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The 2006 Annual Report of the Monitoring Avian Productivity and Survivorship (MAPS) Program in Yosemite National Park

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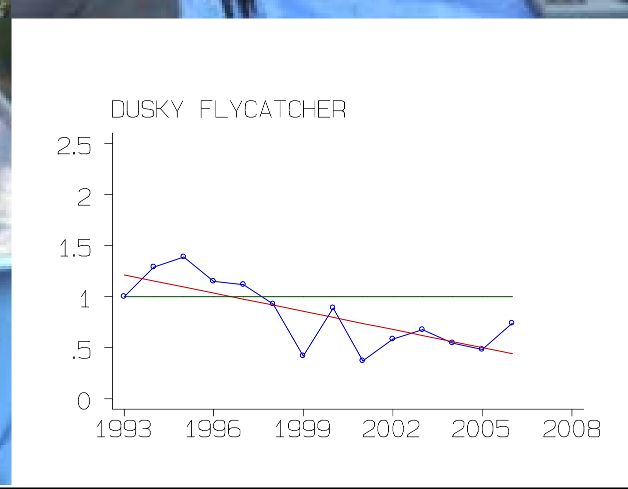

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SUMMARY

Since 1989, The Institute for Bird Populations has coordinated 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 MAPS 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 for addressing declines in North American landbird populations. National parks, including Yosemite, provide ideal locations for this large-scale, long-term biomonitoring, because the parks are among the few sites in the United States where population trends due to large-scale regional or global change patterns are relatively unconfounded with local changes in land-use practices.

A second objective of MAPS is to provide standardized population and demographic data for the landbirds found in local areas or on federally managed public lands, such as national parks, national forests, and military installations. In this light, the MAPS program has operated in Yosemite National Park for the past 14 years (17 years at one station), where it has produced information of value for research and conservation efforts within the park.

Five MAPS stations were re-established and operated in Yosemite National Park in 2006, at the same locations where they were operated in previous years. The five stations, located along an elevation gradient from highest to lowest, were:

- White Wolf Meadow at 2,402 m elevation.
- Gin Flat East Meadow at 2,073 m elevation.
- Crane Flat Meadow at 1,875 m elevation.
- Hodgdon Meadow at 1,408 m elevation.
- Big Meadow at 1,311 m elevation.

The Hodgdon Meadow station was established and first operated in 1990, the Gin Flat East Meadow station in 1998, and the other three stations in 1993.

A total of 2,139 captures of 60 species was recorded during the summer of 2006 at Yosemite National Park. Breeding populations increased by a highly significant 22% in 2006 as compared with those of 2005, with increases recorded at all five stations. By contrast productivity declined at four of five stations (all except Crane Flat). This is nearly the opposite of changes recorded between 2004 and 2005, when populations decreased at all stations except Big Meadow and productivity increased at all stations except Hodgdon Meadow (decreased slightly) and Crane Flat (decreased substantially). Consistent alternating cycles of population increases and decreases such as this, with out-of-phase decreases and increases in productivity, are apparently caused by density-dependent effects on productivity and recruitment, perhaps along with lower productivity of first-time breeders.

Populations of adult birds at MAPS stations in Yosemite National Park have shown a substantial and highly significant decrease of -1.5% per year over the 14 years, 1993-2006, representing a 19% decline. Comparison of long-term population trends at Yosemite with long-term BBS trends from the Sierra Nevada physiographic strata suggests that these dramatic declines for most landbird species in Yosemite are part of a Sierra-wide decline. In contrast to populations trends, trends of productivity showed a substantial but non-significant 14-year increase of +0.042 per year when all species were pooled, with more species showing increases (17) than decreases (9). These declining population trends, coupled with stable or fluctuating productivity trends, might seem to suggest that other factors such as decreased overwinter survival or decreased recruitment into the breeding population may be causing the declines. However, productivity trend does not reflect whether or not productivity levels are high enough or low enough to sustain a population, and there is also substantial species-specific variation in productivity trends.

We were able to obtain estimates of annual adult survival for 31 target species at Yosemite using 14 years of data from all five stations combined. Additional years of data continue to result in increased precision of estimates and numbers of species for which survival estimates can be obtained. Adult survival rates at Yosemite appear to be relatively good compared with values for the Northwest MAPS region as a whole. Estimates are higher than those of the Northwest Region overall for 20 of 29 species for which this comparison could be made, with a mean annual adult survival rate at Yosemite (0.485) that was 3.0% higher than that of the Northwest Region (0.471). This suggests that survival of birds breeding at Yosemite is good, overall, and further suggests that lower productivity (regardless of whether or not productivity is continuing to decline over time) at Yosemite may be the primary cause for the widespread declines in landbirds we are documenting.

In this year's report we have added two new analyses examining 1) population dynamics among four species of *Empidonax* flycatchers, and 2) relationships between early spring snowpack and productivity of Yosemite's birds. Both of these topics are related to potential changes in the park due to global warming, and we believe that our long-term MAPS dataset can contribute substantially to this issue.

The MAPS Program in Yosemite continues to yield station-specific indices of adult population size and post-fledging productivity, park-wide estimates of annual survival rates of adults, and important information on annual changes and longer-term trends in these indices and estimates, for over 25 target species. The Yosemite MAPS Program also continues to yield both new findings and new hypotheses about landbird population dynamics in the park. The generation of preliminary findings and new hypotheses that can then be followed up with targeted research is one of the hallmarks of an effective ecological monitoring program. We conclude that the MAPS Program in Yosemite provides a unique dataset that is vital to understanding ecological processes, particularly the consequences of climate change on landbird populations within the park and beyond. We strongly recommend that the operation of the five MAPS stations currently active in Yosemite National Park be sustained indefinitely into the future.

INTRODUCTION

The National Park Service (NPS) has assumed responsibility for managing natural resources in a manner that maintains the ecological integrity and species diversity of both local and regional ecosystems. In order to carry out this responsibility, integrated long-term programs are needed to monitor the natural resources in national parks and to monitor the effects of varying management practices on those resources.

National parks can fulfill vital roles as both refuges for bird species dependent on late successional forest conditions, and to provide reference sites for assessing the effects of land use and land cover changes on bird populations throughout the larger geographic area (Silsbee and Peterson 1991). These changes may result from regional activities such as land conversion and forest management, or from broader-scale processes such as global climate change. Indeed, monitoring vital rates and population trends at ‘control’ sites in national parks is especially important because the parks are among the few sites in the United States where population trends due to large-scale regional or global change patterns are relatively unconfounded with local changes in land-use practices (Simons et al. 1999).

Landbirds and Monitoring

Landbirds are excellent indicators of environmental change in terrestrial ecosystems, because of their high body temperature, rapid metabolism, and high ecological position on most food webs. 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. An added benefit is that landbird monitoring is often particularly efficient, in the sense that many species can be monitored simultaneously with the same survey protocol, and costs are relatively low. Finally, landbirds hold high and growing public interest (Cordell et al.1999; Cordell and Herbert 2002) and are perhaps the most visible faunal component of park ecosystems.

Primary Demographic Parameters

Population-trend data on Neotropical migrant birds, while suggesting alarming declines in some species, provide no information on primary demographic parameters (productivity and survivorship). Without demographic information, population-trend data alone provide no means for determining at what point(s) in the life cycles problems are occurring, or to what extent population trends are driven by causal factors that affect birth rates, death rates, or both (DeSante 1995). The lack of such information for migratory birds in particular is an obstacle to effective conservation actions, as it leaves unresolved whether critical problems that drive population declines are occurring primarily on temperate breeding grounds, during migration, or on distant tropical wintering grounds. Lack of data on productivity and survivorship thus impedes the formulation of effective management and conservation strategies to reverse population declines (DeSante 1992).

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 time lags 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 population trend data alone. Perhaps even more importantly, because of the vagility of many bird species, local variation 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). Local abundance can sometimes be a poor indicator of reproductive success, particularly in habitats that have been modified substantially by humans (Bock and Jones 2004).

The MAPS Program

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. MAPS has since grown into a continent-wide network of over 500 constant-effort mist-netting and banding stations that 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 has subsequently has attracted participation from numerous federal agencies, including the National Park Service, Department of Defense, Department of the Navy, Department of the Army, Texas Army National Guard, USDA Forest Service, and US Fish and Wildlife Service. Within the past ten years, for example, IBP has been contracted to operate as many as 157 MAPS stations per year on federally managed lands, including five stations in Yosemite National Park, six in Denali National Park, five in Shenandoah National Park, two in Sequoia and Kings Canyon National Parks, and six on Cape Cod National Seashore.

The MAPS Program is organized to fulfill three sets of goals and objectives: monitoring, research, and management:

> *Monitoring goals.* For over 100 target species, including Neotropical-wintering migrants, temperate-wintering migrants, and permanent residents, MAPS provides: (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.
>
> *Research goals*. MAPS identifies and describes: (a) 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 (b) 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.

Management goals. MAPS uses these patterns and relationships 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 MAPS program was established in Yosemite National Park in 1990, and Yosemite now hosts some of the longest-running MAPS stations in the country.

Recent Important Results from MAPS

Recent important results from MAPS reported in the peer-reviewed literature include the following:

- Age ratios obtained during late summer, population-wide mist netting provided a good index to actual productivity in the Kirtland's Warbler (Bart et al. 1999).

- Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales (DeSante et al. 1999).

- Patterns of productivity from MAPS at two large spatial scales (eastern North America and the Sierra Nevada) not only agreed with those found by direct nest monitoring and those predicted from theoretical considerations, but were in general agreement with current life-history theory and were robust with respect to both time and space (DeSante 2000).

- Modeling spatial variation in MAPS productivity indices and survival-rate estimates as a function of spatial variation in population trends provides a successful means for identifying the proximate demographic cause(s) of population change at multiple spatial scales (DeSante et al. 2001).

- Productivity of landbirds breeding in Pacific Northwest national forests is affected by global climate cycles including the El Niño Southern Oscillation and the North Atlantic Oscillation, in such a manner that productivity of Neotropical migratory species is determined more by late winter and early spring weather conditions on their wintering grounds than by late spring and summer weather conditions on their breeding grounds (Nott et al. 2002).

- Analyses describing relationships between four demographic parameters (adult population size, population trend, number of young, and productivity) and landscape-level habitat characteristics for bird species of conservation concern have been completed for 13 military installations in south-central and southeastern United States, allowing conservation management strategies to be formulated and tested (Nott et al. 2003a).

The 2006 Report on the Yosemite MAPS Program

In this report we summarize results of the MAPS program at five stations in Yosemite National Park from 1993 (1998 at the Gin Flat East Meadow station) through 2006. Additional data from the Hodgdon Meadow station from 1990-1992 are presented in previous reports (e.g., Pyle et al. 2006). We present indices of adult population size and productivity for each station and for all stations combined for each species and for all species pooled-- for 2006 and averaged across 14 years of data collection. For selected target species and all species pooled, we present temporal trends in adult population size and productivity. We use mark-recapture models to provide estimates of annual adult apparent survival rate, recapture probability, and proportion of residents among newly captured adults for most of the target species.

In previous reports (e.g., Pyle et al. 2006) we also analyzed vital rates by elevation, considered how changes in productivity affected changes in population size, modeled productivity and survivorship as a function of body mass, and considered all values, relationships, and trends in vital rates to suggest proximate demographic causes of the population trends observed in Yosemite's birds. Readers interested in these results, which will not change substantially with an additional year of data, should refer to Pyle et al. (2006). In this year's report we have added some new analyses examining 1) population dynamics among four species of *Empidonax* flycatchers, and 2) relationships between early spring snowpack and the number of young birds captured. Both of these topics may have important implications for the effects of predicted climate change on Yosemite's birds, an issue to which we believe the long-term MAPS dataset can contribute substantially.

METHODS

Establishment and Operation of Stations

Five MAPS stations were re-established and operated in Yosemite National Park in 2006, at the same locations they were operated in previous years. The five stations, located along an elevation gradient from highest to lowest, were:

- White Wolf Meadow (WHWO), set in a wet montane meadow surrounded by mixed red fir and lodgepole pine forest at 2,402 m elevation.

- Gin Flat East Meadow (GFEM), located in a wet montane meadow surrounded by mixed red fir and lodgepole pine forest at 2,073 m elevation.

- Crane Flat Meadow (CRFL), located in a wet montane meadow with willow and aspen thickets, surrounded by mixed conifer forest at 1,875 m elevation.

- Hodgdon Meadow (HODG), located in a wet montane meadow with willow and dogwood thickets, surrounded by mixed conifer forest and a patch of California Black Oak woodland at 1,408 m elevation.

- Big Meadow (BIME), located in riparian willows and mixed conifer forest (largely consumed by a stand-replacing fire in 1990) in an open, dry meadow at 1,311 m elevation.

The Hodgdon Meadow station was established and first operated in 1990, followed by White Wolf, Crane Flat, and Big Meadow in 1993, and Gin Flat East Meadow in 1998. See Table 1 for details of habitats and operation of each station in 2006.

Through the efforts of four IBP field biologist interns (Geoff Gould, DeeAnne Meliopoulos, Dave Palchak, and Hannah Pruett), intensively trained and supervised by IBP staff field biologist Ron Taylor, these five MAPS banding stations were operated during 2006 in accordance with the standardized banding protocols developed for the MAPS Program throughout North America (DeSante et al. 2006).

Ten net sites (14 sites at the Hodgdon Meadow station) were re-established at each of the stations in 2006, at the exact same locations where they were established and operated in each of the preceding years. One 12-m-long, 30-mm-mesh, nylon mist net was erected at each of the ten net sites at four of the stations on each day of operation. At Hodgdon Meadow, seven of the 14 net sites were operated on one day with the remaining seven net sites operated on a second day. Each of the stations was operated for six morning hours per day (beginning at about local sunrise) during one day (two days for Hodgdon Meadow) in each of eight consecutive 10-day periods between May 21 and August 8 or, for the two higher-elevation stations (White Wolf and Gin Flat East), for one day in each of seven periods between June 23 and August 8. At White Wolf and Gin Flat East Meadow, operation began late due to late-lingering snowpack followed by flooding in the late spring, with extra days of effort making up for the late start. Otherwise, the operation of all stations occurred on schedule in 2006 during each of the ten-day periods.

Data Collection

With few exceptions, all birds captured at MAPS stations were identified to species, age, and sex. If unbanded, the birds 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 was compromised. Such situations could involve exceptionally large numbers of birds being captured at once, or the sudden onset of adverse weather conditions such as high winds or rainfall. The following data were collected from all birds captured, including recaptures:

- capture code (newly banded, recaptured, band changed, unbanded);
- band number
- species
- age and how aged
- sex (if possible) and how sexed (if applicable)
- extent of skull pneumaticization
- breeding condition of adults (i.e., extent of cloacal protuberance or brood patch)
- extent of juvenal plumage in young birds
- extent of body and flight-feather molt
- extent of primary-feather wear
- presence of molt limits and plumage characteristics
- wing chord
- fat class and body mass
- date and time of capture (net-run time)
- station and net site where captured
- any pertinent notes

Effort data (i.e., the number and timing of net-hours on each day of operation) were also collected in a standardized manner. In order to allow constant-effort comparisons of data, 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 five stations, simple habitat maps prepared in previous years (indicating extent and location of major habitats, as well as structures, roads, trails, and streams) were checked and updated where necessary. 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 in the MAPS Habitat Structure Assessment Protocol (Nott et al. 2003b).

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 custom data entry programs. All banding data were then run through a series of verification programs as follows:

- Clean-up programs to check the validity of all codes entered and the ranges of all numerical data.
- Cross-check programs to compare station, date, and net fields from the banding data with those from the summary of mist netting effort data.
- 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.
- Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species.
- 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 are examined manually and corrected if necessary. Wing chord, weight, station of capture, date, and any pertinent notes are used as supplementary information for the correct determination of species, age, and sex in all of these verification processes.

