THE 2005 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM IN YOSEMITE NATIONAL PARK

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EXECUTIVE SUMMARY

Overview

Since 1989, The Institute for Bird Populations has been coordinating the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among public and private agencies and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting and banding stations. The purpose of 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 upon which to initiate research and management actions to reverse the recently documented declines in North American landbird populations. The system of national parks provides a group of ideal locations for this large-scale, long-term biomonitoring, because the parks contain large areas of breeding habitat for year-round resident, short-distance migrant, and Neotropical migratory landbirds that are subject to varying local landscape-related and global climate-related effects.

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 been operated in Yosemite National Park for the past 13 years (16 years at one station) with the hope that it will serve as an integral part of the park's Long-Term Ecological Monitoring (LTEM) program. It is expected that information from MAPS will aid research and management efforts within the park to protect and enhance the park's avifauna and ecological integrity.

Five MAPS stations were re-established and operated in Yosemite National Park in 2005, at the same locations they were operated in previous years. The five stations, located along an elevation gradient from highest to lowest, were 1) White Wolf Meadow at 2402 m elevation; 2) Gin Flat East Meadow at 2073 m elevation; 3) Crane Flat Meadow at 1875 m elevation; 4) Hodgdon Meadow at 1408 m elevation; and 5) Big Meadow at 1311 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.

The goal of this report is to 1) summarize 13 years of MAPS data (1993-2005) from the four long-running stations and eight years of data (1998-2005) from the Gin Flat East station along an elevation gradient in Yosemite National Park; 2) identify declining species in Yosemite National Park that may be in need of management action; and 3) identify the probable proximate, demographic causes (productivity or survival) for these population declines in Yosemite. The long-term goals for the Yosemite MAPS Program are to 1) identify management strategies and formulate management actions to reverse these population declines at several spatial scales: in Yosemite National Park, in the greater Sierra Nevada ecosystem, and in montane western North America as a whole; and 2) evaluate the effectiveness of implemented actions by continuing to monitor the targeted vital rates.

Adult Population Sizes and Productivity in 2005 and Comparison with Previous Years
A total of 2656 captures of 69 species were recorded during the summer of 2005 at Yosemite National Park. Breeding populations decreased by a non-significant 10.8% in 2005 as compared with those of 2004, with decreases recorded at all stations except Big Meadow. Productivity showed slight changes, that were positive at White Wolf, Gin Flat East Meadow, and Big Meadow but negative at Hodgdon Meadow and Crane Flat. This followed wide-scale increases recorded between 2003 and 2004, which could be a positive sign for bird populations at Yosemite.

In previous analyses we have found that productivity tended to be higher during El Niño years, such as 2004-2005 when a weak El Niño was followed by a year of El-Niño-like weather. Although productivity tends to be higher at higher elevations and during warm, wet El Niño years, 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 El Niño/Southern Oscillation (ENSO) events and their associated El Niños tend to depress bird populations in Yosemite and throughout the Sierra. This could explain the fact that increased productivity between 2003 and 2004 did not lead to higher breeding populations in 2005, except at Big Meadow, where moister conditions may lead to both higher populations and higher productivity.

Productivity-population correlations, the degree to which productivity one year affects population sizes the next year, are generally weaker at Yosemite than those at other national parks, including both Denali and Shenandoah. Such dynamics appear to be less strongly manifest in areas, such as Yosemite, that are characterized by high annual variation in weather and snowpack, than in areas where weather is more predictable year-round. It appears that an additional dynamic is operating at Yosemite and in the Sierra Nevada that involves density-independent variation in recruitment rates that may be related to climate, weather, and snowpack variables, and that may affect one-year-old and adult birds differently. In particular, our data suggest that birds in Yosemite are best adapted for conditions associated with average snowpack levels, and that snowpack has a large correlation with reproductive success. Because of the magnitude and unpredictability of such variations in weather (regarding both the extent of and timing of snowmelt as well as summer precipitation and temperatures) and the complex effects these perturbations likely have on avian population dynamics, long, consistent runs of monitoring data and complex modeling of weather variables, climate cycles, and recruitment rates as a function of elevation will be necessary to fully understand the causes of both short-term and long-term changes in Sierra bird populations.

Population and Productivity Trends in Yosemite's Landbirds
Populations of adult birds of all species pooled in Yosemite National Park have shown a substantial and highly significant decrease of -2.0% per year over the 13 years, 1993-2005, indicating a 23% decline during the past 13 years. Population trends were negative at all four long-running stations. Negative trends were nearly significant at Crane Flat and significant at Hodgdon Meadow and Big Meadow, and annual percent declines varied from -1.5% at Hodgdon Meadow to -5.7% at Big Meadow. Adult populations of 19 of 26 target species at the five

currently operating stations combined (and 24 of 34 target species at individual stations) showed declining 13-year trends. Comparison of long-term population trends at Yosemite with long-term Breeding Bird Survey (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 in productivity showed a substantial but non-significant 13-year increase of +0.022 per year when all species were pooled, and more species showed increases (16) than decreases (10).

Of concern are significant or highly significant declines in three species of flycatchers, Western Wood-Pewee, Hammond's Flycacther, and Dusky Flycacther at Yosemite, following dramatic declines (documented elsewhere) in two other species, Olive-sided and Willow flycatchers. The only species of flycatcher that seems not to be declining according to MAPS data is "Western" Flycatcher, which generally shows a non-substantial, fluctuating trend overall but an increase at Crane Flat, where it appears to have supplanted Dusky Flycatcher. We have no immediate explanation for the declines of flycatchers at Yosemite although a long-term decline in insect resources and/or an increase in cowbird parasitism are problems elsewhere for flycatchers and could be factors at Yosemite.

Demographics of Yosemite's Birds Along an Elevation Gradient
Species richness (number of species), total adult population size, productivity, and adult population trend at Yosemite each varied with elevation in a unique way. Total richness of breeding species clearly decreased with increasing elevation, whereas mean annual number of adults of all species pooled was highest at intermediate elevations and decreased progressively both at lower and higher elevations. Mean annual productivity tended to show a positive correlation with elevation, as did station-specific, 13-year population trends (i.e., the trend was non-significantly negative at White Wolf but significantly negative at Big Meadow). These correlations suggest that the increasingly negative population trends at lower elevation stations may have been driven by the increasingly lower productivity at those same stations, especially in drought years with meager snowpacks.

Survival Rates of Yosemite's Birds
We were able to obtain estimates of annual adult survival for 30 target species at Yosemite using 13 years of data from all five stations combined. Mean precision of these survival rate estimates continued to improve, although the increase in precision was smaller and with a lower proportion of the species than in previous years, indicating that it is leveling off and that maximum precision may not be obtained until more than 13-15 years of data are available. $\Delta QAIC_C$ values were relatively high in all but two of the 30 species (Lincoln's Sparrow and Dark-eyed Junco), suggesting that there is relatively little interannual variation in survival for most Yosemite species.

The annual adult survival-rate estimates at Yosemite (1993-2005) appear to be relatively high compared to values for the Northwestern MAPS region as a whole. Estimates for Yosemite were higher than in the Northwest Region for 20 of 29 species for which this comparison could be made, and mean survival at Yosemite (0.495) was 4.2% higher than that of the Northwest Region (0.475). In addition, 11 of 17 species showed higher survival estimates at Hodgdon

Meadow than recently reported estimates at equivalent elevations in Sequoia/Kings Canyon National Park. It is possible that the generally lower survival rates observed at Sequoia/Kings Canyon may relate to local stressors acting on the breeding grounds which are affecting annual survival of adults.

Causes of Population Change in Yosemite's Birds
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. 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 that showed substantial trends, whereas survival only appeared to be driving or influencing trends in five species. This further indicates that the population dynamics of most of Yosemite's breeding species are being affected by conditions in Yosemite National Park and the Sierra Nevada.

Future Analyses
MAPS mark-recapture analyses currently do not permit the estimation of survival of first-year birds, because young birds typically disperse substantial distances to their site of first breeding, resulting in very few or no recaptures of birds banded as juveniles. In future analyses, using reverse symmetry modeling, we hope to estimate recruitment of first-year and older birds for species for which we can identify those age classes during the breeding season. This will allow us to make inferences regarding first-year survival rates for those species as well as extent of immigration and emigration in their populations. We will then be able to examine patterns in adult and first-year survival rates according to geographic location, climate, and habitat considerations, and to identify causes of declines in species such as Hermit Warbler, Dark-eyed Junco, and Black-headed Grosbeak that do not show deficient productivity or adult survival rates at Yosemite and whose declines may be driven by low first-year survival or deficient recruitment. In addition, when we have 15 consecutive years of data from the long-running stations, we hope to be able to perform, at the spatial scale of the four individual stations, many of the analyses that are currently conducted on data from all stations combined, and thus provide further information on the effects of elevation on recruitment and population dynamics.

We have recently initiated additional broad-scale analyses to help us further understand the population dynamics of landbirds and potential management actions to assist bird populations. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we are beginning to determine the proximate demographic causes of population trends within a species on continental, regional, and local spatial scales. Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area around each station are good predictors not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well. These types of analyses provide extremely powerful tools to identify and formulate management actions aimed at reversing declining

populations and maintaining stable or increasing populations of landbirds, because they can address the particular vital rate responsible for the decline. We plan to conduct similar analyses for target species in the Sierra, by modeling productivity as a function of various landscape characteristics that vary along a gradient from the pristine landscapes found in Yosemite National Park to the much more heavily managed landscapes on Sierran national forests.

Indeed, one important objective of the MAPS Program in relatively pristine protected areas such as Yosemite is to provide control data on the vital rates of landbirds, to aid the identification of generalized management guidelines and the formulation of specific management actions that may reverse population declines of focal and priority landbird species and maintain populations of stable or increasing species. The identification and formulation of these management guidelines and actions are to be achieved by modeling the vital rates (productivity, adult survival, first-year survival, and/or recruitment rates) of the various landbird species as a function of landscape-level and elevation-specific habitat characteristics along with spatially explicit weather variables. Management strategies will subsequently involve efforts to modify habitat characteristics from those associated with low productivity or recruitment to those associated with high productivity or recruitment (for species for which low productivity or recruitment is driving the population decline).

