THE 2003 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM AT THE NATURE RESERVE OF ORANGE COUNTY

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September 30, 2003

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) Program, a cooperative effort to provide indices of adult population size and productivity and estimates of adult survivorship for target North American landbird species. The objectives of MAPS on the Nature Reserve of Orange County (NROC) are to: 1) provide integrated data on avian population trends and vital rates; 2) provide information on the causes of population declines; and 3) formulate potential management actions to reverse the declines that can be incorporated into the NROC=s Aadaptive management≅ program. The overall long-term goal of all this work is to conserve avian biodiversity within the NROC.

We operated six MAPS stations on NROC in 2003, at the same locations where they were operated during the previous four (4 stations) or three (2 stations) years. A total of 2043 captures of 51 species was recorded in 2003 during 3234.2 net-hours of operation. In our previous annual report, we documented a nearly complete, region-wide and species-wide reproductive failure at NROC during 2002, the likes of which have never before been recorded by the MAPS program. Following this, the 2003 season was notable in two respects: adult population sizes declined significantly, and productivity rebounded dramatically. The decline in breeding populations was especially severe among permanent resident species that likely experience less recruitment from more distant sources than migratory species. The 2003 decline resulted in 13 of 15 species showing 5-year population declines, of which those for six species and all species pooled were substantial. The 2003 increase in productivity was also region-wide and species-wide, and again occurred most dramatically in resident species. It resulted in 11 of 15 species showing positive 5-year productivity trends, although most were widely fluctuating rather than substantial.

Using five years of data, we obtained survival estimates for eight target species from modified CJS mark-recapture analyses using a transient model. We noted a substantial improvement in precision of the survival-rate estimates using five, rather than four, years of data, and an increase in the number of species for which survival could be estimated with reasonable precision. Except for Orange-crowned Warbler and Spotted Towhee, whose low survival should be monitored closely in future years, survival-rate estimates from NROC appear to be about as high, or possibly even higher, than those from other western locations.

We emphasize that the population and productivity trends and survival estimates presented here are based on only five years of data, and may not be representative of the longer-term population dynamics. With additional years of data, however, we will be able to undertake further analyses to identify the factors causing the declines that we are documenting, analyses that can lead to the formulation of management strategies for reversing those declines. Information on a broad spectrum of both permanent resident and migratory breeding species will also provide increased understanding of the manner in which various biotic and abiotic factors affect the threatened and endangered species on the NROC. We conclude, therefore, that the MAPS Program is very well suited to provide one component of NROC=s long-term monitoring effort and can provide critical

data to aid in reversing declining landbird populations on the Reserve. We suggest that the operation of at least the six currently active stations be sustained 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 (Hamilton 2003, Hamilton and Messer 2003). The coastal sage scrub NCCP program was developed to address this need, with the goal of designating regional reserves to protect a wide range of species while allowing compatible land uses to occur within the reserves and appropriate growth and economic development outside the reserves.

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

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

Landbirds

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

Recent analyses of data from several of these programs, particularly the BBS, suggest that populations of many landbirds, including forest, scrubland, and grassland species, appear to be in serious decline (Peterjohn et al. 1995). Indeed, populations of most landbird species appear to be declining on a global basis. Nearctic-Neotropical migratory landbirds (those that breed in North America and winter in Central and South America and the West Indies; hereafter, Neotropical migratory birds) constitute one group for which pronounced population declines have been documented (Robbins et al. 1989, Terborgh 1989). In response to these declines, the Neotropical Migratory Bird Conservation Program, "Partners in Flight - Aves de las Americas," was initiated in 1991 (Finch and Stangel 1993). The major goal of Partners in Flight (PIF) is to reverse the declines in Neotropical migratory birds through a coordinated program of monitoring, research, management, education, and international cooperation. Recent analyses have also indicated that many resident North American species are also declining; thus, monitoring of all North American landbirds is needed, 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 for monitoring demographic parameters of landbirds. A peer review of the MAPS program and evaluation of the pilot project were completed by a panel assembled by USGS/BRD, which concluded that: (1) MAPS is technically sound and is based on the best available biological and statistical methods; (2) it complements other landbird monitoring programs such as the BBS by providing useful information on landbird demographics that is not available elsewhere; and (3) it is the most important project in the nongame bird monitoring arena since the creation of the BBS (Geissler 1996).

Now in its 15th year (12th year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to nearly 500 stations in 2003. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies, including the Department of Defense, Department of the Navy, Texas Army National Guard, National Park Service, USDA Forest Service, and US Fish and Wildlife Service, and private organizations in PIF. Within the past 12 years, for example, IBP has been contracted to operate over 150 MAPS stations on federal lands, including stations on seven national forests, five national parks, and 21 military installations, as well as three stations on the Flathead Indian Reservation of the Confederated Salish and Kootenai Tribes and ten stations on the Nature Reserve of Orange County. Furthermore, many private organizations and individual bird banders and ornithologists interested in monitoring the vital rates of avian populations on federal, state, local government, and private lands, such as Audubon sanctuaries and nature preserves, have established and operated over 350 additional MAPS stations in each of the past few years.