Data Analysis

We classified the landbird species captured in mist nets into six 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.

- an altitudinal disperser (A) if the species breeds only at lower elevation than that of the station but disperses to higher elevations after breeding.

- 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 analyses if the station was within the breeding range of the species; that is, data were included from stations where the species was a breeder (B, U, or O), or transient (T), but not where the species was an altitudinal disperser (A) or a migrant (M). Data for a given species from a given station were included in trend and survivorship analyses only if the species was classified as a regular (B) or usual (U) breeder at the station. Throughout this report we define "target species" for trend and survivorship analyses as those for which an average of 2.5 individual adult birds were captured per year at all stations combined or at each station for station-specific analysis. For the four long-running stations combined, a total of 38 species met this requirement and are termed target species. For survivorship analyses, an additional requirement for including a target species in the analysis was that at least two returns were recorded at all stations combined.

<u>Adult population index and productivity analyses</u>

The proofed, verified, and corrected banding data from all fourteen years were run through a series of analysis programs that calculated for each species:

- the numbers of newly banded birds, recaptured birds, and birds released unbanded.

- the numbers and capture rates (per 600 net-hours) of first captures (in a given year) of individual adult and young birds.

- the reproductive index. Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach et al. 1996), we used the number of adult birds captured as an index of adult population size. For each species each year, we calculated a yearly reproductive index as the number of young divided by the number of adults.

<u>Analyses of trends in adult population size and productivity</u>

For each target species and for all species pooled we examined multi-year trends (nine-year trends at Gin Flat East Meadow, 14-year trends at the other four stations and for all five stations combined) in adult population size and productivity (reproductive index). Year-to-year comparisons were made in a "constant-effort" manner by means of an 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. We excluded 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 trends in population size, we first calculated adult population indices for each species for each of the 14 years based on an arbitrary starting index of 1.0 in the first year of station operation or analysis (1993, or 1998 for Gin Flat East Meadow). The constant-effort changes were used to calculate these "chain" indices in each subsequent year by multiplying the proportional change (percent change divided by 100) between the two years times the index of the previous year and adding that figure to the index of the previous year:

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

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 (*PT*) of these indices. Because the indices for adult population size are based on percentage changes, we further calculated the annual percent change (*APC*), defined as the average change per year, to provide an estimate of the population trend for the species; *APC* was calculated as:

(actual year-one value of *PSI* / predicted year-one value of *PSI* based on the regression) * *PT*.

We present the *APC*, the standard error of the slope (*SE*), the correlation coefficient (*r*), and the significance of the correlation (*P*) to describe each trend. For 14-year trends, species for which $r \geq 0.30$ are considered to have a substantially increasing trend, those for which $r \leq -0.30$ are considered to have a substantially decreasing trend, those for which absolute $r < 0.3$ and $SE \leq 0.018$ are considered to have a non-substantial and non-fluctuating trend, and those for which absolute $r \leq 0.3$ and $SE > 0.018$ are considered to have non-substantial, widely fluctuating trends.

Trends in Productivity, *PrT*, for all stations combined were calculated in an analogous manner by starting with actual productivity values in 1993 (or 1998) and calculating each successive year's value based on the actual constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r*), and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends, except that, for non-substantial trends, we do not attempt to distinguish between those that are widely fluctuating and those that are non-fluctuating.

<u>Survivorship analyses</u>

Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al. 1990; Lebreton et al.1992) were conducted on the target species using 14 years (1993-2006) of capture histories of adult birds. Using the computer program TMSURVIV (White 1983; Hines et al. 2003), 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 a between- and within-year transient model (Pradel et al.

1997; Nott and DeSante 2002; Hines et al. 2003). 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. Although 14 years of data would allow us to consider all possible combinations of both time-constant and time-dependent models for each of the three parameters estimated from the transient model, for a total of eight models, we limited our consideration to time-constant models that produced estimates for both survival and recapture probability that were neither 0 nor 1. The goodness-of-fit of the models was tested by using a Pearson's goodness-of-fit test. We refer readers to previous reports (e.g., Pyle et al. 2006) for information on time-dependence in these parameters, which show little inter-annual variation at Yosemite and show little change with additional years of data.

RESULTS

A total of 2,251.5 net-hours was accumulated at the five MAPS stations operated in Yosemite National Park in 2006 (Table 1). Data from 2,115.0 of these net-hours could be compared directly to the previous year's data in a constant-effort manner.

2006 Indices of Adult Population Size and Post-fledging Productivity

The 2006 capture summary of the numbers of newly-banded, unbanded, and recaptured birds in Yosemite National Park is presented for each species at each of the five stations individually and for all stations combined in Table 2. A total of 2,139 captures of 60 species was recorded during the summer of 2006. Newly banded birds comprised 75.1% of the total captures. The greatest number of total captures (715) was recorded at the Crane Flat station and the smallest number of total captures (154) was recorded at the White Wolf station. The highest species richness occurred at Gin Flat East Meadow (47 species) and the lowest species richness occurred at White Wolf (24 species).

The 2006 capture rates (per 600 net-hours) of individual adult and young birds and the 2006 reproductive index (number of young birds per adult) are presented for each species and for all species pooled at each station and all stations combined in Table 3. We present capture rates (captures per 600 net-hours, rather than absolute numbers) of adults and young in this table so that the data can be compared among stations which, because of the vagaries of weather and accidental net damage, can differ from one another in effort expended (see Table 1). These capture indices suggest that the total adult population size in 2006 was greatest at Crane Flat (284.9 adults/600 net-hours), followed in descending order by Hodgdon Meadow, Gin Flat East Meadow, Big Meadow, and White Wolf (Table 3). The capture rate of young of all species pooled at each station in 2006 was highest at Crane Flat (343.9 young/600 net-hours), followed by Gin Flat East Meadow, Big Meadow, Hodgdon Meadow, and White Wolf (Table 3). Reproductive index (the number of young per adult) at the five stations in 2006 was greatest at Gin Flat East Meadow (1.45), followed by Crane Flat (1.21), Big Meadow (0.86), Hodgdon Meadow (0.55), and White Wolf (0.46). The mean adult capture rate for the five stations combined was 201.7 per 600 net hours in 2006, compared with 171.5 adults per 600 net-hours for the same six stations in 2005 (Pyle et al. 2006), and the overall reproductive index was 0.91 in 2006, compared with 1.37 in 2005 (Pyle et al. 2006), indicating an increase in breeding population sizes but a decrease in productivity between the two years.

Among individual species in 2006, Dark-eyed Junco was the most frequently captured, followed by Yellow-rumped Warbler, MacGillivray's Warbler, Lincoln's Sparrow, Orange-crowned Warbler, Song Sparrow, Warbling Vireo, Golden-crowned Kinglet, Hermit Warbler, Purple Finch, and Mountain Chickadee (Table 2). Overall, the most abundant species in 2006 (as determined by the number of adults captured per 600 net-hours; Table 3) for which the five Yosemite National Park MAPS stations are within the breeding range of the species (e.g., not including Orange-crowned Warbler), in decreasing order, were Dark-eyed Junco, MacGillivray's Warbler, Yellow-rumped Warbler, Lincoln's Sparrow, Warbling Vireo, Black-headed Grosbeak, Song Sparrow, and Dusky Flycatcher. The following is a list of such species (captured at a rate of at least 7.0 adults per 600 net-hours), in decreasing order, at each station in 2006 (Table 3):

White Wolf
Dark-eyed Junco
Yellow-rumped Warbler
American Robin
Mountain Chickadee

Gin Flat East Meadow
Dark-eyed Junco
Lincoln's Sparrow
MacGillivray's Warbler
Dusky Flycatcher
Mountain Chickadee
Yellow-rumped Warbler
Fox Sparrow
Pine Siskin

Hodgdon Meadow
MacGillivray's Warbler
Warbling Vireo
Song Sparrow
Dark-eyed Junco
Black-headed Grosbeak
Lincoln's Sparrow
Hermit Warbler
Western Wood-Pewee

Big Meadow
Lazuli Bunting
Black-headed Grosbeak
Wrentit
Spotted Towhee
Purple Finch
Nashville Warbler
Western Wood-Pewee
Bushtit

Crane Flat
Dark-eyed Junco
Yellow-rumped Warbler
Lincoln's Sparrow
MacGillivray's Warbler
Warbling Vireo
Pine Siskin
Dusky Flycatcher
Golden-crowned Kinglet
Lazuli Bunting
Pacific-slope Flycatcher
Mountain Chickadee
Hermit Warbler
Western Tanager

Mean Indices of Adult Population Size and Productivity

Table 4 presents mean annual numbers (per 600 net-hours) of individual adult and young birds captured, and reproductive index during a) the 14-year period (1993-2006) at White Wolf, Crane Flat, Hodgdon Meadow, Big Meadow, and all stations combined, and b) the nine-year period (1998-2006) for the Gin Flat East Meadow station. Pooling data across all species, the highest populations at Yosemite occurred at the mid-elevation Crane Flat station, followed in descending order by Hodgdon Meadow, Big Meadow, Gin Flat East Meadow, and White Wolf. Numbers of young captured follow a different sequence: highest at Gin Flat East Meadow, followed by Crane Flat, Hodgdon Meadow, Big Meadow, and White Wolf. Productivity was highest at Gin Flat East, followed by Crane Flat, White Wolf, Big Meadow, and Hodgdon Meadow. Following yet a different sequence, species richness of adults decreased with increasing elevation: highest at Big Meadow (66 species) followed by Hodgdon Meadow (55), Gin Flat East Meadow (46), Crane Flat (44), and White Wolf (40). The most abundant species at MAPS stations in Yosemite over the 14-year period, with overall capture rates greater than 6.0 adults per 600 net-hours, were, in descending order: Dark-eyed Junco, MacGillivray's Warbler, Yellow-rumped Warbler, Lincoln's Sparrow, Warbling Vireo, Dusky Flycatcher, Lazuli Bunting, Song Sparrow, Hermit Warbler, Purple Finch, and Black-headed Grosbeak. Overall, total species richness was 77 species, while the 14-year mean number of adults captured per 600 net-hours was 210.4 and the mean reproductive index was 0.81.

Multi-year Trends in Adult Population Size and Productivity

"Chain" indices of adult population size for the 14-year period 1993-2006 are presented for 25 target species and for all species pooled in Figure 1. See previous reports (e.g., Pyle et al. 2006) for population trends of target species at each station. We used annual percent change (*APC*) for each species as an estimate of the mean annual population trend for that species. These estimates of *APC*, along with the standard error of the slope (in parentheses), the correlation coefficient (r), and the significance of the correlation (P), are included for each target species and for all species pooled on each graph.

Populations of 12 species as well as all species pooled showed substantial declining trends ($r \leq -0.3$ for a 14-year trend). The declines for Dusky Flycatcher, Chipping Sparrow, Lazuli Bunting, and all species pooled were highly significant; those for Western Wood-Pewee, Golden-crowned Kinglet, Hermit Warbler, and Black-headed Grosbeak, were significant; that of Purple Finch was nearly significant, and those of Red-breasted Sapsucker, Hermit Thrush, Yellow Warbler, and Dark-eyed Junco were not significant. In contrast, populations of only four species showed substantial increasing trends ($r \geq 0.3$), which were highly significant for Mountain Chickadee, significant for MacGillivray's Warbler and Western Tanager, and nearly significant for Yellow-rumped Warbler. Populations of the remaining nine species (Hammond's Flycatcher, Cassin's Vireo, Warbling Vireo, Brown Creeper, American Robin, Song Sparrow, Lincoln's Sparrow, Pine Siskin, and Lesser Goldfinch) showed non-substantial (absolute $r < 0.3$) trends. Eight of these nine species showed substantially fluctuating (SE of the slope ≥ 0.018) population trends, whereas only one species (Warbling Vireo) showed a non-fluctuating trend. Overall, 17 of the 25 species showed negative trends, one trend was flat (Brown Creeper), and only seven species showed positive trends. The 14-year trend for all species pooled represented a substantial and highly significant ($P = 0.009$) decrease of -1.5% per year, suggesting that total populations of landbirds in Yosemite have declined by 19% over the 14-year period (1993-2006).

"Chain" indices of productivity for each of the 14 years (1993-2006) are shown in Figure 2 for the same 25 target species and all species pooled, at all five stations combined. Five species showed substantially declining productivity trends ($r \leq -0.30$), which were highly significant for Lesser Goldfinch, nearly significant for Chipping Sparrow, and not significant for Western Wood-Pewee, Brown Creeper, and Hermit Thrush. In contrast, 12 species as well as all species pooled showed substantially increasing productivity trends ($r \geq 0.30$); these were highly significant for Red-breasted Sapsucker, American Robin, Yellow Warbler, Black-headed Grosbeak, and Lazuli Bunting; significant for Mountain Chickadee, Hermit Warbler, Purple Finch, and all species pooled; nearly significant for Yellow-rumped Warbler, Lincoln's Sparrow, and Purple Finch; and not significant for Pine Siskin. The remaining eight species (Hammond's Flycatcher, Dusky Flycatcher, Cassin's Vireo, Warbling Vireo, Golden-crowned Kinglet, MacGillivray's Warbler, Western Tanager, Song Sparrow, and Dark-eyed Junco) showed non-substantial productivity trends. Overall, 17 of the 26 target species had positive productivity trends and nine had negative productivity trends. The productivity trend for all species pooled indicated an average annual increase of 0.042 per year.

Estimates of Adult Survivorship

Using 14 years of data (1993- 2006) from all five stations, we were able to obtain estimates of adult survival and recapture probabilities using transient, time-constant ($\varphi p \tau$) models, for 31 species breeding in Yosemite National Park (Table 5). Estimates of annual adult survival rate ranged from a low of 0.176 for Golden-crowned Kinglet to a high of 0.896 for Cassin's Finch, with a mean of 0.482. Recapture probability varied from a low of 0.005 for Cassin's Finch to a high of 0.678 for Black Phoebe, with a mean of 0.263. Proportion of residents varied from a low of 0.000 for Golden-crowned Kinglet to a high of 1.000 for five species (Table 9), and averaged 0.538. The precision of these survival estimates continues to improve, even after 14 years of data have been collected, although the rate of improvement may be leveling off. Among the 30 species for which could make a comparison (all but Red-breasted Nuthatch), CV(φ) was lower (i.e., the estimate of φ was more precise) using 14 years of data (1993-2006) than using 13 years of data (1993-2005) for 20 species. The mean CV(φ) for the 30 species improved from 26.0% using 13 years of data (DeSante et al. 2005) to 25.0% using 14 years of data.

The survival estimates for adults at Yosemite (1993-2006) appear to be relatively high compared with values for the Northwest MAPS region as a whole (1992-2001; see http://www.birdpop.org/nbii/surv/default.asp). Survival at Yosemite was higher than that for the Northwest Region for 21 of 30 species for which this comparison could be made (all but Black Phoebe, which lacked a value for the Northwest Region). The mean survival for these 30 species at Yosemite (0.485) was 3.0% higher than that of the Northwest Region (0.471). Eleven species (Williamson's Sapsucker, Hairy Woodpecker, Western Wood-Pewee, Hammond's Flycatcher, Brown Creeper, Golden-crowned Kinglet, Western Tanager, Chipping Sparrow, Lincoln's Sparrow, Lazuli Bunting, and Cassin's Finch) showed substantially (>10%) higher values at Yosemite than in the Northwest Region overall, whereas only 5 species (Dusky Flycatcher, Mountain Chickadee, Yellow-rumped Warbler, Red-winged Blackbird, and Purple Finch) showed substantially lower survival at Yosemite.

