THE 2000 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM AT THE NATURE RESERVE OF ORANGE COUNTY

David F. DeSante, Peter Pyle, and Danielle O'Grady

THE INSTITUTE FOR BIRD POPULATIONS
P.O. Box 1346
Point Reyes Station, CA 94956-1346

(415) 663-1436

ddesante@birdpop.org

April 18, 2001

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 six MAPS stations on The Nature Reserve of Orange County (NROC) in 2000 at the same locations at which they were operated or established in 1999. Two of the six stations were first operated in 1998, two of them in 1999, and two of them had their first full year of 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 1 and August 4. A total of 1280 birds of 52 species were banded at the six stations during the summer of 2000, various individuals were recaptured a total of 186 times, and 385 birds were captured and released unbanded. Thus, a total of 1851 captures of 60 species was recorded.

Capture data indicate that the three stations in NROC's coastal reserve generally had higher breeding landbird populations in 2000 than the three stations in the central reserve. In both reserves, the road-edge stations had correspondingly higher breeding populations than the core stations, while the newly established, housing stations appeared to have either intermediate or high breeding populations. Productivity indices, however, tended to show the opposite patterns, at least as far as geographical location was concerned. In each case, productivity on the central reserve was higher than on the coastal reserve. More years of data from these six stations will be needed to confirm these initial findings.

Analyses of constant-effort data indicated that adult population sizes decreased by -35.1% on both a reserve-wide and a species-wide basis between 1999 and 2000. In contrast, the number of young birds captured and productivity (proportion of young in the catch) increased substantially and significantly, by +230.2% and +255.6%, respectively, between 1999 and 2000. These patterns were noted at all four of the stations operated in both 1999 and 2000. The decreases in breeding populations in 2000 are likely attributable to decreased recruitment resulting from the low productivity noted in 1999. It is likely that the combination of a larger proportion of experienced breeders and less competition for food resources among breeding individuals resulted in the substantial and significant increase in productivity between 1999 and 2000.

Three years of data indicate that an alternating “productivity/population” correlation may be manifest at NROC, with lower breeding populations and higher productivity occurring in even-numbered years such as 2000. 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 in 2001.

This, alternating “productivity/population” dynamic has been shown to be characteristic of regions that appear to lack dramatic interannual weather effects. At other MAPS stations, disruptions of this alternating cycle have appeared to be related to unusually favorable or unfavorable weather. We have been able to examine the relationship between global climate patterns and productivity by comparing annual productivity values with the mean monthly Southern Oscillation Index (a measure of the effects El Niños and La Niñas). In western regions, 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 also possible that the La Niña event of 1999 caused productivity to be lower than expected at NROC.

With only three years of data from only two stations, survival estimates were obtained for only five species in 2000. Although reasonable survival estimates were calculated, the mean precision of these estimates (CV=57.7%) was quite low. We expect to see substantial improvements in the precision of our survival-rate estimates as additional years (up to about 12 years) of data accumulate from all six stations. We expect to be able to estimate adult survival rates for as many as 14 target species once data from all six stations are available.

Results of the first three years of the MAPS Program in NROC indicate that important information on the annual indices and estimates and the between-year changes and short-term trends in adult population size, productivity, and survivorship can be obtained for at least 14 key target species (and probably 20 or more once data from all six stations have accumulated) at NROC. 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 beyond.

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 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 numerous species at multiple spatial scales. Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area surrounding 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. Our long-term goal is to implement these analyses with data from NROC.

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 six 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 in 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 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 ecological 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-inhabiting 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 (species 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.

Now in its twelfth year (ninth year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to about 500 stations in 2000. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies in PIF, 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. Additionally, many private bird banders and ornithologists interested in monitoring populations on private lands such as nature reserves have established MAPS stations.

Goals and Objectives of MAPS

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

- The specific monitoring objectives of MAPS are to provide, for over 100 target species, including 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, and recruitment into the adult population from modified Cormack- Jolly-Seber analyses of mark-recapture data on adult birds.

! The specific research objectives 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 objectives 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 goals of MAPS are to achieve the above-outlined objective 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. 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 military installations, national parks, national forests, or nature reserves) to aid research and management efforts within the installations, parks, forests, or reserves 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 both 1999 and 2000. It is expected that information from the MAPS program will be capable of obtaining integrated data on avian population trends and their potential causes, information that is required to inform the NROC's "adaptive management" program with the overall goal of conserving avian biodiversity within the NROC over the long term.

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 northwest 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.

Six MAPS stations were established and operated in NROC in 2000 in the same locations where they were established in 1998 or 1999. Two stations (Little Sycamore Canyon and Weir Canyon) have been operated for three years (1998-2000). 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 all six stations were run, including two stations (Upper Wood Canyon and Upper Weir Canyon) operated for their first full year. Three stations (Little Sycamore Canyon, Upper Laurel Canyon, and Upper Wood Canyon) are located in the NROC's coastal reserve and three stations (Weir Canyon, Irvine Park, and Upper Weir Canyon) are located in NROC's central reserve. Within each reserve, one station is designated as the core station (Little Sycamore Canyon and Weir Canyon) and is located within interior regions of the reserves; one station is designated as the "road-edge" station (Upper Laurel Canyon and Irvine Park) and is located within 300 m of transportation corridors; and one station is designated as the housing station (Upper Wood Canyon and Upper Weir Canyon) and is located within 300 m of suburbs with houses. All six stations were established in relatively mature, coastal sage scrub habitat; four of the stations contained scattered large shrubs and coast live oaks, whereas the two housing stations (Upper Wood Canyon and Upper Weir Canyon) were in pure scrub or scrub/grassland, lacking oak woodland. A summary of the major habitats represented at each of the six stations is presented in Table 1.

In 2000, the NROC stations were operated by MAPS field biologist interns as assisted by the supervising biologist Melanie Madden and a number of trained volunteers. The 2000 NROC field biologist interns, Zsolt Kahancza and Teresa Wicks, received 10 days of intensive training in a comprehensive course in mist netting and bird-banding techniques given by IBP biologist Pilar Velez, which took place April 23-30 at Starr Ranch, Trabuco Canyon, Orange County. Pilar and the interns arrived at NROC on April 30 to re-establish the stations. Data collection began on May 1, and all six stations were re-established by May 9. Teresa Wicks departed during the fifth banding period (mid-June), after which Zsolt Kahancza completed the season with the help of Melanie Madden and with some help in recording data and setting up and taking down nets from the other volunteers.

All ten net sites at each station were re-established without excessive difficulty at the exact same locations as in 1999. One 12-m, 30-mm-mesh, 4-tier, nylon mist net was erected at each of the ten net sites on each day of operation. Each station was operated for six morning hours per day (beginning at local sunrise) on one day in each of seven 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 2000 NROC MAPS Program at each of the six stations is presented in Table 1.

METHODS

The operation of each of the six stations during 2000 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. 2000). 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 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 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 six 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 new MAPS Habitat Structure Assessment Protocol, developed by IBP Landscape Ecologist, Philip Nott (Nott, 2000a).

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. Data for a given species from a given station were included in productivity and survivorship analyses only if the species was classified as a regular (B) or usual (U) breeder at the station. Data from a station for a species classified as an occasional breeder (O), a transient (T), or a migrant (M) at the station were not included in these analyses.

A. Population-size and productivity analyses -- The proofed, verified, and corrected banding data from 2000 were run through a series of analysis programs that calculated for each species and for all species combined 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 2000) 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 number of young birds captured and the proportion of young in the catch were used as indices of post-fledging productivity.

For the four stations that were run throughout the 1999 season, we calculated changes between 1999 and 2000 in the indices of adult population size and post-fledging productivity and determined the statistical significance of any changes that occurred according to methods developed by the BTO in their CES scheme (Peach et al. 1996). 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 a time when that net was not operated in that period in the other year; comparisons between 1999 and 2000 at NROC could only be performed at the four stations operated during both years. For species captured at several stations in NROC, the significance of reserve-wide annual changes in the indices of adult population size and post-fledging productivity was inferred statistically using confidence intervals derived from the standard errors of the mean percentage 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 $0.05 \leq P < 0.10$.

We selected target species which were breeders and usual breeders and for which at least seven individual adults were captured per year at all constant-effort stations combined. For these target species and for all species pooled we provide summaries of constant-effort comparisons during the three-year period 1998-2000. Comparisons between 1998 and 1999 were made using only data from the two stations (Little Sycamore Canyon and Weir Canyon) that were operated in both those years. Comparisons between 1999 and 2000 were made using data from all four stations that were operated throughout both of those two years (all but Upper Wood Canyon and Upper Weir Canyon). These comparisons are presented for adults captured, young captured, and productivity indices (proportion of young in the catch).