Goals and Objectives of MAPS

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

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

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

Cormack- Jolly-Seber analyses of mark-recapture data on adult birds.

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

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

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

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

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

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

Both long-term goals are in agreement with the NROC=s integrated bird monitoring program, as established by the NROC Technical Advisory Committee. Accordingly, a preliminary MAPS program was established at NROC in 1998, which was expanded during 1999-2001 and then reduced to the six longest-running stations in 2003. It is expected that the MAPS program will be capable of providing integrated data on avian population trends and vital rates, as well as information on the causes of population declines and potential management actions that can be undertaken to reverse the declines. This is some of the basic information that is required to drive the NROC=s Aadaptive management≅ program with the overall long-term goal of conserving avian biodiversity within the NROC.

SPECIFICS OF THE NROC MAPS PROGRAM

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

Ten MAPS stations were operated in NROC in 2001 and 2002. Two stations (Little Sycamore Canyon and Weir Canyon) were established and operated in 1998, two more stations (Irvine Park and Upper Laurel Canyon) were established and operated in 1999, six stations including two additional stations (Upper Wood Canyon and Upper Weir Canyon) were run in 2000, and four more new stations (Emerald Canyon, Round Canyon, Sycamore Hills, and Whiting Ranch) were established in 2001, resulting in the ten stations operated in 2001 and 2002. Due to budget considerations, these ten stations were reduced to the six longest-running stations in 2003, those established and first operated during 1998-2000. These six stations were operated in the exact same locations that they have been operated for each of the past four, five, or six years. Three of the 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. In addition, two stations (one in each reserve; Little Sycamore Canyon and Weir Canyon) have been designated as ñcore stationsò and are located within central portions of the reserves; two stations (Upper Laurel Canyon and Irvine Park) have been designated as Aroad-edge stationsò and are located within 300 m of major transportation corridors; and two stations (Upper Wood Canyon and Upper Weir Canyon) have been designated as ñhousing stationsò and are located within 300 m of suburbs with houses. A summary of the major habitats represented at each of the six stations, along with the geographic location (coastal preserve, central preserve), local landscape type (core, road-edge, housing-development), latitude-longitude, and average elevation of the station, is presented in Table 1.

In 2003, the NROC stations were operated by IBP field biologist interns, who were assisted by a number of trained volunteers. The 2003 NROC field biologist interns, Jackie Garneau and Greg Moore, received seven days of intensive training in a comprehensive course in mist netting and bird-banding techniques given by IBP biologist Kerry Wilcox, with assistance from Starr Ranch Sanctuary managers Sandy and Pete DeSimone, which took place April 27-May 4 at Starr Ranch, Trabuco Canyon, Orange County. Kerry and the interns began to re-establish and set-up the six stations on April 24, and data collection began at the six stations during May 5-11. Kerry Wilcox then supervised the 2003 interns for the duration of the field work at the NROC.

All ten net sites at each of the six stations were re-established at the exact same locations as in all previous years, with all of the ten fixed net sites at each station being located within the interior eight ha of each station. On each day of operation, one 12-m long, 30-mm mesh, 4-tier, black nylon mist net was erected at each of the ten net sites. These ten nets at each station were operated for six morning hours per day (beginning at local sunrise) on one day during each of ten consecutive 10-day periods between Period 1 (May 1-10) and Period 10 (July 30-August 8). With the single exception of one station being operated in Period 1 on May 11 (which is well within the 5-day grace period for operating stations before and after each actual 10-day period), the operation of all stations occurred on schedule in each of the ten 10-day periods. A summary of the operation of the 2003 NROC MAPS Program at each of the six stations, along with the number of years of operation at each station, is presented in Table 1.

METHODS

The operation of each of the six stations during 2003 and during each of the preceding years followed MAPS protocol, as established for use by the MAPS Program throughout North America and detailed in the MAPS Manual (DeSante et al. 2003). An overview of both the field and analytical techniques is presented here.

Data Collection

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

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

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

For each of the 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 MAPS Habitat Structure Assessment Protocol, developed by IBP Landscape Ecologist, Phil Nott and the IBP staff (Nott et al. 2002a).

Computer Data Entry and Verification

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

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

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

Data Analysis

To facilitate analyses, we first classified the landbird species captured in mist nets into five groups based upon their breeding or summer residency status. Each species was classified as one of the following: a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during all years* that the station was operated; a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during more than half but not all of the years* that the station was operated; an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during half or fewer of the years* that the station was operated; a transient (T) if the species was *never* a breeder or summer resident at the station, but the station was within the overall breeding range of the species; and a migrant (M) if the station was not located within the overall breeding range of the species. All data for a given species from a given station were included in year-specific (i.e., 2002 or 2003) or mean population size and productivity analyses for the species (e.g., Tables 3, 4 [in part], and 5-8) unless the species was classified as a migrant (M) at the station. For survivorship estimates (Table 9) and population size and productivity trends (Figures 1 and 2), data for a given species from a given station were included only if the species was classified as a regular (B) or usual (U) breeder and summer resident at the station. Thus, data from a station for a species classified as a migrant (M) at the station were included only in year-specific summaries of the total numbers of captures (Tables 2 and 4 [in part]).