Effects of Climate Change on Landbirds at Yosemite

The MAPS dataset at Yosemite is a rich source of information about ongoing and potential effects of climate change on landbirds in the park. For this year's report we pursued two relevant lines of investigation: *Empidonax* flycatcher dynamics and the effects of spring snowpack on the number of young birds produced each year. Many other relevant topics could also be investigated with data collected as part of the existing program.

Empidonax flycatcher dynamics

Yosemite National Park hosts four species of breeding *Empidonax* flycatchers, including Willow Flycatcher (a California Endangered Species), Hammond's Flycatcher, Dusky Flycatcher, and Pacific-slope Flycatcher. The four species generally have similar habits and food requirements but inhabit somewhat different habitats and/or elevation zones, making them an interesting group of species in which to study contrasts in population dynamics, particularly given concerns about historical and recent declines of Yosemite's Willow Flycatcher population (Siegel and Wilkerson 2006) and uncertainty regarding the causes of those declines.

Figure 3 illustrates proportional changes in *Empidonax* flycatcher populations at each station during the 14-year period 1993-2006 (nine-year period, 1998-2006, at Gin Flat East Meadow). As has been emphasized in previous reports, Willow Flycatcher has clearly declined in the Yosemite region as a whole, with a regression on adults per 600 net hours at all five stations combined indicating a significant decline (r = -0.735, P = 0.003). This decline was also observed at Hodgdon Meadow (r = -0.715, P = 0.004) where most individuals of this species have been captured over the years, but none since 2002. Although still commonly encountered throughout the park, Dusky Flycatcher has also declined severely at the Yosemite MAPS stations (r = -0.810, $P < 0.001$; see also Fig. 1), with the declines most prominent at the lower elevation stations, Hodgdon Meadow (r = -0.918, $P < 0.001$) and Big Meadow (r = -0.472, P = 0.089). A non-significant decline in Dusky Flycatcher was also noted at Crane Flat (r = -0.411, P = 0.144), whereas at the two higher elevation stations, Gin Flat East and White Wolf, populations show non-significant increases.

For Pacific-slope Flycatcher, populations pooled across all stations have increased slightly (r = 0.353, P = 0.216), but examination of station-specific trends suggests up-slope shifts: populations have declined non-significantly at the lower elevation stations (Big Meadow and Hodgdon Meadow where the species has historically occurred in greater abundance than at the higher stations), whereas they have increased significantly at all three higher-elevation stations, Crane Flat (r = 0.675, P = 0.008), Gin Flat East Meadow (r = 0.735, P = 0.037), and White Wolf (r = 0.756, P = 0.002). Likewise, although no population trends were significant for Hammond's Flycatcher, populations have declined at the two lower-elevation stations (Big Meadow and Hodgdon Meadow), and have increased at the two higher-elevation stations where the species is captured, Crane Flat and Gin Flat East Meadow.

Thus, the population centers of the three more-abundant *Empidonax* flycatcher species appear to be shifting upslope. To further investigate this phenomenon, we examined trends in *Empidonax* productivity, but found no significant trends at any station or at all stations combined.

<u>Effects of spring snowpack on the number of young birds produced</u>

Spring snowpack levels vary substantially by year in Yosemite and likely affect bird behavior, reproductive success, and population dynamics. Average spring snowpack levels are also likely to change over the coming years, in association with global climate change. To measure the effects of spring snowpack on breeding success of Yosemite's landbirds, we obtained daily snow water content measurements at Gin Flat from the California Department of Water Resources. We assessed the relationship between mean daily snow water content measurements at Gin Flat in April and May (Figure 4) and the annual number of young birds captured per 600 net hours for 25 target species and all species pooled, during the 14-year period 1993-2006. Mean daily snow water content for April at the Gin Flat snow sensor ranged from 29.3 cm (1994) to 111.1 cm (1995), with a mean of 65.9 cm. For May, mean daily snowpack levels ranged from 2.6 cm (2004) to 89.9 cm (1995), with a mean of 33.2 cm. Neither the April nor the May snow water content values exhibited any trend over the 14-year period ($P = 0.65$, and $P = 0.95$, respectively), and the two values fairly closely tracked one another, although the April value was of course consistently higher. Linear regressions of mean daily snow water content for April versus annual number of young birds captured are provided in Figure 5; regression results for May were generally similar, unless otherwise noted.

For all species pooled, the annual number of young captured declined with increasing average April snowpack, although the relationship did not reach the threshold of statistical significance ($P = 0.104$). Seventeen of the 25 species showed negative correlations, a proportion that while suggestive, is not significantly different from 0.50 (chi-square = 2.56, $P > 0.05$). Of these 17 species, four (Dusky Flycatcher, Warbling Vireo, Brown Creeper, and MacGillivray's Warbler) showed significant or near-significant negative correlations with April snowpack, and a fifth species (Song Sparrow) showing a significant negative correlation with May snowpack ($r = -0.200$, $P = 0.029$). Of eight species with positive correlations between annual number of young birds and spring snowpack, only Lazuli Bunting showed a significant correlation with snowpack values for either month ($r = 0.664$, $P = 0.010$ for April; $r = 0.664$, $P = 0.054$ for May).

DISCUSSION AND CONCLUSIONS

Annual Changes in Adult Population Size and Productivity

Breeding bird populations at the Yosemite MAPS stations increased by a highly significant 22.0% from 2005 to 2006, with increases recorded at all five stations, whereas productivity decreased at four of five stations, all except Crane Flat. This is nearly the opposite of changes recorded between 2004 and 2005, when populations decreased at all stations except Big Meadow and productivity increased at all stations except Hodgdon Meadow (decreased slightly) and Crane Flat (decreased substantially). Consistent alternating cycles of population increases and decreases such as this, with out-of-phase decreases and increases in productivity, are in evidence at many MAPS stations across the continent. They are apparently caused by density-dependent effects on productivity and recruitment, perhaps along with lower productivity of first-time breeders. This pattern has been exhibited in MAPS data from Yosemite during past time intervals as well, for example between 1996 and 2001 (DeSante et al. 2004). At other times, however, the pattern appears to be disrupted or occluded by other factors. For example, productivity at Yosemite was very low in 2003 but, except for Big Meadow, population declines the following year did not occur. In addition, although productivity-population correlations over the 13 years 1993-2005 were positive at Yosemite for 16 of 27 species and for all species pooled (Pyle et al. 2006), generally supporting the idea that changes in productivity one year bring about corresponding changes in population size the next year, the productivity-population correlations at Yosemite were generally weaker than those at other national parks, including both Denali and Shenandoah. Overall, an alternating out-of-phase density-dependent dynamic appears to be less strongly manifest in areas such as Yosemite, that are characterized by high annual variation in weather and snowpack (Pyle et al. 2006).

Populations of adult birds of all species pooled at MAPS stations in Yosemite have shown a substantial and highly significant decrease of -1.5% per year from 1993-2006. While this may not seem to be a large annual decline, when compounded over 14 years it represents a 19% decline. Thirteen-year population trends were negative at all four long-running stations, with 19 of 26 target species at individual stations showing declines (Pyle et al. 2006). In contrast, populations of only four species showed substantial 13-year increasing trends. Comparison of long-term population trends at Yosemite with long-term BBS trends from the Sierra Nevada physiographic strata suggests that these dramatic declines for most landbird species in Yosemite are part of a Sierra-wide decline (DeSante et al. 2004). Further evidence that results from Yosemite MAPS stations are indicative of patterns across the greater Sierra region come from DeSante et al. (2005), which showed that populations of a given species generally appeared to trend in the same direction at the Yosemite stations as at the Sequoia and Kings Canyon stations.

In contrast to populations trends, trends of productivity across all Yosemite stations showed a substantial but non-significant 14-year increase of +0.042 per year when all species were pooled, with more species showing increases (17) than decreases (9).

Overall, declining population trends coupled with stable or fluctuating productivity trends may suggest that other factors such as decreased overwinter survival or decreased recruitment into the breeding population may be causing the declines. However, productivity trend does not indicate whether or not productivity levels are high enough or low enough to sustain a population, and there is also substantial species-specific variation in productivity trends.

Survival and Causes of Population Change

We were able to obtain estimates of annual adult survival for 31 target species at Yosemite using 14 years of data from all five stations combined. As mentioned in previous reports, increased years of data have resulted in increased numbers of species for which survival estimates could be obtained, and the addition of a fourteenth year was no exception. These results suggest that maximum precision may not be obtained until more than 15 years of data are available, even though Rosenberg (1996) and Rosenberg et al. (1999) estimated that precision should level off after 12 years of data have been collected.

The estimated annual adult survival rates at Yosemite (1993-2006) appear to be relatively high compared with values for the Northwestern MAPS region as a whole. Estimates are higher than those of the Northwest Region for 20 of 29 species for which this comparison could be made, with a mean annual adult survival rate at Yosemite (0.485) that was 3.0% higher than that of the Northwest Region (0.471). In addition, DeSante et al. (2005) found that 11 of 17 species showed higher survival at Hodgdon Meadow than at equivalent elevations in Sequoia/Kings Canyon National Park. This suggests that survival of birds breeding at Yosemite is good, overall.
In previous reports (e.g., Pyle et al. 2006) we made assessments as to whether population declines or increases in Yosemite were driven by productivity on the breeding grounds, survival during migration and/or on the winter grounds, both, or neither. We found that lower-than-expected productivity appears to be driving or contributing to the population declines of seven of the 12 declining species (Western Wood-Pewee, Dusky Flycatcher, Warbling Vireo, Hermit Thrush, Yellow Warbler, Chipping Sparrow, and Lazuli Bunting) whereas low survivorship appears only to be affecting the declines of Red-breasted Sapsucker, Golden-crowned Kinglet, and Hermit Thrush. Similarly, it appears that higher than expected or increasing productivity may be driving the population changes of two increasing species (Mountain Chickadee and Yellow-rumped Warbler) whereas higher survival may be contributing to increases in MacGillivray's Warbler and Western Tanager. Thus, overall, it appears that productivity at Yosemite is driving or influencing the population dynamics of nine of the 15 species showing substantial trends. Productivity is presumably affected by events on the breeding ground, so declines in these species could be within the Park's ability to influence, through stewardship and/or management action.

Effects of Climate Change on Landbirds at Yosemite

We have previously shown that species richness (number of species), total adult population size, productivity, and adult population trend each varied with station elevation at Yosemite. We also showed that long-term population trends for all species pooled are increasingly negative at lower elevation stations, and that this may be driven by the increasingly lower productivity (the ratio in the catch of young birds to adult birds) at those lower-elevation stations, especially during drought years with meager snowpacks. Some of this variation undoubtedly relates to climate cycles. For example, productivity has tended to be higher at Yosemite during El Niño/Southern Oscillation (ENSO) events (e.g., DeSante et al. 2003), but the heavy, late-melting snowpacks often associated with such years tended to reduce breeding population sizes, at least at higher elevations, by limiting recruitment of the previous year's young birds. Thus, despite increases in productivity, strong and frequent ENSO events and their associated El Niños tend to depress bird populations in Yosemite and throughout the Sierra. Stronger and more frequent ENSO events are predicted to occur with increased warming associated with global climate change, a phenomenon that may portend trouble for landbird populations at Yosemite.

To further investigate how climate change may be affecting landbird population dynamics at Yosemite, we pursued two new analyses, one examining population dynamics of four species of *Empidonax* flycatchers in the park and one examining the effects of spring snowpack on the annual number of young birds caught at the stations.

Empidonax flycatcher dynamics

As has been emphasized in previous reports, Willow and Dusky Flycatcher are clearly declining in the Yosemite region as a whole. For Dusky Flycatcher, declines are most noticeable and significant at the lower elevation stations (Hodgdon Meadow and Big Meadow) and they are slight and non-significant at the mid-elevation Crane Flat station, whereas at the two higher elevation stations, Gin Flat East and White Wolf, we see no evidence of declines. A similar pattern (though non-significant) is apparent for Hammond's Flycatcher. For Pacific-slope Flycatcher, populations have declined non-significantly at the lower elevation stations (Big Meadow and Hodgdon Meadow), where the species has historically been more abundant than at the higher stations, whereas they have increased significantly at all three higher-elevation stations (Crane Flat, Gin Flat East Meadow, and White Wolf). Thus, the population centers of the three more-abundant *Empidonax* flycatcher species appear to be shifting upslope. For Hammond's and Pacific-slope Flycatcher, this could suggest that ranges are actually extending up into higher elevations than in previous years. However, for Dusky Flycatcher, which already nests up to tree-line in the park, this is not possible, and instead our results may simply indicate the beginning of a contraction in the species' range (with the low-elevation boundary moving upslope), rather than an expansion upslope.

However, the number of independent sites represented by Yosemite's MAPS stations is small. Fully exploring the apparent upslope shifts in *Empidonax* species could perhaps best be done through a spatially extensive survey. Present-day occurrence patterns and density estimates from throughout the park could be compared with historical data, either from recent times (Siegel and DeSante 2002) or the more distant early twentieth century (Grinnell and Storer 1924).

If confirmed, these uspslope shifts are consistent with recent evidence suggesting uplope shifts of other montane taxa throughout North America, associated with global warming (e.g., Luckman and Kavanagh 2000; Grace et al. 2002; Beever et al. 2003; Parmesan and Yohe 2003). Furthermore, they may be bellwethers for more extensive changes in the elevational distribution of Yosemite's landbirds. The dwindling of Yosemite's Willow Flycatcher population attests to the potential vulnerability of bird populations even in relatively pristine environments like

Yosemite, and suggests that further attention paid to the other *Empidonax* species may be warranted.

Effects of spring snowpack on the number of young birds produced

Our finding that a) the annual number of young captured is significantly negatively related to spring snowpack for Dusky Flycatcher, Warbling Vireo, Brown Creeper, MacGillivray's Warbler, and Song Sparrow, and b) similar but non-significant relationships are apparent for a preponderance of other species, suggests that landbird population dynamics in Yosemite may be quite sensitive to climate change, even in the absence of substantial changes in habitat structure or composition (which may be likely to occur as well). It is notable that four of the five species exhibiting statistically significant negative relationships with spring snowpack (all except Brown Creeper) generally nest fairly low in shrubs, particularly riparian shrubs. These nesting habits may make their nests more vulnerable to being buried or soaked by late spring snowstorms. Alternately, these species may be particularly likely to delay nesting during years when snowpack is still substantial early in the breeding season. Under either of these scenarios, overall production of young birds could be reduced during years with late-lingering snow, either because early nesting attempts fail at a high rate, or because most nesting attempts are postponed, perhaps precluding second nesting attempts later in the season. Yet another possibility, one consistent with observations from previous years that adult breeding populations appear depressed by ENSO events, is that reduced populations of breeding birds produce fewer young in the aggregate, even as productivity (young per adult) remains high.

Lazuli Bunting, the only species showing a statistically significant positive relationship to spring snowpack at Gin Flat, provides an interesting exception to the phenomenon. Virtually all of the Lazuli Buntings recorded at Yosemite MAPS stations are caught at Big Meadow, which is at the lowest-elevation station in the park, and presumably receives the least snow. It may be that spring snowpack at Big Meadow is too negligible to have a substantial impact on birds nesting near the station, and that a much more important factor in determining the production of young at this site is water availability later in the summer. Deeper spring snowpack higher upslope likely correlates with wetter conditions later in the breeding season at Big Meadow, which may yield greater food availability for nesting birds.

Both of these hypotheses about years with substantial spring snowpack, a) that in such years shrub-nesting higher-elevation birds tend to postpone their first nesting attempts or nest at the usual time but see their first nesting attempts fail, and b) that lower-elevation birds enjoy greater food resources leading to greater production of young, could be tested with thoughtfully targeted research. If confirmed, either hypothesis would have substantial implications for Yosemite’s bird populations in the context of projected climate change, which generally suggest reductions in spring snowpack.

