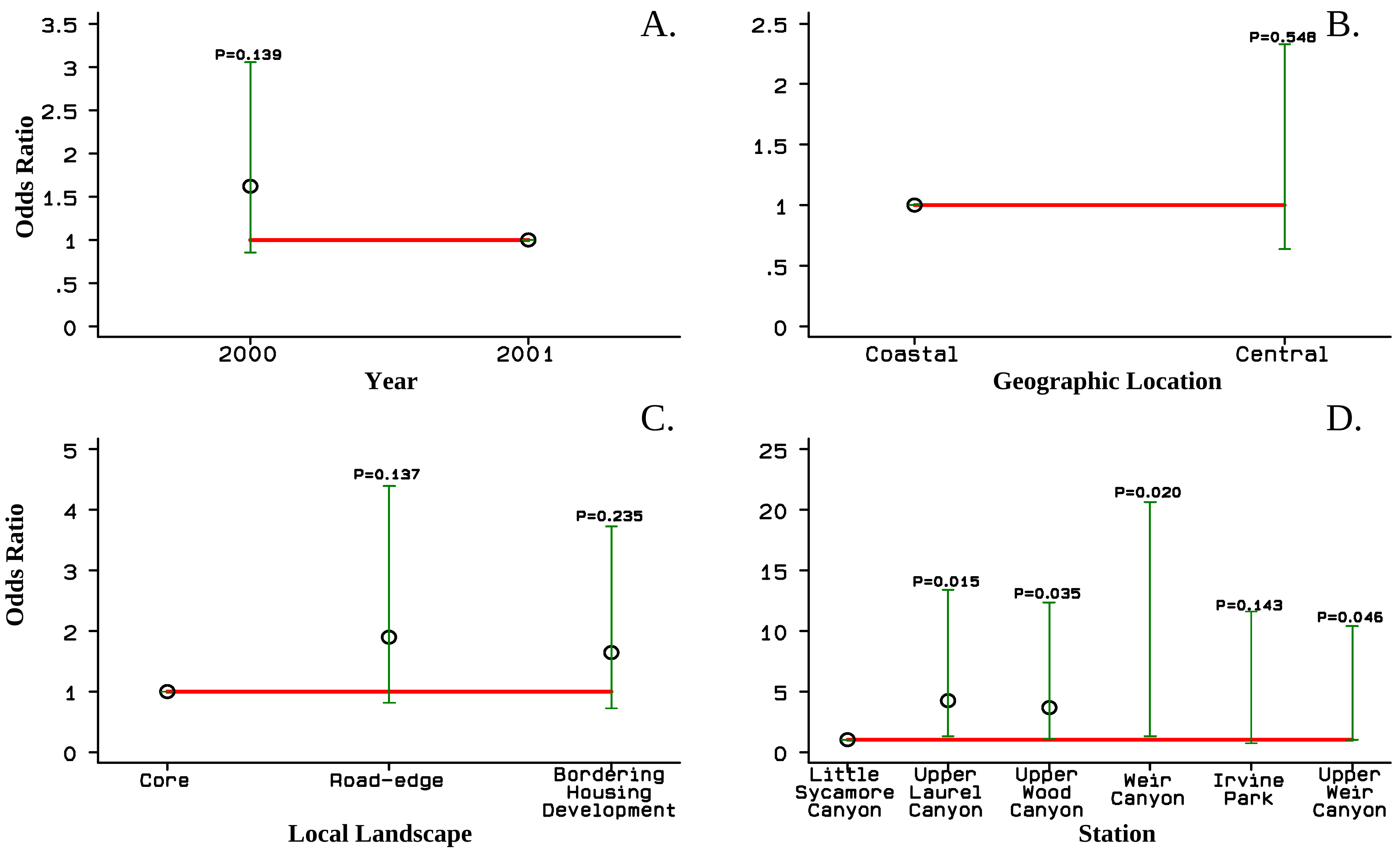

Figure 3. The odds ratios for productivity indices (with 95% confidence intervals) for **Bushtit** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

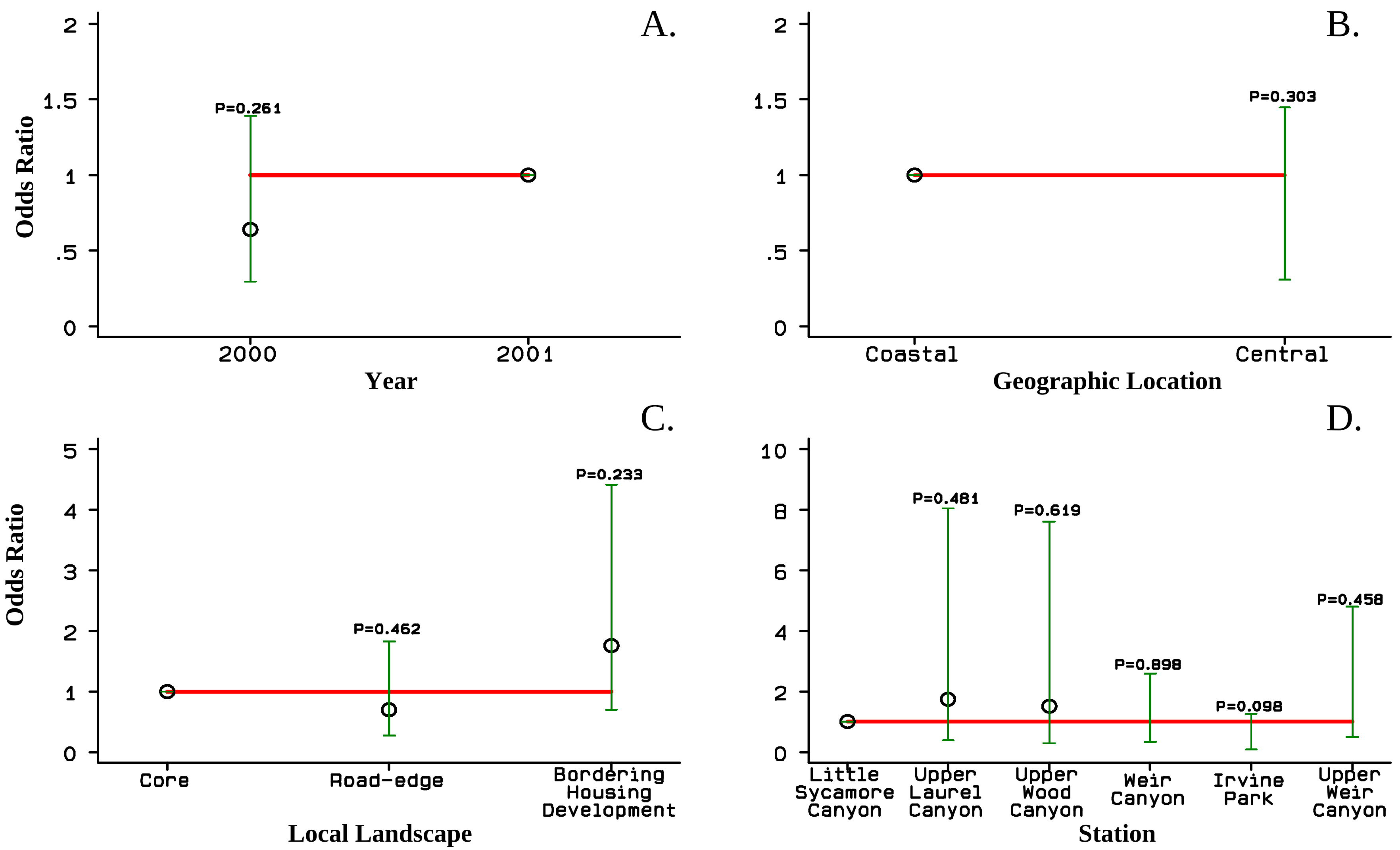

Figure 4. The odds ratios for productivity indices (with 95% confidence intervals) for **Bewick's Wren** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