A. Population-size and productivity analyses X The proofed, verified, and corrected banding data from 2003 were run through a series of analysis programs that calculated for each species and for all species pooled at each station and for all stations pooled:

(1) the numbers of newly banded birds, recaptured birds, and birds released unbanded;
(2) the numbers and capture rates (per 600 net-hours) of first captures (in 2003) of individual adult and young birds; and
(3) the proportion of young in the catch.

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

For each of the six stations, we calculated percent changes between 2002 and 2003 in the numbers of adult and young birds captured, and actual changes in post-fledging productivity. These year-to-year comparisons were made in a "constant-effort" manner by means of a specially designed analysis program that used actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by- period basis to exclude captures that occurred in a given net in a given period in one year during the time when that net was not operated in that period in the other year. For species captured at several stations on the Nature Reserve of Orange County, we followed the methods developed by the BTO in their CES scheme (Peach et al. 1996) and inferred the statistical significance of reserve-wide changes in the indices of population size and productivity using confidence intervals derived from the standard errors of the mean percentage (or, for productivity, mean actual) changes. The statistical significance of the overall change at a given station was inferred from a one-sided binomial test on the proportion of species at that station that increased (or decreased). Throughout this report, we use an alpha level of 0.05 for statistical significance. For year-to-year comparisons, however, we use the term Anear-significant≅ or Anearly significant≅ for differences for which $0.05 \leq P < 0.10$.

For each of the six stations operated for the four years, 2000-2003, and for all stations combined, we calculated four-year means for the numbers of adult and young birds captured per 600 net hours and the proportion of young in the catch for each individual species and for all species pooled. Four-year means for population size and productivity at the two reserves and in the three habitat categories can thus be compared. Because of reduced funding in 2003, multivariate analyses of adult population size and logistic regression analyses of productivity could not be undertaken.

B. Analyses of trends in adult population size and productivity X We examined five-year (1999-2003) trends in indices of adult population size and productivity for target species for which we recorded an average of seven or more individual adult captures per year at the six stations. Note that only four of these stations (Little Sycamore Canyon, Upper Laurel Canyon, Weir Canyon, and Irvine Park) were operated for five years and that the remaining two stations (Upper Wood Canyon and Upper Weir Canyon) were only operated for four years; constant-effort comparisons for 1999-2000 were thus performed with just the original four stations. Data were only included for a given species from stations at which that species was a regular (B) or usual (U) breeders. For trends in adult population size, we first calculated adult population indices for each species for each of the five years based on an arbitrary starting index of 1.0 in 1999. Constant-effort changes (as defined above) were used to calculate these Achain≅ indices in each subsequent year by multiplying the proportional change (percent change divided by 100) between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

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

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

(actual 1999 value of *PSI* / predicted 1999 value of *PSI* based on the regression) * *PT*.

We present *APC*, the standard error of the slope (*SE*), the correlation coefficient (*r*), and the significance of the correlation (*P*) to describe each trend. Again, we use an alpha level of 0.05 for statistical significance. For purposes of discussion, however, we use the terms Anearly significant≅ or Anear-significant≅ for trends for which $0.05 \leq P < 0.10$. Species for which r > 0.5 are considered to have a substantially increasing trend; those for which $r < -0.5$ are considered to have a substantially decreasing trend; those for which $-0.5 \leq r \leq 0.5$ and $SE \leq 0.140$ (for five-year trends) are considered to have a stable trend; and those for which $-0.5 \leq r \leq 0.5$ and $SE > 0.140$ are considered to have widely fluctuating values but no substantial trend.

Trends in Productivity, *PrT*, were calculated in an analogous manner by starting with actual productivity values in 1999 and calculating each successive year=s value based on the actual constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r),* and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends, except that productivity trends are considered to be highly fluctuating if the SE of the slope > 0.0.80 (for five-year productivity trends).

C. Survivorship analyses X Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) were conducted on select target species using five years (1999-2003) of capture histories of adult birds. Stations utilized and criteria for including data from a station for a given species were the same as for population and productivity trends, as noted above, that is, we only included data from a station for a species if that species was a regular (B) or usual (U) breeder at the station. Using the computer program SURVIV (White 1983), we calculated, for each target species, maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability (φ), adult recapture probability (p), and the proportion of residents among newly captured adults (τ) using both a between-year and within-year transient model (Pradel et al. 1997, Nott and DeSante 2002). The use of the transient model ($\varphi p \tau$) accounts for the existence of transient adults (dispersing and floater individuals which are only captured once) in the sample of newly captured birds, and provides survival estimates that are unbiased with respect to these transient individuals (Pradel et al. 1997). Recapture probability is defined as the conditional probability of recapturing a bird in a subsequent year that was banded in a previous year, given that it survived and returned to the place it was originally banded. We limited our consideration to models that produced estimates for both survival and recapture probability that were neither 0 nor 1, and to models that fit the data. The goodness of fit of the models was tested by using a Pearson's goodness-of-fit test.