Conclusions

The MAPS Program in Yosemite continues to yield station-specific indices of adult population size and post-fledging productivity, park-wide estimates of annual survival rates of adults, and important information on annual changes and longer-term trends in these indices and estimates, for over 25 target species. The results in this and previous reports underscore the complexity of the population dynamics of Yosemite's breeding birds, complexity which can only be unraveled through long-term data collection.

The Yosemite MAPS Program also continues to yield both new findings and new hypotheses about landbird population dynamics in the park. The generation of preliminary findings and new hypotheses that can then be followed up with targeted research is one of the hallmarks of an effective ecological monitoring program. A recent example of this monitoring-research cycle is that MAPS results over the past decade have suggested disturbing declines in the park's Willow Flycatcher population, and the status of Willow Flycatcher in the park is now the subject of an intensive research project (Siegel and Wilkerson 2006). The new findings and hypotheses discussed in this report further underscore how well-suited the MAPS Program is to monitoring the effects of climate change on birds, and formulating relevant questions for more targeted research.

We conclude that the MAPS Program in Yosemite provides a unique dataset that is vital to understanding ecological processes, particularly the consequences of climate change on landbird populations within the park and beyond. We strongly recommend that the operation of the five MAPS stations currently active in Yosemite National Park be sustained indefinitely into the future.

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Table 1. Summary of the 2006 MAPS program in Yosemite National Park.

Station Name	Station Code	Station No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	2006 operation: Total number of net-hours[1]	2006 operation: No. of periods	2006 operation: Inclusive dates
White Wolf	WHWO	11904	Wet montane meadow, red fir/ lodgepole pine forest	37°52'10"N,-119°39'08"W	2402	413.3 (373.5)	7	6/24 - 8/05
Gin Flat East Meadow	GFEM	11980	Wet montane meadow, mixed fir forest	37°45'59"N,-119°45'37"W	2073	399.3 (373.0)	7	6/23 - 8/06
Crane Flat	CRFL	11907	Wet montane meadow, willow/ aspen thickets, mixed coniferous forest	37°45'20"N,-119°48'13"W	1875	406.5 (399.2)	8	5/27 - 7/31
Hodgdon Meadow	HODG	11107	Wet montane meadow, willow/ dogwood thickets, mixed oak and coniferous forest	37°47'41"N,-119°51'50"W	1408	640.2 (599.2)	8	5/24 - 8/01
Big Meadow	BIME	11905	Riparian willows, mixed coniferous forest (largely consumed by a stand-replacing fire in 1990), open dry meadow	37°42'16"N,-119°45'07"W	1311	392.2 (370.2)	8	5/26 - 8/03
ALL STATIONS COMBINED						2251.5 (2115.0)	8	5/24 - 8/06

[1] Total net-hours in 2006. Net-hours in 2006 that could be compared in a constant-effort manner to 2005 are shown in parentheses.

Table 2. Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2006.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Anna's Hummingbird		2			3			2			21			5			33	
Calliope Hummingbird		1			1			2			1			1			6	
Rufous Hummingbird		2			3			4			1						10	
Unidentified Selas. Hum.		6			12			9			3						30	
Unidentified Hummingbird					3			5			9			2			19	
Williamson's Sapsucker	2			1												3		
Red-breasted Sapsucker				9		2	8		1	6			1			24		3
Hairy Woodpecker							2									2		
White-headed Woodpecker				2			2		1	1						5		1
Northern Flicker										1			1			2		
Olive-sided Flycatcher										1						1		
Western Wood-Pewee				5						12	1	3	7	1	3	24	2	6
Hammond's Flycatcher	1			21			15			4			1			42		
Dusky Flycatcher	2		1	15			15		6	6						38		7
Pacific-slope Flycatcher	2			5			9		1	10		3	1			27		4
Unidentified Empidonax					1			3	1		1						5	1
Black Phoebe				1												1		
Cassin's Vireo				2			8			8						18		
Warbling Vireo	1		1	2			20	1	7	29		8	4			56	1	16
Steller's Jay	1									2						3		
Western Scrub-Jay													1			1		
N. Rough-winged Swallow													1			1		
Mountain Chickadee	9		6	13	1		11		2	3						36	1	8
Oak Titmouse													3		1	3		1
Bushtit													11		5	11		5
Red-breasted Nuthatch	1			6			10			6		2				23		2
Brown Creeper	8			6	1		15		2	12	1		1		1	42	2	3
Bewick's Wren													6			6		
House Wren				5	1		15	1	1	5			5			30	2	1

Table 2. (continued.) Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2006. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Winter Wren							4			5						9		
Golden-crowned Kinglet	1			20	3		33	3	1	2	1					56	7	1
Western Bluebird				1												1		
Townsend's Solitaire				4									1			5		
Hermit Thrush		1					6		2	6						12	1	2
American Robin	8		1	2			5	1	1	4	1	4	1			20	2	6
Wrentit													13	1	7	13	1	7
Orange-crowned Warbler	3			13	1		69	2	4	21		2	10	4		116	7	6
Nashville Warbler	1			5			11		2	5	1		8		3	30	1	5
Yellow Warbler							2			5		1	4			11		1
Yellow-rumped Warbler	16		7	79	2		46	3		9						150	5	7
Hermit Warbler	6			13			27	1	1	16						62	1	1
MacGillivray's Warbler	1			16	1	5	35	2	23	51	3	40	7	1		110	7	68
Wilson's Warbler										6		1				6		1
Unidentified Warbler								1									1	
Western Tanager				3			7			5		1	5			20		1
Green-tailed Towhee				2						1						3		
Spotted Towhee										5			11	1	2	16	1	2
Chipping Sparrow							4			1						5		
Grasshopper Sparrow														1			1	
Fox Sparrow				6												6		
Song Sparrow							13	1	13	49	3	31	2			64	4	44
Lincoln's Sparrow	1			25	2	30	38	2	20	12		12				76	4	62
Dark-eyed Junco	30	2	22	55	1	6	85	8	28	37	6	12	1			208	17	68
Unidentified Sparrow								2			1	1					3	1
Black-headed Grosbeak				3			4			13			41	2		61	2	
Lazuli Bunting				1			8	1	1	2			27		2	38	1	3
Red-winged Blackbird										5						5		
Brewer's Blackbird										4	1		1			5	1	

Table 2. (continued.) Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2006. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Bullock's Oriole													1			1		
Purple Finch				4			2			8			29	4	1	43	4	1
Cassin's Finch	4			4	1		2									10	1	
Pine Siskin	4			8			12			3						27		
Lesser Goldfinch				2						1		1	10	1		13	1	1
Lawrence's Goldfinch													1			1		
Evening Grosbeak													5	1		5	1	
Unidentified Bird														1			1	
ALL SPECIES POOLED	102	14	38	359	37	43	543	54	118	382	55	122	221	26	25	160	186	346
Total Number of Captures		154			439			715			559			272			213	
Number of Species	20	5	6	34	13	4	32	15	19	40	12	14	32	12	9	56	29	31
Total Number of Species		24			47			35			43			35			60	

Table 3. Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2006.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Williamson's Sapsucker	1.5	1.5	1.00	0.0	1.5	und.[1]										0.3	0.5	2.00
Red-breasted Sapsucker				10.5	6.0	0.57	5.9	5.9	1.00	4.7	0.9	0.20	1.5	0.0	0.00	4.5	2.4	0.53
Hairy Woodpecker							1.5	1.5	1.00							0.3	0.3	1.00
White-headed Woodpecker				1.5	1.5	1.00	4.4	0.0	0.00	0.9	0.0	0.00				1.3	0.3	0.20
Northern Flicker										0.9	0.0	0.00				0.3	0.0	0.00
Olive-sided Flycatcher										0.9	0.0	0.00				0.3	0.0	0.00
Western Wood-Pewee				4.5	3.0	0.67				8.4	0.0	0.00	9.2	1.5	0.17	4.8	0.8	0.17
Hammond's Flycatcher	0.0	1.5	und.[1]	4.5	21.0	4.67	4.4	8.9	2.00	3.7	0.0	0.00	1.5	0.0	0.00	2.9	5.6	1.91
Dusky Flycatcher	2.9	1.5	0.50	13.5	4.5	0.33	11.8	4.4	0.38	4.7	0.9	0.20				6.4	2.1	0.33
Western Flycatcher	2.9	0.0	0.00	6.0	1.5	0.25	7.4	1.5	0.20	5.6	2.8	0.50	0.0	0.0	0.00	4.5	1.3	0.29
Black Phoebe				0.0	0.0	0.00										0.0	0.0	und.[1]
Cassin's Vireo				0.0	0.0	0.00	0.0	7.4	und.[1]	3.7	2.8	0.75				1.1	2.1	2.00
Warbling Vireo	1.5	0.0	0.00	3.0	0.0	0.00	19.2	1.5	0.08	23.4	6.6	0.28	6.1	0.0	0.00	12.0	2.1	0.18
Steller's Jay	1.5	0.0	0.00							0.9	0.0	0.00				0.5	0.0	0.00
Western Scrub-Jay													1.5	0.0	0.00	0.3	0.0	0.00
N. Rough-winged Swallow													1.5	0.0	0.00	0.3	0.0	0.00
Mountain Chickadee	8.7	7.3	0.83	13.5	6.0	0.44	7.4	7.4	1.00	1.9	0.9	0.50				5.9	4.0	0.68
Oak Titmouse													1.5	4.6	3.00	0.3	0.8	3.00
Bushtit													9.2	6.1	0.67	1.6	1.1	0.67
Red-breasted Nuthatch	0.0	1.5	und.	6.0	3.0	0.50	4.4	10.3	2.33	3.7	2.8	0.75				2.9	3.5	1.18
Brown Creeper	2.9	8.7	3.00	4.5	4.5	1.00	3.0	16.2	5.50	2.8	8.4	3.00	1.5	1.5	1.00	2.9	8.0	2.73
Bewick's Wren													6.1	3.1	0.50	1.1	0.5	0.50

Table 3. (continued.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2006.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
House Wren													3.1	4.6	1.50	0.5	0.8	1.50
Winter Wren							3.0	1.5	0.50	1.9	1.9	1.00				1.1	0.8	0.75
Golden-crowned Kinglet	1.5	0.0	0.00	4.5	24.0	5.33	11.8	38.4	3.25	0.9	0.9	1.00				3.5	11.5	3.31
Western Bluebird				0.0	1.5	und.										0.0	0.3	und.
Townsend's Solitaire				4.5	1.5	0.33							0.0	1.5	und.[1]	0.8	0.5	0.67
Hermit Thrush							5.9	3.0	0.50	2.8	2.8	1.00				1.9	1.3	0.71
American Robin	11.6	0.0	0.00	3.0	0.0	0.00	5.9	3.0	0.50	4.7	0.9	0.20	0.0	1.5	und.	5.1	1.1	0.21
Wrentit													15.3	9.2	0.60	2.7	1.6	0.60
Nashville Warbler										0.9	3.7	4.00	10.7	1.5	0.14	2.1	1.3	0.63
Yellow Warbler							0.0	1.5	und.	3.7	0.0	0.00	3.1	3.1	1.00	1.6	0.8	0.50
Yellow-rumped Warbler	26.1	2.9	0.11	13.5	105.2	7.78	31.0	29.5	0.95	6.6	1.9	0.29				14.7	25.1	1.71
Hermit Warbler	2.9	4.4	1.50	6.0	13.5	2.25	7.4	28.0	3.80	9.4	5.6	0.60				5.6	9.9	1.76
MacGillivray's Warbler	0.0	1.5	und.	15.0	10.5	0.70	25.1	20.7	0.82	41.2	16.9	0.41	1.5	7.6	5.00	19.2	12.0	0.63
Wilson's Warbler										4.7	0.9	0.20				1.3	0.3	0.20
Western Tanager				4.5	0.0	0.00	7.4	3.0	0.40	5.6	0.0	0.00	3.1	1.5	0.50	4.3	0.8	0.19
Green-tailed Towhee				3.0	0.0	0.00				0.9	0.0	0.00				0.8	0.0	0.00
Spotted Towhee										1.9	2.8	1.50	13.8	4.6	0.33	2.9	1.6	0.54
Chipping Sparrow							5.9	0.0	0.00	0.9	0.0	0.00				1.3	0.0	0.00
Fox Sparrow				9.0	0.0	0.00										1.6	0.0	0.00
Song Sparrow							4.4	14.8	3.33	19.7	33.7	1.71	3.1	0.0	0.00	6.9	12.3	1.77
Lincoln's Sparrow	1.5	0.0	0.00	25.5	19.5	0.76	26.6	32.5	1.22	11.2	3.7	0.33				12.8	10.1	0.79
Dark-eyed Junco	39.2	18.9	0.48	31.6	55.6	1.76	47.2	97.4	2.06	15.9	23.4	1.47	0.0	1.5	und.	25.8	37.8	1.46

Table 3. (continued.) Numbers of adult and young individual birds captured per 600 net-hours and reproductive index (young/adult) at the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2006.

	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
Species	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Black-headed Grosbeak				1.5	1.5	1.00	3.0	1.5	0.50	12.2	0.0	0.00	16.8	27.5	1.64	7.2	5.3	0.74
Lazuli Bunting				0.0	1.5	und.	10.3	1.5	0.14	0.9	0.9	1.00	21.4	19.9	0.93	5.9	4.3	0.73
Red-winged Blackbird										3.7	0.9	0.25				1.1	0.3	0.25
Brewer's Blackbird										3.7	0.0	0.00	1.5	0.0	0.00	1.3	0.0	0.00
Bullock's Oriole													1.5	0.0	0.00	0.3	0.0	0.00
Purple Finch				1.5	4.5	3.00	1.5	1.5	1.00	6.6	0.0	0.00	13.8	22.9	1.67	4.8	5.1	1.06
Cassin's Finch	5.8	0.0	0.00	4.5	1.5	0.33	3.0	0.0	0.00							2.4	0.3	0.11
Pine Siskin	2.9	2.9	1.00	9.0	3.0	0.33	16.2	1.5	0.09	2.8	0.0	0.00				5.9	1.3	0.23
Lesser Goldfinch				1.5	1.5	1.00				0.9	0.0	0.00	3.1	7.6	2.50	1.1	1.6	1.50
Lawrence's Goldfinch													0.0	1.5	und.	0.0	0.3	und.
Evening Grosbeak													6.1	3.1	0.50	1.1	0.5	0.50
ALL SPECIES POOLED	113.2	52.3	0.46	205.8	297.5	1.45	284.9	343.9	1.21	230.6	127.5	0.55	157.6	136.2	0.86	201.7	184.1	0.91
Number of Species	15	11		26	24		27	26		38	23		25	21		52	44	
Total Number of Species		18			29			29			38			29			54	

[1] Reproductive index (young/adult) is undefined because no adults of this species were captured at this station in this year.

Table 4. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations operated in 2006 at Yosemite National Park averaged over the 14 years, 1993-2006 (1998-2006 for Gin Flat East Meadow). Data for each species are included only from stations that lie within the breeding range of the species.