B. Survivorship analyses -- Modified Cormack-Jolly-Seber mark-recapture analyses (Pollock et al. 1990, Lebreton et al. 1992) were conducted using the computer program SURVIV (White 1983) on three years of banding data (1998-2000) from the two long-running stations (Little Sycamore Canyon and Weir Canyon) for target species which were regular or ususal breeders at the station, and for which, on average, at least seven individual adults per year were recorded during periods one through ten at the two stations combined.

Using SURVIV, we estimated survivorship parameters for each of the target species using the non-transient model, the only possible model that can be applied to three years of data. Once four years of data have accumulated we will be able to run transient models, which account for the presence of transient adults (migrant and floater individuals which are only captured once) in the sample of newly captured birds (Pradel et al. 1997). The transient model provides the most unbiased survivorship estimates for all species, provided there is sufficient years of data (four) to use it. The transient model calculates maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability (φ), adult recapture probability (P), and proportion of residents among newly-captured adults (τ); in the non-transient model the proportion of residents cannot be estimated and is set at 1.0 (100%). 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. These estimates were derived from the capture histories of all adult birds for each target species captured at all stations at which they were classified as regular (B) or usual (U) breeders (see above).

RESULTS

A total of 3596.8 net-hours was accumulated at the six MAPS stations operated in NROC in 2000 (Table 1). Because only four of the six stations were operated in both years, data from only 2196.5 of these net-hours could be compared directly to 1999 data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

A. 2000 values -- The 2000 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 six stations in Table 2. The greatest number of total captures was recorded at the Upper Laurel Canyon station (434), while Weir Canyon produced the smallest number (187). The highest species richness, 43 species, was also recorded at the Upper Laurel Canyon station while species richness was lowest at Irvine Park, with 26 species.

In order to standardize the number of captures for variability in mist-netting effort expended at the stations (due to unsuitable weather conditions and accidental net damage; see Table 1), we present the capture rates (per 600 net-hours) of individual adult and young birds as well as the percentage of young in the catch for each species and for all species pooled at each station in Table 3. These capture indices indicate that the total adult population size in 2000 was greatest at Upper Laurel Canyon, followed in descending order by Upper Wood Canyon, Upper Weir Canyon, Little Sycamore Canyon, Irvine Park, and Weir Canyon. Captures of young (Table 3) of all species pooled at each station in 2000 followed a different sequence to that of adults, being highest at Upper Weir Canyon, followed by Upper Laurel Canyon, Upper Wood Canyon, Weir Canyon, Irvine Park, and Little Sycamore Canyon. Due to the variation in adults and young captured by station, the index of productivity (Table 3), as determined by the percentage of young in the catch, followed yet a different sequence. Productivity was highest at Weir Canyon (0.54) followed by Upper Weir Canyon (0.52), Upper Wood Canyon (0.45), Irvine Park (0.44), Upper Laurel Canyon (0.39), and Little Sycamore Canyon (0.28).

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 2000 (see Table 3):

Little Sycamore Canyon
- Spotted Towhee
- Bushtit
- Pacific-slope Flycatcher
- California Towhee
- Wrentit
- Orange-crowned Warbler
- Lesser Goldfinch
- Yellow Warbler

Irvine Park
- Wrentit
- California Towhee
- Spotted Towhee
- Lesser Goldfinch

Weir Canyon
- California Towhee
- Wrentit
- House Wren
- Spotted Towhee

Upper Laurel Canyon
- Spotted Towhee
- Lesser Goldfinch
- California Towhee
- Common Yellowthroat
- Song Sparrow
- Lawrence's Goldfinch
- Bushtit
- Wrentit
- Pacific-slope Flycatcher

Upper Wood Canyon
- Wrentit
- Spotted Towhee
- Orange-crowned Warbler
- Common Yellowthroat
- Bushtit
- Song Sparrow
- Lesser Goldfinch

Upper Weir Canyon
- Wrentit
- House Finch
- Lesser Goldfinch
- Bushtit
- California Towhee
- Western Scrub-Jay

Table 4 summarizes the banding results at all six 2000 NROC MAPS stations combined. Altogether, a total of 1851 birds of 60 species were captured during the 2000 breeding season. Newly-banded birds comprised 69.2% of the total captures. Overall, Wrentit was the most frequently captured, followed by Spotted Towhee, California Towhee, Bushtit, Lesser Goldfinch, Swainson's Thrush, Bewick's Wren, Anna's Hummingbird, and California Thrasher. The 11 most abundant breeding species at the six NROC MAPS stations in 2000 (as determined by adults captured per 600 net-hours), in decreasing order, were Wrentit, California Towhee, Spotted Towhee, Bushtit, Lesser Goldfinch, House Finch, Pacific-slope Flycatcher, Common Yellowthroat, Song Sparrow, Bewick's Wren, and California Thrasher.

B. Comparisons between 1999 and 2000 -- Constant-effort comparisons between 1999 and 2000 were undertaken at four of the six NROC MAPS stations (those operated throughout 1999) 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 nearly significant -35.1% between 1999 and 2000 (Table 5). Decreases were recorded for 22 of 41 species, a proportion not significantly greater than 0.50 (Table 5, $P = 0.318$). The overall adult population size for all species pooled decreased at each of the four stations by amounts ranging from -10.2% at Upper Laurel Canyon to -61.5% at Weir Canyon. The proportion of decreasing species was significantly greater than 0.50 at Weir Canyon and near-significantly greater than 0.50 at Irvine Park. Significant ($P<0.05$) or near-significant ($0.05<P<0.1$) decreases in the number of adults captured for all stations combined were recorded for Ash-throated Flycatcher, Oak Titmouse, Bushtit, Bewick's Wren, Wrentit, Common Yellowthroat, California Towhee, and Rufous-crowned Sparrow, while no such increases were recorded. The near significant decrease in all species pooled, the significant or near-significant proportion of decreasing species at two of the four stations, and the eight individual species that significantly or near-significantly decreased (compared with none that increased), reflects a general decrease in adult populations in 2000 that was both reserve wide and species wide.

The number of young birds captured of all species pooled at all four stations combined increased between 1999 and 2000, by a significant +230.2% (Table 6). Increases were recorded for 22 of 28 species, a proportion highly significantly greater than 0.50 (Table 6, $P = 0.002$). Captures of young for all species pooled increased at each of the four stations by amounts ranging from +105.3% at Little Sycamore Canyon to +385.7% at Weir Canyon. The proportion of increasing species was significantly greater than 0.50 at Weir Canyon, Irvine Park, and Upper Laurel Canyon. A significant ($P<0.05$) increase in the number of young captured for all stations combined was recorded for Spotted Towhee, while no such decreases were recorded.

With adult populations decreasing and numbers of young increasing, productivity (the proportion of young in the catch) showed a significant absolute increase of +0.276 (+255.5%) from 0.108 in 1999 to 0.384 in 2000, for all species pooled and all stations combined (Table 7). Increases in productivity were noted at all four stations, by absolute values ranging from +0.151 at Little Sycamore Canyon to +0.447 at Weir Canyon. The proportion of species with increasing productivity was significantly greater than 0.50 at Weir Canyon. Six species (Bushtit, Wrentit, Spotted Towhee, California Towhee, Rufous-crowned Sparrow, and Lazuli Bunting) showed significant or near-significant increases in productivity across all stations, whereas only one species, House Wren, showed a significant decrease. As with the decrease in adult populations the increase in productivity was generally both reserve-wide and species wide.

C. Three-year Trends in Adult Population Size and Productivity -- Table 8 presents annual indices and year-to-year changes in numbers of adult and young birds captured and proportion of young in the catch for 14 target species for which an average of at least seven individual adults per year were captured at all stations combined over the three years 1998-2000. The annual indices presented in this table are based on all captures during MAPS Periods 1-10 in the given year, while the year-to-year changes are based only on constant-effort data. Note that the 1998 indices and 1998-1999 comparison involve just two stations, whereas the 1999-2000 indices and comparison involve four stations; this explains why the constant-effort comparisons between 1998 and 1999 do not reflect changes in the indices as presented. In addition, the year-to-year changes presented in Table 8 are based on data for a given target species only from stations where the species was a regular or usual breeder. In contrast, the data presented in Tables 5-7 includes stations where the species was an occasional breeder or transient. Thus, the calculated indices of adults, young, and productivity, as well as the year-to-year differences, presented in Table 8 may differ from those in Tables 5-7.