RESULTS

A total of 3234.2 net-hours was accumulated at the six MAPS stations operated on the NROC in 2003 (Table 1). Data from 3026.2 of these net-hours could be compared directly to 2002 data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity

A. 2003 values X The 2003 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 (435) was recorded at the Little Sycamore Canyon station, while Irvine Park produced the smallest number (229). The highest species richness, 38 species, was recorded at Upper Weir Canyon, while species richness was lowest at Upper Wood Canyon and Irving Park, with 30 species each.

Capture rates (per 600 net-hours) of individual adult and young birds and the proportion of young in the catch during 2003 are presented for each species and for all species pooled at each of the six stations in Table 3. We present capture rates (captures per 600 net-hours) of adults and young in this table so that the data can be compared among species and stations which, because of the vagaries of weather and accidental net damage, can differ from one another in effort expended (see Table 1). 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 2003 (see Table 3):

COASTAL RESERVE STATIONS

Little Sycamore Canyon	**Upper Laurel Canyon**	**Upper Wood Canyon**
Bewickôs Wren	Wrentit	Wrentit
Wrentit	Spotted Towhee	House Finch
Spotted Towhee	Common Yellowthroat	Bushtit
ñWesternò Flycatcher	California Towhee	Spotted Towhee
Orange-crowned Warbler	Lesser Goldfinch	
California Towhee	Orange-crowned Warbler	

CENTRAL RESERVE STATIONS

Weir Canyon	**Irving Park**	**Upper Weir Canyon**
House Wren	Wrentit	Bushtit
Lazuli Bunting	Bewickôs Wren	Wrentit
ñWesternò Flycatcher		Bewickôs Wren
Bewickôs Wren		House Wren
Wrentit		Orange-crowned Warbler
		California Towhee
		Black-headed Grosbeak
		Lesser Goldfinch
		ñWesternò Flycatcher

Capture rates of adults indicate that the total adult population size of all species pooled in 2003 was greatest at Upper Weir Canyon, followed in descending order by Upper Laurel Canyon, Little Sycamore Canyon, Upper Wood Canyon, Weir Canyon, and Irvine Park. Captures rates of young of all species pooled at each station in 2003 followed a different sequence than that of adults, being highest at Little Sycamore Canyon, followed by Upper Laurel Canyon, Upper Weir Canyon, Weir Canyon, Upper Wood Canyon, and Irvine Park. The index of productivity, as determined by the proportion of young in the catch, followed yet a different sequence from both adults and young. Productivity was highest at Little Sycamore Canyon (0.65) followed by Upper Laurel Canyon and Weir Canyon (0.61 each), Irving Park (0.58), Upper Wood Canyon (0.53), and Upper Weir Canyon (0.51).

Table 4 summarizes the banding results at all six 2003 NROC MAPS stations combined. Altogether, a total of 2043 birds of 51 species were captured during the 2003 breeding season. Newly-banded birds comprised 64.4% of the total captures. Overall, Wrentit was by far the most frequently captured species, followed by Bewickόs Wren, Spotted Towhee, Orange-crowned Warbler, Annaόs Hummingbird, California Towhee, Bushtit, Wilson=s Warbler, House Wren, Common Yellowthroat, Song Sparrow, Swainsonόs Thrush, and House Finch. The most abundant breeding species at the six NROC MAPS stations in 2003 (as determined by adults captured at a rate of at least 4.0 birds per 600 net-hours), in decreasing order, were Wrentit, Spotted Towhee, Bewick=s Wren, ñWesternò Flycatcher, Bushtit, Orange-crowned Warbler, California Towhee, Common Yellowthroat, and Lesser Goldfinch (note that we could not calculate a breeding population size for Anna=s Hummingbird because individuals were not banded and thus the actual number of individuals could not be determined).

<u>B. Comparisons between 2002 and 2003</u> X Constant-effort comparisons between 2002 and 2003 were undertaken at the six NROC MAPS stations 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 six stations combined decreased by a significant 31.0% between 2002 and 2003 (Table 5). Decreases were recorded for 20 of 36 species for all stations combined, a proportion not significantly greater than 0.50 (P = 0.556). The overall adult population size for all species pooled decreased at five of the six stations by amounts ranging from ï 23.7% at Irvine Park to ï 52.7% at Weir Canyon. Only at Little Sycamore Canyon did adult population size increase (by +54.2%). The proportion of decreasing species was not significantly greater than 0.50 at any station. Significant or near-significant decreases in the number of adults captured for all stations combined were recorded for six species (Nuttallόs Woodpecker, Ash-throated Flycatcher, Western Scrub-Jay, Bushtit, Wrentit, and California Thrasher), whereas no species showed such increases. Note that five out of these six (all except the flycatcher) are permanent resident (non-migratory) species at NROC.

The number of young birds captured of all species pooled at all six stations combined increased between 2002 and 2003 by 2469.2%, from 26 young captured in 2002 to 668 in 2003 (Table 6).