Because of the pronounced elevation factor at Yosemite, and the complex effects of weather on population size and productivity, we will need to incorporate elevation-specific habitat analyses and account for weather on an annual basis. Elevation effects on adult population size appear to reflect the effects of dry years (greater population sizes at higher elevations due to lack of snow pack and warmer temperatures) vs. wet years (greater population sizes at lower elevations due to higher levels of food resources and cooler temperatures). Thus, landscape-level analyses at Yosemite will necessarily involve interactions between elevation and weather as well as habitat characteristics. It is the complexity of these interactions that create the need for long-term data.

Conclusions
Analyses of 13 years of MAPS data from four stations along an elevation gradient in Yosemite National Park, plus eight years of data from a fifth station, have shown that bird populations in Yosemite have decreased significantly over the 13 years with substantially more species decreasing than increasing. We have also demonstrated how MAPS data can be used to measure and assess the effects of productivity and survivorship at different elevations as driving forces for the varying avian population trends documented in Yosemite National Park. Clearly, the indices and estimates of primary demographic parameters produced by the Yosemite MAPS Program are providing critical information that can be extremely useful for the management and conservation of landbirds in Yosemite and the Sierra Nevada and, in combination with similar data from other areas, across the whole of North America.

The results highlighted in this report reveal that population dynamics of the breeding birds of Yosemite National Park are complex, as are the likely causes of the dynamics and, for those trends deemed problematic, their solutions. This complexity, in turn, underscores the importance of standardized, long-term data. Once 15 years of data have accumulated and the precision of our estimates improves further, and both short- and long-term trends become more

clearly established, we will be able to incorporate weather and climate data as well as landscape-level habitat data as additional co-variates in logistic regression analyses of productivity and in survivorship models. With these additional years of data we will be able to further our understanding of the population dynamics of Yosemite's birds and shed more light on the complex paths leading from environmental stressors to population responses.

We conclude that the MAPS protocol is very well-suited to provide a critical component of the National Park Service's Long-Term Ecological Monitoring program in Yosemite National Park. Based on the above information, we recommend that the operation of the five MAPS stations in Yosemite National Park be sustained into the future, and funding be sought for a comprehensive analysis of all Sierran MAPS data (including Yosemite's) to be conducted after 15 years of data have accumulated.

INTRODUCTION

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

The development and implementation of an effective long-term monitoring program in National Parks can be of even wider importance than aiding the NPS in its management of those resources. Because National Parks provide large areas of multiple and often relatively pristine ecosystems that are subject to varying management practices, studies conducted on these lands can provide invaluable information for understanding natural ecological processes and for evaluating the effects of large-scale, even global, environmental changes. Thus, long-term monitoring data from National Parks can provide information that is crucial for efforts to preserve natural resources and biodiversity on a continental or even global scale.

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

Recent analyses of data from several of these programs, particularly the BBS, suggest that populations of many landbirds, including forest-, scrubland-, and grassland-inhabiting species, are in serious decline (Peterjohn et al. 1995). Nearctic-Neotropical migratory landbirds (species that breed in North America and winter in Central and South America and the West Indies; hereafter, Neotropical migratory birds) constitute one group for which pronounced population declines have been documented (Robbins et al. 1989, Terborgh 1989). In response to these declines, the Neotropical Migratory Bird Conservation Program, "Partners in Flight - Aves de las Americas," was initiated in 1991 (Finch and Stangel 1993). The major goal of Partners in Flight (PIF) is to reverse the declines in Neotropical migratory birds through a coordinated program of monitoring, research, management, education, and international cooperation. As one of the major cooperating agencies in PIF, the NPS has established long-term avian monitoring efforts in National Parks using protocols developed by the Monitoring Working Group of PIF. Clearly, the long-term ecological monitoring (LTEM) goals of the NPS and the monitoring and research goals of PIF share many common elements. A difference between the two objectives, however, is that a major goal of PIF is to reverse population declines, especially in rare or uncommon (although not threatened or endangered) species, while a major objective of the NPS's LTEM

program is to understand the ecological processes driving population changes. This latter goal often necessitates concentrating on relatively common or even abundant species that are undergoing population changes, rather than rare or uncommon ones. Thus, appropriate target species might be expected to differ somewhat between PIF and LTEM efforts.

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

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

MAPS
In 1989, The Institute for Bird Populations (IBP) established the Monitoring Avian Productivity and Survivorship (MAPS) program, a cooperative effort among public agencies, private organizations, and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting and banding stations to provide long-term demographic data on landbirds (DeSante et al. 1995). The design of the MAPS program was patterned after the very successful British Constant Effort Sites (CES) Scheme that has been operated by the British Trust for Ornithology since 1981 (Peach et al. 1996). The MAPS program was endorsed in 1991 by both the Monitoring Working Group of PIF and the USDI Bird Banding Laboratory, and a four-year pilot project (1992-1995) was approved by the USDI Fish and Wildlife Service and National Biological Service (now the Biological Resources Division [BRD] of the U.S. Geological Survey [USGS]) to evaluate its utility and effectiveness for monitoring demographic

parameters of landbirds.

Now in its 17th year (14th year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to nearly 500 stations in 2005. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies in PIF, including the 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 federal properties. Within the past 13 years, IBP has been contracted to operate five MAPS stations in Yosemite National Park, as well as six in Denali, five in Shenandoah, two in Kings Canyon National Park, and six on Cape Cod National Seashore.

Goals and Objectives of MAPS
MAPS is organized to fulfill three sets of goals and objectives: monitoring, research, and management. The specific **monitoring** goals of MAPS are to provide, for over 100 target species, including Neotropical-wintering migrants, temperate-wintering migrants, and permanent residents: (a) annual indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured; and (b) annual estimates of adult population size, adult survival rates, proportions of residents, and recruitment into the adult population from modified Cormack- Jolly-Seber analyses of mark-recapture data on adult birds.

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

The specific **management** goals of MAPS are to use these patterns and relationships, at the appropriate spatial scales, to: (a) identify thresholds and trigger points to notify appropriate agencies and organizations of the need for further research and/or management actions; (b) determine the proximate demographic cause(s) of population change; (c) suggest management actions and conservation strategies to reverse population declines and maintain stable or increasing populations; and (d) evaluate the effectiveness of the management actions and conservation strategies actually implemented through an adaptive management framework.

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

The second, smaller-scale but still long-term objective is to fulfill the above-outlined goals for specific geographical areas (perhaps based on physiographic strata or Bird Conservation Regions) or specific locations (such as individual national parks, military installations, or

national forests) to aid research and management efforts within the parks, installations, or forests to protect and enhance their avifauna and ecological integrity. The sampling strategy utilized at these smaller scales should be hypothesis-driven and should be integrated with other research and monitoring efforts. DeSante et al. (1999) showed that measures of productivity and survival derived from MAPS data were consistent with observed population changes at these smaller spatial scales. This provides considerable assurance that the goals and objectives outlined above can be achieved.

All of these monitoring, research, and management goals are in agreement with the NPS Partners-in-Flight (PIF) strategy. Moreover, because birds are excellent indicators of the health of ecological systems, they can serve as a sensitive barometer of the overall effectiveness of efforts to maintain the biodiversity and ecological integrity of national parks. Accordingly, the MAPS program was established in Yosemite National Park in 1989. It is expected that information from the MAPS program will be capable of aiding research and management efforts in Yosemite National Park to protect and enhance the park's avifauna and ecological integrity.

Recent Important Results from MAPS
Recent important results from MAPS reported in the peer-reviewed literature include the following: (1) 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). (2) Measures of productivity and survival derived from MAPS data were consistent with observed population changes at multiple spatial scales (DeSante et al. 1999). (3) 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). (4) 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). (5) 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). These results indicate that MAPS is capable of achieving, and in some cases is already achieving, its objectives and goals.

The 2005 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 Gin Flat East Meadow and additionally from 1990 at the Hodgdon Meadow station) through 2005. We present annual changes in the numbers of adult and young

birds and in reproductive indices between 2004 and 2005, 13-year (eight-year at Gin Flat East) mean indices of adult population size and productivity at each individual station and for all stations combined for each species and for all species pooled. For selected target species and all species pooled, we present temporal trends in adult population size at each station and for all stations combined and productivity trends for all stations combined. 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. Finally, we model productivity and survivorship as a function of body mass, and consider all values, relationships, and trends in these vital rates in order to suggest proximate demographic causes of the population trends observed in Yosemite's and the Sierra Nevada's birds.

METHODS

Establishment and Operation of Stations

Five MAPS stations were re-established and operated in Yosemite National Park in 2005, at the same locations they were operated in previous years. The five stations, located along an elevation gradient from highest to lowest, were as follows: 1) White Wolf Meadow, set in a wet montane meadow with red fir/lodgepole pine forest at 2402 m elevation; 2) Gin Flat East Meadow, located in a wet montane meadow with mixed red fir and lodgepole pine at 2073 m elevation; 3) Crane Flat Meadow, located in a wet montane meadow with willow/aspen thickets and mixed coniferous forest at 1875 m elevation; 4) Hodgdon Meadow, located in a wet montane meadow with willow/dogwood thickets, mixed coniferous forest, and a patch of California Black Oak woodland at 1408 m elevation; and 5) Big Meadow, located in riparian willows and mixed coniferous forest in an open dry meadow at 1311 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 2005.

Through the efforts of two field biologist interns of The Institute for Bird Populations, Becky Sears and Emily Gable, intensively trained and supervised by IBP staff field biologist Victor Sepulveda, these five MAPS banding stations were operated during 2005 (and in all preceding years) in accordance with the highly standardized banding protocols developed for the MAPS Program throughout North America (DeSante et al. 2005a).

Ten net sites (or 14 sites at the Hodgdon Meadow station) were re-established at each of the stations in 2005, 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 the extensive snow pack and flooding that occurred at these sites during the spring of 2005, with extra days of effort making up for the late start. Otherwise, the operation of all stations occurred on schedule in 2005 during each of the ten-day periods. A brief overview of both the field and analytical techniques used in 2005 is presented here.