	White Wolf			Gin Flat E. Mead. (1998-2006)			Crane Flat			Hodgdon Meadow			Big Meadow			All stations pooled		
Species	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]
Sharp-shinned Hawk				0.2	0.0	0.00										*0.0*	*0.0*	*0.00*
Belted Kingfisher													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*
Acorn Woodpecker													0.8	0.0	0.00	0.2	0.0	0.00
Williamson's Sapsucker	4.8	0.8	0.21	0.0	0.3	und.[3]										0.8	0.2	0.29
Red-breasted Sapsucker	0.7	0.5	0.25	5.9	3.7	0.88	2.5	1.0	0.35	6.8	3.2	0.58	1.3	0.6	0.61	3.6	1.7	0.52
Downy Woodpecker										0.5	0.2	0.00	1.7	0.7	0.20	0.5	0.2	0.33
Hairy Woodpecker	0.1	0.1	0.00	0.5	0.5	0.67	0.9	0.2	0.14	0.1	0.6	0.50	2.0	0.8	0.28	0.8	0.5	0.90
White-headed				1.2	0.5	0.50	1.3	0.2	0.08	0.6	0.1	0.00	0.7	0.1	0.25	0.7	0.1	0.15
Northern Flicker	0.3	0.2	0.00	0.3	0.2	0.00	0.3	0.1	0.33	0.9	0.3	0.45	1.9	0.2	0.18	0.8	0.2	0.25
Olive-sided Flycatcher				0.4	0.0	0.00				0.6	0.0	0.00	0.2	0.0	0.00	0.3	0.0	0.00
Western Wood-Pewee	1.4	0.3	0.00	1.7	1.0	0.42	0.1	0.1	0.00	3.9	0.7	0.31	6.2	0.9	0.13	3.0	0.6	0.24
Willow Flycatcher							0.4	0.1	0.00	1.5	0.5	0.41	1.0	0.0	0.00	0.8	0.2	0.23
Hammond's Flycatcher	0.0	2.3	und.[3]	2.1	11.1	6.69	3.1	2.2	0.97	1.8	0.8	0.43	0.3	0.1	0.25	1.5	2.3	2.30
Dusky Flycatcher	2.2	0.6	0.15	5.1	2.2	0.51	16.8	2.5	0.16	13.2	1.8	0.13	1.2	0.1	0.00	9.0	1.4	0.19
Western Flycatcher	0.7	0.1	0.25	1.0	1.9	2.08	4.4	1.7	0.35	4.6	3.8	1.11	0.4	0.4	0.25	2.6	1.8	0.74
Black Phoebe				0.2	0.3	0.00	0.1	0.1	0.00	0.2	0.6	0.33	5.2	6.5	1.99	1.2	1.6	2.28
Ash-throated Flycatcher													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*
Western Kingbird													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*
Cassin's Vireo	0.0	0.4	und.	0.7	0.2	0.00	1.5	0.8	0.19	4.7	2.9	0.65	1.3	0.1	0.13	2.2	1.2	0.63
Hutton's Vireo							0.0	0.1	und.[3]	0.0	0.1	und.[3]				*0.0*	*0.0*	*0.00*
Warbling Vireo	2.6	0.2	0.05	2.4	0.2	0.00	16.9	1.7	0.10	23.6	10.7	0.50	8.1	1.0	0.14	13.4	4.0	0.30
Steller's Jay	0.2	0.0	0.00	0.2	0.2	0.00	0.1	0.0	0.00	1.2	0.1	0.18	0.2	0.1	0.00	0.5	0.1	0.23
Western Scrub-Jay													0.2	0.0	0.00	*0.0*	*0.0*	*0.00*
Tree Swallow													0.0	0.1	und.[3]	*0.0*	*0.0*	*0.00*
N.Rough-winged Swallow													0.2	0.2	0.00	*0.0*	*0.0*	*0.00*
Mountain Chickadee	5.5	3.0	0.61	12.9	10.0	1.06	5.8	5.3	1.59	1.4	0.7	0.50	0.2	0.0	0.00	4.1	2.9	0.85
Chestnut-backed Chick.	0.0	0.1	und.				0.0	0.1	und.	0.7	0.4	0.14				0.2	0.1	0.29
Oak Titmouse													0.2	0.4	1.50	0.0	0.1	1.50
Bushtit										0.7	2.2	3.00	3.7	4.9	2.39	0.9	1.6	2.19

Table 4. (continued.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations operated in 2006 at Yosemite National Park averaged over the 14 years, 1993-2006 (1998-2006 for Gin Flat East Meadow). Data for each species are included only from stations that lie within the breeding range of the species.

	White Wolf			Gin Flat E. Mead. (1998-2006)			Crane Flat			Hodgdon Meadow			Big Meadow			All stations pooled		
Species	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]
Red-breasted Nuthatch	0.2	1.6	1.00	2.9	9.3	2.33	4.5	6.4	1.90	1.1	1.7	0.93				1.7	3.1	2.18
White-breasted Nuthatch				0.4	0.0	0.00				0.0	0.1	und.	1.0	0.1	0.00	0.2	0.0	0.00
Brown Creeper	3.5	6.1	1.73	3.4	4.9	2.01	3.7	6.8	2.78	0.9	3.1	2.83	2.1	2.1	1.24	2.5	4.3	2.08
Bewick's Wren													1.7	1.1	0.77	0.3	0.2	0.77
House Wren													4.9	6.4	1.71	1.0	1.4	1.71
Winter Wren	0.0	0.1	und.				0.4	0.7	0.50	0.4	1.0	1.25	0.2	0.2	0.50	0.2	0.5	1.42
American Dipper													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*
Golden-crowned Kinglet	1.8	7.1	1.71	4.5	28.1	8.46	15.4	22.8	1.51	1.4	2.6	1.10				4.5	10.0	2.38
Ruby-crowned Kinglet	0.7	0.1	0.00													0.1	0.0	0.00
Western Bluebird				0.0	0.2	und.							2.0	0.6	0.08	0.4	0.1	0.08
Townsend's Solitaire				0.7	0.3	0.17				0.1	0.3	0.00	0.0	0.1	und.	0.1	0.2	0.22
Swainson's Thrush										0.3	0.0	0.00				0.1	0.0	0.00
Hermit Thrush	1.6	0.3	0.11	0.4	0.0	0.00	4.3	0.9	0.27	1.6	0.8	0.52	0.2	0.1	0.00	1.8	0.5	0.38
American Robin	6.8	0.8	0.08	5.2	1.6	0.32	3.0	0.4	0.07	3.7	1.2	0.48	4.0	0.4	0.12	4.3	0.8	0.21
Wrentit													3.4	2.3	0.75	0.6	0.4	0.75
European Starling													0.0	0.1	und.	*0.0*	*0.0*	*0.00*
Nashville Warbler										5.3	12.0	2.24	4.4	6.8	2.59	2.5	5.1	1.71
Yellow Warbler							1.1	0.5	0.04	4.6	2.4	1.52	7.1	5.7	1.15	3.1	2.0	0.81
Yellow-rumped Warbler	25.5	24.1	0.88	31.8	127.9	4.49	29.5	22.8	0.82	5.1	2.6	0.57	1.5	0.0	0.00	15.6	23.7	1.39
Black-thrted. Gray Warb.	0.0	0.1	und.	0.0	0.7	und.	0.1	1.2	0.00	0.1	1.7	2.50	0.2	0.8	1.00	0.1	1.0	6.11
Hermit Warbler	2.4	10.6	3.68	3.8	14.8	2.68	20.9	22.2	1.33	9.5	9.1	1.48	0.1	0.0	0.00	8.2	10.8	1.42
MacGillivray's Warbler	0.0	0.9	und.	7.6	4.5	0.55	15.4	12.1	0.76	34.3	19.9	0.59	7.0	9.2	2.51	16.1	11.3	0.73
Wilson's Warbler	0.0	1.1	und.	0.2	2.0	1.00	1.4	3.8	2.42	3.4	1.2	0.48	0.9	0.7	0.48	1.7	1.7	1.26
Western Tanager	0.5	0.4	0.17	10.5	6.3	0.49	3.4	0.9	0.16	5.1	2.8	0.49	3.3	0.2	0.14	4.2	1.8	0.44
Green-tailed Towhee				1.0	0.0	0.00	0.3	0.0	0.00	0.1	0.1	0.00	0.1	0.1	0.00	0.2	0.0	0.00
Spotted Towhee										0.8	0.7	0.94	7.2	2.1	0.32	1.6	0.6	0.35
Chipping Sparrow	0.9	0.1	0.20	0.5	0.2	0.00	5.4	0.6	0.12	3.1	0.7	0.19	8.2	2.7	0.54	4.2	1.0	0.30
Sage Sparrow													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*
Fox Sparrow	0.0	0.1	und.	1.9	0.5	0.00	0.3	0.1	0.50	0.1	0.0	0.00	0.1	0.2	0.00	0.3	0.1	0.17

Table 4. (continued.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations operated in 2006 at Yosemite National Park averaged over the 14 years, 1993-2006 (1998-2006 for Gin Flat East Meadow). Data for each species are included only from stations that lie within the breeding range of the species.

	White Wolf			Gin Flat E. Mead. (1998-2006)			Crane Flat			Hodgdon Meadow			Big Meadow			All stations pooled		
Species	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]	Ad.	Yg.	Repr. Ind.[1]
Song Sparrow	0.3	0.0	0.00	0.0	1.2	und.	2.1	3.0	1.36	21.7	24.5	1.16	5.8	3.7	0.57	8.4	9.0	1.11
Lincoln's Sparrow	5.0	3.3	0.47	26.2	14.0	0.57	26.9	27.4	1.03	17.3	10.1	0.58	0.9	1.7	1.45	15.0	11.6	0.78
Dark-eyed Junco	38.4	28.2	0.81	30.0	43.3	1.72	55.3	62.1	1.12	16.4	20.5	1.27	3.2	1.9	0.66	27.1	29.5	1.10
Black-headed Grosbeak	0.2	0.1	0.50	1.0	1.0	0.83	0.8	0.4	0.36	11.6	2.1	0.25	11.5	11.6	1.95	6.5	3.0	0.73
Lazuli Bunting	0.0	0.3	und.	0.2	0.2	0.00	6.9	1.0	0.27	0.6	0.2	0.44	32.9	16.0	0.60	8.9	3.8	0.52
Red-winged Blackbird										3.1	0.3	0.05				0.9	0.1	0.05
Brewer's Blackbird	0.6	0.1	0.17	0.0	0.2	und.	0.0	0.1	und.	0.9	0.0	0.00	2.9	0.2	0.03	1.0	0.1	0.12
Brown-headed Cowbird				0.2	0.0	0.00	0.1	0.0	0.00	0.3	0.0	0.00	0.7	0.2	0.13	0.3	0.0	0.05
Bullock's Oriole													2.4	0.2	0.11	0.5	0.0	0.11
Pine Grosbeak	3.8	0.1	0.00													0.6	0.0	0.00
Purple Finch	0.4	0.3	0.00	1.0	0.5	0.75	6.1	2.2	0.41	10.3	2.3	0.22	9.8	11.7	1.47	6.8	3.5	0.90
Cassin's Finch	12.0	0.6	0.03	2.6	0.7	0.25	2.2	0.2	0.06	1.7	0.4	0.12	1.2	0.9	0.44	3.4	0.5	0.17
House Finch							0.1	0.0	0.00	0.0	0.2	und.				0.0	0.1	und.[3]
Red Crossbill	0.1	0.0	0.00							0.5	0.1	0.25	0.2	0.0	0.00	0.2	0.0	0.10
Pine Siskin	6.1	0.9	0.19	8.2	13.9	4.54	5.4	0.3	0.06	2.0	0.8	0.19	0.7	0.2	0.08	3.9	2.0	0.56
Lesser Goldfinch				1.7	2.5	1.25	0.5	0.3	1.00	0.6	0.2	0.17	11.4	7.8	0.87	2.9	2.0	0.86
Lawrence's Goldfinch				0.2	0.2	1.00							1.9	0.2	0.00	0.4	0.1	0.02
Evening Grosbeak	0.3	0.0	0.00	0.2	0.0	0.00				0.1	0.0	0.00	1.8	0.5	0.21	0.5	0.1	0.19
House Sparrow													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*
ALL SPECIES POOLED	129.8	96.1	0.77	181.0	311.2	1.73	269.7	215.3	0.79	234.9	155.4	0.66	184.4	116.0	0.69	210.4	167.3	0.81
Number of species	31	36		41	39		41	40		52	49		63	52		72	59	
Total number of species		40			46			44			55			66			77	

[1] Years for which the reproductive index was undefined (no adult birds were captured in the year) are not included in the mean reproductive index.

[2] For numbers presented in italics, the mean number of adults or young is greater than or equal to 0.1 at one or more stations, but over the entire location the mean number is less than 0.05. The species is counted in the number of species over all stations pooled.

[3] The reproductive index is undefined at this station because no young individual of the species was ever captured in the same year as an adult individual of the species.

Table 5. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using a time-constant model for 31 species breeding at MAPS stations in Yosemite National Park obtained from 14 years (1993-2006)[1] of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.[5]	Survival probability[6]	Surv. C.V.[7]	Recapture probability[8]	Proportion of residents[9]
Williamson's Sapsucker	1	33	43	5	0.730 (0.142)	19.4	0.116 (0.078)	0.255 (0.271)
Red-breasted Sapsucker	3	145	202	27	0.492 (0.089)	18.0	0.309 (0.106)	0.638 (0.251)
Hairy Woodpecker *	5	33	39	4	0.622 (0.173)	27.8	0.121 (0.097)	0.461 (0.506)
Northern Flicker *	5	37	42	4	0.464 (0.197)	42.5	0.202 (0.167)	0.390 (0.433)
Western Wood-Pewee	4	125	172	18	0.659 (0.085)	13.0	0.142 (0.061)	0.618 (0.285)
Hammond's Flycatcher *	3	71	81	2	0.486 (0.273)	56.2	0.269 (0.306)	0.095 (0.127)
Dusky Flycatcher	4	397	620	72	0.409 (0.048)	11.8	0.450 (0.080)	0.554 (0.127)
Black Phoebe	1	44	59	7	0.402 (0.157)	39.0	0.658 (0.261)	0.321 (0.217)
Cassin's Vireo *†	3	111	123	4	0.490 (0.200)	40.9	0.051 (0.090)	1.000 (1.784)
Warbling Vireo	5	612	868	62	0.469 (0.048)	10.3	0.281 (0.056)	0.307 (0.076)
Mountain Chickadee	5	187	232	22	0.389 (0.091)	23.4	0.304 (0.116)	0.566 (0.237)
Red-breasted Nuthatch *	4	79	84	2	0.575 (0.266)	46.2	0.047 (0.064)	0.379 (0.527)
Brown Creeper	5	121	151	12	0.422 (0.111)	26.4	0.438 (0.177)	0.174 (0.112)
Golden-crowned Kinglet*	4	209	245	8	0.176 (0.104)	59.0	0.345 (0.252)	0.000 (1.593)
Hermit Thrush †	3	83	99	6	0.330 (0.156)	47.1	0.189 (0.150)	1.000 (0.782)
American Robin †	5	186	240	27	0.610 (0.071)	11.7	0.117 (0.038)	1.000 (0.377)
Yellow Warbler	2	112	230	35	0.579 (0.062)	10.8	0.300 (0.072)	0.402 (0.201)
Yellow-rumped Warbler	4	717	831	50	0.299 (0.054)	18.0	0.199 (0.056)	0.843 (0.235)
Hermit Warbler	4	389	429	21	0.633 (0.079)	12.5	0.049 (0.019)	0.678 (0.290)
MacGillivray's Warbler	4	622	1361	206	0.484 (0.027)	5.5	0.503 (0.043)	0.505 (0.087)
Western Tanager	4	205	219	7	0.644 (0.152)	23.7	0.046 (0.030)	0.157 (0.168)
Spotted Towhee	1	61	79	9	0.359 (0.116)	32.3	0.456 (0.212)	0.383 (0.290)

Table 5. (continued.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using a time-constant model for 31 species breeding at MAPS stations in Yosemite National Park obtained from 14 years (1993-2006)[1] of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.[5]	Survival probability[6]	Surv. C.V.[7]	Recapture probability[8]	Proportion of residents[9]
Chipping Sparrow	4	167	237	24	0.432 (0.074)	17.2	0.207 (0.072)	0.965 (0.368)
Song Sparrow	3	319	665	99	0.468 (0.036)	7.8	0.508 (0.060)	0.532 (0.128)
Lincoln's Sparrow	4	554	1425	185	0.430 (0.026)	6.1	0.619 (0.048)	0.456 (0.091)
Dark-eyed Junco	5	1051	1921	274	0.421 (0.022)	5.2	0.490 (0.037)	0.615 (0.082)
Black-headed Grosbeak	3	265	335	41	0.520 (0.058)	11.1	0.203 (0.051)	0.505 (0.182)
Lazuli Bunting	2	367	445	25	0.552 (0.071)	12.8	0.090 (0.029)	0.273 (0.146)
Red-winged Blackbird *†	1	43	51	4	0.288 (0.181)	62.7	0.265 (0.263)	1.000 (0.978)
Purple Finch *	4	365	397	13	0.199 (0.100)	50.3	0.198 (0.136)	0.598 (0.368)
Cassin's Finch *†	1	88	91	2	0.896 (0.242)	27.1	0.005 (0.007)	1.000 (1.405)

[1] Analysis of all stations pooled include data from 1993-2006 from the White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow stations as well as data from 1998-2006 from the Gin Flat East Meadow station.
[2] Number of stations where the species was a regular or usual breeder and at which adults of the species were captured. Stations within one km of each other were combined into a single super-station to prevent individuals whose home ranges included portions of two or more stations from being counted as multiple individuals.
[3] Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).
[4] Total number of captures of adult birds of the species at stations where the species was a regular or usual breeder.
[5] 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.
[6] Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate).
[7] The coefficient of variation for survival probability, CV(φ).
[8] Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate).
[9] The proportion of residents among newly captured adults (τ) presented as the maximum likelihood estimate (standard error of the estimate).
* The estimate for survival probability should be viewed with caution because it is based on fewer than five between-year recaptures or the estimate is very imprecise ($SE(\varphi)\geq0.200$ or $CV(\varphi)\geq50.0\%$)
† The estimate for survival probability, recapture probability, or both may be biased low because the estimate for τ was 1.00.