These high percent increases are due to a rebound from the near-complete reproductive failure in 2002 at NROC, highlighted in last yearôs report. Increases were recorded at all six stations, by amounts ranging from +456.3% at Upper Weir Canyon to +17,000% at Little Sycamore Canyon (and +infinity at Irvine Park, where no young were captured in 2002). This huge variation in the percent increase is the reason for the anomalous result that the overall increase was not statistically significant. It was obviously, however, highly biologically significant. Increases were recorded for 23 of 25 species for all stations combined, a proportion highly significantly greater than 0.50 (P = 0.000). The proportion of decreasing species was also highly significantly greater than 0.50 at each of the six stations. Significant or near-significant increases in the number of young captured for all stations combined were recorded for no species; again, this results from the huge variation among stations in the extent of the increases for each species, rather than variation between increases and decreases.

With adult populations decreasing significantly and numbers of young increasing dramatically, productivity (the proportion of young in the catch) showed a highly significant increase of +0.553 (+93.7%) from 0.037 in 2002 to 0.591 in 2003 for all species pooled and all stations combined (Table 7). Increases in productivity were noted at each of the six stations, by amounts ranging from +0.391 at Upper Weir Canyon to +0.636 at both Little Sycamore Canyon and Weir Canyon. The proportion of species with increasing productivity was highly significantly greater than 0.50 at all stations combined and at each station except for Weir Canyon. Eighteen species showed significant or near significant increases in productivity across all stations, whereas no species showed such decreases. Significant increases in productivity were shown by all of the common resident species at NROC (e.g., Nuttall's Woodpecker, Bushtit, Bewick's Wren, Wrentit, California Thrasher, Spotted and California towhees, and Rufous-crowned and Song sparrows).

<u>C. Four-year mean population size and productivity values</u> X Mean numbers of individual adults (an index of adult population size) and young captured per 600 net-hours, and proportion of young in the catch (an index of productivity), over the four-year period 2000-2003, are presented in Table 8 for the six stations that operated for each of those four years. Examination of all-species-pooled values suggests that adult population sizes tended to be somewhat higher at the three coastal reserve stations (Little Sycamore Canyon, Upper Laurel Canyon, and Upper Wood Canyon; mean 116.6 adults captured per 600 net hours) than at the three central reserve stations (Weir Canyon, Irvine Park, and Upper Weir Canyon; mean 100.5 adults captured per 600 net hours). Four-year means for adult population size also tended to be somewhat higher at the housing-development (Upper Wood Canyon and Upper Weir Canyon; mean 120.3 adults captured per 600 net hours) and road-edge (Upper Laurel Canyon and Irvine Park; mean 113.9 adults captured per 600 net hours) stations than at the core stations (Little Sycamore Canyon and Weir Canyon; mean 91.4 adults captured per 600 net hours). These comparisons were essentially the same as last year using three-year means, indicating that the relationship among stations for total population size tends not to vary too much from year to year, even in years of greatly reduced population sizes. Productivity, despite being fairly constant across all stations, showed a different pattern, being slightly higher at the central reserve (mean 0.397) than the coastal reserve (mean 0.383) stations, and highest at the housing-development stations (0.405), followed by the core stations (0.390) and the road-edge stations (0.375). These four-year patterns were also the

same as the three-year patterns reported last year.

D. Four-year trends in adult population size and productivity -- "Chain" indices of adult population size are presented in Figure 1 for the 15 target species (with an average of at least seven total individual adults captured per year from stations at which the species was a regular (B) or usual (U) breeder) and for all species pooled at all six stations over the five years 1999-2003. See Methods for an explanation of the calculations used to obtain these indices. We used the slope of the regression line for each species to calculate the Annual Percentage Change (*APC*) for the population. *APC*, along with the standard error of the slope (SE), the correlation coefficient (*r*), and the significance of the correlation (*P*), are presented for each target species and for all species pooled in Figure 1.

Population trends for six species (Orange-crowned Warbler, Common Yellowthroat, Spotted Towhee, California Towhee, Rufous-crowned Sparrow, and Song Sparrow), as well as all species pooled, showed substantial decreases ($r \leq -0.5$) over the five years 1999-2003. Of these, Spotted and California towhees showed near-significant declines and Song Sparrow showed a significant decline. No species showed a population trend with a substantial increase ($r \geq 0.05$). The remaining nine species (AWestern≅ Flycatcher, Ash-throated Flycatcher, Bushtit, Bewick's Wren, House Wren, Wrentit, California Thrasher, House Finch, and Lesser Goldfinch) showed relatively stable populations and no substantial trend (absolute $r < 0.5$, $SE \leq 0.140$). Overall, as indicated by *APC* values, population trends for 13 species were negative, whereas only two species (Bewick's Wren and House Wren) showed positive trends. The annual percentage change (*APC*) in populations between 1999 and 2003 varied from -17.8% for Song Sparrow to +4.5% for Bewick's Wren, and was -8.1% for all species pooled.