Data Collection

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

according to MAPS guidelines using standardized codes and forms (DeSante et al. 2005a):

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

Effort data, i.e., the number and timing of net-hours on each day (period) of operation, were also collected in a standardized manner. In order to allow constant-effort comparisons of data, 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 operated, simple habitat maps were prepared on which up to four major habitat types, as well as the locations of all structures, roads, trails, and streams, were identified and delineated; when suitable maps from previous years were available, these were updated. The pattern and extent of cover of each of four major vertical layers of vegetation (upperstory, midstory, understory, and ground cover), in each major habitat type, were classified into one of twelve pattern types and eleven cover categories according to guidelines spelled out in the MAPS Habitat Structure Assessment Protocol, developed by IBP Landscape Ecologist, Philip Nott (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 specially designed data entry programs. All banding data were then run through a series of verification programs as follows:

(1) Clean-up programs to check the validity of all codes entered and the ranges of all numerical data;

(2) Cross-check programs to compare station, date, and net fields from the banding data with those from the summary of mist netting effort data;

(3) Cross-check programs to compare species, age, and sex determinations against degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), and extent of body and flight-feather molt, primary-feather wear, and juvenal plumage;

(4) Screening programs which allow identification of unusual or duplicate band numbers or unusual band sizes for each species; and

(5) Verification programs to screen banding and recapture data from all years of operation for inconsistent species, age, or sex determinations for each band number.

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

Data Analysis

To facilitate analyses, we first classified the landbird species captured in mist nets into five groups based upon their breeding or summer residency status. Each species was classified as one of the following: a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during all years* that the station was operated; a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during more than half but not all of the years* that the station was operated; an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during half or fewer of the years* that the station was operated; a transient (T) if the species was *never* a breeder or summer resident at the station, but the station was within the overall breeding range of the species; an altitudinal disperser (A) if the species breeds only at lower elevation than that of the station but disperses to higher elevations after breeding; and a migrant (M) if the station was not located within the overall breeding range of the species. Data for a given species from a given station were included in productivity 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), transient (T), or altitudinal disperser (A), but not where the species was 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.

A. Population-size and productivity analyses. The proofed, verified, and corrected banding data from 2005 were run through a series of analysis programs that calculated for each species and for all species combined at each station and for all stations pooled:

(1)   the numbers of newly banded birds, recaptured birds, and birds released unbanded;

(2)   the numbers and capture rates (per 600 net-hours) of first captures (in 2005) of individual adult and young birds; and

(3)   the reproductive index.

Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach et al. 1996), the number of adult birds captured was used as an index of adult population size. As our index of post-fledging productivity we are now using "reproductive index" (number of young divided by number of adults) as opposed to "proportion of young in the catch" previously used. Reproductive index is a more intuitive value for productivity, and it is also more comparable to other calculated MAPS parameters such as recruitment indices.

For all five stations we calculated changes between 2004 and 2005 in the numbers of adult and young birds captured and in the indices of post-fledging productivity. We determined the statistical significance of any changes that occurred according to methods developed by the BTO in their CES scheme (Peach et al. 1996). These year-to-year comparisons were made in a "constant-effort" manner by means of a 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 species captured at several stations in Yosemite National Park, the significance of park-wide annual changes in the numbers of adult and young birds and in the indices post-fledging productivity was inferred statistically using confidence intervals derived from the standard errors of the mean percentage changes. The statistical significance of the overall change at a given station was inferred from a one-sided binomial test on the proportion of species at that station that increased (or decreased). Throughout this report, we use an alpha level of 0.05 for statistical significance and we use the term "near-significant" or "nearly significant" for differences for which $0.05 \leq P < 0.10$.

B. Analyses of trends in adult population size and productivity. For each target species and for all species pooled we examined multi-year trends (eight-year trends at Gin Flat East Meadow, 13-year trends at the other four stations and for all five stations combined, and additional 16-year trends at Hodgdon Meadow) in indices of adult population size, and 13-year trends (for all five stations combined) in productivity indices. For trends in adult population size, we first calculated adult population indices for each species for each of the 13 years based on an arbitrary starting index of 1.0 in the first year of station operation or analysis. Constant-effort changes (as defined above) were used to calculate these "chain" indices in each subsequent year by multiplying the proportional change (percent change divided by 100) between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

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

where PSI_i is the population size index for year i and d_i is the percentage change in constant-effort numbers from year i to year i+1. A regression analysis was then run to determine the slope (*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 significant of the correlation (*P*) to describe each trend. For 13-year trends, species for which $r \geq 0.30$ are considered to have a substantially increasing trend, those for which $r \leq -0.3$ are considered to have a substantially decreasing trend, those for which absolute $r < 0.3$ and $SE \leq 0.029$ are considered to have a non-substantial and non-fluctuating trend, and those for which absolute $r \leq 0.3$ and $SE > 0.021$ are considered to have non-substantial, widely fluctuating trends. Cut-off values for substantial and fluctuating trends vary by number of years of data: the cut-off for *r* is 0.50 and that for *SE* is 0.055 for eight-year trends (at the Gin Flat East station), and the cut-off for *r* remains 0.30 and that for *SE* is 0.016 for 16-year trends (at the Hodgdon Meadow station).

Trends in Productivity, *PrT*, for all stations combined were calculated in an analogous manner by starting with actual productivity values in 1993 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.

C. Survivorship analyses – Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) were conducted on the target species using 13 years (1993-2005) 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 (*SEs*) 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.

The 13 years of data, 1993-2005, allowed 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 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. Of those models that fit the data, the one that produced the lowest Akaike Information Criterion, correcting for dispersion of data and for use with smaller sample sizes relative to the number of parameters examined ($QAIC_C$), was chosen as the optimal model (Burnham et al. 1995). Models showing $QAIC_C$'s within 2.0 $QAIC_C$ units of each other were considered effectively equivalent (Anderson and Burnham 1999). The $QAIC_C$ was calculated by multiplying the log-likelihood for the given model by -2, adding two times the number of estimable parameters in the model, and providing corrections for overdispersed data and small sample sizes.

To assess the degree of annual variation in survival for each species, we calculated $\Delta QAIC_C$ as the difference between the completely time-constant model ($\varphi p \tau$) and the model with time-dependent survival but time-constant capture probability and proportion of residents ($\varphi_t p \tau$); thus, $\Delta QAIC_C$ was calculated as $QAIC_C(\varphi_t p \tau)$-$QAIC_C(\varphi p \tau)$, with lower (or more negative) $\Delta QAIC_C$ values indicating stronger interannual variation in survival.

D. Analyses of productivity and survival as a function of mean body mass. In bird species, both productivity and survival vary with body mass: on average, the larger the bird species the lower the annual productivity and the higher the annual survival. Thus, in order to assess whether or not annual productivity or survival in a given species is higher or lower than expected, body mass needs to be accounted for. We regressed both mean productivity indices and time-constant survival-rate estimates against body mass (log transformed to normalize the values) for all target species at the five currently operating stations combined, and compared productivity indices and survival-rate estimates for individual species to the regression lines produced by these fits. We used the log of mean body mass values given by Dunning (1993). In this way we attempted to assess whether or not productivity and survival of a given species at Yosemite was as expected, lower than expected, or higher than expected based on its body mass.

RESULTS

A total of 2306.2 net-hours was accumulated at the five MAPS stations operated in Yosemite National Park in 2005 (Table 1). Data from 2070.5 of these net-hours could be compared directly to the previous year's data in a constant-effort manner.

Indices of Adult Population Size and Post-fledging Productivity
A. 2005 values. The 2005 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 2656 captures of 69 species was recorded during the summer of 2005. Newly banded birds comprised 75.1% of the total captures. The greatest number of total captures (733) was recorded at the Crane Flat station and the smallest number of total captures (305) was recorded at the Big Meadow station. The highest species richness occurred at Big Meadow (48 species) and the lowest species richness occurred at White Wolf (33 species).

The 2005 capture rates (per 600 net-hours) of individual adult and young birds and the 2005 reproductive index (number of young 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) 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 2005 was greatest at Crane Flat (231.1 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 2005 was highest at Gin Flat East Meadow (489.0 young/600 net-hours), followed by Crane Flat, Big Meadow, White Wolf, and Hodgdon Meadow (Table 3). Reproductive index (the number of young per adult) at the five stations in 2005 was greatest at Gin Flat East Meadow (3.01), followed by Big Meadow (1.45), White Wolf (1.37), Crane Flat (1.04), and Hodgdon Meadow (0.80).

Among individual species in 2005, Orange-crowned Warbler was the most frequently captured, followed by Dark-eyed Junco, Yellow-rumped Warbler, Lincoln's Sparrow, MacGillivray's Warbler, Nashville Warbler, Hermit Warbler, Song Sparrow, Golden-crowned Kinglet, Warbling Vireo, Mountain Chickadee, and Black-headed Grosbeak (Table 2). Overall, the most abundant species in 2005 (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, in decreasing order, were Dark-eyed Junco, Lincoln's Sparrow, Yellow-rumped Warbler, MacGillivray's Warbler, Warbling Vireo, Mountain Chickadee, Hermit Warbler (6.8), and Song Sparrow (6.8). The following is a list of these species (captured at a rate of at least 6.0 adults per 600 net-hours), in decreasing order, at each station in 2005 (Table 3):

White Wolf
Yellow-rumped Warbler
Dark-eyed Junco
Lincoln's Sparrow
Cassin's Finch
Pine Siskin

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

Gin Flat East Meadow
Yellow-rumped Warbler
Lincoln's Sparrow
Mountain Chickadee
Dark-eyed Junco
Western Tanager
Pine Siskin

Big Meadow
Lazuli Bunting
Wrentit
Lesser Goldfinch
Yellow Warbler
Western Wood-Pewee
Purple Finch
Cassin's Finch

Crane Flat
Dark-eyed Junco
Lincoln's Sparrow
Hermit Warbler
Warbling Vireo
Yellow-rumped Warbler
MacGillivray's Warbler
"Western" Flycatcher
Golden-crowned Kinglet
Mountain Chickadee
Dusky Flycatcher

B. Comparisons between 2004 and 2005. Constant-effort comparisons between 2004 and 2005 were undertaken at all five Yosemite National Park MAPS stations for numbers of adult birds captured (adult population size; Table 4), numbers of young birds captured (Table 5), and reproductive index (numbers of young per adult; Table 6).