Adult population sizes of all species pooled decreased during both between-year comparisons, with the 1999-2000 decrease being substantially larger than the 1998-1999 decrease. Decreases during both comparisons were shown by eight species (Ash-throated Flycatcher, Bushtit, Bewick's Wren, House Wren, Wrentit, California Thrasher, Orange-crowned Warbler, and Rufous-crowned Sparrow) whereas just one species (Pacific-slope Flycatcher) showed increases during both comparisons. Ten species showed larger decreases (or smaller increases) in 1999-2000 than in 1998-1999 while only four species showed the opposite pattern.

Table 8 indicates that captures of young and productivity both decreased substantially between 1998 and 1999 and increased substantially between 1999 and 2000. Only five species did not show this pattern fully, Pacific-slope Flycatcher and House Wren (which showed decreases in both between-year comparisons), California Thrasher and Common Yellowthroat (which showed increases [or no change] in both comparisons) and Lesser Goldfinch (which showed mixed patterns but showed the opposite pattern for productivity, increasing between 1998 and 1999 and decreasing between 1999 and 2000).

Estimates of Adult Survivorship

Using three years of data (1998-2000) from the two long-running stations (Little Sycamore Canyon and Weir Canyon), estimates of adult survival and recapture probabilities could be obtained for only five of the 14 target species breeding in NROC (Table 9). Estimates of survival probability will undoubtedly be available for many more species once data from additional years and stations are included in the analyses. In addition, three years of data only allow us to present estimates from time-constant non-transient models, those in which the proportion of residents has been set at 1.0 (see Methods).

Table 9 presents the maximum-likelihood estimates of annual adult survival probability and recapture probability for the time-constant, non-transient model for each of the five species. Survivorship estimates ranged from a low of 0.426 for Bewick's Wren to a high of 0.823 for Spotted Towhee, with a mean of 0.613. Estimates of recapture probability for the five species varied from 0.126 for Spotted Towhee to 0.575 for Bewick's Wren, with a mean of 0.278. Based on data from other MAPS stations in California, these estimates from NROC appear to be reasonable. However, the mean Coefficient of Variation (CV) of the adult survival-rate estimate (57.7%) was relatively high, indicating poor precision. This is expected from only three years of data from two stations. We expect substantial improvements in precision once more years of data accumulate.

DISCUSSION OF RESULTS

Capture data indicate that the three stations in NROC's coastal reserve (Little Sycamore Canyon, Upper Laurel Canyon, and Upper Wood Canyon) generally had higher capture rates of adults (and thus breeding populations) than the three stations in the central reserve (Weir Canyon, Irvine Park, and Upper Weir Canyon) in 2000. In both reserves, the road-edge stations (Upper Laurel Canyon and Irvine Park, located within 300 m of transportation corridors) had higher breeding populations than the core stations (Little Sycamore Canyon and Weir Canyon, located near the centers of each reserve) in 2000. In the coastal reserve, the newly established housing station (Upper Wood Canyon) had capture rates of adults that were more similar to the core station than to the road-edge station, while in the central reserve, the newly established housing station (Upper Weir Canyon) showed a higher capture rate of adults than either of the other two stations.

In contrast, productivity in 2000 generally showed the opposite pattern. Thus, in each case, productivity at the central preserve was higher than that in the coastal preserve. No clear pattern of productivity emerged, however, among stations located in core, road-edge, or housing areas. For all species pooled, for example, the highest productivity index (0.54) occurred at the central core station, Weir Canyon, while the lowest productivity index (0.28) occurred at the coastal core station, Lower Sycamore Canyon.

Data from other MAPS stations indicate that these types of comparisons among station specific productivity or breeding population size can vary substantially from year to year, apparently due to the effects of local climate on food resources and/or dramatic changes in the proportions of adults and young captured. Thus, more years of data from these six stations will be needed to confirm these initial findings. Furthermore, because the MAPS season at NROC starts in Period 1, beginning May 1st, some migrating individuals of the target breeding species may still be passing through the stations, and these may show distributional patterns within the reserve that do not reflect those of breeding populations. Again, once more years of data have been collected at all six stations, we will be better able to examine this possibility.

Despite this variation among stations, landbird population dynamics at NROC appeared to show patterns that were both reserve-wide and species-wide. Adult breeding populations decreased slightly between 1998 and 1999 (as based on only two stations) and decreased significantly between 1999 and 2000, whereas productivity declined substantially between 1998 and 1999 and increased substantially and significantly between 1999 and 2000. 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. The low productivity in 1999 and subsequent lack of recruitment of first-year birds in 2000 was likely a primary factor leading to the significant reductions in adult populations noted in 2000. The lower adult breeding populations in 2000, which were likely comprised of a high proportion of experienced breeders and which probably benefitted from a lower level of both intra- and inter-specific competition with other breeders, in turn, showed relatively high reproductive success. If this pattern continues, we might expect to see higher breeding populations with lower reproductive success in 2001.

This, alternating "productivity/population" dynamic has been shown to be significant in regions that appear to lack dramatic interannual climate effects (e.g., extreme drought or excessive snowpack accumulations). At other MAPS stations, disruptions of this alternating cycle have appeared to be related to unusually favorable or unfavorable weather. We have also been able to examine the relationship between global climate patterns and productivity by comparing annual productivity values with the mean monthly Southern Oscillation Index (a measure of the effects El Niños and La Niñas) and have found significant correlations between these two measures. In western regions, 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 possible that the La Niña event of 1999, resulting in one of the highest SOI values during the past decade, caused productivity to be lower than expected at NROC. Once more years of data have accumulated at NROC we hope to be able to better understand these population dynamics in the Southern California region and their relationship to global climate patterns.

With three years of data, survival estimates were obtained for only five species in 2000. Although reasonable survival estimates were calculated, the mean precision of these estimates (CV=57.7%) was quite low. At other MAPS stations we see substantial improvements in precision as additional years (up to about 12 years) of data accumulate. 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 six stations are available. These predictions are in agreement with simulations of MAPS data completed by Dan Rosenberg as part of his evaluation of the statistical properties of MAPS data (Rosenberg et al. 1996, 1999). In addition, as we accumulate more years of data at NROC, the transient model can be used to provide increasingly accurate estimates of survival, particularly for those species (e.g., Pacific-slope Flycatcher, Ash-throated Flycatcher, House Wren, and Orange-crowned Warbler) that are long-distance migrants and/or that have transient summer populations in Southern California. Time-dependence in estimates of survivorship, recapture probability, and/or proportion of residents can also be calculated once at least five years of data have accumulated.

We must emphasize that the results presented here are based on only three years of data from two to six 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 low precision and power because of the limited number of years and small number of stations.

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 resolve problems associated with declining landbird populations in Southern California.

Finally, in addition to the analyses involving SOI, we have initiated two broad-scale analyses to help us further understand the population dynamics of landbirds and potential management actions to assist bird populations. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we are beginning to examine the proximate demographic causes of population trends within a species on a continental scale (DeSante et al. 2001). 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, 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 2000b). 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 all 500 stations that are 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 adding data from NROC to these analyses in upcoming years.

CONCLUSIONS AND RECOMMENDATIONS

(1) Capture data indicate that the three stations in NROC's coastal reserve generally had higher breeding landbird populations than the three stations in the central reserve in 2000. In both reserves, the road-edge stations had correspondingly higher breeding populations than the core stations, while the newly established, housing stations appeared to have either intermediate or high breeding populations. Productivity indices, however, tended to show the opposite patterns, at least as far as geographical location was concerned. In each case, productivity at the central reserve was higher than at the coastal reserve. More years of data from these six stations will be needed to confirm these initial findings.

(2) Adult population sizes at NROC decreased substantially and significantly on a reserve-wide and a species-wide basis between 1999 and 2000. These decreases are likely attributable to decreased recruitment of young resulting from the low productivity noted in 1999. It is likely that the combination of a larger proportion of experienced breeders and less competition for food resources among breeding individuals resulted in the substantial and significant increase in productivity between 1999 and 2000.

(3) Three years of data indicate that an alternating, "productivity/population" correlation may be manifest at NROC, with lower breeding populations and higher productivity occurring in even-numbered years such as 2000. 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 in 2001.

(4) This, alternating "productivity/population" dynamic has been shown to be characteristic of MAPS data from regions that appear to lack dramatic interannual weather effects. At other MAPS stations, disruptions of this alternating cycle have appeared to be related to unusually favorable or unfavorable weather. We have been able to examine the relationship between global climate patterns and productivity by comparing annual productivity values with the mean monthly Southern Oscillation Index (a measure of the effects El Niños and La Niñas). In western regions, 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 also possible that the La Niña event of 1999 caused productivity to be lower than expected at NROC.

(5) With only three years of data from two stations, survival estimates were obtained for only five species. Although reasonable survival estimates were calculated, the mean precision of these estimates (CV=57.7%) was quite low. 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 six stations. We expect to be able to estimate adult survival rates for as many as 20 target species once data from all six stations are available.