Figure 2 indicates generally erratic fluctuations in productivity during the five-year period 1999-2003, with few substantial trends. Productivity trends for no species showed a substantial decrease ($r \leq -0.5$), and those for only two species (Orange-crowned Warbler and House Finch) showed substantial increases ($r \geq 0.05$), with that of House Finch being nearly significant. Productivity trends for four species ("Western" Flycatcher, Ash-throated Flycatcher, Bushtit, and Lesser Goldfinch) were relatively stable, with absolute $r < 0.5$ and $SE \leq 0.80$. Productivity trends for the remaining nine species (Bewick=s and House wrens, Wrentit, California Thrasher, Common Yellowthroat, Spotted and California towhees, and Rufous-crowned and Song sparrows), as well as all species pooled, showed erratic fluctuations, but no substantial trend (absolute $r < 0.5$ and $SE > 0.80$). Virtually all of the species showed substantially lower productivity in 2002 than in 2001 and 2003, due to the reproductive failure in 2002 highlighted in last year's report. The annual change in the index of productivity (*PrT*) between 1999 and 2003 varied from -0.010 for Lesser Goldfinch to +0.144 for Orange-crowned Warbler, and was +0.044 for all species pooled. Overall, as indicated by *PrT* values, productivity trends for eleven species and all species pooled were positive, whereas trends for only four species (Bewickõs and House wrens, California Thrasher, and Lesser Goldfinch) were negative. This pattern of five-year productivity trends contrasts with the previous four-year pattern in which 10 of 14 species and all species pooled showed decreasing productivity trends. The difference was caused by the significant rebound in productivity during 2003.

Estimates of Adult Survivorship

Using five years of data from the six stations, estimates of adult survival and recapture probabilities could be obtained for eight of the 15 target species breeding at NROC (target species are those with an average of at least seven total individual adults captured per year from stations at which the species was a regular (B) or usual (U) breeder). Estimates for the remaining seven species ("Western" and Ash-throated flycatchers, House Wren, Common Yellowthroat, Rufous-crowned Sparrow, House Finch, and Lesser Goldfinch) could not be obtained due to insufficient numbers of between-year recaptures. Maximum-likelihood estimates of annual adult survival probability, recapture probability, and proportion of residents among newly captured adults are presented in Table 9 from the time-constant transient model for each of the eight species.

Annual adult survival-rate estimates ranged from a low of 0.370 for Orange-crowned Warbler to a high of 0.881 for California Thrasher, with a mean of 0.582 for the eight species. With the exception of Orange-crowned Warbler and Spotted Towhee, which seemed to have low survival-rate estimates, estimates for the remaining species seemed to be at least as high as elsewhere in western North America. Estimates of recapture probability for the eight species varied from 0.121 for California Thrasher to 0.577 for Bewick=s Wren, with a mean of 0.314, perhaps a little low considering the low stature of the habitat. Estimates of the proportion of residents among newly captured adults ranged from 0.331 for Song Sparrow to 0.832 for Spotted Towhee, with a mean of 0.596, about as expected for a community comprised of many permanent resident species.

The mean coefficient of variation of the annual adult survival-rate estimates (CV(φ)) from five years of data for the seven species for which survivorship estimates were available last year from four year of data (all but Orange-crowned Warbler) was 19.0%, as compared with a four-year mean CV(φ) of 31.9% for these same seven species. Moreover, survival-rate estimates having CV(φ) < 30% were obtained for seven species from five years of data, as compared to only four species from four years of data. These results indicate a substantial improvement in precision as a result the additional year of data.

DISCUSSION OF RESULTS AND CONCLUSIONS

In last year's report (DeSante et al. 2003) we documented a nearly complete, region-wide and species-wide reproductive failure at the NROC MAPS stations during the 2002 breeding season, the likes of which have not been recorded within the MAPS program since its inception in 1989. No young were captured for 29 of 39 species and only 54 young birds were captured at all ten stations combined, 25 of which were House Finches. Mean productivity for all stations combined was just 0.04, the lowest ever recorded at a MAPS location, and ranged from 0.00 at Irvine Park to 0.09 at Upper Weir Canyon. Following this failure, the 2003 season was notable in two respects: adult population sizes declined substantially and significantly, and productivity rebounded dramatically during 2003.

The decline in breeding populations was region-wide (occurring at virtually all stations) but not completely species-wide, being especially dramatic among permanent resident species. These non-migratory species might be expected to show stronger local population declines than migratory species, due to a smaller amount of natal and, possibly, breeding dispersal among permanent resident species than among migratory species, and hence less potential recruitment from other populations. Of six species with significant or near-significant declines between 2002 and 2003, five (Nuttallõs Woodpecker, Western Scrub-Jay, Bushtit, Wrentit, and California Thrasher) were permanent resident (non-migratory) species whose population declines were undoubtedly due to the lack of recruitment of second year birds (those that would have hatched in 2002) in 2003. The substantial declines in adults in 2003 also caused the five-year trends for 13 of 15 species to become negative. In contrast to decline in adult populations in 2003, the rebound in productivity witnessed at NROC in 2003 was both region-wide and species-wide, although it also occurred most dramatically with resident species. This dramatic increase in productivity resulted in 11 of 15 species showing positive five-year productivity trends, a reversal of the four-year trends recorded after 2002, 10 of 14 of which were negative.