Adult population size for all species pooled for all five stations combined showed a moderate and non-significant decrease between 2004 and 2005, of -10.8% (Table 4). This is very similar in magnitude to the increase of 10.7% noted between 2003 and 2004. Twenty-two of 56 species showed decreases, a proportion not significantly greater than 0.50. The change in adult population size for all species pooled showed decreases at four of the five stations, by amounts ranging from -1.0% at Hodgdon Meadow to -30.9% at Gin Flat East Meadow, but increased at Big Meadow by +3.4%. Again, these changes are remarkably similar to those observed between 2003 and 2004, but in the opposite direction. The proportion of decreasing or increasing species was not significant at any station. Significant or near-significant decreases in the number of adults captured, for all stations combined, were recorded for three species, Red-breasted Sapsucker, Northern Flicker, and Dark-eyed Junco, whereas no species showed such increases.

The number of young birds captured of all species pooled at all five stations in Yosemite National Park combined showed a slight and non-significant increase, of +5.8% between 2004 and 2005 (Table 5). Increases were recorded for 25 of 55 species, a proportion not significantly greater than 0.50. Increases were recorded at three of the five stations, by amounts ranging from +15.3% at Big Meadow to +107.1% at White Wolf , whereas declines in young captured were noted at Hodgdon Meadow (-7.5%) and Crane Flat (-25.8%), where the proportion of species showing declines was nearly significant (Table 5). Three species (Red-breasted Sapsucker, Black-throated Gray Warbler, and Wilson's Warbler) showed significant decreases in numbers of young captured across all stations, while one species (Yellow Warbler) showed such an increase.

Productivity (the reproductive index or number of young per adult) of all species pooled at all stations combined in 2005 (1.403) increased from that in 2004 (1.183) by a moderate and non-significant absolute value of +0.220 (Table 6). Nineteen of 44 species increased, a proportion not significantly greater than 0.50. Productivity increased at three of the five stations, ranging from +0.146 at Big Meadow to +1.320 at Gin Flat East Meadow, whereas it decreased at Hodgdon Meadom (-0.059) and Crane Flat (-0.185). The proportion of increasing or decreasing species was not significant at any station. Two species (White-headed Woodpecker and Pine Siskin) showed significant or near-significant decreases in productivity across stations, whereas no species showed such increases (Table 6).

Thus, breeding populations tended to decrease in 2005 as compared with those of 2004 at all stations except Big Meadow, while productivity generally showed slight changes, that were positive at White Wolf, Gin Flat East Meadow, and Big Meadow but negative at Hodgdon Meadow and Crane Flat. Except for the increases in productivity at White Wolf and Gin Flat East Meadow, these changes are opposite to those observed between 2003 and 2004, when populations decreased moderately and productivity increased markedly at all stations, with the exception of Big Meadow, where populations increased and only a slight (rather than a marked) increase in productivity was observed. As in past years we suspect that variations caused by local climate and snowpack have been a factor in these changes, although the alternating patterns suggests that a density-dependent effect is operating as well (see Discussion).

Mean Indices of Adult Population Size and Productivity
Table 7 presents mean annual numbers (per 600 net-hours) of individual adult and young birds captured, and proportions of young in the catch during a) the 13-year period (1993-2005) at White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow, as well as all stations combined, b) the eight-year period (1998-2005) for the Gin Flat East Meadow station, and c) the 16-year period (1990-2005) for Hodgdon Meadow. The all-species-pooled values at the bottom of the table indicate that 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. The 13-year mean at Hodgdon Meadow was higher than the 16-year mean there by 12.7%, indicating lower-than-average adult population sizes there during 1990-1992.

Following a different sequence, numbers of young captured were 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 White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow. Productivity at Hodgdon Meadow was slightly higher during the 13-year period (0.68) than during the 16-year period (0.64). Species richness of adults followed yet a different sequence, being highest at Big Meadow (65 species) followed by Hodgdon Meadow (55), Gin Flat East Meadow (45), Crane Flat (44), and White Wolf (40), and thus showing a general decrease with increasing elevation. The most abundant species at MAPS stations in Yosemite over the 13-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 13-year mean number of adults captured per 600 net-hours was 211.1 and the mean reproductive index was 0.80.

Multi-year Trends in Adult Population Size and Productivity
"Chain" indices of adult population size are presented for target species and for all species pooled, at each of the five stations individually and for the five currently operating stations combined, in Figures 1-7. For the five stations combined (Fig. 1), White Wolf (Fig. 2), Crane Flat (Fig. 4), Hodgdon Meadow (Fig. 5), and Big Meadow (Fig. 7) we show 13-year trends (1993-2005); for Gin Flat East Meadow we show eight-year trends (1998-2005; Fig. 3); and for Hodgdon Meadow we additionally show 16-year trends (1990-2005; Fig. 6). 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.

Thirteen-year (1993-2005) population trends for 26 species and all species pooled at the five currently operating stations combined are shown in Figure 1. Populations of 14 species as well as all species pooled showed substantial declining trends ($r \leq -0.3$ for a 13-year trend). Substantial declines for Dusky Flycatcher, Chipping Sparrow, Black-headed Grosbeak, Lazuli Bunting, and all species pooled were highly significant; those for Western Wood-Pewee, Hammond's Flycacther, Golden-crowned Kinglet, Yellow Warbler, Hermit Warbler, and Purple Finch were significant; and those of Red-breasted Sapsucker, Warbling Vireo, Hermit Thrush, and Dark-eyed Junco were not significant. In contrast, populations of only four species, (Mountain Chickadee, Yellow-rumped Warbler, MacGillivray's Warbler, and Western Tanager) showed substantial increasing trends ($r \geq 0.3$). The increasing trend was highly significant for Mountain Chickadee, significant for Western Tanager, and nearly significant for the other two species. Populations of the remaining eight species (Cassin's Vireo, Brown Creeper, American Robin, Song Sparrow, Lincoln's Sparrow, Cassin's Finch, Pine Siskin, and Lesser Goldfinch) showed non-substantial (absolute $r < 0.3$) and substantially fluctuating (SE of the slope ≥ 0.021) trends. Overall, 19 of the 26 species showed negative trends, two trends were flat (American Robin and Lincoln's Sparrow), and only five showed positive trends. The 13-year trend for all species pooled represented a substantial and highly significant ($P = 0.002$) decrease of -2.0% per year, suggesting that total populations of landbirds in Yosemite have been reduced by 23% over the 13-year period (1993-2005).

At White Wolf (Fig. 2), populations of Yellow-rumped Warbler, Dark-eyed Junco, and all species pooled showed non-substantial and highly-fluctuating 13-year trends. Trends of both target species were positive whereas that of all species pooled was negative and indicated an annual decrease of -1.8% per year. At Gin Flat East Meadow (Fig. 7), three of 10 species as well as all species pooled showed substantial positive eight-year trends ($r > 0.5$), with that of Mountain Chickadee being significant and those of American Robin and Lincoln's Sparrow being nearly significant, whereas no species showed substantial negative trends. Populations of all species pooled increased by 5.8% per year. At Crane Flat (Fig. 4), 13-year population trends for six of nine species as well as all species pooled were substantially negative. Declines were significant for Warbling Vireo, Golden-crowned Kinglet, Hermit Warbler, and Lazuli Bunting

and nearly significant for all species pooled. The population of only one species, Yellow-rumped Warbler, was substantially but non-significantly positive. Overall, nine of 10 species showed negative trends and that of all species pooled showed an annual decline of -1.9%. At Hodgdon Meadow (Fig. 5), 13-year population trends for five of 15 species as well as all species pooled were substantially negative. These declines were significant for Dusky Flycatcher and all species pooled and nearly-significant for Lincoln's Sparrow. Population trends for three two species, Yellow-rumped Warbler and Song Sparrow, were substantially and significantly positive. Trends for eight of the 15 target species were negative and that of all species pooled indicated a decline of -1.5% per year. Sixteen-year trends at Hodgdon (Fig. 6) were more positive (or less negative) than 13-year trends for 12 of the 15 species and all species pooled. Only Western Wood-Pewee, Yellow-rumped Warbler, and Purple Finch had less positive or more negative 16-year than 13-year trends. These patterns indicate that population sizes for most species at Hodgdon Meadow in 1990-1992 were lower than what would be expected from the subsequent 13-year trend, as also observed when comparing means (Table 7). The 16-year trend for all species pooled at Hodgdon Meadow was essentially flat. At Big Meadow (Fig. 6), four of seven species showed substantial negative trends, with those of Song Sparrow, Black-headed Grosbeak, and Lazuli Bunting being highly significant. No species showed a substantial positive trend. Five of the seven target species showed negative trends and the trend for all species pooled indicated a highly significant decrease of -5.7% per year.

"Chain" indices of productivity for each of the 13 years (1993-2005) are shown in Figure 8 for 26 target species and all species pooled at all five stations combined. Six species (Cassin's Vireo, Brown Creeper, Hermit Thrush, Chipping Sparrow, Cassin's Finch, and Lesser Goldfinch) showed substantially declining productivity trends ($r \leq -0.30$), which were significant for Cassin's Vireo and Lesser Goldfinch. Twelve species as well as all species pooled showed substantially increasing productivity trends ($r \geq 0.30$); these were highly significant for Yellow Warbler, Black-headed Grosbeak, and Lazuli Bunting; significant for Red-breasted Sapsucker, Mountain Chickadee, American Robin, Yellow-rumped Warbler, and all species pooled; nearly significant for Hammond's Flycatcher, Hermit Warbler, and Purple Finch; and not significant for Lincoln's Sparrow and Pine Siskin. The remaining eight species (Western Wood-Pewee, Dusky Flycacther, Warbling Vireo, Golden-crowned Kinglet, MacGillivray's Warbler, Western Tanager, Song Sparrow, and Dark-eyed Junco) showed non-substantial productivity trends. Overall, 16 of the 26 target species had positive productivity trends and 10 had negative productivity trends. The productivity trend for all species pooled indicated an average annual increase of 0.022 per year.

Thus, in summary, populations of adults of all species pooled at the five currently operating stations combined at Yosemite National Park have shown a substantial and highly significant 13-year decline of -2.0% per year (-23% over the 13-year period), whereas productivity of all species pooled has shown a substantial and significant 13-year increase of +0.022 per year. Population trends for all species pooled over the 13-year period were negative at all four stations, and were substantial at all but White Wolf, nearly significant at Crane Flat, significant at Hodgdon Meadow, and highly significant at Big Meadow. Annual percent declines varied from -1.5% at Hodgdon Meadow to -5.7% at Big Meadow. Similarly, adult populations of 19 of 26 target species at the five currently operating stations combined (and 24 of 34 target species at

individual stations) have shown declining 13-year trends, while productivity trends at the five currently operating stations combined showed more increases (16 species) and decreases (10 species). The eight-year population trends at Gin Flat East Meadow and the 16-year trends at Hodgdon Meadow were more positive than the 13 year trends because they covered different time periods.