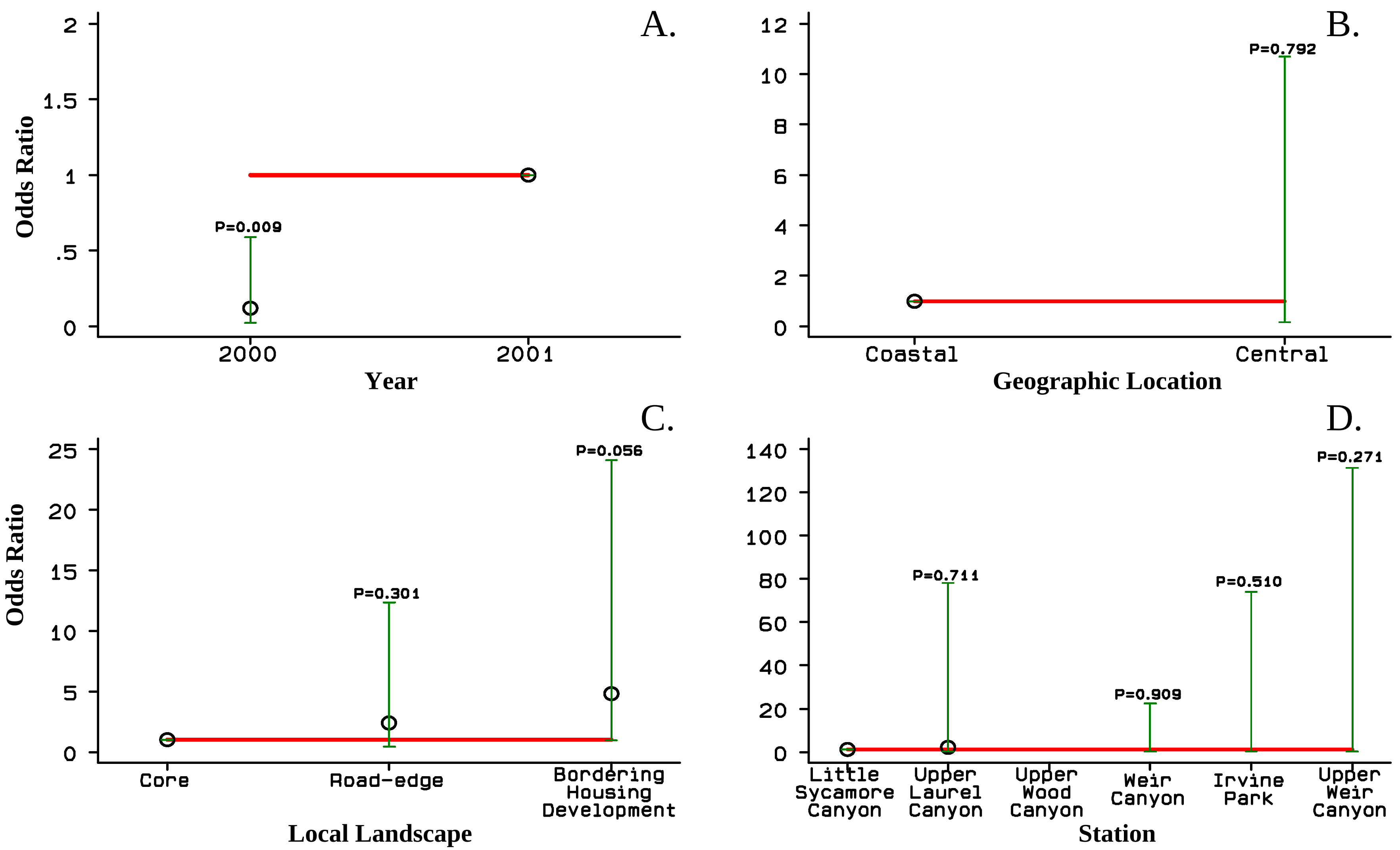

Figure 5. The odds ratios for productivity indices (with 95% confidence intervals) for **House Wren** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

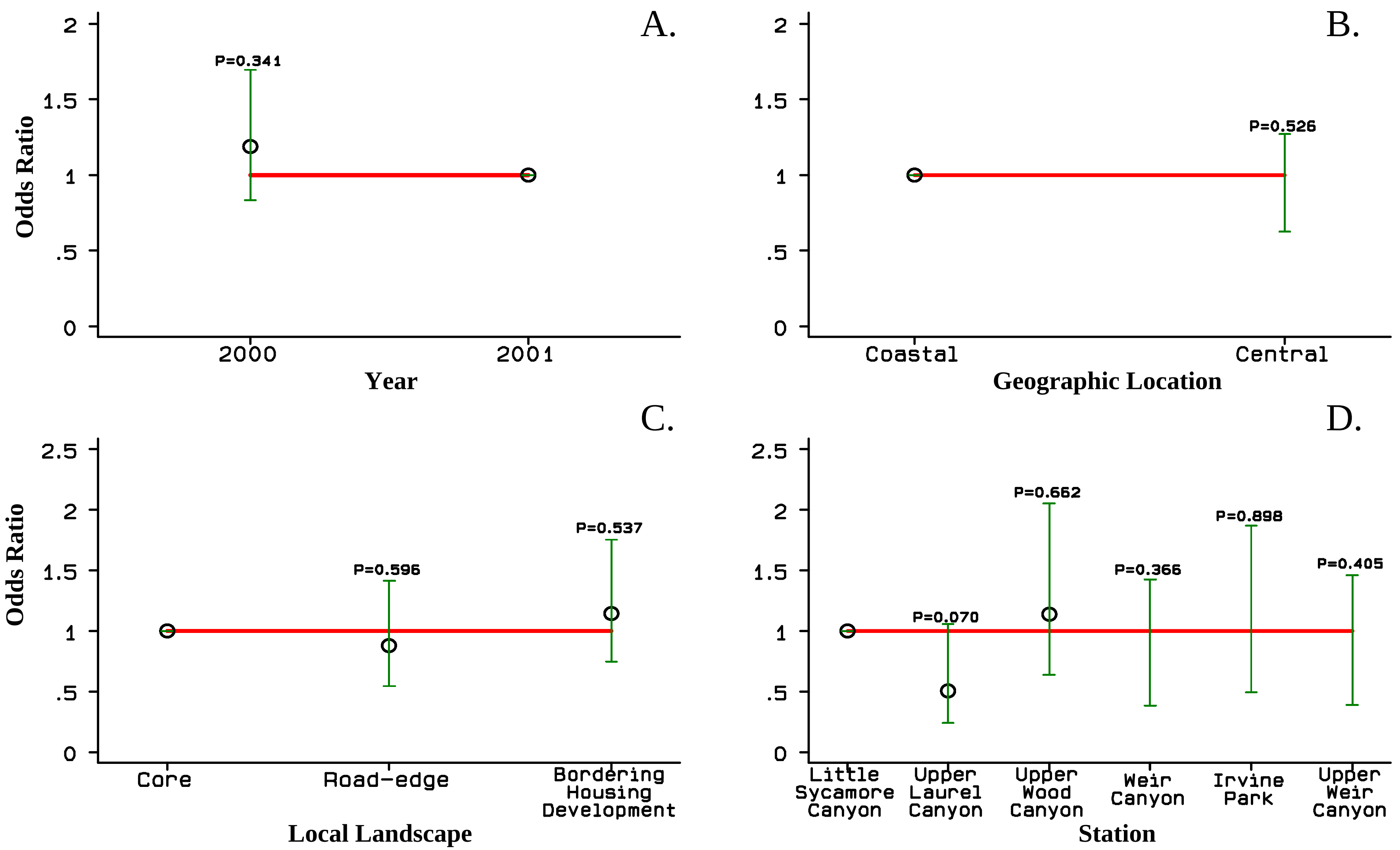

Figure 6. The odds ratios for productivity indices (with 95% confidence intervals) for **Wrentit** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