(6) Results of the first three years of the MAPS Program in 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 probably 20 or more species once data from all six stations have accumulated for a number of 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 beyond.

(7) 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.

(8) Finally, we have initiated two additional types of broad-scale analyses 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 within a 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.

(9) 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 six currently active stations be sustained indefinitely into the future.

ACKNOWLEDGMENTS

All data collected for the MAPS Program in NROC in 2000 were gathered by Zsolt Kahancza and Teresa Wicks (field biologist interns of The Institute for Bird Populations), as well as by supervising biologist Melanie Madden and several qualified assistants. We thank Melanie, the interns, and assistants, particularly Zsolt Kahancza, for their excellent work in re-establishing and operating the NROC MAPS stations. We thank Pilar Velez who provided training of the NROC interns and helped re-establish the stations. We also thank Robb Hamilton for spearheading the establishment of the stations and for indispensable information on the background of the project. We thank Trish Smith, Tim Neely, and John Hingtgen of the Nature Reserve of Orange County for their support and assistance, and all the folk at Starr Ranch, especially Sandy DeSimone and Dana Kamada, for supplying a wonderful place for and help with the training program. Financial support for the 2000 MAPS Program, for which we are very grateful, was provided by The Nature Reserve of Orange County. This is Contribution Number 145 of The Institute for Bird Populations.

LITERATURE CITED

Bart, J., Kepler, C., Sykes, P., & Bocetti, C. (1999) Evaluation of mist-net sampling as an index to productivity in Kirtland's Warblers. Auk 116:1147-1151.

DeSante, D.F. (1995) Suggestions for future directions for studies of marked migratory landbirds from the perspective of a practitioner in population management and conservation. Journal Applied Statistics 22, pp. 949-965.

DeSante, D.F. (1992) Monitoring Avian Productivity and Survivorship (MAPS): a sharp, rather than blunt, tool for monitoring and assessing landbird populations. *In*: D. R. McCullough and R. H. Barrett (Eds.), Wildlife 2001: Populations, pp. 511-521. (London, U.K.: Elsevier Applied Science).

DeSante, D.F. (1990) The role of recruitment in the dynamics of a Sierran subalpine bird community. American Naturalist 136, pp. 429-455.

DeSante, D.F., Burton, K.M., Saracco, J.F., & Walker, B.L. (1995) Productivity indices and survival rate estimates from MAPS, a continent-wide programme of constant-effort mist netting in North America. Journal Applied Statistics, 22, pp. 935-947.

DeSante, D.F., Burton, K.M., Velez, P., & Froehlich, D. (2000) MAPS Manual, Point Reyes Station, CA: The Institute for Bird Populations; 49 pp.

DeSante, D.F., & George, T.L. (1994) Population trends in the landbirds of western North America, *In*: J. R. Jehl, Jr. & N. K. Johnson (Eds.), A Century of Avifaunal Change in Western North America, Studies in Avian Biology, No. 15, pp. 173-190 (Cooper Ornithological Society).

DeSante, D.F., Nott, M.P., & O'Grady, D.R. (2001) Identifying the proximate demographic cause(s) of population change by modeling spatial variation in productivity, survivorship, and population trends. Ardea 89 (special issue):185-207.

DeSante, D.F., O'Grady, D.R. & Pyle, P. (1999) Measures of productivity and survival derived from standardized mist netting are consistent with observed population changes. Bird Study 46 (suppl.):S178-188.

DeSante, D.F., Pyle, P. & O'Grady, D.R. (1997) The 1996 annual report of the Monitoring Avian Productivity and Survivorship (MAPS) program in Shenandoah National Park. Unpubl. Report, The Institute for Bird Populations, Pt. Reyes Station, CA.

DeSante, D.F., & Rosenberg, D.K. (1998) What do we need to monitor in order to manage landbirds? *In*: J. Marzluff & R. Sallabanks (Eds.), Avian Conservation: Research Needs and Effective Implementation, pp. 93-106. Island Press, Washington, DC.

Finch, D.M., & Stangel, P.W. (1993) Status and Management of Neotropical Migratory Birds. USDA Forest Service, General Technical Report RM-229. 422 pp

George, T.L., Fowler, A.C., Knight, R.L., & McEwen, L.C. (1992) Impacts of a severe drought

on grassland birds in western North America. Ecological Applications, 2, pp. 275-284.
Lebreton, J.-D., Burnham, K.P., Clobert, J., & Anderson, D.R. (1992) Modeling survival and testing biological hypotheses using marked animals: a unified approach with case studies, Ecological Monographs, 62, pp. 67-118.
Nott, P. (2000a) Monitoring Avian Productivity and Survivorship (MAPS) Habitat Structure Assessment Protocol. The Institute for Bird Populations, Pt. Reyes Station, CA, 16pp.
Nott, P. (2000b) Identifying management actions on DoD installations to reverse declines in Neotropical landbirds. The Institute for Bird Populations, Pt. Reyes Station, CA.
Peach, W.J., Buckland, S.T., & Baillie, S.R. (1996) The use of constant effort mist-netting to measure between-year changes in the abundance and productivity of common passerines. Bird Study, 43, pp. 142-156.
Peterjohn, B.G., Sauer, J.R., & Robbins, C.S. (1995) Population trends from the North American Breeding Bird Survey. *In*: T.E. Martin and D.M. Finch, Ecology and Management of Neotropical Migratory Birds, New York: Oxford University Press; pp. 3-39.
Pollock, K.H., Nichols, J.D., Brownie, C., & Hines, J.E. (1990) Statistical inference for capture-recapture experiments, Wildlife Monographs, No. 107.
Pradel, R., Hines, J., Lebreton, J.-D., & Nichols, J.D. (1997) Estimating survival probabilities and proportions of 'transients' using capture-recapture data. Biometrics, 53, pp. 60-72.
Robbins, C.S., Sauer, J.R., Greenberg, R.S., & Droege, S. (1989) Population declines in North American birds that migrate to the Neotropics, Proceedings of the National Academy of Sciences (USA), 86, pp. 7658-7662.
Rosenberg, D.K. (1996) Evaluation of the statistical properties of the Monitoring Avian Productivity and Survivorship (MAPS) program. The Institute for Bird Populations Pt. Reyes Station, CA
Rosenberg, D.K., DeSante, D.F., McKelvey, K.S., & Hines, J.E. (1999) Monitoring survival rates of Swainson's Thrush Catharus ustulatus at multiple spatial scales. Bird Study 46 (suppl.): 198-208.
Temple, S.A., & Wiens, J.A. (1989) Bird populations and environmental changes: can birds be bio-indicators?, American Birds, 43, pp. 260-270.
Terborgh, J. (1989) Where Have All the Birds Gone?, Essays on the Biology and Conservation of Birds that Migrate to the American Tropics, Princeton, NJ: Princeton Univ. Press; 207 pp.
White, G.C. (1983) Numerical estimation of survival rates from band-recovery and biotelemetry data. J. Wildlife Management, 47, pp. 716-728.

Table 1. Summary of the 2000 MAPS program on the Nature Reserve of Orange County.

Station Name	Station Code	Station No.	Major Habitat Type	Latitude-longitude	Elev. (m)	2000 operation: number of net-hours[1]	2000 operation: Avg. No. of periods	2000 operation: Total Inclusive dates
Little Sycamore Canyon	LISY	12269	coastal sage scrub, scrub oak woodland	33°36'48"N,117°46'09"W	176	600.0 (480.0)	10	5/04-7/30
Weir Canyon	WEIR	12270	coastal sage scrub, coast live oak woodland	33°48'54"N,117°44'52"W	220	590.0 (590.0)	10	5/09-8/04
Irvine Park	IRPA	12292	coastal sage scrub, coast live oak woodland	33°47'35"N,117°44'07"W	223	602.2 (529.7)	10	5/08-8/03
Upper Laurel Canyon	UPLA	12293	coastal sage scrub, coast live oak woodland	33°35'48"N,117°46'33"W	195	608.3 (600.0)	10	5/06-8/01
Upper Wood Canyon	UPWO	12294	coastal sage scrub, bordering housing development	33°35'30"N,117°44'41"W	140	596.0 (0.0)	10	5/05-7/31
Upper Weir Canyon	UPWE	12295	coastal sage scrub, grassland, bordering housing development	33°50'20"N,117°44'22"W	329	600.3 (0.0)	10	5/01-8/02
ALL STATIONS COMBINED						3596.8 (2199.7)	10	5/01-8/04

[1] Total net-hours in 2000. Net-hours in 2000 that were compared in a constant-effort manner to 1999 are shown in parentheses.