Relationships of Population Trends, Productivity, and Elevation
To investigate the relationships among 13-year (1993-2005) population trends with elevation and reproductive indices, we modeled, for all species pooled at the four long-running stations: (**A**) the annual percentage change in adult population size (*APC*; see Fig. 1), (**B**) the direction and strength of the correlation between adult population size and year (*r*; see Fig. 1), and (**C**) the mean reproductive index (see Table 7) as functions of elevation; and (**D**) *APC* and (**E**) *r* as functions of mean reproductive index. The five graphs in Figure 9 indicate that population trends for all species pooled (Figs. 9**A** and 9**B**) became increasingly (and near-significantly for *r*) positive as elevation increased, from Big Meadow to White Wolf. Mean productivity showed the same (significant) relationship (Fig. 9**C**), which in turn resulted in population trends correlating positively (but non-significantly) with productivity (Figs. 9**D** and 9**E**). These correlations suggest that the negative population trends at Yosemite, that became more negative at lower elevations, were likely driven by low productivity, which also became lower at lower elevations.

Productivity-Population Correlations
To see if productivity in a given year has had a direct effect on breeding population size the following year, we regressed the proportional change in the number of adults between year *i*+2 and year *i*+1 on the absolute change in productivity between year *i*+1 and year *i* for 27 target species and all species pooled from all five stations in Yosemite National Park over the 13 years 1993-2005 (Fig. 10). The slopes and r-values in Figure 10, hereafter termed "productivity-population correlations", are used as indicators of the strength of this relationship. The productivity-population correlation was positive for 16 of 27 species. Eleven species showed substantial positive correlations ($r \geq 0.3$): Hammond's Flycatcher, Warbling Vireo, Mountain Chickadee, Hermit Thrush, American Robin, Hermit Warbler, MacGillivray's Warbler, Western Tanager, Lincoln's Sparrow, Lazuli Bunting, and Purple Finch; these were significant or near-significant for Hammond's Flycatcher, Hermit Thrush, Lincoln's Sparrow, and Lazuli Bunting. It is likely that productivity on the breeding grounds is a contributing factor determining population fluctuation in these species. Of the remaining 11 species, only one, Golden-crowned Kinglet, showed a substantial and nearly significant negative correlation. Overall, these results support the concept that changes in productivity one year tend to correspond to changes in population size the next year for some species, but suggest that other factors besides productivity must be involved to bring about the observed annual changes in population size of other species.

Estimates of Adult Survivorship
Using 13 years of data (1993- 2005) from all five stations, we were able to obtain estimates of adult survival and recapture probabilities using transient models for 30 species breeding in Yosemite National Park (Tables 8-9). Table 8 indicates that the fully time-constant model ($\varphi p \tau$) was selected over all time-dependent models for 27 of the 30 species, which had an Akaike

Information Criterion ($QAIC_C$) value or the fully time-constant model that was at least 2.0 $QAIC_C$ units lower than that for any other model. For Warbling Vireo, a model detecting time-dependence in proportion of residents was the selected model; for Lincoln's Sparrow, a model detecting time dependence in recapture probability was the selected model; and for Dark-eyed Junco, models detecting time-dependence in survival and recapture probability were equivalent to the time-constant model. The high positive $\Delta QAIC_C$ values (> 7.0 for 28 of the 30 species) suggest that little interannual variation in survival exists for most of the species. Only for Lincoln's Sparrow (+3.10) and Dark-eyed Junco (-0.60) did the $\Delta QAIC_C$ value indicate substantial time-dependence in survival.

In Table 9, we present the maximum-likelihood time-constant estimates of annual adult survival, recapture probability, and proportion of residents, as well as the maximum-likelihood estimates for these parameters from the selected or equivalent time-dependent models identified in Table 8. Estimates of annual adult survival rate for the 30 species, using the time-constant model, ranged from a low of 0.206 for Purple Finch to a high of 0.791 for Cassin's Finch, with a mean of 0.493. Recapture probability varied from a low of 0.010 for Cassin's Finch to a high of 0.679 for Black Phoebe, with a mean of 0.304. Proportion of residents varied from a low of 0.114 for Hammond's Flycatcher to a high of 1.000 for seven species (Table 9), and averaged 0.613. The precision of these survival estimates continues to improve, even after 13 years of data have been collected, although the rate of improvement may be leveling off. For the same 30 species, $CV(\varphi)$ was lower (i.e., the estimate of φ was more precise) using 13 years of data (1993-2005) than using 12 years of data (1993-2004) for 22 species. The mean $CV(\varphi)$ for the 30 species improved from 26.7% using 12 years of data (DeSante et al. 2005b) to 26.0% using 13 years of data.

The estimated survival estimate for adults at Yosemite (1993-2005) appears to be relatively good compared with values for the Northwestern MAPS region as a whole (1992-2001; see http://www.birdpop.org/nbii/surv/default.asp). Survival at Yosemite was higher than that of the Northwest Region for 20 of 29 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 29 species at Yosemite (0.495) was 4.2% higher than that of the Northwest Region (0.475). 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, whereas only 5 species (Dusky Flycatcher, Mountain Chickadee, Yellow-rumped Warbler, Red-winged Blackbird, and Purple Finch) showed substantially lower survival at Yosemite.

For Warbling Vireo, proportion of residents was relatively high (> 0.5) in 1993-1995, 1997, and 1998; and it was relatively low (< 0.2) in 1996 and 1999-2004. As of yet we have no explanation for inter-annual variation in proportion of residents, although the apparent shift from high values to low values throughout the 13 years of the study is of interest. Recapture probability for Lincoln's Sparrow was relatively high (> 0.65) in 2000-2002 and 2004-2005, and relatively low (<0.4) in 1995-1996, and 1998; and recapture probability for Dark-eyed Junco was relatively high (> 0.6) in 1994, 1996, and 2003-2004; and it was relatively low (<0.4) in 1995 and 2001. We also have no explanation, as yet, for the causes of time dependence in recapture

probability. For Dark-eyed Junco survival was relatively high (> 0.55) during the winters of 1995-1996, 2002-2003, and 2003-2004; and it was relatively low (< 0.4) during the winters of 1994-1995, 1997-1998, 1998-1999, 2000-2001, and 2004-2005. We suspect that these differences reflect differences in weather and food availability the Pacific slope of California, where this species winters.

Productivity and Survival as a Function of Body Mass
It has previously been shown that both productivity and survival of birds vary with body mass: on average, the larger the bird the lower the productivity and the higher the survival. Thus, in order to assess whether or not productivity or survival in a given species is higher or lower than expected, body mass needs to be accounted for. Figure 11 shows mean productivity indices and time-constant annual adult survival rate estimates recorded at Yosemite National Park as a function of mean body mass (log transformed) for 20 target species for which 13-year population trends could be calculated and relatively more precise survival estimates (≥ 5 between-year returns, $SE(\varphi) \leq 0.2$, and $CV(\varphi) \leq 50\%$) were obtained. The purpose of this analysis was to determine which species at Yosemite showed higher or lower productivity or survival than might be expected given their body mass. Two regression lines are presented on each graph, one (solid) for the 20 target species using data from Yosemite National Park, and one (dashed) using data from 210 (productivity) and 89 (survival) species for which these parameters could be estimated from MAPS data collected from stations distributed across the entire North American continent. For both productivity (Fig. 11**A**) and survival (Fig. 11**B**), the regression lines based on data from the 20 species at Yosemite were fairly similar to those based on data from North America as a whole, although productivity of smaller species generally appeared to be higher at Yosemite than in North America as a whole, resulting in a steeper (and significant) slope to the correlation with body mass.

Twelve of the 20 species shown in Figure 11 (species alpha codes in bold uppercase letters) showed substantial population declines (Figure 1). Seven of these 12 species, Western Wood-Pewee (**WEWP**), Dusky Flycatcher (**DUFL**), Warbling Vireo (**WAVI**), Hermit Thrush (**HETH**), Yellow Warbler (**YWAR**), Chipping Sparrow (**CHSP**), and Lazuli Bunting (**LAZB**), each showed lower-than-expected productivity, at least as compared to the relationship between productivity and body mass at Yosemite. Six of the seven species (all but Hermit Thrush) showed near-expected or better-than-expected adult survival. For these species it appears that low productivity at Yosemite is the major contributing factor to population declines in the park. Hermit Thrush showed an adult survival rate that was slightly lower than expected, indicating that low adult survival may also be contributing to its decline. Two species, Red-breasted Sapsucker (**RBSA**) and Golden-crowned Kinglet (**GCKI**), showed lower-than-expected survival but better-than-expected productivity, suggesting that low survival is the major factor contributing to their population declines. The remaining three species, Hermit Warbler (**HEWA**), Dark-eyed Junco (**DEJU**), and Black-headed Grosbeak (**BHGR**), showed as-expected or better-than-expected values for both productivity and adult survival, suggesting that other factors (low first-winter survival or low recruitment) may be contributing to their population declines.

Four of the 20 species (shown in Figure 11 in non-bold uppercase letters) showed substantial population increases (Figure 1). Mountain Chickadee (MOCH), showed near-expected productivity (higher than expected when compared to that of North America as a whole) but lower-than-expected survival, and Yellow-rumped Warbler (YRWA) showed higher-than-expected productivity and slightly lower-than-expected survival, suggesting that good productivity at Yosemite is contributing to the population increases of these species (although productivity of cavity-nesting species such as Mountain Chickadee is generally higher than expected and survival lower than expected in relation to body mass). MacGillivray's Warbler (MGWA) showed slightly higher-than-expected survival and slightly lower-than-expected productivity, and Western Tanager (WETA) showed high survival and expected productivity, suggesting that good survival, probably away from Yosemite, is contributing to the population increases of these species.

The remaining four species (shown in Figure 11 in non-bold lowercase letters) had non-substantial (and often widely fluctuating) population trends over the 13 years at Yosemite (see Fig. 1). Two of these species, Brown Creeper (brcr) and Song Sparrow (sosp), showed higher-than expected productivity and near-expected adult survival, suggesting that some other factor (low first-winter survival or low recruitment) may be counterbalancing the high productivity. The remaining two species, American Robin (amro) and Lincoln's Sparrow (lisp), showed near-expected productivity and survival values, which is an expected outcome in species with non-substantial population trends.