Data from the NROC MAPS stations also illustrate a density-dependent effect that we have noted at other MAPS stations across the country. Adult breeding populations decreased slightly between 1998 and 1999, decreased significantly between 1999 and 2000, decreased slightly again between 2000 and 2001, increased substantially and significantly between 2001 and 2002, and decreased significantly between 2002 and 2003. In contrast, productivity generally followed the opposite pattern, including substantial declines between 1998 and 1999, increases between 2000 and 2001, substantial and significant declines between 2001 and 2002, and substantial and significant increases between 2002 and 2003. These out-of-phase alternating patterns in productivity and population size relate to effects of productivity and recruitment on subsequent breeding populations, along with lower productivity of first-time breeders. For example, good productivity in 2001 led to increased adult population sizes in 2002, which were then comprised of less-experienced breeders that, along with exceptionally dry weather (see last year's report and Hamilton 2003), brought about a reproductive failure in 2002. This failure, in turn, resulted in a significant decline in the 2003 breeding populations, but those adults that survived to 2003 were older and more experienced and not constrained by intra- and inter-specific competition. These factors, along with the substantial rainfall that occurred just prior to the 2003 breeding season, then contributed to excellent reproductive success (the highest recorded during the entire five years for many species) in 2003, as predicted in last year's report.

Of concern is the fact that, superimposed upon this pattern, is a pattern of general population decline. That 13 of 15 species have shown declining trends, that six species and all species pooled showed substantial decreasing trends while no species showed a substantial increasing trend, and that all three significant or near-significant declines have been negative, may be evidence for this general decline at NROC. In contrast, 11 of 15 species and all species pooled showed increasing productivity trends, although only two of the 16 trends (both increasing) were substantial and only one was nearly significant. Indeed, the productivity trends for nine of the 15 species showed erratic fluctuations with no substantial trend. On the other hand, five years of data are really not a lot to work with, especially given the highly fluctuating alternating dynamic that we have documented at NROC. Clearly, several more years of data will likely be required to confirm that the overall declines in landbird breeding populations now observed at NROC are real, and determine if there is an actual trend to productivity.

Assessment of variation in breeding population sizes by reserve and landscape during the four year period 2000-2003 suggests that populations may tend to be slightly higher in the coastal reserve (mean 116.6 adults captured per 600 net hours at the three stations) than in the central reserve (mean 100.5), and may tend to be slightly higher at housing development (mean 120.3) and road-edge (mean 113.9) stations than at the core stations (mean 91.4), although these differences might only be significant for select species. These four-year patterns were much the same as three-year patterns reported last year, and essentially the same as the patterns revealed by multivariate ANOVAS that were also reported last year.

In contrast to adult population sizes, productivity indices did not vary much from station to station. Overall, however, productivity tended to show a different patterns than adult population size, being slightly higher in the central reserve (mean 0.397) than in the coastal reserve (mean 0.383), and highest at the housing-development stations (0.405) followed by the core stations (0.390) and the road-edge stations (0.375). These four-year patterns in productivity were also essentially the same as three-year patterns reported last year, and much the same as the patterns revealed by multivariate logistic regression analyses that were also reported last year, although the nearly significant differences seen in previous years may have been overwhelmed by the greatly increased productivity noted at all stations in 2003.

Using nine or ten years of data from other MAPS stations, (Nott et al. 2002b), we have been able to examine relationships between global climate cycles (such as the El Niño/Southern Oscillation and the North Atlantic Oscillation) and productivity, and have found significant correlations. In particular, we have found that productivity in the Pacific Northwest and most other locations in western and southern United States is strongly related to the mean monthly El Niño/Southern Oscillation Precipitation Index (ESPI; a measure of the effects of El Niños and La Niñas) in such a manner that productivity averages higher during El Niño conditions (such as those in 1998) than during La Niña conditions (such as those in 1999). Once more years of data have accumulated at NROC, we will be able to better understand avian population dynamics on NROC and in the

Southern California region generally and their relationship to global climate cycles. Given the weather-related reproductive failure of 2002 and dramatic rebound in 2003, it will be of particular interest to compare variation in annual breeding success with variation in rainfall totals during the previous winter and spring.

Using five years of data, we were able to obtain survival estimates for eight target species using modified CJS mark-recapture models. We noted a substantial improvement in precision of the survival-rate estimates using five, rather than four years of data; the mean CV(φ) for the seven species for which survival rates could be estimated from both four and five years of data decreased from 31.9% to 19.0%, which amounts to a 40% increase in precision. We have noted substantial improvements in precision with each additional year of data (so far, up to eleven years) at other MAPS stations. These predictions are in agreement with simulations of MAPS data completed by Dan Rosenberg as part of his evaluation of the statistical properties of the MAPS Program (Rosenberg et al. 1996, 1999). We expect to be able to estimate adult survival rates for as many as 14 target species at NROC once more years of data from the six (or more) stations are available. Time-dependence in estimates of survivorship, recapture probability, and/or proportion of residents may also become available when at least six years of data have accumulated from the six (or more) stations.