Table 2. Capture summary for the six individual MAPS stations operated on Nature Reserve of Orange County lands in 2000.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	L. Sycamore Can.			Weir Canyon			Irvine Park			U. Laurel Canyon			U. Wood Canyon			U. Weir Canyon		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
California Quail								1			1						2	
Mourning Dove		1									1			2			1	
Black-chinned Hummingbird		2			4			2			5			1			6	
Anna's Hummingbird		26			4			2			9			13			12	
Costa's Hummingbird		4			6			1			6			2			4	
Calliope Hummingbird																	1	
Rufous Hummingbird		2									3			2				
Allen's Hummingbird		6			1						1			1				
Acorn Woodpecker							2											
Nuttall's Woodpecker				1			3			2		1	1			2		
Downy Woodpecker										1								
Olive-sided Flycatcher																1		
Western Wood-Pewee	1												1			1		
Willow Flycatcher				1						1						1		
Pacific-slope Flycatcher	15		1	4			2			6		2	5			5		1
Black Phoebe							1			2								
Ash-throated Flycatcher	1			6		2	1			2			2		1	3		
Cassin's Kingbird										13								
Western Kingbird										2								
Hutton's Vireo				2									1					
Warbling Vireo	6						1			8			2			1		
Western Scrub-Jay										3			2			8		1
Northern Rough-wing. Swal.	1																	
Oak Titmouse				2		1	3		2							1		
Bushtit	17	1	7	10	2	4	6	1		22	1	7	15	1	1	18	2	8
Cactus Wren				2						1								
Bewick's Wren	10	1	6	6		5	4		7	4			7		2	13	1	5
House Wren				4	1	5	2									4		1

Table 2.(cont.) Capture summary for the six individual MAPS stations operated on Nature Reserve of Orange County lands in 2000.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS

	L. Sycamore Can.			Weir Canyon			Irvine Park			U. Laurel Canyon			U. Wood Canyon			U. Weir Canyon		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Blue-gray Gnatcatcher	1																	
Swainson's Thrush	20			4			4	1		16		3	11			17		
Wrentit	16		13	24	1	16	25	3	14	11	1	23	84	5	70	41		41
Northern Mockingbird										1			1			1		1
California Thrasher	5		1	3	1	2	3		2	17	2	6	5	1	1	11		1
Phainopepla	1						1						1			1		
Orange-crowned Warbler	12		1							2		6	13	1	2	1		
Yellow Warbler	6									3			2					
Black-throated Gray Warbler	2		1															
Townsend's Warbler	11												3			2		
Townsend's x Hermit Warbler	1																	
Hermit Warbler	2									3			1			1		
MacGillivray's Warbler	1			1						1						1		
Common Yellowthroat	6			1						29		6	13	1	2	1		
Wilson's Warbler	13	1	1	3			1			10			12	1		8		
Western Tanager	1															9		
Green-tailed Towhee																1		
Spotted Towhee	17		4	11	1	5	15	1	3	37	1	8	34		14	17	1	1
California Towhee	10	3	4	13	2	8	19		10	29	1	9	4		2	26	2	4
Rufous-crowned Sparrow	5	1	1	4			12	2	3	1						3		
Black-chinned Sparrow				1												2		
Lark Sparrow				1						1								
Song Sparrow	3									21	1	7	13	2	6	7		
White-crowned Sparrow										1								
Rose-breasted Grosbeak				1														
Black-headed Grosbeak	1						4			2			1			4		
Blue Grosbeak										3		2				1		
Lazuli Bunting				2			5			11		1				3		

Table 2.(cont.) Capture summary for the six individual MAPS stations operated on Nature Reserve of Orange County lands in 2000.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	L. Sycamore Can.			Weir Canyon			Irvine Park			U. Laurel Canyon			U. Wood Canyon			U. Weir Canyon		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Bullock's Oriole						1				4								
House Finch	7			2			8			2	1		4	1		38		1
Lesser Goldfinch	10			6			7			25	1	5	7			24		1
Lawrence's Goldfinch										14		2						
ALL SPECIES POOLED	202	48	40	115	23	49	129	14	41	311	35	88	245	34	101	278	32	66
TOTAL NUMBER OF CAPTURES		290			187			184			434			380			376	
NUMBER OF SPECIES	29	11	11	25	10	10	22	9	7	36	15	15	26	14	10	35	10	12
TOTAL NUMBER OF SPECIES		35			30			26			43			32			41	

Table 3. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated on Nature Reserve of Orange County lands in 2000.

	L. Sycamore Canyon			Weir Canyon			Irvine Park			Upp. Laurel Canyon			Upp. Wood Canyon			Upp. Weir Canyon		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Acorn Woodpecker							1.0	1.0	0.50									
Nuttall's Woodpecker				1.0	0.0	0.00	3.0	0.0	0.00	3.0	0.0	0.00	1.0	0.0	0.00	2.0	0.0	0.00
Downy Woodpecker										1.0	0.0	0.00						
Western Wood-Pewee	1.0	0.0	0.00										1.0	0.0	0.00	1.0	0.0	0.00
Pacific-slope Flycatcher	15.0	0.0	0.00	3.1	1.0	0.25	2.0	0.0	0.00	6.9	0.0	0.00	5.0	0.0	0.00	5.0	0.0	0.00
Black Phoebe							0.0	1.0	1.00	0.0	2.0	1.00						
Ash-throated Flycatcher	1.0	0.0	0.00	3.1	4.1	0.57	1.0	0.0	0.00	2.0	0.0	0.00	2.0	0.0	0.00	2.0	1.0	0.33
Cassin's Kingbird										5.9	6.9	0.54						
Western Kingbird										1.0	1.0	0.50						
Hutton's Vireo				2.0	0.0	0.00							1.0	0.0	0.00			
Western Scrub-Jay										3.0	0.0	0.00	0.0	2.0	1.00	6.0	3.0	0.33
Northern Rough-winged	1.0	0.0	0.00															
Oak Titmouse				1.0	1.0	0.50	2.0	3.0	0.60							1.0	0.0	0.00
Bushtit	17.0	3.0	0.15	3.1	6.1	0.67	2.0	4.0	0.67	10.8	14.8	0.58	10.1	5.0	0.33	12.0	6.0	0.33
Cactus Wren				1.0	1.0	0.50				1.0	0.0	0.00						
Bewick's Wren	5.0	5.0	0.50	5.1	4.1	0.44	5.0	2.0	0.29	1.0	3.0	0.75	3.0	4.0	0.57	3.0	10.0	0.77
House Wren				7.1	0.0	0.00	2.0	0.0	0.00							1.0	3.0	0.75
Blue-gray Gnatcatcher	1.0	0.0	0.00															
Wrentit	8.0	12.0	0.60	9.2	21.4	0.70	16.0	15.0	0.48	9.9	6.9	0.41	35.2	62.4	0.64	22.0	30.0	0.58
Northern Mockingbird										1.0	0.0	0.00	0.0	1.0	1.00	0.0	1.0	1.00
California Thrasher	2.0	4.0	0.67	3.1	2.0	0.40	3.0	2.0	0.40	4.9	13.8	0.74	4.0	1.0	0.20	4.0	7.0	0.64
Phainopepla	1.0	0.0	0.00				1.0	0.0	0.00				0.0	1.0	1.00	1.0	0.0	0.00
Orange-crowned Warbler	7.0	5.0	0.42							5.9	0.0	0.00	12.1	2.0	0.14	0.0	1.0	1.00
Yellow Warbler	6.0	0.0	0.00							3.0	0.0	0.00	2.0	0.0	0.00			
Common Yellowthroat	4.0	2.0	0.33	0.0	1.0	1.00				13.8	15.8	0.53	12.1	1.0	0.08	1.0	0.0	0.00
Spotted Towhee	20.0	1.0	0.05	6.1	8.1	0.57	9.0	7.0	0.44	27.6	13.8	0.33	21.1	14.1	0.40	5.0	12.0	0.71
California Towhee	11.0	1.0	0.08	10.2	7.1	0.41	13.0	10.0	0.44	15.8	16.8	0.52	3.0	2.0	0.40	9.0	17.0	0.65

Table 3. (cont.) Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual MAPS stations operated on Nature Reserve of Orange County lands in 2000.