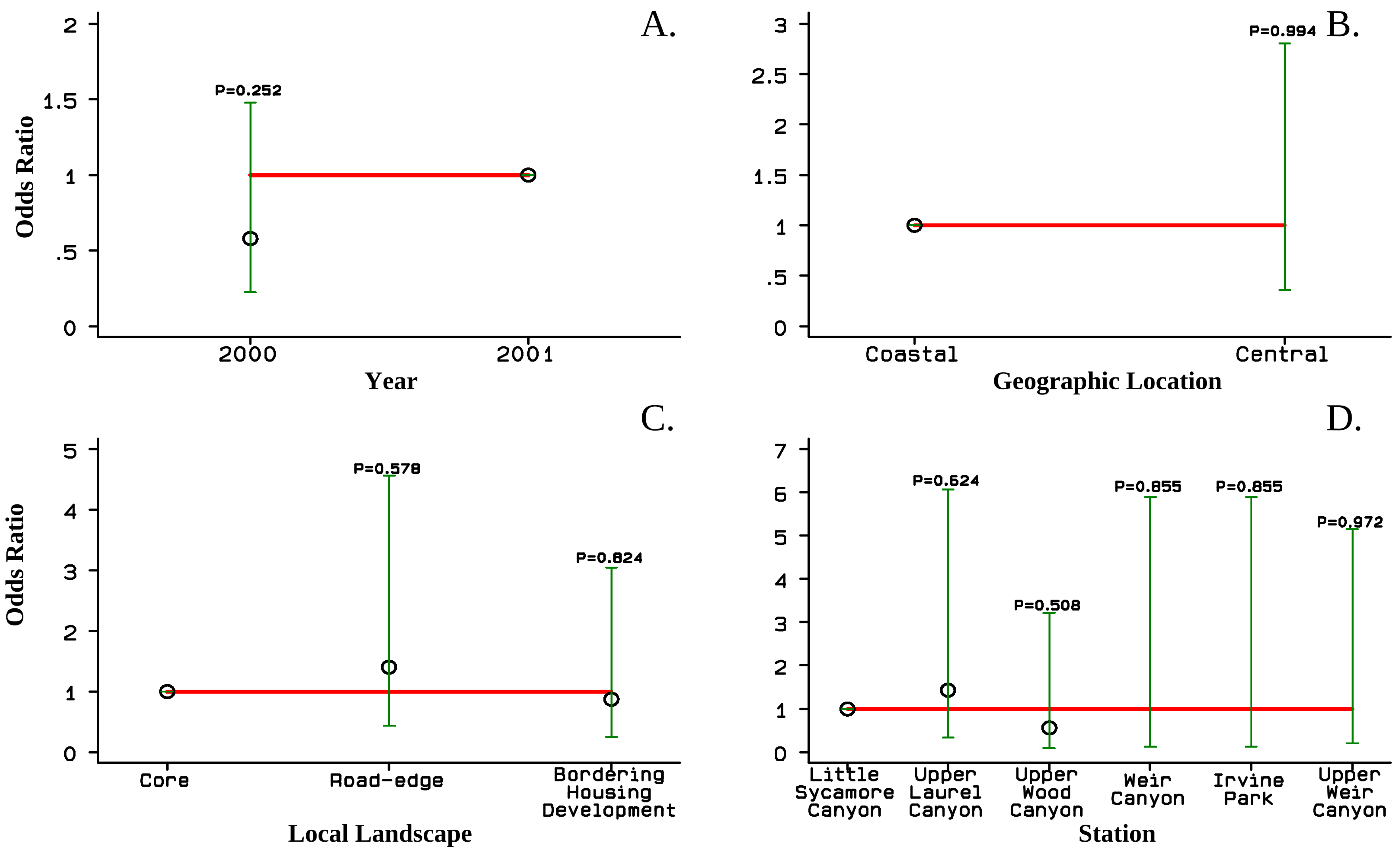

Figure 7. The odds ratios for productivity indices (with 95% confidence intervals) for **California Thrasher** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