Based on data from other MAPS stations in California, the survival-rate estimates from NROC for most resident species appeared to be about as high, or possibly even higher, than those from other locations. Notable exceptions appear to be Orange-crowned Warbler, a migratory species, and Spotted Towhee, a permanent resident species, both of which showed adult survival-rate estimates that seemed low, especially considering their body masses. Overall, however, these initial survivorship estimates suggest that, for most species, adult survival rates at NROC are generally relatively good or, at least, not really deficient. This may generally reflect the mild winters experienced in Southern California, although lack of food related to drought conditions (such as those experienced during the winter of 2001-2002) may take its toll on adult survival as well as productivity. With more years of data, we will be able to determine interannual variation in survival to help answer these questions.

We must emphasize again that the population trend, productivity trend, and survival rate results presented here are based on only five years of data from 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 still have relatively low precision and statistical power because of the limited number of years of data. This, of course, will improve dramatically as more years of data accumulate from the six (or more) stations that can be operated on the NROC.

Conclusions

Previous extensive analyses conducted on MAPS data have indicated that the indices and estimates of primary demographic parameters (productivity and survivorship) of common landbird species produced by the MAPS Program 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 Amist-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 effort, and can provide critical data to aid in resolving problems associated with declining landbird populations in Southern California.

Although the six currently operated MAPS stations on the Nature Reserve of Orange County have only been operated for four years (five years for four of the stations), important data have been gathered on breeding populations and productivity for a number of permanent and summer resident landbird species on the Reserve. We have documented an out-of-phase pattern of alternating increases and decreases in both productivity and adult population size that suggest that populations are generally being regulated in a density-dependent manner. However, we have also documented a massive reproductive failure in 2002 that operated independently of density and was apparently caused by a severe drought preceding the breeding season. With four years of data, we were able to begin to assess interannual variation in breeding populations and productivity, and provide robust analyses on the effects of geographic location of the preserve and landscape-level habitat type on the adult population sizes and productivity of landbirds on the Reserve. Now, with five years of data, we are able to provide population and productivity trends, and provide estimates of time-constant annual adult survival rates, recapture probabilities, and proportions of residents among newly marked adults for eight species with increased precision using the transient model. With a few additional years of data, we will be able to undertake powerful analyses into the causal factors leading to the declining trends that we are documenting on the Reserve. Such information on a broad spectrum of non-migratory permanent resident species as well as a number of migratory summer resident species will shed invaluable light on the understanding of the biotic and abiotic factors potentially being faced by threatened and endangered species on the Reserve, including the California Gnatcatcher and Cactus Wren.

Finally, we have initiated two broad-scale analyses on longer-term data from other locations to help us further understand the population dynamics of landbirds and to allow us to identify potential management actions to reverse population declines and maintain stable or increasing populations. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends, we are beginning to determine the proximate demographic causes of population trends for species at multiple spatial scales (DeSante et al. 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 populations in this species. Second, by modeling vital rates as a function of landscape-level habitat characteristics, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area of each station are good predictors not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well (Nott 2000). This latter study revealed the existence of threshold values of critical habitat characteristics, such as mean forest 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 more years of data and additional funding from a variety of sources, we hope to undertake such analyses with data from the NROC, as well as with data from all 500 stations that are now being operated across North America. We also hope to include estimates of juvenile recruitment and indices of first-year survival in future analyses in order to fully understand what parameters are most affecting population changes in each target species. We are excited by the prospect of conducting these types of analyses on additional years of data from the NROC in upcoming years.

ACKNOWLEDGMENTS

All data collected for the MAPS Program in NROC in 2003 were gathered by Jackie Garneau and Greg Moore (field biologist interns of The Institute for Bird Populations), as well as by several qualified assistants. We thank the interns and assistants for their excellent work in establishing, re-establishing, and operating the NROC MAPS stations. We thank Kerry Wilcox for providing indispensable training for the NROC interns, helping to re-establish the stations, and providing excellent supervision of the NROC interns over the entire field season. We thank Sandy and Pete DeSimone of Starr Ranch Audubon Sanctuary for assisting Kerry Wilcox with training the NROC interns. We especially thank Robb Hamilton for spearheading the establishment of the stations, for indispensable information on the background of the project, and for frequent feedback throughout the study period. We thank Trish Smith of The Nature Conservancy and Lyndine McAfee of the Nature Reserve of Orange County for their excellent support and kind assistance with all aspects of this project, especially for finding funding during these difficult financial times. We also thank all the folk at Starr Ranch, especially Pete and Sandy DeSimone, Gail Hall, and Dana Kamada, for supplying a wonderful place for and help with the training program, and for allowing the interns to stay at Starr Ranch throughout the summer. Financial support for the 2003 MAPS Program, for which we are very grateful, was provided by The Nature Conservancy and The Nature Reserve of Orange County. This is Contribution Number 213 of The Institute for Bird Populations.

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