	L. Sycamore Canyon			Weir Canyon			Irvine Park			Upp. Laurel Canyon			Upp. Wood Canyon			Upp. Weir Canyon		
Species	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Rufous-crowned Sparrow	0.0	5.0	1.00	0.0	4.1	1.00	4.0	9.0	0.69	0.0	1.0	1.00				0.0	3.0	1.00
Black-chinned Sparrow				0.0	1.0	1.00										1.0	1.0	0.50
Lark Sparrow				0.0	1.0	1.00				1.0	0.0	0.00						
Song Sparrow	1.0	2.0	0.67							13.8	9.9	0.42	8.1	6.0	0.43	3.0	4.0	0.57
Black-headed Grosbeak	1.0	0.0	0.00				3.0	1.0	0.25	2.0	0.0	0.00	1.0	0.0	0.00	3.0	1.0	0.25
Blue Grosbeak										3.9	0.0	0.00				1.0	0.0	0.00
Lazuli Bunting				0.0	2.0	1.00	3.0	2.0	0.40	4.9	5.9	0.55				3.0	0.0	0.00
Bullock's Oriole				1.0	0.0	0.00				3.9	0.0	0.00						
House Finch	5.0	2.0	0.29	0.0	2.0	1.00	3.0	5.0	0.63	2.0	0.0	0.00	0.0	4.0	1.00	18.0	20.0	0.53
Lesser Goldfinch	7.0	3.0	0.30	4.1	2.0	0.33	7.0	0.0	0.00	20.7	3.9	0.16	7.0	0.0	0.00	15.0	9.0	0.38
Lawrence's Goldfinch										13.8	0.0	0.00						
ALL SPECIES POOLED	114.0	45.0	0.28	60.0	69.2	0.54	79.8	61.9	0.44	183.5	115.4	0.39	128.9	105.7	0.45	118.9	128.9	0.52
NUMBER OF SPECIES	19	12		15	17		18	13		27	14		17	13		22	17	
TOTAL NUMBER OF SPECIES	20			21			19			29			21			25		

Table 4. Summary of results for all six Nature Reserve of Orange County MAPS stations combined in 2000.

Species	Birds captured: Newly banded	Un-banded	Recap-tured	Birds/600net-hours: Adults	Young	Prop. Young
California Quail		4				
Mourning Dove		5				
Black-chinned Hummingbird		20				
Anna's Hummingbird		66				
Costa's Hummingbird		23				
Calliope Hummingbird		1				
Rufous Hummingbird		7				
Allen's Hummingbird		9				
Acorn Woodpecker	2			0.2	0.2	0.50
Nuttall's Woodpecker	9		1	1.2	0.0	0.00
Downy Woodpecker	1			0.2	0.0	0.00
Olive-sided Flycatcher	1					
Western Wood-Pewee	3			0.5	0.0	0.00
Willow Flycatcher	3					
Pacific-slope Flycatcher	37		4	4.3	0.2	0.04
Black Phoebe	3			0.0	0.5	1.00
Ash-throated Flycatcher	15		3	1.2	0.8	0.42
Cassin's Kingbird	13			0.0	1.2	1.00
Western Kingbird	2			0.2	0.2	0.50
Hutton's Vireo	3			0.2	0.0	0.00
Warbling Vireo	18					
Western Scrub-Jay	13		1	1.5	0.8	0.36
Northern Rough-winged Swallow	1			0.2	0.0	0.00
Oak Titmouse	6		3	0.3	0.7	0.67
Bushtit	88	8	27	9.2	6.5	0.42
Cactus Wren	3			0.3	0.2	0.33
Bewick's Wren	44	2	25	3.7	4.7	0.56
House Wren	10	1	6	1.7	0.5	0.23
Blue-gray Gnatcatcher	1			0.0	0.0	0.00
Swainson's Thrush	72	1	3			
Wrentit	201	10	177	16.7	24.2	0.59
Northern Mockingbird	3		1	0.2	0.3	0.67
California Thrasher	44	4	13	3.3	5.0	0.60
Phainopepla	4			0.5	0.2	0.25
Orange-crowned Warbler	28	1	9	2.7	1.3	0.33
Yellow Warbler	11			1.3	0.0	0.00
Black-throated Gray Warbler	2		1			
Townsend's Warbler	16					
Townsend's x Hermit Warbler	1					
Hermit Warbler	7					
MacGillivray's Warbler	4					
Common Yellowthroat	50	1	8	4.0	3.3	0.46

Table 4.(cont.) Summary of results for all six Nature Reserve of Orange County MAPS stations combined in 2000.

Species	Birds captured: Newly banded	Un-banded	Recap-tured	Birds/600net-hours: Adults	Young	Prop. Young
Wilson's Warbler	47	2	1			
Western Tanager	10					
Green-tailed Towhee	1					
Spotted Towhee	131	4	35	9.7	9.3	0.49
California Towhee	101	8	37	10.3	8.8	0.46
Rufous-crowned Sparrow	25	3	4	0.2	3.7	0.96
Black-chinned Sparrow	3			0.0	0.3	1.00
Lark Sparrow	2			0.0	0.2	1.00
Song Sparrow	44	3	13	3.8	3.7	0.49
White-crowned Sparrow	1					
Rose-breasted Grosbeak	1					
Black-headed Grosbeak	12			1.2	0.3	0.22
Blue Grosbeak	4		2	0.7	0.0	0.00
Lazuli Bunting	21		1	0.7	1.7	0.71
Bullock's Oriole	4		1	0.8	0.0	0.00
House Finch	61	2	1	4.5	5.5	0.55
Lesser Goldfinch	79	1	6	6.0	3.0	0.33
Lawrence's Goldfinch	14		2	1.7	0.0	0.00
ALL SPECIES POOLED	1280	186	385	114.4	87.2	0.43
TOTAL NUMBER OF CAPTURES		1851				
NUMBER OF SPECIES	52	23	26	33	28	
TOTAL NUMBER OF SPECIES		60			37	

Table 5. Percentage changes between 1999 and 2000 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

Species	L.Syca. Canyon	Weir Canyon	Irvine Park	U.Laurel Canyon	All four stations combined: n[1]	No. adults 1999	No. adults 2000	% change	SE[2]
Acorn Woodpecker			++++[3]		1	0	1	++++[3]	
Nuttall's Woodpecker	-100.0	-50.0	+200.0	+200.0	4	7	7	0.0	70.0
Downy Woodpecker				++++[3]	1	0	1	++++	
Western Wood-Pewee	++++[3]				1	0	1	++++	
Pacific-slope Flycatcher	+7.7	-88.9	-80.0	+75.0	4	45	25	-44.4	30.9
Black Phoebe					0	0	0		
Ash-throated Flycatcher	-80.0	-25.0	-50.0	-77.8	4	20	7	-65.0	12.3**
Cassin's Kingbird				++++	1	0	4	++++	
Western Kingbird				++++	1	0	1	++++	
Hutton's Vireo	-100.0	0.0		-100.0	3	7	2	-71.4	32.4
Western Scrub-Jay		-100.0		+200.0	2	2	3	+50.0	150.0
Northern Rough-winged Swallow	++++				1	0	1	++++	
Cliff Swallow				-100.0	1	10	0	-100.0	
Oak Titmouse		-50.0	-33.3		2	5	3	-40.0	8.0**
Bushtit	+6.3	-83.3	-90.5	-47.6	4	76	33	-56.6	20.3*
Cactus Wren		++++[3]		++++	2	0	2	++++	
Bewick's Wren	-64.3	-37.5	0.0	-80.0	4	32	16	-50.0	13.3**
House Wren	-100.0	0.0	-50.0	-100.0	4	15	8	-46.7	32.7
Blue-gray Gnatcatcher	-100.0				1	2	0	-100.0	
California Gnatcatcher				-100.0	1	1	0	-100.0	
Wrentit	-70.0	-71.0	-60.5	-16.7	4	101	40	-60.4	7.4***
Northern Mockingbird		-100.0		++++	2	3	1	-66.7	66.7
California Thrasher	-71.4	0.0	-33.3	+150.0	4	15	12	-20.0	38.5
Phainopepla	++++	-100.0	++++		3	2	2	0.0	150.0
Orange-crowned Warbler	+133.3	-100.0	-100.0	-62.5	4	24	13	-45.8	30.4
Yellow Warbler	+150.0			0.0	2	5	8	+60.0	72.0

Table 5.(cont.) Percentage changes between 1999 and 2000 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