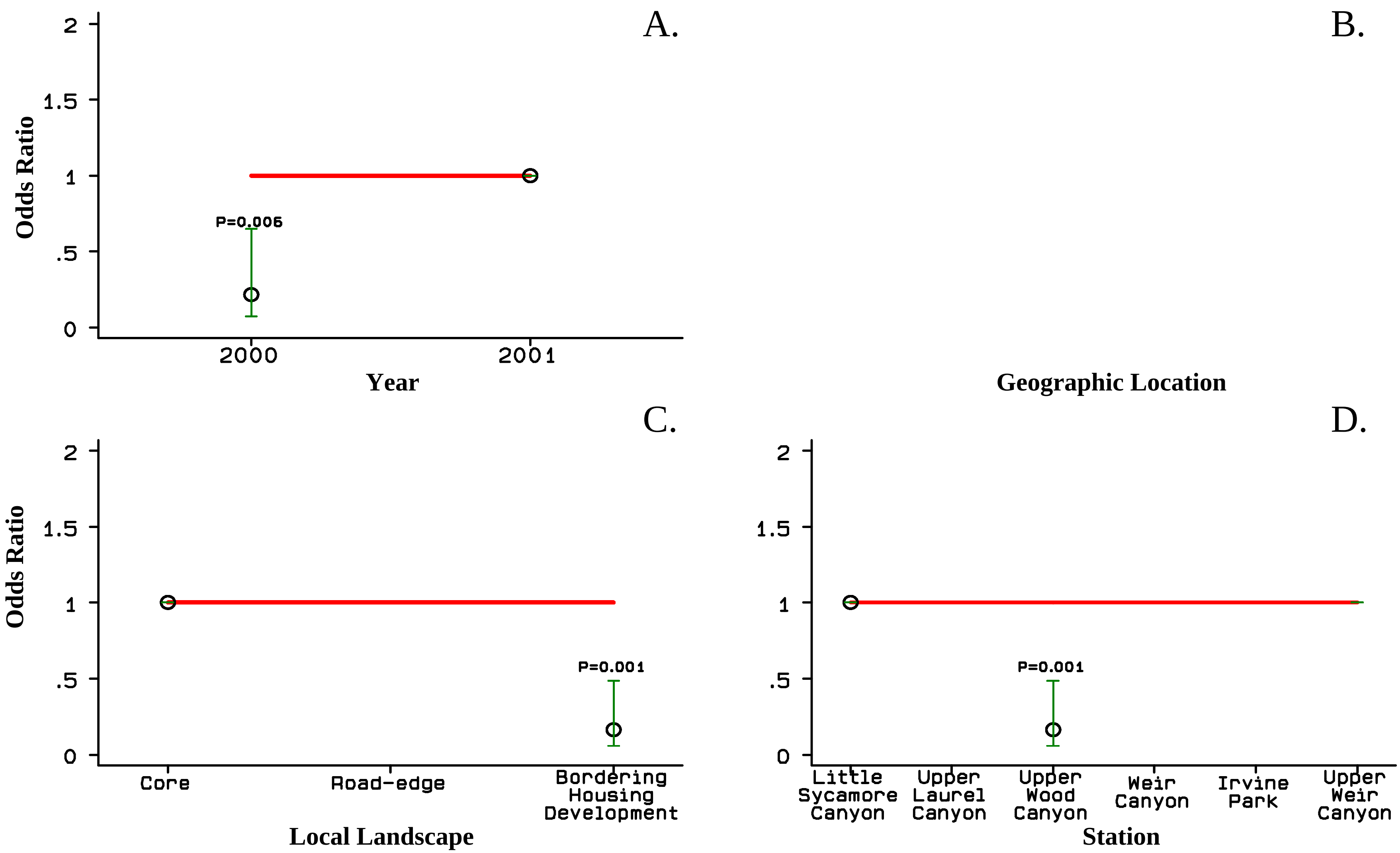

Figure 8. The odds ratios for productivity indices (with 95% confidence intervals) for **Orange-crowned Warbler** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. Because both of the stations included in these analyses occur in the same geographic location, B is not presented as no probabilities could be calculated. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

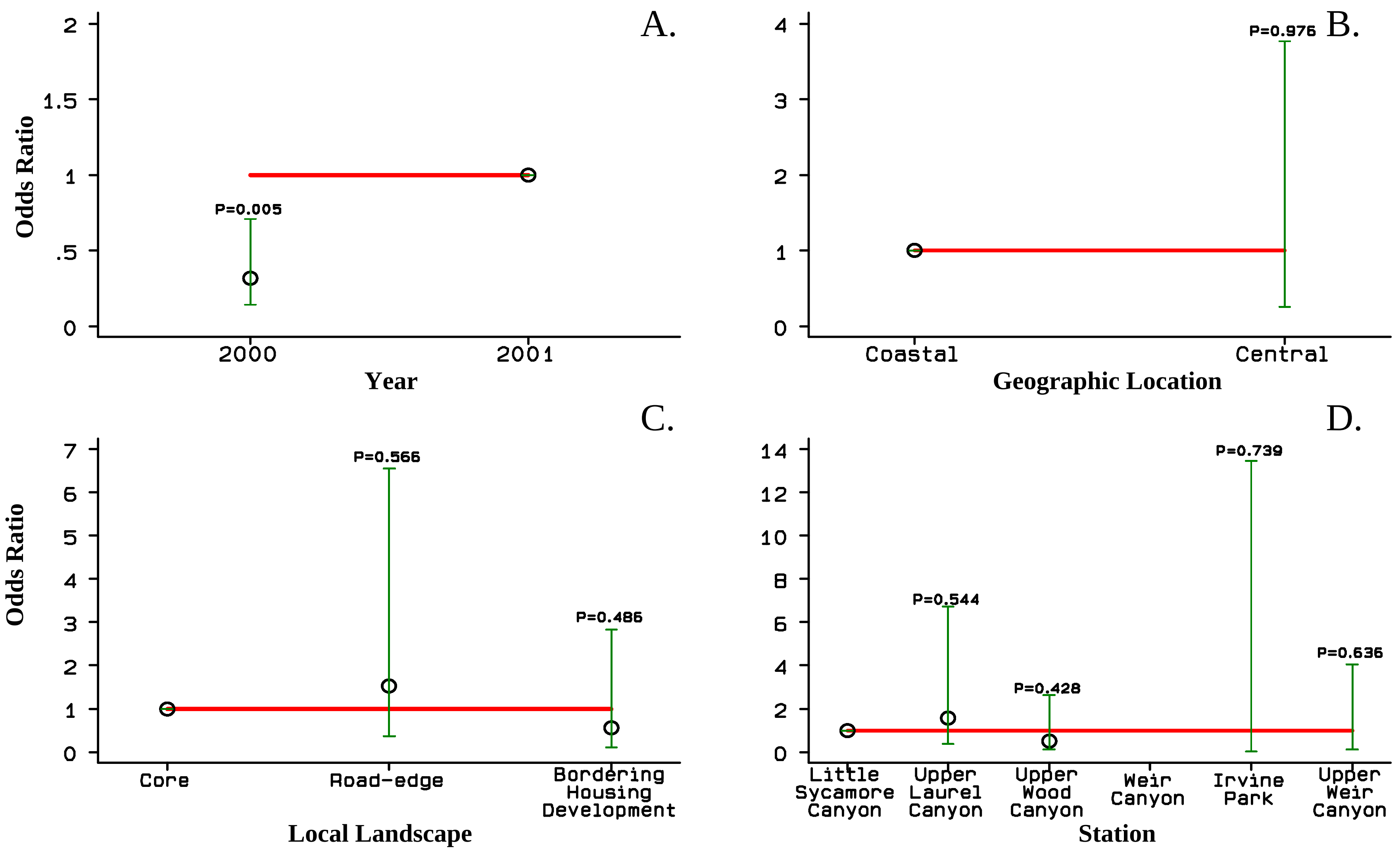

Figure 9. The odds ratios for productivity indices (with 95% confidence intervals) for **Common Yellowthroat** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