Causes of Population Declines and Increases Based on Demographic Data
Based on all of the above demographic data, we made assessments as to whether Yosemite population declines or increases were driven by productivity on the breeding grounds, adult survival presumably during migration and/or on the winter grounds, both, or neither (Table 10). Assessments for each species were based on a synthesis of productivity indices, productivity trends, survival estimates, $\Delta QAIC_C$ values, and productivity and survival values relative to body mass, and survival rates relative to those in the Northwestern MAPS region as a whole. As an example, for Dusky Flycatcher, a highly significantly decreasing species (Fig. 1) that also decreased at both stations at which it was a target species, Crane Flat (Fig. 3) and Hodgdon Meadow (Figs. 4 and 5), reproductive index was very low (0.14) based on the 13-year mean for all stations pooled (Table 7) and in comparison with body mass (Fig. 11); the productivity trend was flat (Fig. 8); the productivity-population correlation was slightly positive (Fig. 10); survival (0.425; Table 9) was near-expected in comparison with body mass (Fig. 11) and 12% lower than that in the Northwestern MAPS region as a whole; and $\Delta QAIC_C$ was relatively high (+11.0; Table 8). In this case, all evidence suggests that low and decreasing productivity, rather than low survival, has been driving the significant population decrease for Dusky Flycatcher. As another example, for Yellow-rumped Warbler, a substantially increasing species at Yosemite overall (Fig. 1) as well as at Crane Flat (Fig. 3), Hodgdon Meadow (Fig. 4), and Big Meadow (Fig. 6), reproductive index (0.50; Table 7) was higher than expected in comparison with body mass (Fig. 11); the productivity trend was substantially increasing (Fig. 8); the productivity-population correlation was positive (Fig. 10); survival (0.360; Table 9) was lower than expected in comparison to body mass (Fig. 11) and was 39% lower than that recorded in the Northwestern MAPS region; and $\Delta QAIC_C$ was relatively high (+10.10; Table 8). Here, most or all of the

evidence suggests that high productivity, rather than high survival, has been driving the population increase for Yellow-rumped Warbler at Yosemite.

Using this approach, we suggest that lower-than-expected productivity may be driving 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 (Table 10). Low survival may also be contributing to the population decline of Hermit Thrush. Productivity for both Yellow Warbler and Lazuli Bunting is increasing so we might expect to see populations for these species rebounding in the future. The population decreases in Red-breasted Sapsucker and Golden-crowned Kinglet appear to be due primarily to low survival, although we note that survival of Golden-crowned Kinglet was higher at Yosemite than in the Northwestern MAPS region as a whole and that of Red-breasted Sapsucker was close to the regional value. For the remaining three declining species, Hermit Warbler, Dark-eyed Junco, and Black-headed Grosbeak, both productivity and survivorship were near-expected or higher than expected. We can only surmise that other factors not currently measured by MAPS (e.g., low intrinsic recruitment due to habitat degradation outside the Park, or low first-winter survival rates) are causing the population declines.

It also appears that higher-than-expected or as-expected productivity may be more of a factor in the population increases for Mountain Chickadee and Yellow-rumped Warbler than adult survival, whereas higher survival may be driving increases in MacGillivray's Warbler and Western Tanager (Table 10). Thus, overall, it appears that productivity at Yosemite is driving or contributing to the population dynamics of seven of the eleven declining species and two of four increasing species, whereas survival appears only to be contributing to the declines of three species and the increases of two species.

DISCUSSION AND CONCLUSIONS

Annual Changes in Adult Population Size and Productivity
Breeding populations in Yosemite National Park decreased by a non-significant 10.8% in 2005 as compared with those of 2004, with decreases recorded at all stations except Big Meadow. This is exactly opposite to changes recorded between 2003 and 2004, both overall and at each station. Productivity showed slight changes, that were positive at White Wolf, Gin Flat East Meadow, and Big Meadow but negative at Hodgdon Meadow and Crane Flat. This followed wide-scale increases recorded between 2003 and 2004, which could be a positive sign for bird populations at Yosemite.

Many MAPS stations across the continent show consistent alternating cycles of population increases and decreases, with out-of-phase decreases and increases in productivity. These alternating out-of-phase patterns are apparently caused by density-dependent effects on productivity and recruitment along with lower productivity of first-time breeders, and are typically reflected by positive productivity-population correlations. Such alternating out-of-phase patterns in population size and productivity have been seen at Yosemite during certain years, for example between 1996 and 2001 (DeSante et al. 2004), but are much more characteristic of other MAPS locations than Yosemite. For instance, 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, 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, than in areas where weather is more predictable year-round. Despite the 13 years of data now available over an elevation gradient at Yosemite National Park, there appears to be an additional dynamic involving density-independent, inter-annual recruitment probabilities that are related to climate, weather, and snowpack variables, and that likely affect one-year-old and adult birds differently, that we do not as yet understand. Clearly, the large magnitude of the weather perturbations (both regarding the extent of and timing of snowmelt as well as summer precipitation and temperatures) that affect montane environments, and the complex effects these perturbations likely have on avian population dynamics, means that long, consistent runs of monitoring data will be necessary to understand the causes of both short-term and long-term changes in Sierran bird populations. In the future, given adequate funding, we hope to undertake more detailed analyses and modeling of climate and recruitment rates of both one-year-old and adult birds, so as to more fully understand this dynamic at Yosemite.

Population and Productivity Trends of Yosemite's Birds
Populations of adult birds of all species pooled at MAPS stations in Yosemite National Park have shown a substantial and highly significant decrease of -2.0% per year over the 13 years,

1993-2005. While this may not seem to be a large annual decline, when compounded over 13 yields it represents a 23% decline. Thirteen-year population trends were negative at all four long-running stations, and were nearly significant at Crane Flat and significant at Hodgdon Meadow and Big Meadow, with annual percent declines ranging from -1.5% at Hodgdon Meadow to -5.7% at Big Meadow. Adult populations of 19 of 26 target species (and 24 of 34 target species at individual stations) showed declining 13-year trends. Substantial declines were shown by 14 species: Red-breasted Sapsucker, Western Wood-Pewee, Dusky Flycatcher, Hammond's Flycatcher, Warbling Vireo, Golden-crowned Kinglet, Hermit Thrush, Yellow Warbler, Hermit Warbler, Chipping Sparrow, Dark-eyed Junco, Black-headed Grosbeak, Lazuli Bunting, and Purple Finch. In contrast, populations of only four species showed substantial increasing trends: Mountain Chickadee, Yellow-rumped Warbler, MacGillivray's Warbler, and Western Tanager.

Comparison of long-term population trends at Yosemite with long-term BBS trends from the Sierra Nevada physiographic strata (see http://www.mbr-pwrc.usgs.gov/bbs/bbs.html) suggests that these dramatic declines for most landbird species in Yosemite are part of a Sierra-wide decline (DeSante et al. 2004). Supporting this latter result, a comparison between the 41 species with population-size changes between 1991-1993 and 2001-2004, at both Yosemite and Sequoia/Kings Canyon, revealed that 28 showed changes in the same direction at both Yosemite and Sequoia/Kings Canyon and only 13 showed changes in the opposite direction (DeSante et al. 2005c).

In contrast to populations trends, trends of productivity showed a substantial but non-significant 13-year increase of +0.022 per year when all species were pooled. More species showed increases (16) and decreases (10). For most species and all species pooled, productivity was very low during the summer of 2003, but recovered markedly during the 2004 breeding season when the numbers of young birds captured of all species pooled increased by 136% over 2003 and productivity (the reproductive index, young/adult), increased by 113.5% over 2003. The cause of these huge differences in productivity at Yosemite is not entirely clear, although the roughly average snowpack present during the winter of 2003-04 reached its peak about March 1 whereas in 2002-03 it didn't reach its peak until about May 15. Snowpack in 2005 was again roughly average, and productivity increased further over that of 2004. This suggests that birds in Yosemite are best adapted for average snowpack levels, and that snowpack has a large correlation with reproductive success. In future years we will analyze snowpack levels against population sizes and productivity to attempt a better understanding of these relationships.

In previous analyses we have also found a weak relationship between annual productivity for all species pooled at Yosemite and the El Niño/Southern Oscillation (ENSO), such that productivity tended to be higher during El Niño years, such as 2004-2005 when a weak El Niño was followed by a year of El-Niño-like weather. Although productivity tends to be higher at higher elevations and during warm wet El Niño years, 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. This could explain the fact that increased productivity

between 2003 and 2004 did not lead to higher breeding populations in 2005, except at Big Meadow, where moister conditions may lead to higher populations and productivity.

Overall, declining population trends coupled by 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 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. In order to investigate the role of productivity in driving population trends at Yosemite, additional results need to be considered.

Of concern are significant or highly significant declines in three species of flycatchers, Western Wood-Pewee, Hammond's Flycacther, and Dusky Flycatcher. These declines follow on the heels of dramatic declines (documented elsewhere) in two other species, Olive-sided and Willow flycatchers. The only species of flycatcher that seems not to be declining according to MAPS data is "Western" Flycatcher (in Yosemite, consisting primarily of the locally breeding Pacific-slope Flycacther but also possibly including some roaming Cordilleran Flycatchers from the eastern side of the Sierra). Although we could not calculate population trends for "Western" Flycatchers (because none were captured in 1993) general inspection of the data suggests a non-substantial (but fluctuating) trend overall but an increase at Crane Flat, where it appears to have supplanted Dusky Flycatcher. We have no immediate explanation for the declines of flycatchers at Yosemite although a long-term decline in insect resources and/or an increase in cowbird parasitism are problems elsewhere for flycatchers and could be factors at Yosemite.

Demographics of Yosemite's Birds Along an Elevation Gradient
Thirteen years (1993- 2005) of data from four MAPS stations (and eight years from a fifth) along an elevation gradient on the west slope of the Sierra Nevada in Yosemite National Park have shown that species richness (number of species), total adult population size, productivity, and adult population trend each varied with elevation in a unique way. Total richness of breeding species was highest at the lowest elevation (Big Meadow – 64 species), lowest at the highest elevation (White Wolf Meadow – 40 species), and clearly decreased with increasing elevation. In marked contrast to total species richness, mean annual number of adults of all species pooled (essentially an index of total bird density) was highest at intermediate elevations (Crane Flat) and decreased progressively both at lower (Hodgdon and Big Meadows) and higher (Gin Flat East and White Wolf) elevations.