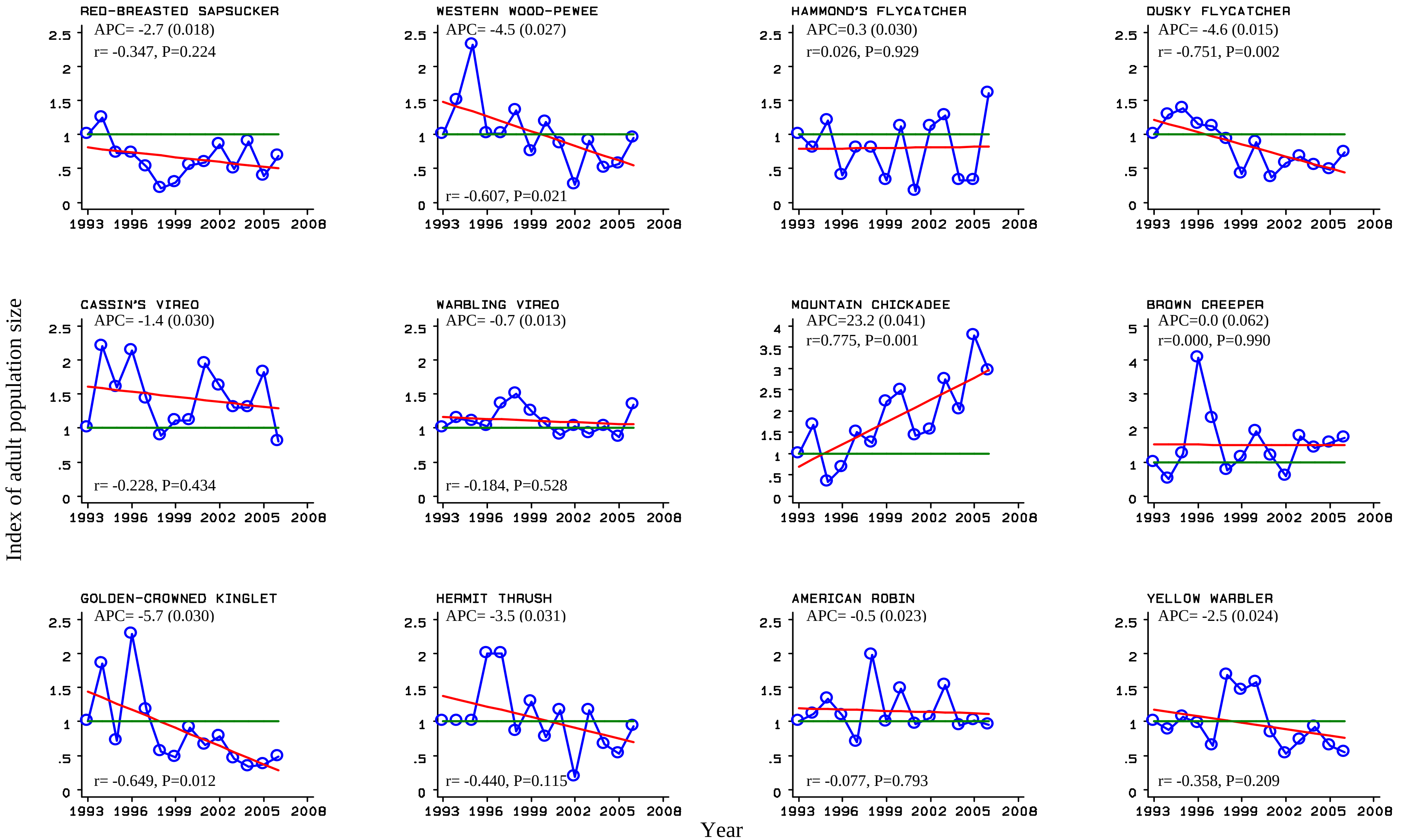


Figure 1. Population trends for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

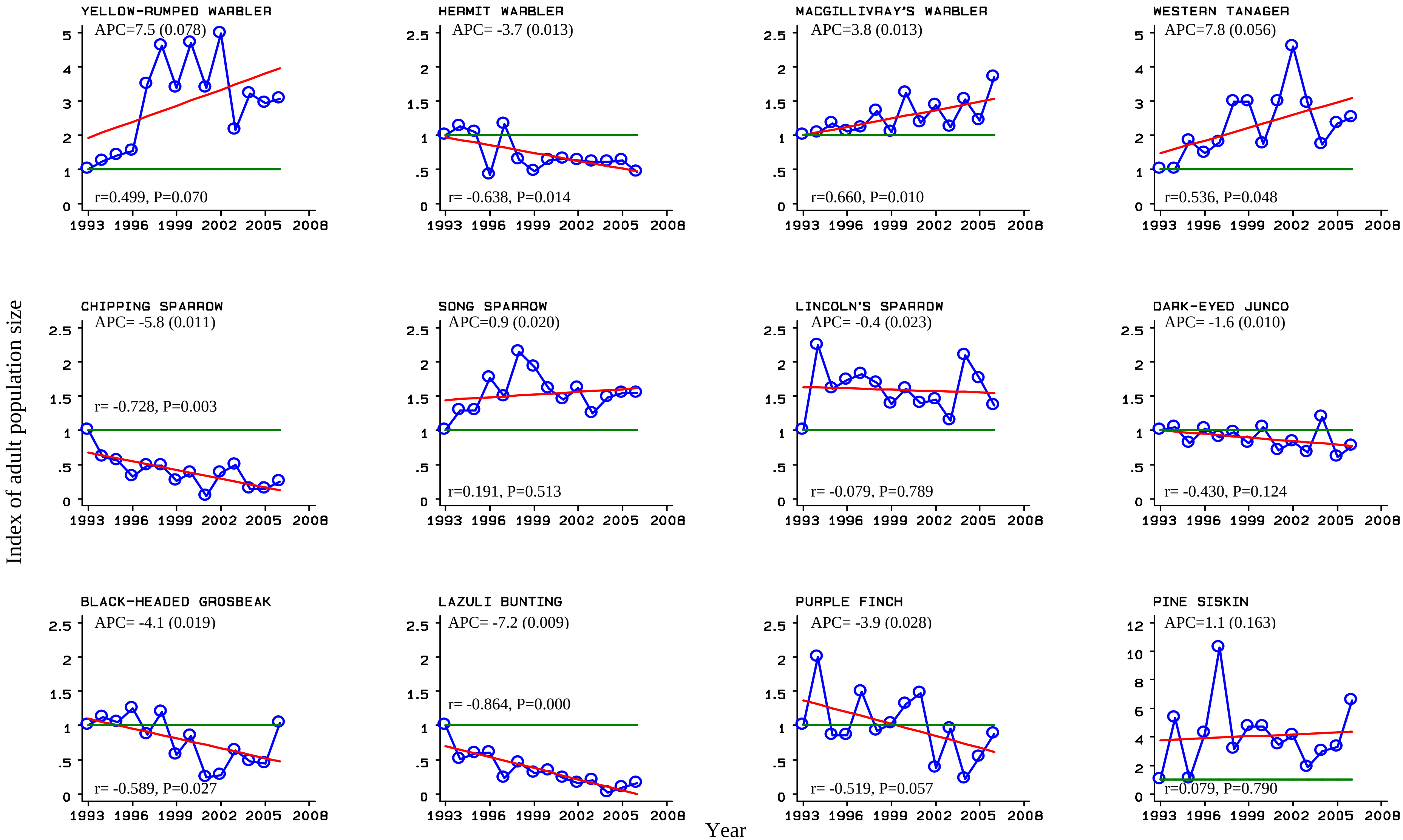


Figure 1. (cont.) Population trends for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

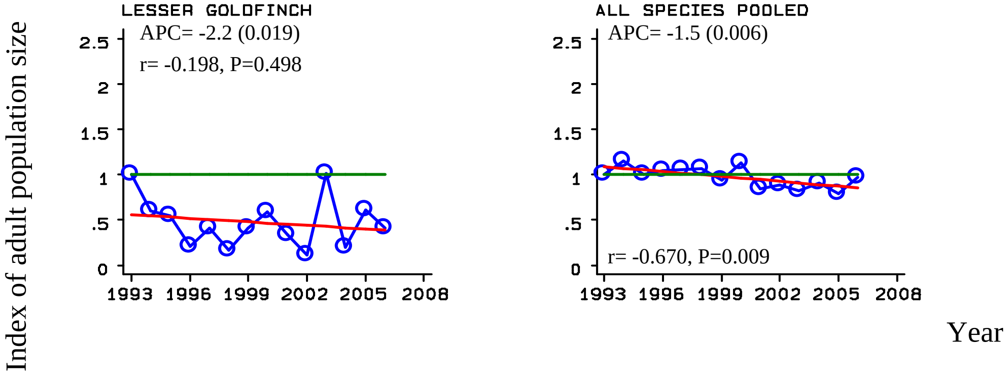


Figure 1. (cont.) Population trends for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

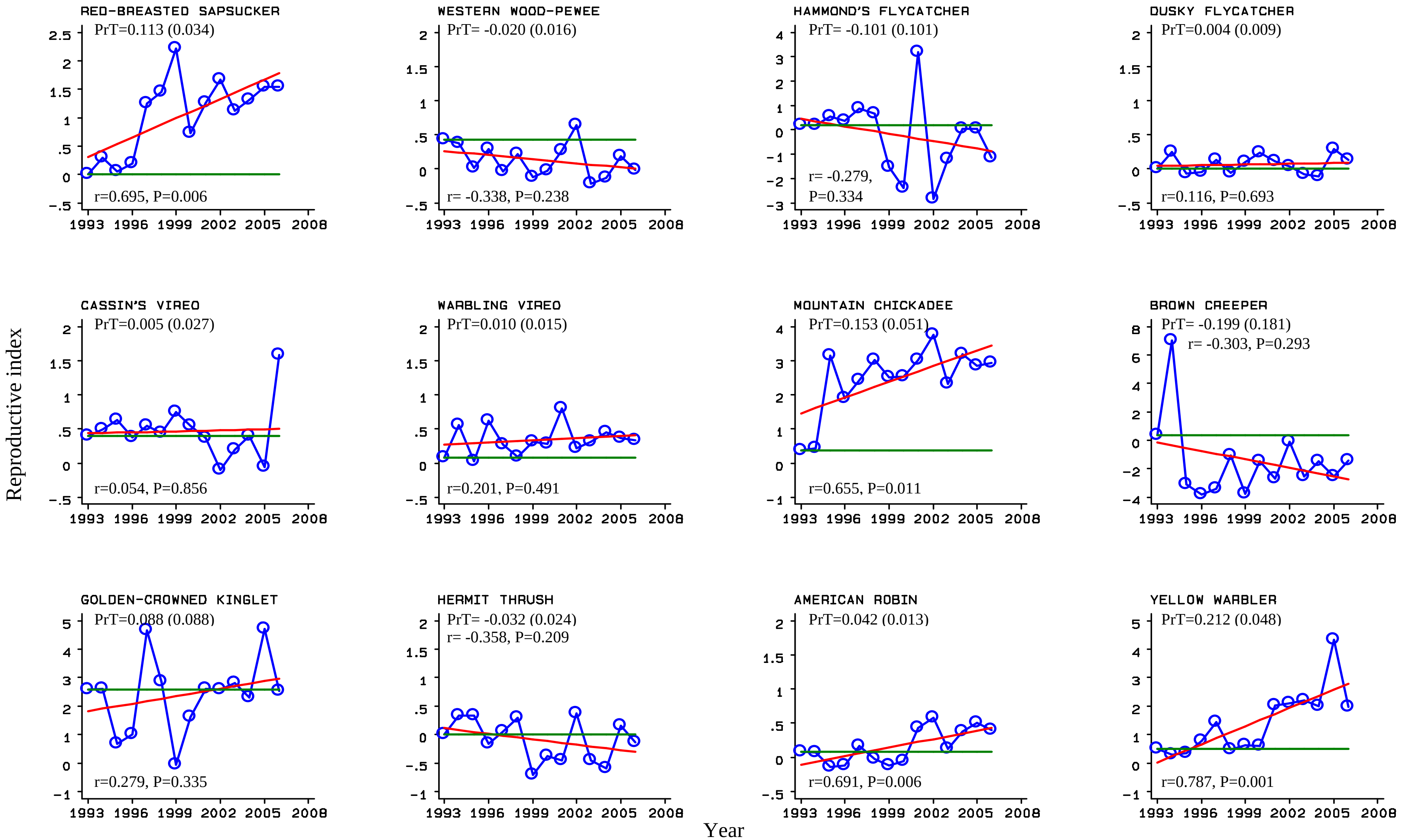


Figure 2. Trend in productivity for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The reproductive index was defined as the actual reproductive index value in 1993. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