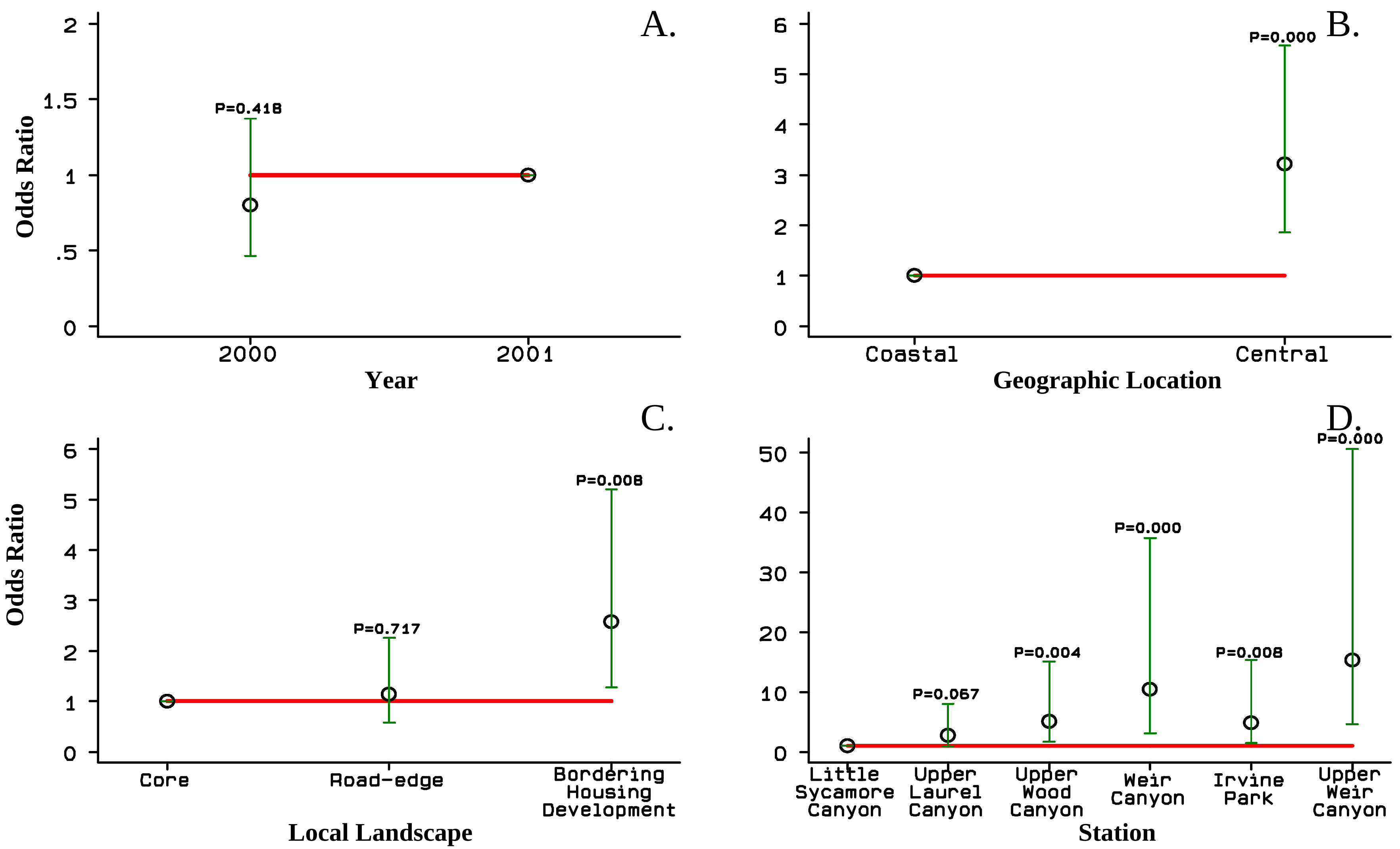

Figure 10. The odds ratios for productivity indices (with 95% confidence intervals) for **Spotted Towhee** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

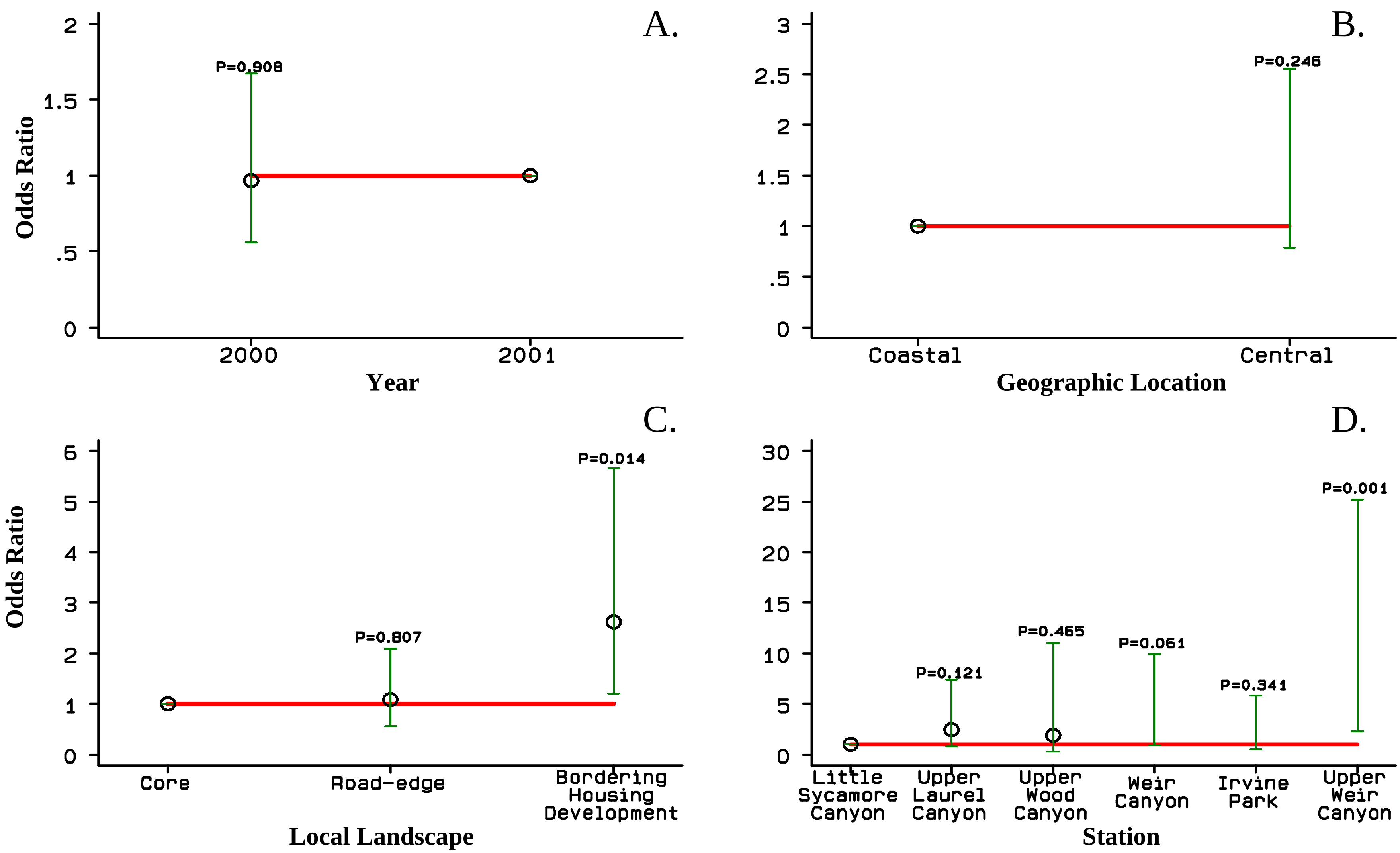

Figure 11. The odds ratios for productivity indices (with 95% confidence intervals) for **California Towhee** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