In further contrast, mean annual productivity for all species pooled was highest at still higher elevations (Gin Flat East) and, again, decreased progressively both at lower (Crane Flat, Hodgdon Meadow, and Big Meadow) and higher (White Wolf) elevations. Excluding Gin Flat East, which has only been operated for eight years, productivity showed a positive correlation with elevation. Station-specific, 13-year population trends for all species pooled also correlated positively with elevation; e.g., the trend was non-significantly negative at White Wolf but significantly negative at Big Meadow. These correlations suggest that the increasingly negative population trends at lower elevation stations may have been driven by the increasingly lower

productivity at those same stations, especially during drought years with meager snowpacks.

Survival Rates of Yosemite's Birds
We were able to obtain estimates of annual adult survival for 30 target species at Yosemite using 13 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. The addition of a thirteenth year was no exception, although the increase in precision was smaller and with a lower proportion of the species than in previous years, suggesting that it is leveling off. These results suggest that maximum precision may not be obtained until more 13-15 years of data are available; Rosenberg (1996) and Rosenberg et al. (1999) suggested that precision should level off after 12 years of data have been collected. $\Delta QAIC_C$ values were relatively high (> 7.0) in all but two (Lincoln's Sparrow and Dark-eyed Junco) of these 30 species, suggesting that there is relatively little interannual variation in survival for most Yosemite species.

The estimated annual adult survival rates at Yosemite (1993-2005) appear to be relatively good 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 (0.495) that was 4.2% higher than that of the Northwest Region (0.475). 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. It is possible that the generally lower survival rates observed at Sequoia/Kings Canyon may relate to local stressors acting on the breeding grounds which can affect annual survival of adults.

Causes of Population Changes in Yosemite's Birds
Based on all demographic data, 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. 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, 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, whereas survival away from Yosemite is only driving or influencing trends in five species. This indicates that the population dynamics of most of Yosemite's breeding species are being affected by events in Yosemite National Park, and could be within the Park's ability to influence through management action.

Future Analyses
We cannot estimate first year survival with current MAPS analyses. This is because young birds typically disperse substantial distances from their natal site to their site of first breeding, resulting in very few or no recaptures of birds banded as juveniles. In future analyses we hope to be able to index first year survival by using data on species for which we can identify both one-year-old (second-year; SY) and older (after-second-year; ASY) birds in spring and using CJS mark-recapture models to estimate annual recruitment of both SY and ASY birds. Then, by comparing spatial and temporal patterns of productivity and recruitment of SY and ASY birds, we will be able to make inferences regarding first year survival rates as well as amounts of immigration and emigration in the populations. Once these analyses have been performed, we will be able to examine patterns in adult and first year survival rates according to geographic location, climate, and habitat considerations, and to identify species (e.g., declining species at Yosemite that do not show deficient productivity or adult survival, such as Hermit Warbler, Dark-eyed Junco, and Black-headed Grosbeak) for which declines may be driven by low first year survival and/or a declining recruitment rate.

In two more years, when we will have 15 consecutive years of data from each of the four long-running stations, we hope to perform many of these park-wide analyses at the spatial scale of the four individual stations. This may yield especially important results at Yosemite, where the stations span such a significant elevation range and the population dynamics appear to be influenced by elevation. Once these analyses have been completed we will be able not only to identify the effects of elevation on various demographic processes, but also identify species that are declining based on poor productivity at each station (or within each of the parks elevation regimes), and make recommendations for management of these species accordingly.

We have recently initiated additional broad-scale analyses to help us further understand the population dynamics of landbirds and potential management actions to assist bird populations. First, by modeling spatial variation in vital rates as a function of spatial variation in population trends we are beginning to determine the proximate demographic causes of population trends for various species on both continental and regional spatial scales (DeSante et al. 2001). Analyses of spatial variation in productivity and survival as a function of spatial variation in population trends appear to be very effective in understanding causes of population declines. We hope to undertake such analyses (e.g., between Sierra stations within and outside of Yosemite) sometime in the future, when we will have accumulated about 15 years of data.

Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area around each station are good predictors not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well (Nott 2000). For Wilson's Warblers in Pacific Northwest national forests, for example, we found that the amount of deciduous forest cover (in otherwise coniferous forest matrices), within two km of the stations, correlated positively and highly significantly with breeding population size, but non-significantly with productivity, indicating that increasing the deciduous component of these forests can increase adult population size without compromising productivity. These types of analyses provide extremely powerful tools to identify and formulate management actions aimed at reversing declining populations and maintaining stable or increasing populations of landbirds,

because they can address the particular vital rate responsible for the decline. We plan to conduct similar analyses for the target species in the Sierra, by modeling productivity as a function of various landscape characteristics that vary along a gradient from the pristine landscapes found in Yosemite National Park to the much more heavily managed landscapes on Sierran national forests where we also have MAPS stations. Again, given adequate funding, we plan to conduct such analyses after we have accumulated about 15 years of data.

One important objective of the MAPS Program in relatively pristine protected areas such as large national parks like Yosemite is to provide control data on the vital rates of landbird species in order to aid the identification of generalized management guidelines and the formulation of specific management actions that can be implemented to reverse the population declines of focal or priority landbird species and to maintain the populations of stable or increasing species. The identification and formulation of these management guidelines and actions are to be achieved by modeling the vital rates (productivity, adult survival, first-year survival, and/or recruitment rates) of the various landbird species as a function of landscape-level and elevation-specific habitat characteristics along with spatially explicit weather variables. Management strategies will subsequently involve efforts to modify habitat characteristics from those associated with low productivity or recruitment to those associated with high productivity or recruitment (for species for which low productivity or recruitment is driving the population decline). We are currently in our third year of implementing such guidelines and actions on eight military installations in Eastern North America, and beginning the first such year on six national forests in the Pacific Northwest.

Because of the pronounced elevation factor at Yosemite, and the complex effects of weather on population size and productivity, we will need to incorporate elevation-specific habitat analyses and account for weather on an annual basis. Elevation effects on adult population size appear to reflect the effects of dry years (greater population sizes at higher elevations due to lack of snow pack and warmer temperatures) vs. wet years (greater population sizes at lower elevations due to higher levels of food resources and cooler temperatures). Thus, landscape-level analyses at Yosemite will necessarily involve interactions between elevation and weather as well as habitat characteristics. It is the complexity of these interactions that create the need for long-term data.

Conclusions
Analyses of 13 years of MAPS data from four stations along an elevation gradient in Yosemite National Park, plus eight years of data from a fifth station, have shown that bird populations in Yosemite have decreased significantly over the 13 years with substantially more species decreasing than increasing. These data have also shown that species richness, total bird density, productivity, and population trends all vary with elevation in generally different ways. We have also demonstrated how MAPS data can be used to measure and assess the effects of productivity and survivorship as driving forces for the varying avian population trends documented in Yosemite National Park, both overall and at the individual species level. In future analyses, we hope to include estimates of first-year and adult recruitment and indices of first-year survival in order to more fully understand what parameters are most affecting population changes in each target species.

This report demonstrates that the indices and estimates of primary demographic parameters produced by the Yosemite MAPS Program are providing critical information that will be extremely useful for the management and conservation of landbirds in the Sierra Nevada and, in combination with similar data from other areas, across the whole of North America. The results highlighted above have also revealed that the population dynamics of the breeding birds of Yosemite National Park are complex, as are the likely causes of the dynamics and, for those trends deemed problematic, their solutions. This complexity, in turn, underscores the importance of standardized, long-term data. Once 15 years of data have accumulated and the precision of our estimates improves further, and both short- and long-term trends are more clearly established, we will be able to incorporate weather and climate data as well as landscape-level habitat data as additional co-variates in logistic regression analyses of productivity and in survivorship models. We believe that, with these additional years of data, we will be able to further our understanding of the population dynamics of Yosemite's birds and shed more light on the complex paths leading from stressors to population responses.

Results from the first 13 years of the MAPS Program in Yosemite National Park (16 years at the Hodgdon Meadow station), as documented in this report, indicate that meaningful station-specific indices of adult population size and post-fledging productivity, precise park-wide estimates of annual survival rates of adults, and important information on annual changes, longer-term trends, and elevation differences in these indices and estimates are being obtained for up to 30 target species. We conclude that the MAPS protocol is very well-suited to provide a critical component of the Park Service's Long-Term Ecological Monitoring program in Yosemite National Park. Based on the above information, we recommended that the operation of the five MAPS stations currently active in Yosemite National Park be sustained indefinitely into the future, and a comprehensive analysis of all Sierran MAPS data (including Yosemite's) be conducted after 15 years of data have been accumulated, that is, depending on the availability of additional funding for these analyses, after the 2007 field season.

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Table 1. Summary of the 2005 MAPS program in Yosemite National Park.

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	Station						2005 operation		
Name	Code	No.	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours[1]	No. of periods	Inclusive dates
White Wolf	WHWO	11904	Wet montane meadow, red fir/ lodgepole pine forest	37°52'10"N,-119°39'08"W	2402	386.2 (330.7)	7	7/03 - 8/08
Gin Flat East Meadow	GFEM	11980	Wet montane meadow, mixed fir forest	37°45'59"N,-119°45'37"W	2073	380.3 (375.7)	7	6/24 - 8/07
Crane Flat	CRFL	11907	Wet montane meadow, willow/ aspen thickets, mixed coniferous forest	37°45'20"N,-119°48'13"W	1875	457.0 (417.0)	8	6/02 - 8/06
Hodgdon Meadow	HODG	11107	Wet montane meadow, willow/ dogwood thickets, mixed oak and coniferous forest	37°47'41"N,-119°51'50"W	1408	654.7 (576.3)	8	5/25 - 8/03
Big Meadow	BIME	11905	Riparian willows, mixed coniferous forest, open dry meadow	37°42'16"N,-119°45'07"W	1311	428.0 (370.8)	8	5/27 - 8/04
ALL STATIONS COMBINED						2306.2 (2070.5)	8	5/25 - 8/08

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[1] Total net-hours in 2005. Net-hours in 2005 that could be compared in a constant-effort manner to 2004 are shown in parentheses.