Species	L.Syca. Canyon	Weir Canyon	Irvine Park	U.Laurel Canyon	All four stations combined: n[1]	No. adults 1999	No. adults 2000	% change	SE[2]
Common Yellowthroat	-42.9		-100.0	-33.3	3	29	18	-37.9	5.1**
Yellow-breasted Chat	-100.0				1	1	0	-100.0	
Spotted Towhee	-37.9	-66.7	-25.0	+47.4	4	75	60	-20.0	23.9
California Towhee	-23.1	-52.6	-60.0	-40.7	4	84	45	-46.4	6.8***
Rufous-crowned Sparrow	-100.0	-100.0	-66.7	-100.0	4	19	4	-78.9	10.6***
Black-chinned Sparrow	-100.0				1	1	0	-100.0	
Lark Sparrow				++++	1	0	1	++++	
Song Sparrow	-66.7			-36.4	2	25	15	-40.0	6.4
Black-headed Grosbeak	++++		++++	++++	3	0	6	++++	
Blue Grosbeak				-33.3	1	6	4	-33.3	
Lazuli Bunting			+200.0	++++	2	1	8	+700.0	1000.0
Bullock's Oriole	-100.0	++++	-100.0	+100.0	4	5	5	0.0	73.0
House Finch	+400.0	-100.0	+200.0	+100.0	4	5	10	+100.0	117.8
Lesser Goldfinch	+133.3	+33.3	-14.3	+110.0	4	23	38	+65.2	37.6
Lawrence's Goldfinch				++++	1	0	14	++++	
ALL SPECIES POOLED	-27.9	-61.4	-51.0	-10.2	4	646	419	-35.1	12.3*
No. species that increased[4]	10(4)	3(2)	6(3)	17(9)				15(10)	
No. species that decreased[5]	16(8)	15(6)	14(3)	14(5)				22(5)	
No. species remained same	0	3	1	1				3	
TOTAL NUMBER OF SPECIES	26	21	21	32				41	
Proportion of increasing (decreasing) species	(0.615)	(0.714)	(0.667)	(0.438)				(0.550)	
Sig. of increase (decrease)[6]	(0.163)	(0.039) **	(0.094) *	(0.811)				(0.318)	

Table 5.(cont.) Percentage changes between 1999 and 2000 in the numbers of individual ADULT birds captured at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS

[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 1999.

[4] No. of species for which adults were captured in 2000 but not in 1999 are in parentheses.

[5] No. of species for which adults were captured in 1999 but not in 2000 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 1999 and 2000 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

Species	L.Syca. Canyon	Weir Canyon	Irvine Park	U.Laurel Canyon	n[1]	All four stations combined: No. young 1999	No. young 2000	% change	SE[2]
Acorn Woodpecker			++++ [3]		1	0	1	++++ [3]	
Nuttall's Woodpecker				-100.0	1	1	0	-100.0	
Downy Woodpecker					0	0	0		
Western Wood-Pewee					0	0	0		
Pacific-slope Flycatcher		++++ [3]	-100.0	-100.0	3	3	1	-66.7	50.9
Black Phoebe			++++	++++ [3]	2	0	3	++++	
Ash-throated Flycatcher		++++			1	0	4	++++	
Cassin's Kingbird				++++	1	0	7	++++	
Western Kingbird				++++	1	0	1	++++	
Hutton's Vireo					0	0	0		
Western Scrub-Jay					0	0	0		
Northern Rough-winged Swallow					0	0	0		
Cliff Swallow					0	0	0		
Oak Titmouse		++++	+50.0		2	2	4	+100.0	100.0
Bushtit	++++ [3]	+50.0	++++	+275.0	4	8	28	+250.0	136.9
Cactus Wren		++++			1	0	1	++++	
Bewick's Wren	+300.0	0.0	-33.3	++++	4	8	13	+62.5	77.9
House Wren		-100.0		-100.0	2	4	0	-100.0	88.9
Blue-gray Gnatcatcher	-100.0				1	2	0	-100.0	
California Gnatcatcher					0	0	0		
Wrentit	++++	+950.0	+150.0	+250.0	4	10	52	+420.0	249.6
Northern Mockingbird					0	0	0		
California Thrasher	-63.6	++++	++++	+180.0	4	16	22	+37.5	97.5
Phainopepla					0	0	0		
Orange-crowned Warbler	++++				1	0	5	++++	
Yellow Warbler					0	0	0		

Table 6.(cont.) Percentage changes between 1999 and 2000 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

Species	L.Syca. Canyon	Weir Canyon	Irvine Park	U.Laurel Canyon	All four stations combined: n[1]	No. young 1999	No. young 2000	% change	SE[2]
Common Yellowthroat	++++	++++		+23.1	3	13	18	+38.5	23.1
Yellow-breasted Chat					0	0	0		
Spotted Towhee	0.0	+700.0	+500.0	+600.0	4	5	29	+480.0	134.0**
California Towhee	++++	++++	++++	++++	4	0	35	++++	
Rufous-crowned Sparrow	++++	++++	+700.0	++++	4	1	18	+1700.0	1376.0
Black-chinned Sparrow		++++			1	0	1	++++	
Lark Sparrow		++++			1	0	1	++++	
Song Sparrow	++++			+400.0	2	2	11	+450.0	100.0
Black-headed Grosbeak			++++		1	0	1	++++	
Blue Grosbeak				-100.0	1	1	0	-100.0	
Lazuli Bunting		++++	++++	++++	3	0	10	++++	
Bullock's Oriole					0	0	0		
House Finch	+100.0	++++	++++		3	1	9	+800.0	1081.7
Lesser Goldfinch	0.0	++++	-100.0	+100.0	4	9	9	0.0	62.9
Lawrence's Goldfinch					0	0	0		
ALL SPECIES POOLED	+105.3	+385.7	+215.8	+244.1	4	86	284	+230.2	43.9**
No. species that increased[4]	9(7)	16(13)	12(8)	14(7)				22(12)	
No. species that decreased[5]	2(1)	1(1)	3(2)	4(4)				5(4)	
No. species remained same	2	1	0	0				1	
TOTAL NUMBER OF SPECIES	13	18	15	18				28	
Proportion of increasing (decreasing) species	0.692	0.889	0.800	0.778				0.786	
Sig. of increase (decrease)[6]	0.133	0.001	0.018	0.015				0.002	
		***	**	**				***	

Table 6.(cont.) Percentage changes between 1999 and 2000 in the numbers of individual YOUNG birds captured at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

[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 1999.
[4] No. of species for which young were captured in 2000 but not in 1999 are in parentheses.
[5] No. of species for which young were captured in 1999 but not in 2000 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. Absolute changes between 1999 and 2000 in the PROPORTION OF YOUNG in the catch at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

						All four stations combined			
						Prop. young			
Species	L. Syca. Canyon	Weir Canyon	Irvine Park	U.Laurel Canyon	n[1]	1999	2000	Absol. change	SE[2]
Acorn Woodpecker			+-+-+[3]		1	-----[4]	0.500	+-+-+[3]	
Nuttall's Woodpecker	+-+-+[3]	0.000	0.000	-0.500	4	0.125	0.000	-0.125	0.128
Downy Woodpecker				+-+-+[3]	1	-----	0.000	+-+-+	
Western Wood-Pewee	+-+-+				1	-----	0.000	+-+-+	
Pacific-slope Flycatcher	0.000	+0.333	-0.167	-0.200	4	0.063	0.039	-0.024	0.068
Black Phoebe			+-+-+	+-+-+	2	-----	1.000	+-+-+	
Ash-throated Flycatcher	0.000	+0.571	0.000	0.000	4	0.000	0.364	+0.364	0.179
Cassin's Kingbird				+-+-+	1	-----	0.636	+-+-+	
Western Kingbird				+-+-+	1	-----	0.500	+-+-+	
Hutton's Vireo	+-+-+	0.000		+-+-+	3	0.000	0.000	0.000	0.000
Western Scrub-Jay		+-+-+[3]		0.000	2	0.000	0.000	0.000	0.000
Northern Rough-winged Swallow	+-+-+				1	-----	0.000	+-+-+	
Cliff Swallow				+-+-+	1	0.000	-----[4]	+-+-+	
Oak Titmouse		+0.500	+0.200		2	0.286	0.571	+0.286	0.168
Bushtit	+0.150	+0.485	+0.667	+0.417	4	0.095	0.459	+0.364	0.146*
Cactus Wren		+-+-+		+-+-+	2	-----	0.333	+-+-+	
Bewick's Wren	+0.378	+0.111	-0.089	+0.750	4	0.200	0.448	+0.248	0.111
House Wren	+-+-+	-0.300	0.000	+-+-+	4	0.211	0.000	-0.211	0.063**
Blue-gray Gnatcatcher	+-+-+				1	0.500	-----	+-+-+	
California Gnatcatcher				+-+-+	1	0.000	-----	+-+-+	
Wrentit	+0.600	+0.639	+0.364	+0.269	4	0.090	0.565	+0.475	0.072***
Northern Mockingbird		+-+-+		+-+-+	2	0.000	0.000	0.000	0.000
California Thrasher	+0.056	+0.400	+0.500	+0.023	4	0.516	0.647	+0.131	0.138
Phainopepla	+-+-+	+-+-+	+-+-+		3	0.000	0.000	0.000	0.000
Orange-crowned Warbler	+0.417	+-+-+	+-+-+	0.000	4	0.000	0.278	+0.278	0.151
Yellow Warbler	0.000			0.000	2	0.000	0.000	0.000	0.000