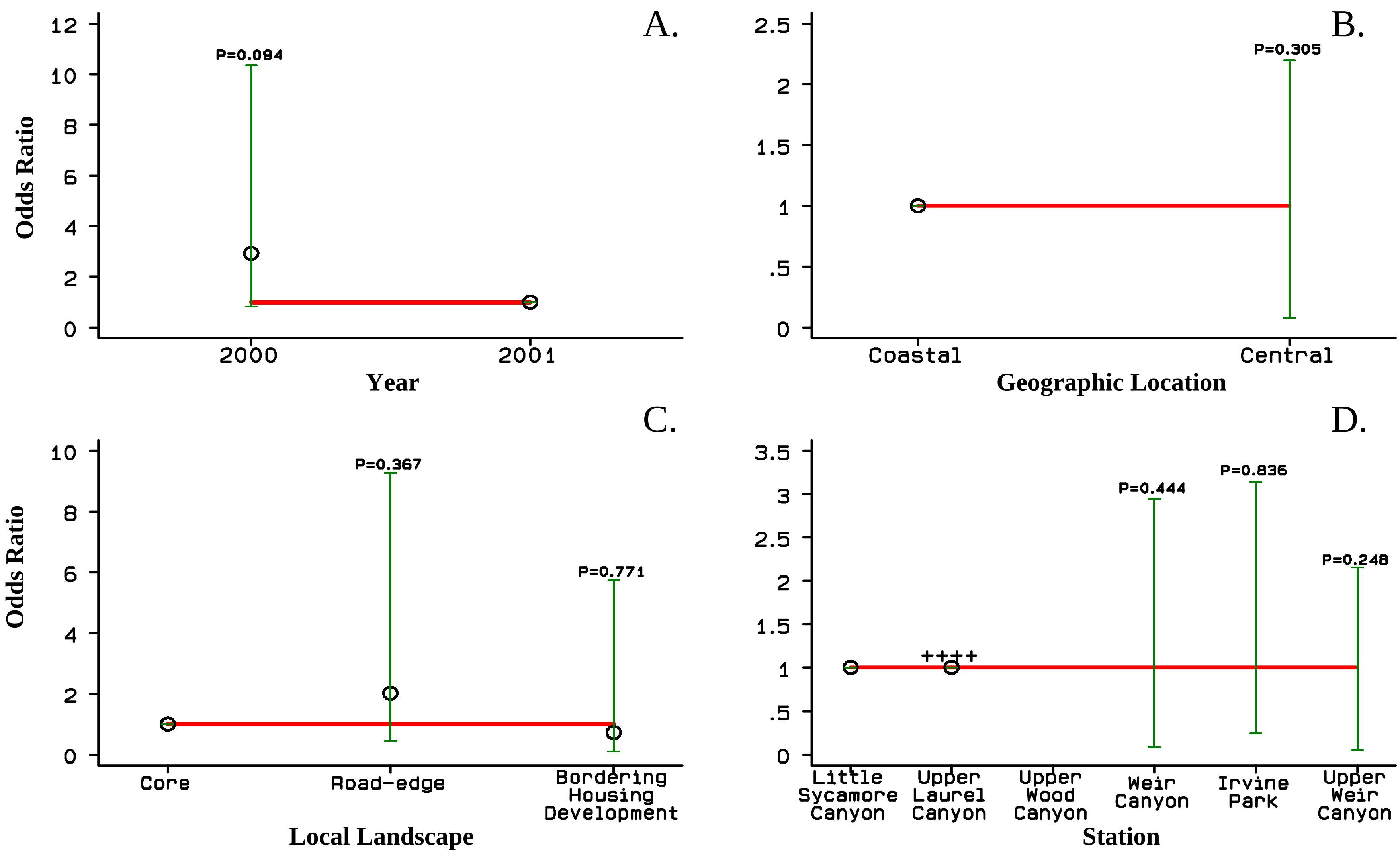

Figure 12. The odds ratios for productivity indices (with 95% confidence intervals) for **Rufous-crowned Sparrow** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. Only young birds were captured at Upper Laurel Canyon so no odds ratio can be calculated. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

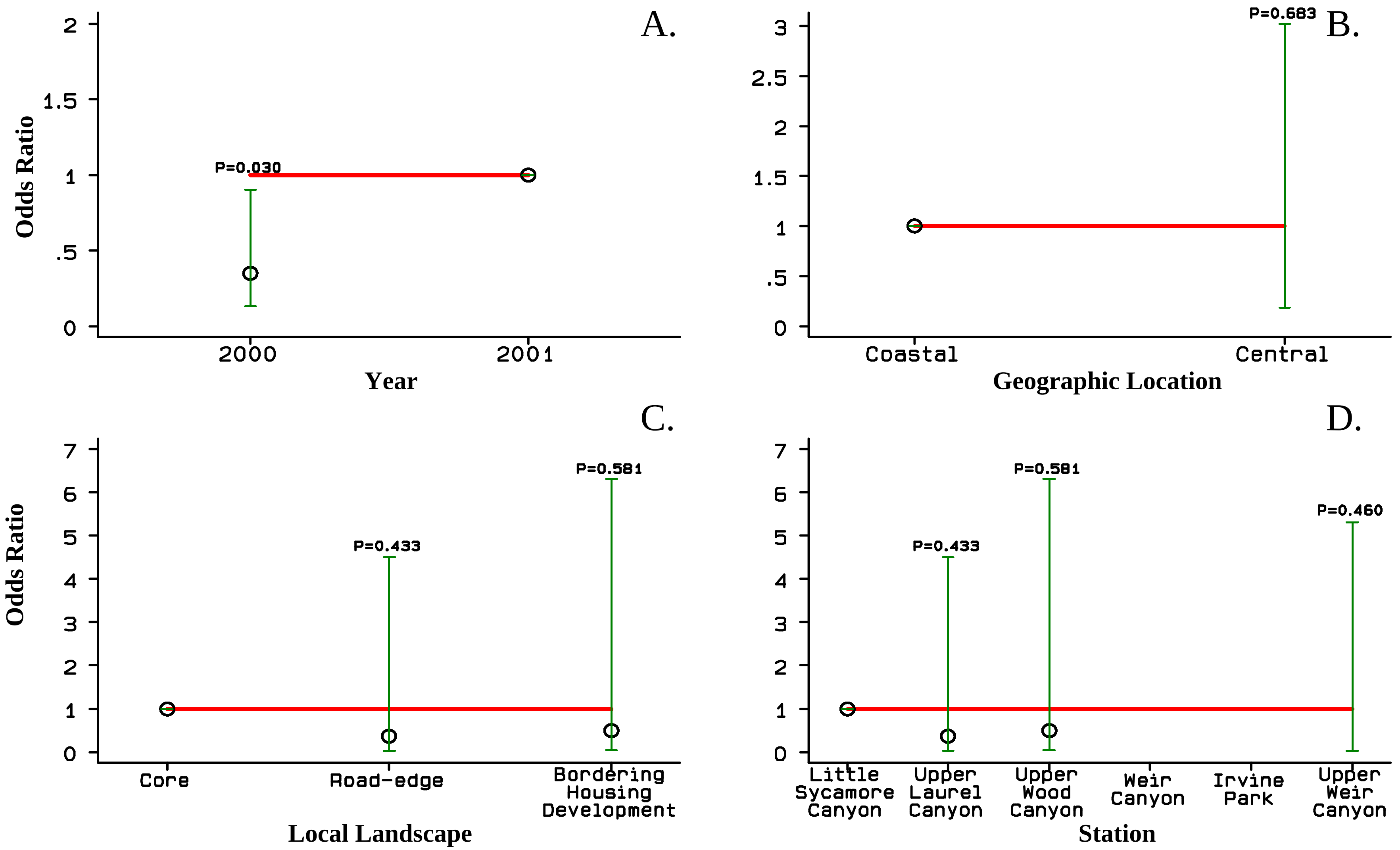

Figure 13. The odds ratios for productivity indices (with 95% confidence intervals) for **Song Sparrow** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