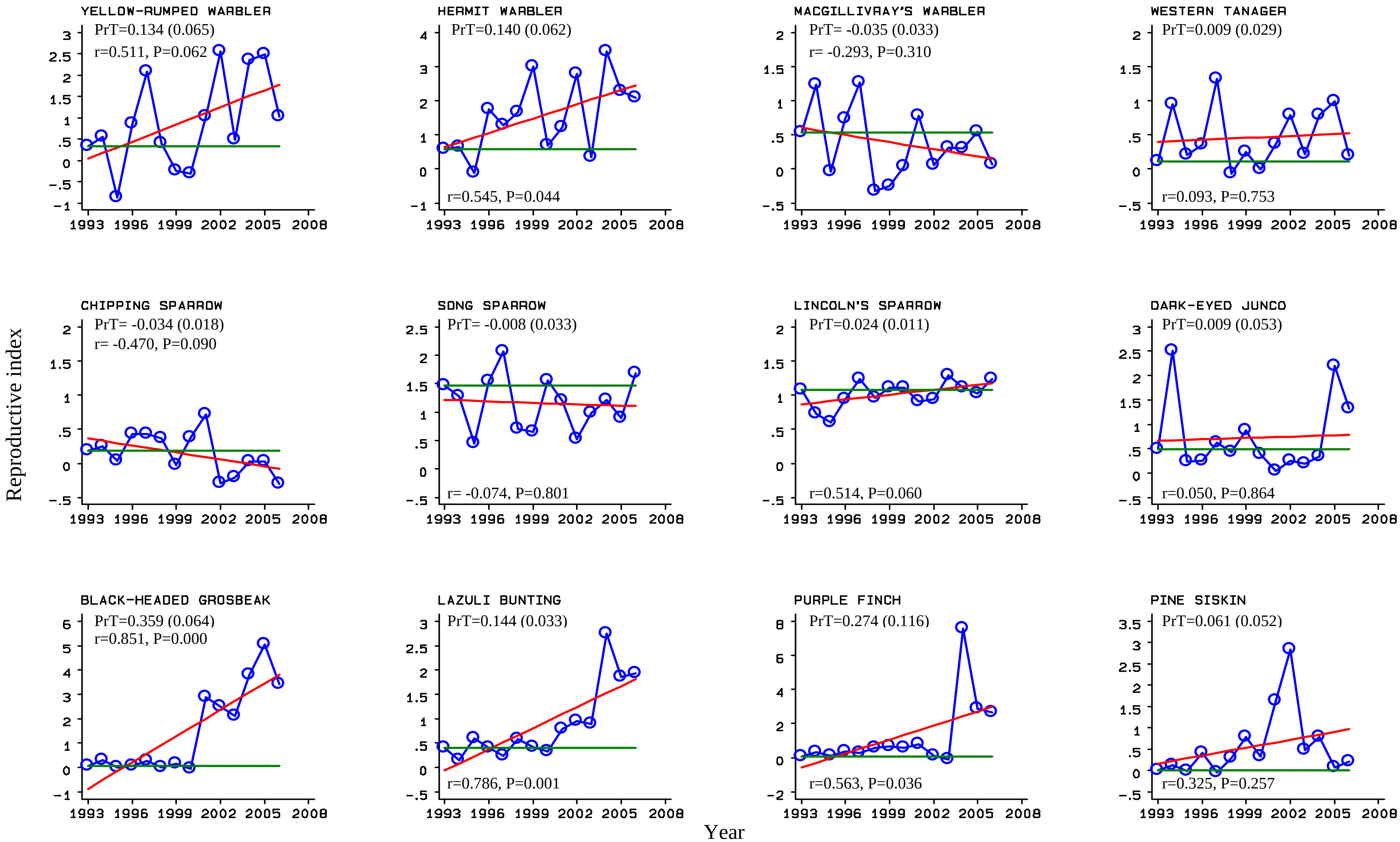


Figure 2. (cont.) Trend in productivity for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The reproductive index was defined as the actual reproductive index value in 1993. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

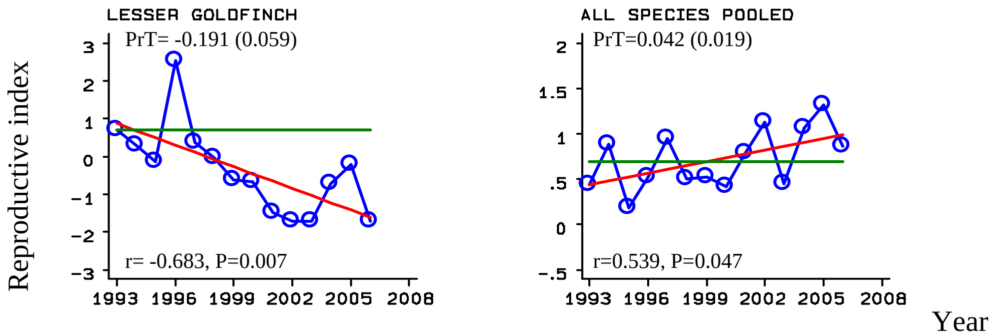


Figure 2. (cont.) Trend in productivity for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The reproductive index was defined as the actual reproductive index value in 1993. Indices for subsequent years were determined from constant-effort between-year changes in reproductive index from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line for annual change in the index of productivity was used as the measure of the productivity trend (PrT), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.

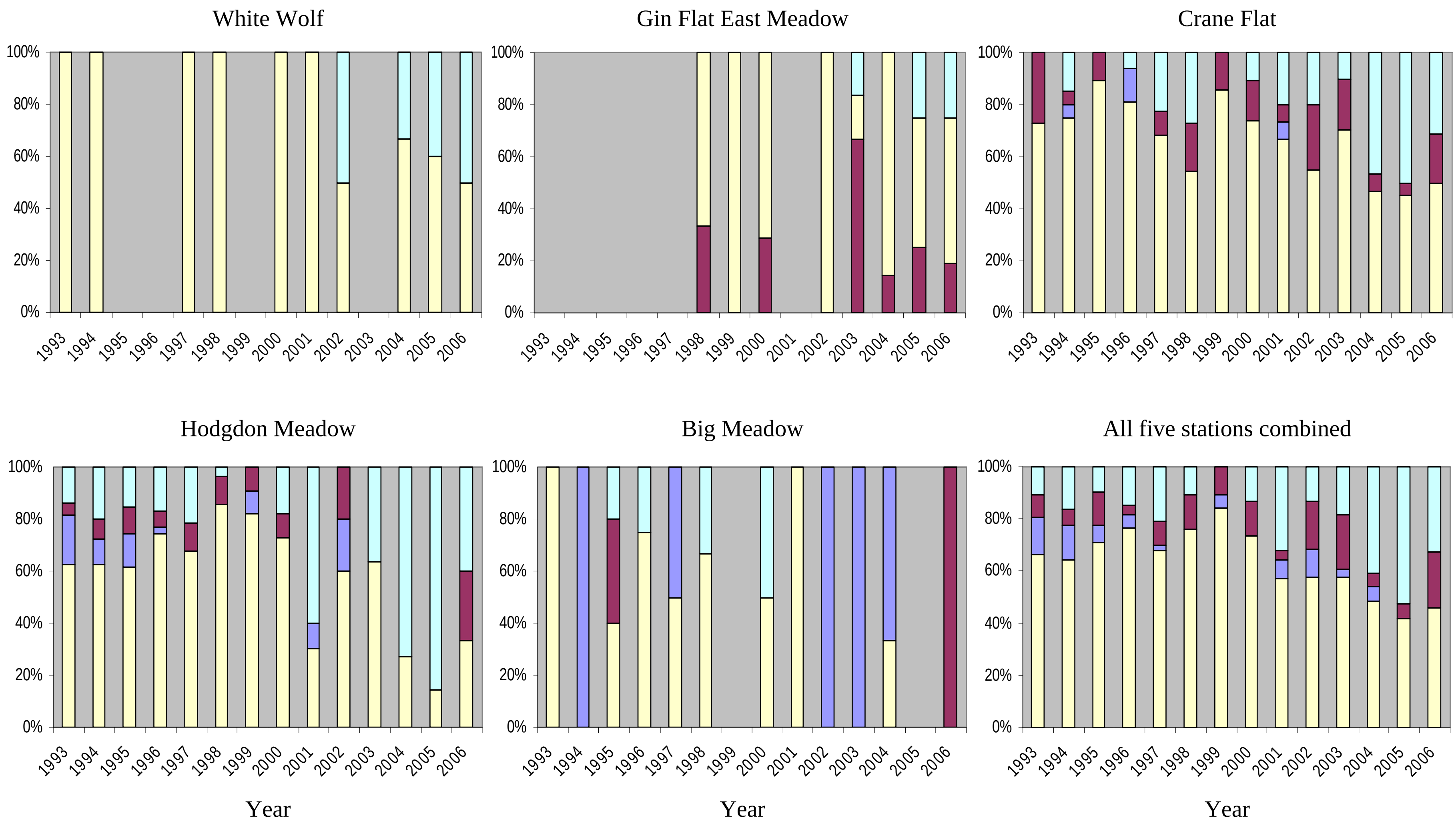


Figure 3. Proportion of the catch of adult *Empidonax* flycatchers comprised by each *Empidonax* species at the five currently operating MAPS stations in Yosemite National Park, and all five stations pooled, over the 14 years 1993-2006.

Pacific-slope Flycatcher; Hammond's Flycatcher; Willow Flycatcher; Dusky Flycatcher

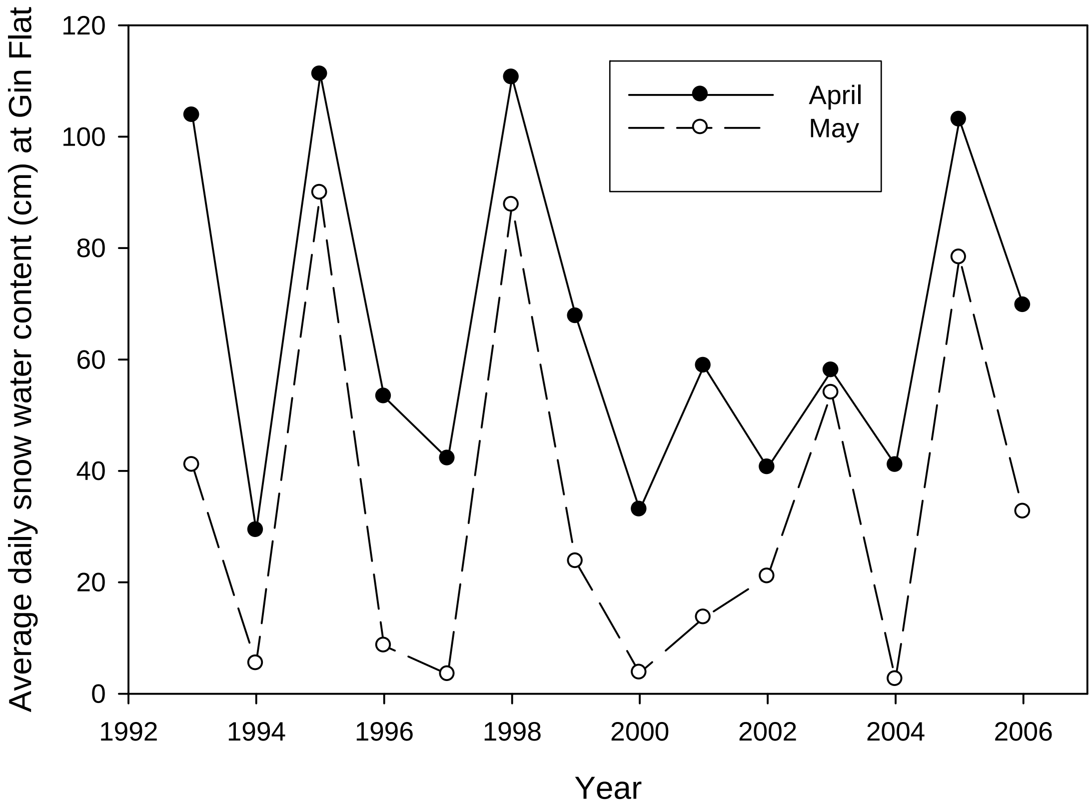


Figure 4. Annual average daily snow water content during April and May at Gin Flat, Yosemite National Park, over the 14-year period 1993-2006. Data were obtained from the California Department of Water Resources http://cdec.water.ca.gov/selectQuery.html). Neither the April values (r = 0.133, P = 0.650) nor the May values (r = 0.020, P = 0.946) display any temporal trend over the 14-year period.

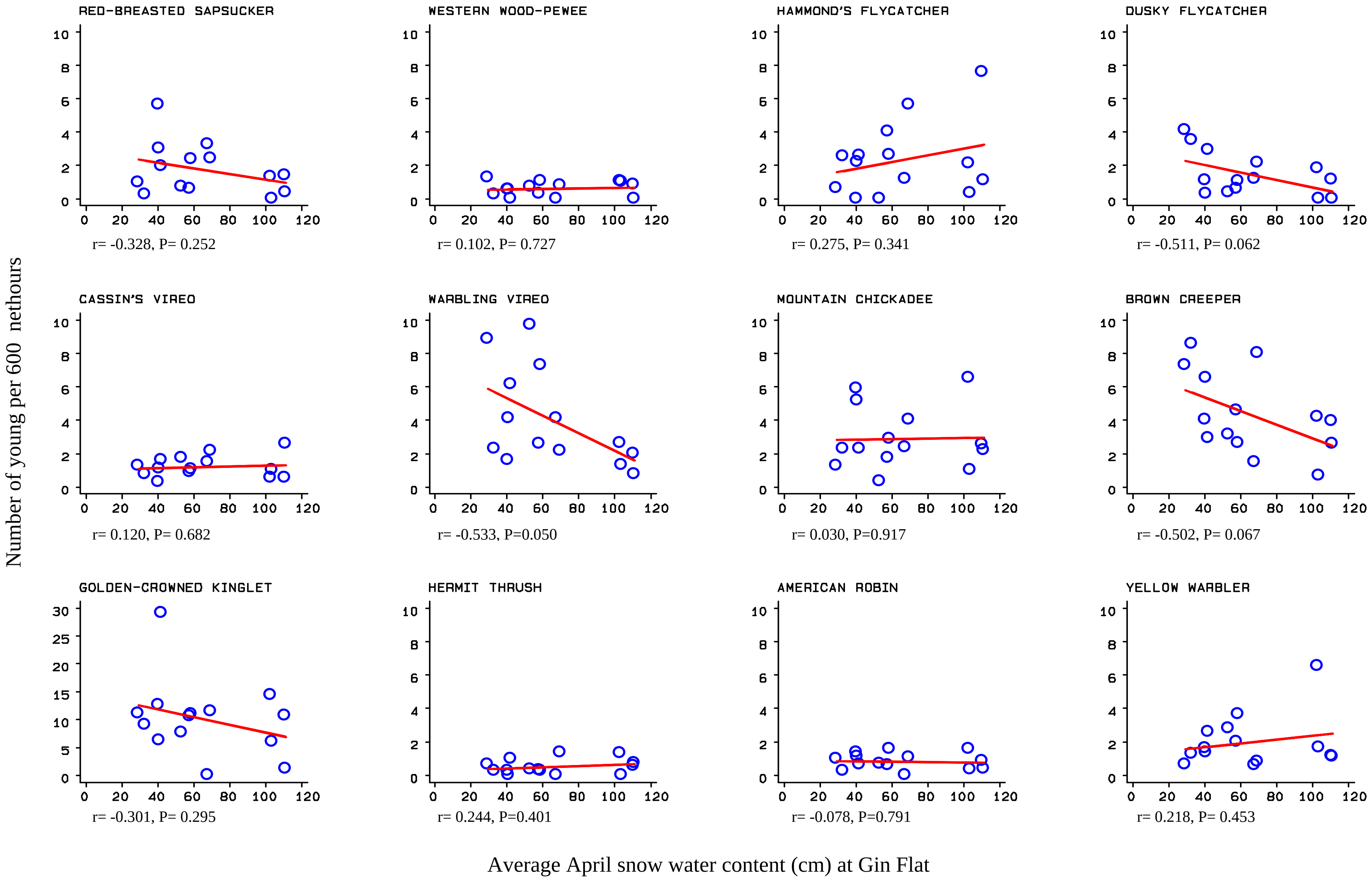


Figure 5. Relationships of annual mean daily snow water content (cm) in April to the number of young birds captured per six hundred net-hours for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The correlation coefficient (r) and significance of the correlation coefficient (P) are shown on each graph.