Table 7.(cont.) Absolute changes between 1999 and 2000 in the PROPORTION OF YOUNG in the catch at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

					All four stations combined				
						Prop. young			
Species	L. Syca. Canyon	Weir Canyon	Irvine Park	U.Laurel Canyon	n[1]	1999	2000	Absol. change	SE[2]
Common Yellowthroat	+0.200	+-+-+	+-+-+	+0.151	4	0.310	0.500	+0.191	0.109
Yellow-breasted Chat	+-+-+				1	0.000	-----	+-+-+	
Spotted Towhee	+0.019	+0.553	+0.323	+0.238	4	0.063	0.326	+0.263	0.086*
California Towhee	+0.091	+0.438	+0.500	+0.515	4	0.000	0.438	+0.438	0.069***
Rufous-crowned Sparrow	+1.000	+1.000	+0.590	+1.000	4	0.050	0.818	+0.768	0.116***
Black-chinned Sparrow	+-+-+	+-+-+			2	0.000	1.000	+1.000	0.000
Lark Sparrow		+-+-+		+-+-+	2	-----	0.500	+-+-+	
Song Sparrow	+0.500			+0.333	2	0.074	0.423	+0.349	0.020
Black-headed Grosbeak	+-+-+		+-+-+	+-+-+	3	-----	0.143	+-+-+	
Blue Grosbeak				-0.143	1	0.143	0.000	-0.143	
Lazuli Bunting		+-+-+	+0.400	+-+-+	3	0.000	0.556	+0.556	0.081**
Bullock's Oriole	+-+-+	+-+-+	+-+-+	0.000	4	0.000	0.000	0.000	0.000
House Finch	-0.214	+1.000	+0.625	0.000	4	0.167	0.474	+0.307	0.205
Lesser Goldfinch	-0.200	+0.333	-0.364	-0.007	4	0.281	0.192	-0.090	0.095
Lawrence's Goldfinch				+-+-+	1	-----	0.000	+-+-+	
ALL SPECIES POOLED	+0.151	+0.447	+0.335	+0.232	4	0.108	0.384	+0.276	0.049 **
No. species that increased	10	12	9	9				15	
No. species that decreased	2	1	3	4				5	
No. species remained same	4	3	4	7				7	
TOTAL NUMBER OF SPECIES[5]	16	16	16	20				27	
Proportion of increasing (decreasing) species	0.625	0.750	0.563	0.450				0.556	
Sig. of increase (decrease)[6]	0.227	0.038 **	0.402	0.748				0.351	

Table 7.(cont.) Absolute changes between 1999 and 2000 in the PROPORTION OF YOUNG in the catch at four constant-effort MAPS stations on Nature Reserve of Orange County lands.

[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. Annual numbers of individuals captured (based on all captures) and year-to-year changes (based on constant-effort comparisons) of adults and young and of the proportion of young in the catch for 14 target species on the Nature Reserve of Orange County from 1998-2000.

	Adults[1]				
Target species[2]	1998	%Chg.	1999	%Chg.	2000
Pacific-slope Flycatcher	13	+20.0	24	+23.5	22
Ash-throated Flycatcher	19	-55.6	20	-65.0	7
Bushtit	37	-8.1	76	-56.6	33
Bewick's Wren	27	-16.0	33	-50.0	16
House Wren	13	-41.7	14	-42.9	9
Wrentit	59	-8.9	111	-60.4	43
California Thrasher	13	-23.1	16	-20.0	13
Orange-crowned Warbler	12	-72.7	19	-31.6	13
Common Yellowthroat	2	+250.0	30	-35.7	18
Spotted Towhee	27	+72.0	81	-20.0	63
California Towhee	27	+23.1	85	-46.4	50
Rufous-crowned Sparrow	7	-42.9	21	-78.9	4
Song Sparrow	0	0.0	25	-40.0	15
Lesser Goldfinch	14	-53.8	26	+65.2	39
ALL SPECIES POOLED	291	-6.9	629	-38.6	381

	Young[1]				
Target species[2]	1998	%Chg.	1999	%Chg.	2000
Pacific-slope Flycatcher	1	-100.0	2	-100.0	0
Ash-throated Flycatcher	5	-100.0	0	++++ [3]	4
Bushtit	24	-83.3	8	+250.0	28
Bewick's Wren	35	-83.9	9	+62.5	14
House Wren	7	-57.1	4	-100.0	0
Wrentit	45	-95.3	10	+420.0	55
California Thrasher	12	0.0	16	+37.5	22
Orange-crowned Warbler	13	-100.0	0	++++	5
Common Yellowthroat	1	0.0	13	+30.8	18
Spotted Towhee	34	-93.9	6	+480.0	30
California Towhee	40	-100.0	0	++++	35
Rufous-crowned Sparrow	14	-100.0	3	+1700.0	19
Song Sparrow	4	-100.0	2	+450.0	12
Lesser Goldfinch	6	-50.0	12	0.0	9
ALL SPECIES POOLED	253	-86.0	92	+213.1	271

Table 8. (cont.) Annual numbers of individuals captured (based on all captures) and year-to-year changes (based on constant-effort comparisons) of adults and young and of the proportion of young in the catch for 14 target species on the Nature Reserve of Orange County from 1998-2000.

Target species[2]	Proportion of young[1] 1998	Chg.	1999	Chg.	2000
Pacific-slope Flycatcher	0.071	-0.091	0.077	-0.056	0.000
Ash-throated Flycatcher	0.208	-0.217	0.000	+0.364	0.364
Bushtit	0.393	-0.288	0.095	+0.364	0.459
Bewick's Wren	0.565	-0.361	0.214	+0.248	0.467
House Wren	0.350	-0.068	0.222	-0.222	0.000
Wrentit	0.433	-0.397	0.083	+0.475	0.561
California Thrasher	0.480	+0.065	0.500	+0.131	0.629
Orange-crowned Warbler	0.520	-0.450	0.000	+0.278	0.278
Common Yellowthroat	0.333	0.000	0.302	+0.169	0.500
Spotted Towhee	0.557	-0.525	0.069	+0.263	0.323
California Towhee	0.597	-0.594	0.000	+0.438	0.412
Rufous-crowned Sparrow	0.667	-0.667	0.125	+0.768	0.826
Song Sparrow	1.000	-1.000	0.074	+0.349	0.444
Lesser Goldfinch	0.300	+0.018	0.316	-0.090	0.188
ALL SPECIES POOLED	0.465	-0.347	0.128	+0.295	0.416

[1] 1998 values and 1998 to 1999 changes are based only on data from the Little Sycamore Canyon and Weir Canyon stations. 1999 and 2000 numbers and 1999 to 2000 changes are based on data from four stations (Little Sycamore Canyon, Weir Canyon, Irvine Park, and Upper Laurel Canyon). Year-to-year changes in the number of adults or young captured or proportion of young are from analyses of constant-effort data only. They do not reflect exactly the percentage changes in annual numbers. The two sets of data are presented for efficiency, and because constant-effort totals for a given year (e.g., 1999) will differ for comparisons with previous (1998) vs. subsequent (2000) years.

[2] Target species are those for which an average of at least seven individual adult birds (pooled from stations where the species was classified as a regular or usual breeder) were recorded per year over the three years 1998-2000 (21 year-unique records) .

[3] Increase indeterminate (infinite) because no young was captured during the first of the two years being compared.

Table 9. Estimates of adult survival and recapture probabilities for five species breeding at MAPS stations on the Nature Reserve of Orange County obtained from three years (1998-2000) of mark-recapture data.

Species	Num. sta[1]	Num. ind.[2]	Num. caps.[3]	Num. ret.[4]	Survival probability[5]	Surv. C.V.[6]	Recapture probability[7]
Ash-throated Flycatcher	2	28	33	4	0.628 (0.554)	88.2	0.171 (0.211)
Bewick's Wren	2	47	89	13	0.426 (0.161)	37.8	0.575 (0.259)
Wrentit	2	115	184	22	0.505 (0.194)	38.4	0.314 (0.152)
Spotted Towhee	2	93	111	10	0.823 (0.538)	65.4	0.126 (0.108)
California Towhee	2	70	94	10	0.681 (0.399)	58.6	0.202 (0.158)

[1] Number of stations where the species was a regular or usual breeder at which adults of the species were captured. Only data from the two stations that were operated during all three years (Little Sycamore Canyon and Weir Canyon) were used.

[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] Survival probability presented as the maximum likelihood estimate (standard error of the estimate).

[6] The coefficient of variation for survival probability.

[7] Recapture probability presented as the maximum likelihood estimate (standard error of the estimate).