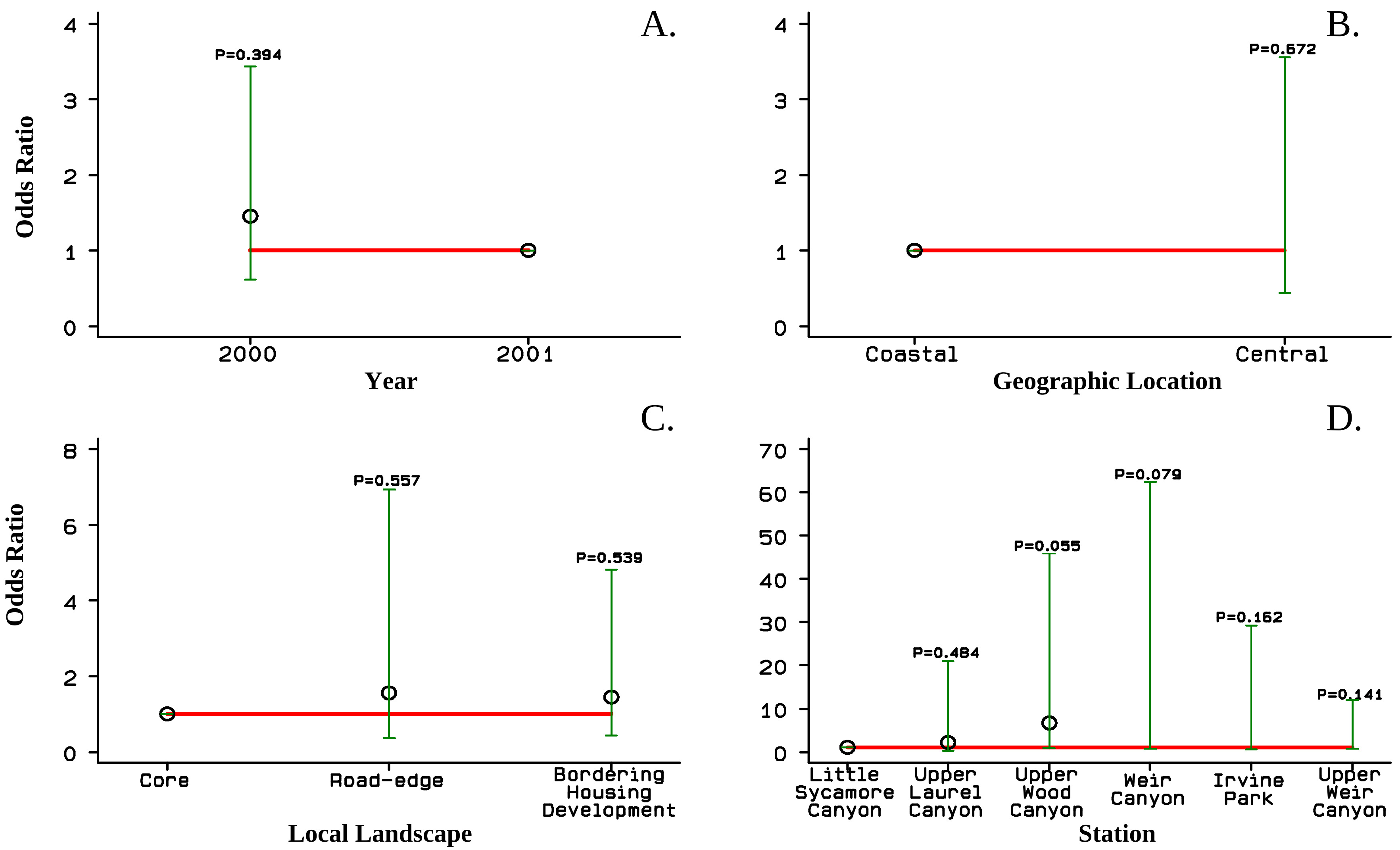

Figure 14. The odds ratios for productivity indices (with 95% confidence intervals) for **House Finch** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

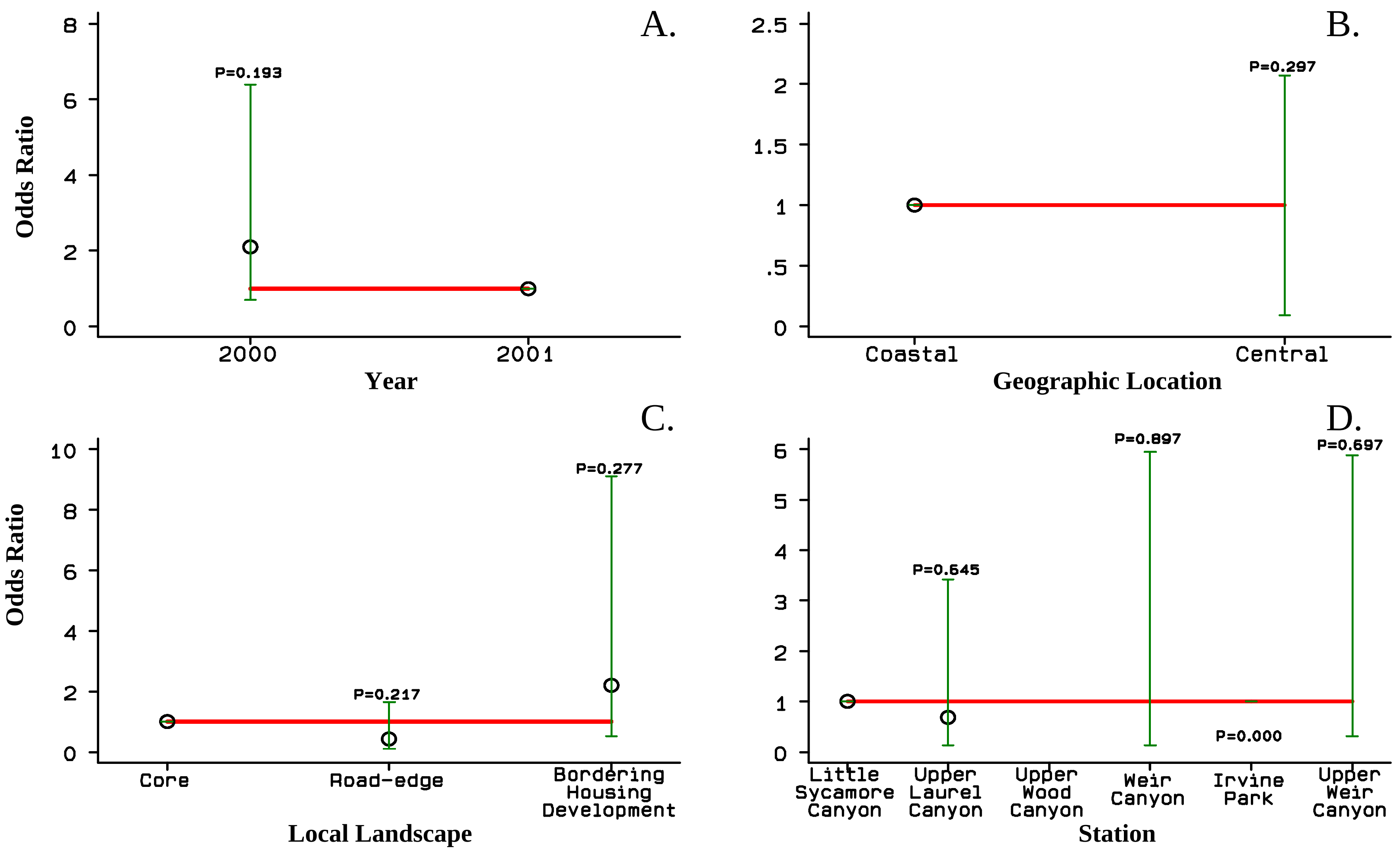

Figure 15. The odds ratios for productivity indices (with 95% confidence intervals) for **Lesser Goldfinch** at the Nature Reserve of Orange County for the design variables: A. year; B. geographic location; C. local landscape; and D. station. The odds ratios for each design variable were estimated using multivariate logistic regression. The regressions for graphs A (year), B (geographic location), and C (local landscape) each include the factors year, geographic location, and local landscape. The regression for graph D (station) only includes the factors year and station. For each design variable, the estimated odds ratios are compared to a reference value set at 1.0, and the reference point (lacking a 95% confidence interval) and a reference line are plotted for ease of comparison.