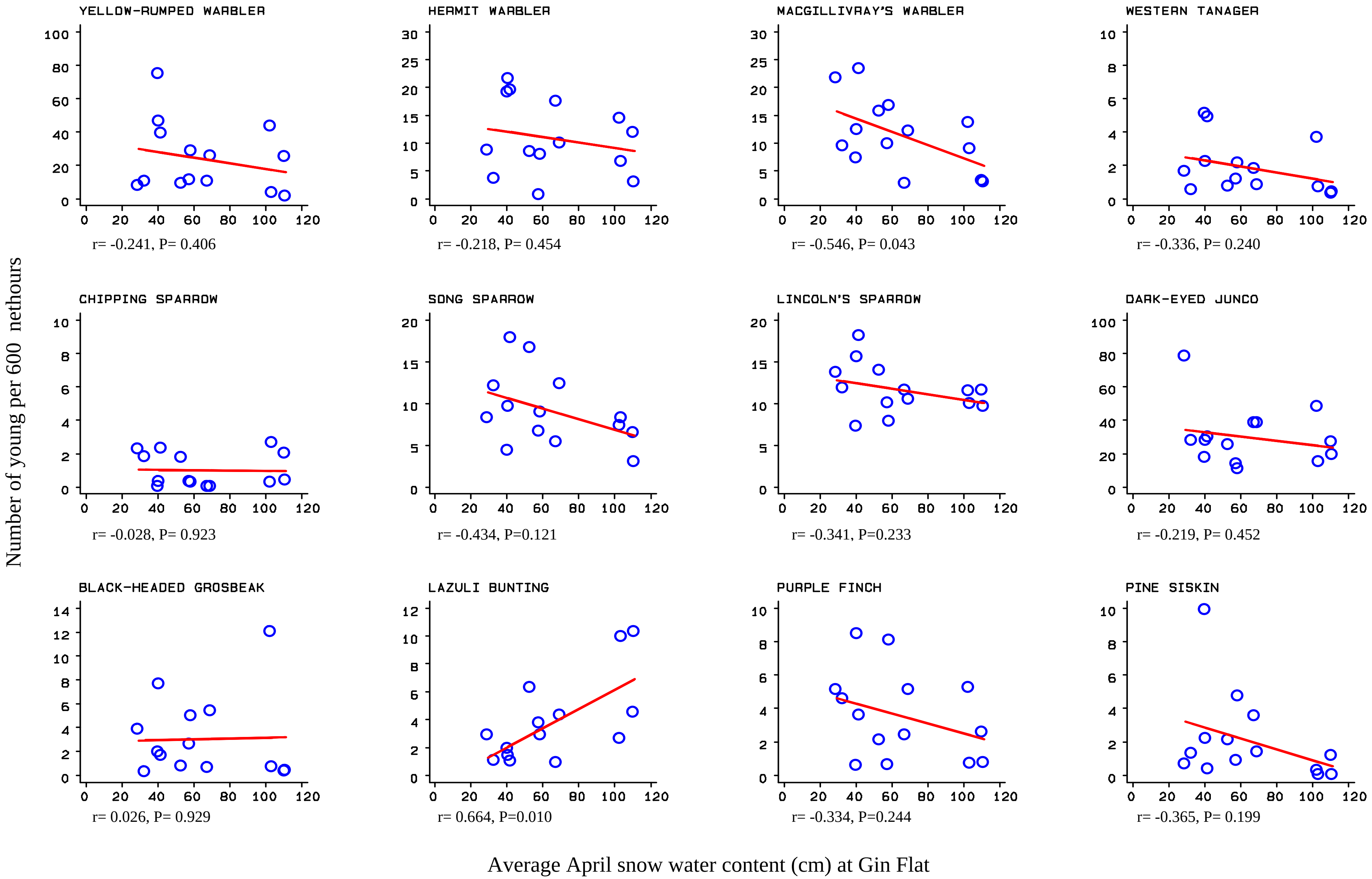
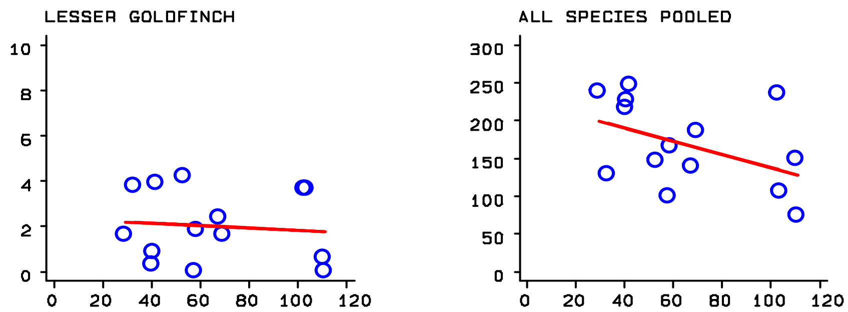


Figure 5. (cont.) Relationships of annual mean daily snow water content (cm) in April to the number of young birds captured per six hundred net-hours for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The correlation coefficient (r) and significance of the correlation coefficient (P) are shown on each graph.

Number of young per 600 nethours



r= -0.095, P= 0.746

r= -0.453, P= 0.104

Average April snow water content (cm) at Gin Flat

Figure 5. (cont.) Relationships of annual mean daily snow water content (cm) in April to the number of young birds captured per six hundred net-hours for 25 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 14 years 1993-2006. The correlation coefficient (r) and significance of the correlation coefficient (P) are shown on each graph.

Appendix I. Numerical listing (in AOU checklist order) of all the species sequence numbers, species alpha codes, and species names for all species banded or encountered during the 17 years, 1990-2006, of the MAPS Program on the six stations ever operated on **Yosemite National Park**

Cumulative breeding status for all years in which each station was operated are also included (B = Regular Breeder (all years); **U =** Usual Breeder (>½, not all, years); **O** = Occasional Breeder (≤½ years); **T** = Transient; **M** = Migrant; **A=** Altitudinal Disperser; **?** = Uncertain Species ID

NUMB	SPEC	SPECIES NAME	White Wolf (WHWO)	Gin Flat East Meadow (GFEM)	Crane Flat (CRFL)	Hodgdon Meadow (HODG)	Big Meadow (BIME)	Tamarak Meadow (TAME)
01010	GBHE	Great Blue Heron					T	
01300	TUVU	Turkey Vulture	T	T	T	T	T	
01630	MALL	Mallard		O		O	O	
01980	COME	Common Merganser					T	
02020	OSPR	Osprey					T	
02170	NOHA	Northern Harrier					T	
02200	SSHA	Sharp-shinned Hawk		T		T		
02210	COHA	Cooper's Hawk	T		T	O	T	
02240	NOGO	Northern Goshawk	T	T		T		
02380	RSHA	Red-shouldered Hawk			M			
02460	RTHA	Red-tailed Hawk	T	T	T	U	O	
02510	GOEA	Golden Eagle					T	
02545	UNHA	Unidentified Hawk				?		
02630	AMKE	American Kestrel					O	
03000	BLUG	Blue Grouse	T	T	O	O		
03040	WITU	Wild Turkey					T	
03100	MOUQ	Mountain Quail	O	U	O	U	B	
03130	CAQU	California Quail				T	O	
03370	VIRA	Virginia Rail				T		T
05440	BTPI	Band-tailed Pigeon	T	T	T	O	T	
05570	MODO	Mourning Dove		T	T	O	O	
06670	WESO	Western Screech-Owl				T		
06800	GHOW	Great Horned Owl	T		T	O	T	
06830	NOPO	Northern Pygmy-Owl				T	T	
06940	SPOW	Spotted Owl				O		
06970	GGOW	Great Gray Owl	T	U	O	O		
07040	NSWO	Northern Saw-whet Owl				T		
07330	BLSW	Black Swift					T	
07410	VASW	Vaux's Swift				T	T	
07530	WTSW	White-throated Swift		T		T		
08640	BCHU	Black-chinned Hummingbird			T	T	T	

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	WHWO	GFEM	CRFL	HODG	BIME	TAME
08670	ANHU	Anna's Hummingbird	T	O	O	U	U	T
08690	CAHU	Calliope Hummingbird	T	O	O	O	O	T
08730	RUHU	Rufous Hummingbird	M	M	M	M	M	M
08740	ALHU	Allen's Hummingbird	M	M	M	M	M	
08774	USHU	Unidentified Selasphorus Hummingbird	?	?	?	?	?	
08775	UNHU	Unidentified Hummingbird	?	?	?	?	?	
09110	BEKI	Belted Kingfisher			T	T	U	
09390	LEWO	Lewis's Woodpecker					M	
09430	ACWO	Acorn Woodpecker	T		T		U	
09570	WISA	Williamson's Sapsucker	U	T	T	T		
09600	RBSA	Red-breasted Sapsucker	O	B	B	B	O	O
09640	NUWO	Nuttall's Woodpecker				T	T	
09650	DOWO	Downy Woodpecker	T		T	O	U	T
09660	HAWO	Hairy Woodpecker	U	B	U	U	U	B
09690	WHWO	White-headed Woodpecker	O	B	B	U	O	B
09710	BBWO	Black-backed Woodpecker						U
09800	RSFL	Red-shafted Flicker	U	B	U	B	B	U
09860	PIWO	Pileated Woodpecker	T	U	U	B	T	O
09915	UNWO	Unidentified Woodpecker	?					
11340	OSFL	Olive-sided Flycatcher	T	U	O	B	O	B
11380	WEWP	Western Wood-Pewee	U	U	O	B	B	B
11475	TRFL	Traill's Flycatcher			T	U	O	T
11475	WIFL	Willow Flycatcher			T	U	O	T
11510	HAFL	Hammond's Flycatcher	O	U	U	U	T	O
11515	HDFL	Hammond's/Dusky Flycatcher		?	?	?		
11520	GRFL	Gray Flycatcher	M		M	M	M	
11530	DUFL	Dusky Flycatcher	B	B	B	U	T	B
11555	PSFL	Pacific-slope Flycatcher	T	O	U	U	O	T
11555	WEFL	Western Flycatcher	T	O	U	U	O	T
11595	UEFL	Unidentified Empidonax Flycatcher	?	?	?	?	?	
11600	BLPH	Black Phoebe	T	T	T	O	B	
11740	ATFL	Ash-throated Flycatcher					T	T
12020	WEKI	Western Kingbird	T			T	T	
12085	UNFL	Unidentified Flycatcher	?	?	?	?	?	
12710	CAVI	Cassin's Vireo	T	O	B	B	U	U
12740	HUVI	Hutton's Vireo		T	O	O		
12760	WAVI	Warbling Vireo	U	U	B	B	B	B
12790	REVI	Red-eyed Vireo			M	M		
12920	STJA	Steller's Jay	B	B	B	B	U	B
13110	WESJ	Western Scrub-Jay	T			T	O	

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	WHWO	GFEM	CRFL	HODG	BIME	TAME
13150	CLNU	Clark's Nutcracker	T	T		T		
13190	AMCR	American Crow		M		M		
13300	CORA	Common Raven	U	U	B	B	U	O
13410	TRES	Tree Swallow		T		T	T	T
13440	VGSW	Violet-green Swallow		T		T	O	T
13490	NRWS	Northern Rough-winged Swallow				T	U	
13540	BARS	Barn Swallow					O	
13555	UNSW	Unidentified Swallow					?	
13580	MOCH	Mountain Chickadee	B	B	B	U	U	B
13600	CBCH	Chestnut-backed Chickadee	T	T	T	O		T
13640	OATI	Oak Titmouse					O	
13680	BUSH	Bushtit			T	O	O	T
13690	RBNU	Red-breasted Nuthatch	B	B	B	B	O	B
13700	WBNU	White-breasted Nuthatch	T	O	O	O	O	O
13710	PYNU	Pygmy Nuthatch		T				
13730	BRCR	Brown Creeper	B	B	B	B	B	B
14040	BEWR	Bewick's Wren	T			T	O	
14070	HOWR	House Wren	A	A	A	A	U	A
14110	WIWR	Winter Wren	T	T	O	O	O	T
14205	UNWR	Unidentified Wren				?	?	
14210	AMDI	American Dipper					O	
14240	GCKI	Golden-crowned Kinglet	B	B	B	B	T	U
14250	RCKI	Ruby-crowned Kinglet	O			T		
14570	WEBL	Western Bluebird		T		O	U	
14590	TOSO	Townsend's Solitaire	T	O	O	T	T	
14810	SWTH	Swainson's Thrush	T			O		
14820	HETH	Hermit Thrush	U	O	B	U	T	T
15000	AMRO	American Robin	B	B	B	B	B	B
15110	WREN	Wrentit					O	
15370	EUST	European Starling				O	O	
15550	CEDW	Cedar Waxwing				M	M	
15660	OCWA	Orange-crowned Warbler	A	A	A	A	A	A
15670	NAWA	Nashville Warbler	A	A	A	B	U	A
15750	YWAR	Yellow Warbler	O	T	O	B	B	T
15800	AUWA	Audubon's Warbler	B	B	B	B	O	B
15810	BTYW	Black-throated Gray Warbler	T	T	T	T	T	T
15840	TOWA	Townsend's Warbler	M	M	M	M		M
15850	HEWA	Hermit Warbler	U	B	B	B	T	U
16040	AMRE	American Redstart				M		
16090	NOWA	Northern Waterthrush					M	

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	WHWO	GFEM	CRFL	HODG	BIME	TAME
16140	MGWA	MacGillivray's Warbler	T	B	B	B	U	B
16150	COYE	Common Yellowthroat				M		
16280	HOWA	Hooded Warbler				M		
16290	WIWA	Wilson's Warbler	T	T	O	U	T	B
16460	YBCH	Yellow-breasted Chat				T	T	
16495	UNWA	Unidentified Warbler			?	?	?	
16840	WETA	Western Tanager	O	B	B	B	U	B
17790	GTTO	Green-tailed Towhee		O	T	T	T	
17810	SPTO	Spotted Towhee			T	O	U	
17850	CALT	California Towhee					T	
18020	CHSP	Chipping Sparrow	U	T	U	U	U	B
18110	SAGS	Sage Sparrow					T	
18130	SAVS	Savannah Sparrow					M	
18140	GRSP	Grasshopper Sparrow					M	
18220	FOSP	Fox Sparrow	T	O	T	T	T	O
18230	SOSP	Song Sparrow	O	O	U	B	B	O
18240	LISP	Lincoln's Sparrow	B	B	B	B	O	B
18290	MWCS	Mountain White-crowned Sparrow	T			T		
18320	ORJU	Oregon Junco	B	B	B	B	U	B
18335	UNSP	Unidentified Sparrow		?	?	?	?	
18600	RBGR	Rose-breasted Grosbeak				M		
18610	BHGR	Black-headed Grosbeak	O	O	U	B	B	O
18660	LAZB	Lazuli Bunting	T	T	U	O	B	T
18670	INBU	Indigo Bunting				M		
18730	RWBL	Red-winged Blackbird	T	T	T	B	O	O
18810	WEME	Western Meadowlark					U	
18820	YHBL	Yellow-headed Blackbird					M	
18860	BRBL	Brewer's Blackbird	U	O	T	B	B	
18960	BHCO	Brown-headed Cowbird	O	T	O	U	U	
19105	BUOR	Bullock's Oriole				T	U	T
19330	PIGR	Pine Grosbeak	U	T	T			
19350	PUFI	Purple Finch	O	U	U	B	U	O
19360	CAFI	Cassin's Finch	U	O	O	O	O	O
19370	HOFI	House Finch			T	T	T	
19375	UCFI	Unidentified Carpodacus Finch			?	?	?	
19380	RECR	Red Crossbill	O	T	T	T	O	
19430	PISI	Pine Siskin	B	B	U	U	O	U
19490	LEGO	Lesser Goldfinch	T	O	T	O	B	T
19500	LAGO	Lawrence's Goldfinch		T		T	O	T
19510	AMGO	American Goldfinch				M	M	M

Appendix I. Continued.

NUMB	SPEC	SPECIES NAME	WHWO	GFEM	CRFL	HODG	BIME	TAME
19580	EVGR	Evening Grosbeak	O	T	T	T	O	T
19920	HOSP	House Sparrow					T	
20085	UNBI	Unidentified Bird			?	?	?	?