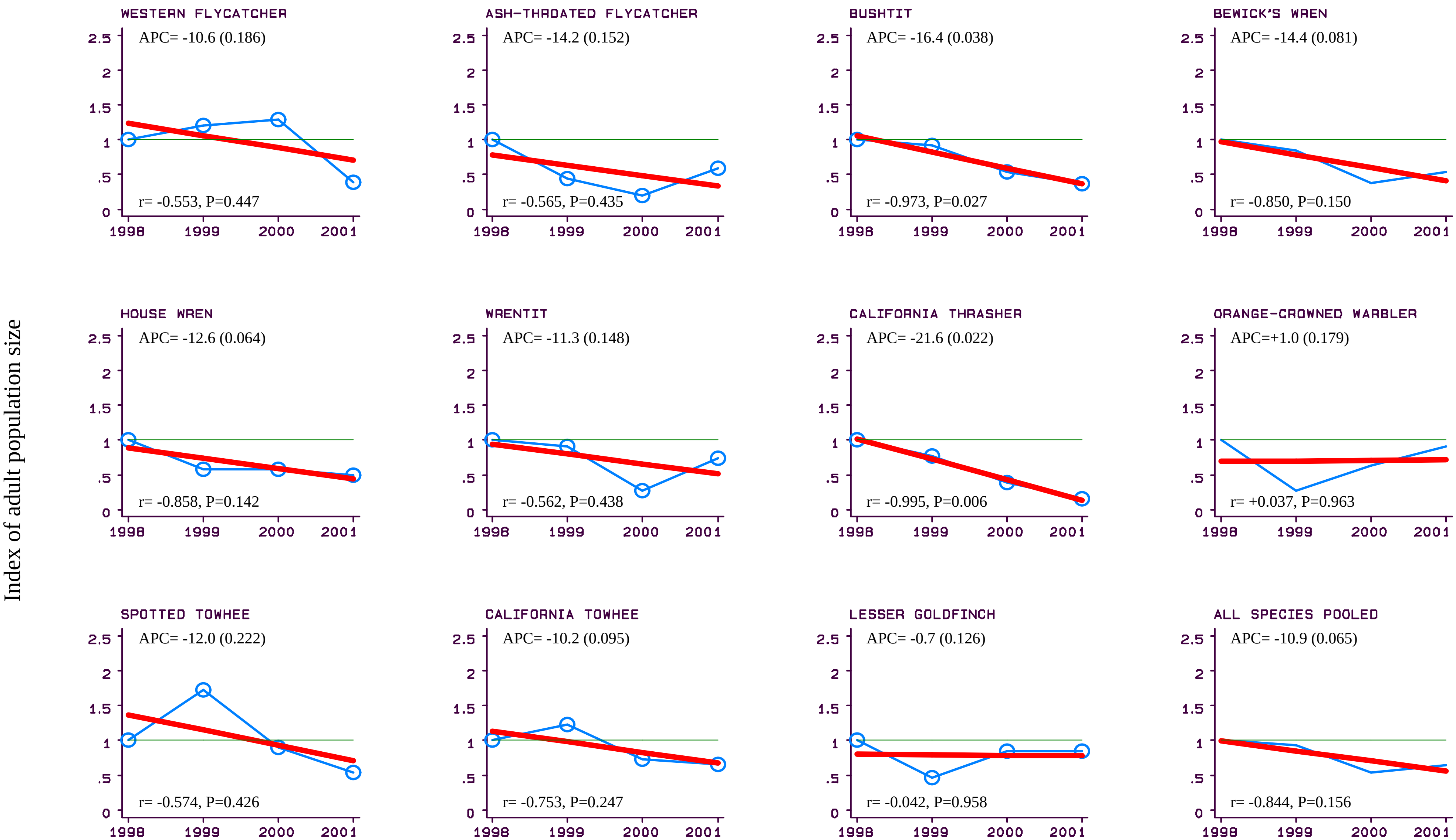

Figure 16. Population trends for 11 species and all species pooled at the Little Sycamore Canyon and Weir Canyon stations on the Nature Reserve of Orange County over the four years 1998-2001. The index of population size was arbitrarily defined as 1.0 in 1998. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (*APC*), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are also shown on each graph.

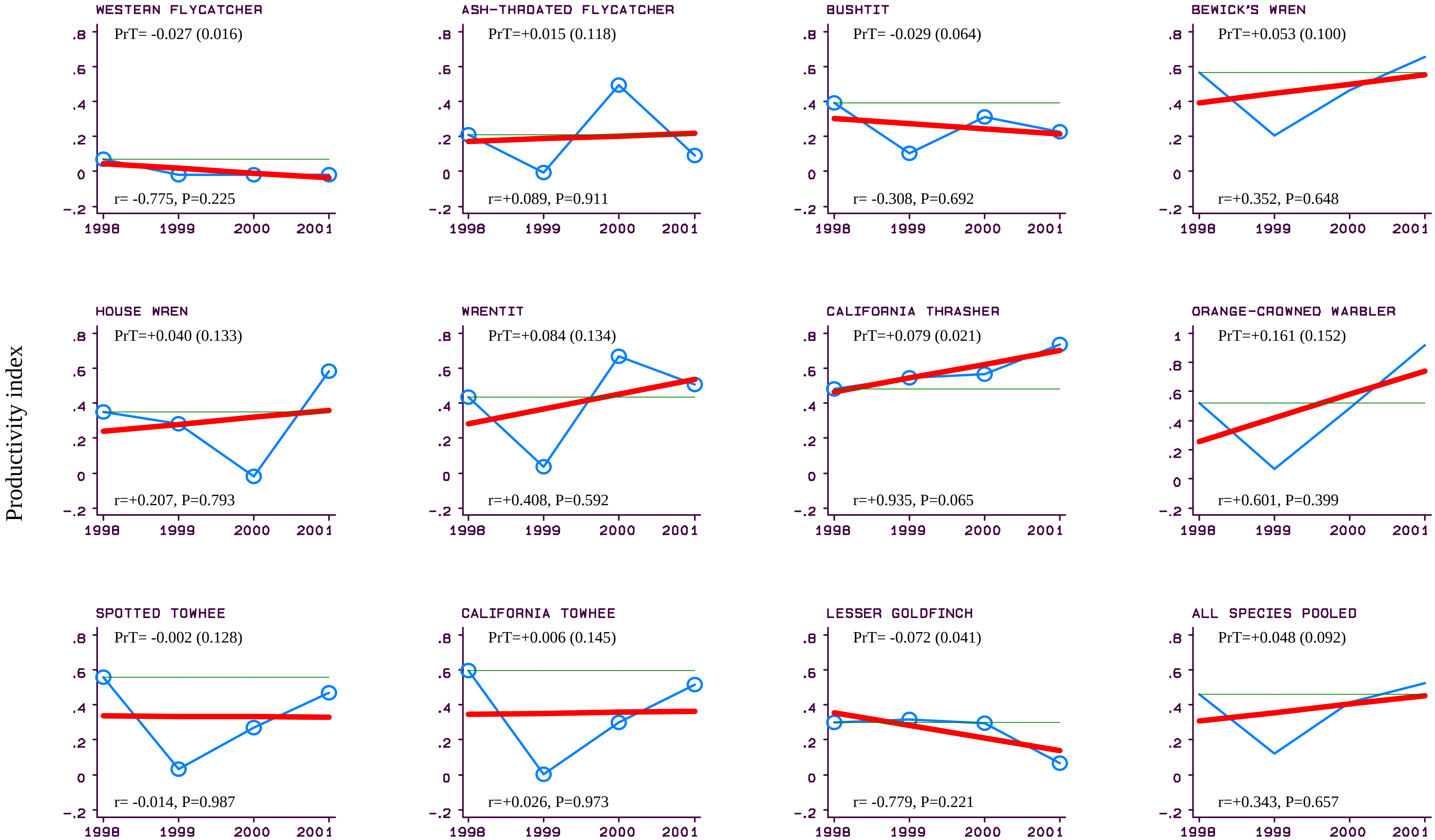

Figure 17. Trends in productivity for 11 species and all species pooled at the Little Sycamore Canyon and Weir Canyon stations on the Nature Reserve of Orange County over the four years 1998-2001. The productivity index was defined as the actual productivity value in 1998. Indices for subsequent years were determined from constant-effort between-year changes in proportion of young in the catch from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (*PrT*), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are also shown on each graph.