Table 2. Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2005. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	White Wolf N	U	R	Gin Flat East Meadow N	U	R	Crane Flat N	U	R	Hodgdon Meadow N	U	R	Big Meadow N	U	R	All five stations combined N	U	R
Mountain Quail											1			2			3	
California Quail														1			1	
Anna's Hummingbird					3			2			2			3			10	
Calliope Hummingbird		1									1						2	
Rufous Hummingbird		5			2			5			2			3			17	
Unidentified Hummingbird		2			6			7			14	1		13			42	1
Williamson's Sapsucker	1															1		
Red-breasted Sapsucker				2		1	2		2	5		4				9		7
Downy Woodpecker										1			1			2		
Hairy Woodpecker				1			1						1			3		
White-headed Woodpecker				1			1									2		
Northern Flicker	1			1		1										2		1
Western Wood-Pewee	2			4			1			1		1	6		3	14		4
Hammond's Flycatcher	2			5			3			1						11		
Dusky Flycatcher	6			6			10		3	1		1	1			24		4
"Western" Flycatcher	5			7			12		1	12		1	1			37		2
Unidentified Empid. Flycat.		1						1			2			1			5	
Black Phoebe				1									6			7		
Ash-throated Flycatcher													1			1		
Cassin's Vireo	1			1			2	2	2	4			3			11	2	2
Hutton's Vireo										1						1		
Warbling Vireo	2			2			19	1	6	22		5	4	1	1	49	2	12
Steller's Jay										1		1				1		1
N. Rough-winged Swallow													3			3		
Mountain Chickadee	3	1		19	3	3	18	1	2	10	1	2				50	6	7
Chestnut-backed Chickadee											2						2	

Table 2. (cont.) Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2005.
N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Oak Titmouse													1			1		
Bushtit													3		2	3		2
Red-breasted Nuthatch	2			6	3	1	10			8						26	3	1
White-breasted Nuthatch						1							1			1		1
Brown Creeper	8		1	8			5	1		1		2	2		1	24	1	4
House Wren	4	1		3	4		10			6	2	1	5			28	7	1
Winter Wren							1			2			1			4		
Golden-crowned Kinglet	4			39	10		21	8		1	1					65	19	
Ruby-crowned Kinglet	1															1		
Western Bluebird													1			1		
Townsend's Solitaire				1												1		
Swainson's Thrush										1						1		
Hermit Thrush	1						5		1	2			1			9		1
American Robin	2			4		1	4			9	2		4	1		23	3	1
Wrentit													14	1	3	14	1	3
European Starling													1			1		
Orange-crowned Warbler	119	4	2	59	21		135	28	11	59	1	4	15	1	1	387	55	18
Nashville Warbler	31			29	2	1	51	8	4	19		1	5			135	10	6
Yellow Warbler							2			13		1	15		4	30		5
Yellow-rumped Warbler	47	1	1	133	22	4	29	8	5	8			1			218	31	10
Black-throated Gray Warbler							1			1			2			4		
Townsend's Warbler	1															1		
Hermit Warbler	17			19	1		33	1	3	16						85	2	3
MacGillivray's Warbler	1			3	1		27		10	53	3	49	8		1	92	4	60
Wilson's Warbler	3			1			3			6	1	1				13	1	1
Western Tanager				18	2		4	1		5	1	2	2			29	4	2
Spotted Towhee										6	2	2	5	1	2	11	3	4

Table 2. (cont.) Capture summary for the five individual MAPS stations, and all stations pooled, operated in Yosemite National Park in 2005. N = Newly Banded, U = Unbanded, R = Recaptures of banded birds.

Species	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Chipping Sparrow	2						1		1							3		1
Savannah Sparrow													1			1		
Fox Sparrow				1									1			2		
Song Sparrow										43	3	32	5		2	48	3	34
Lincoln's Sparrow	13	2	9	14	4	27	29	6	35	30	4	25	2			88	16	96
Dark-eyed Junco	37	2	13	86	19	10	78	18	27	30	3	11				231	42	61
Unidentified Sparrow											1						1	
Black-headed Grosbeak				6			1			8		3	42	1	1	57	1	4
Lazuli Bunting							1						25			26		
Red-winged Blackbird										3	1					3	1	
Brewer's Blackbird													1			1		
Bullock's Oriole													3			3		
Purple Finch	1						1			6			24	1		32	1	
Cassin's Finch	4			1						6			11			22		
House Finch										1						1		
Pine Siskin	4			6			1			1			1			13		
Lesser Goldfinch				2									21	1	1	23	1	1
American Goldfinch													1			1		
Evening Grosbeak				1												1		
Unidentified Bird											1						1	
ALL SPECIES POOLED	325	20	26	490	104	49	522	98	113	405	50	149	252	31	22	1994	303	359
Total Number of Captures		371			643			733			604			305			2656	
Number of Species	29	10	5	33	16	9	33	16	15	39	22	20	42	14	12	64	31	30
Total Number of Species		33			37			37			47			48			69	

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 2005.

Species	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
	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	1.6	0.0	0.00													0.3	0.0	0.00
Red-breasted Sapsucker				3.2	1.6	0.50	2.6	1.3	0.50	4.6	2.7	0.60				2.3	1.3	0.56
Downy Woodpecker										0.0	0.9	und.[1]	1.4	0.0	0.00	0.3	0.3	1.00
Hairy Woodpecker				0.0	1.6	und.[1]	1.3	0.0	0.00				1.4	0.0	0.00	0.5	0.3	0.50
White-headed Woodpecker				1.6	0.0	0.00	1.3	0.0	0.00							0.5	0.0	0.00
Northern Flicker	1.6	0.0	0.00	0.0	1.6	und.										0.3	0.3	1.00
Western Wood-Pewee	3.1	0.0	0.00	3.2	3.2	1.00	1.3	0.0	0.00	0.9	0.9	1.00	7.0	1.4	0.20	2.9	1.0	0.36
Hammond's Flycatcher	0.0	3.1	und.[1]	1.6	6.3	4.00	1.3	1.3	1.00	0.0	0.9	und.				0.5	2.1	4.00
Dusky Flycatcher	4.7	3.1	0.67	3.2	4.7	1.50	10.5	2.6	0.25	0.9	0.0	0.00				3.6	1.8	0.50
"Western" Flycatcher	3.1	0.0	0.00	1.6	9.5	6.00	14.4	0.0	0.00	5.5	5.5	1.00	0.0	1.4	und.[1]	5.2	3.4	0.65
Black Phoebe				1.6	0.0	0.00							4.2	4.2	1.00	1.0	0.8	0.75
Ash-throated Flycatcher													1.4	0.0	0.00	0.3	0.0	0.00
Cassin's Vireo	0.0	1.6	und.	1.6	0.0	0.00	3.9	0.0	0.00	2.7	0.9	0.33	4.2	0.0	0.00	2.6	0.5	0.20
Hutton's Vireo										0.0	0.9	und.				0.0	0.3	und.[1]
Warbling Vireo	3.1	0.0	0.00	3.2	0.0	0.00	17.1	5.3	0.31	13.7	4.6	0.33	4.2	1.4	0.33	9.1	2.6	0.29
Steller's Jay										0.9	0.0	0.00				0.3	0.0	0.00
N. Rough-winged Swallow													0.0	2.8	und.	0.0	0.5	und.
Mountain Chickadee	4.7	1.6	0.33	20.5	12.6	0.62	11.8	14.4	1.22	4.6	4.6	1.00				7.8	6.5	0.83
Chestnut-backed Chickadee										0.9	0.0	0.00				0.3	0.0	0.00
Oak Titmouse													0.0	1.4	und.	0.0	0.3	und.
Bushtit													4.2	1.4	0.33	0.8	0.3	0.33
Red-breasted Nuthatch	0.0	3.1	und.	4.7	3.2	0.67	2.6	9.2	3.50	2.7	4.6	1.67				2.1	4.2	2.00
White-breasted Nuthatch				1.6	0.0	0.00							1.4	0.0	0.00	0.5	0.0	0.00

Table 3. (cont.) 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 2005.

Species	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
	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													4.2	2.8	0.67	0.8	0.5	0.67
Winter Wren							0.0	1.3	und.[1]	0.9	0.9	1.00	0.0	1.4	und.	0.3	0.8	3.00
Golden-crowned Kinglet	0.0	6.2	und.	1.6	59.9	38.00	13.1	14.4	1.10	0.0	1.8	und.				2.9	14.3	5.00
Ruby-crowned Kinglet	0.0	1.6	und.													0.0	0.3	und.
Western Bluebird													1.4	0.0	0.00	0.3	0.0	0.00
Townsend's Solitaire				1.6	0.0	0.00										0.3	0.0	0.00
Swainson's Thrush										0.9	0.0	0.00				0.3	0.0	0.00
Hermit Thrush	0.0	1.6	und.				5.3	2.6	0.50	0.0	0.9	und.	0.0	1.4	und.	1.0	1.3	1.25
American Robin	3.1	0.0	0.00	4.7	1.6	0.33	3.9	1.3	0.33	4.6	3.7	0.80	5.6	0.0	0.00	4.4	1.6	0.35
Wrentit													12.6	11.2	0.89	2.3	2.1	0.89
European Starling													0.0	1.4	und.	0.0	0.3	und.
Nashville Warbler										4.6	12.8	2.80	1.4	4.2	3.00	1.6	4.4	2.83
Yellow Warbler							0.0	2.6	und.	0.9	11.0	12.00	8.4	15.4	1.83	1.8	6.5	3.57
Yellow-rumped Warbler	34.2	38.8	1.14	26.8	184.6	6.88	15.8	27.6	1.75	5.5	1.8	0.33	1.4	0.0	0.00	15.1	42.7	2.83
Black-throated Gray Warbler							1.3	0.0	0.00	0.9	0.0	0.00	1.4	1.4	1.00	0.8	0.3	0.33
Hermit Warbler	3.1	23.3	7.50	4.7	22.1	4.67	22.3	23.6	1.06	7.3	7.3	1.00				7.8	14.3	1.83
MacGillivray's Warbler	0.0	1.6	und.	1.6	1.6	1.00	15.8	22.3	1.42	39.4	24.7	0.63	1.4	8.4	6.00	14.8	13.5	0.91
Wilson's Warbler	0.0	4.7	und.	0.0	1.6	und.	0.0	3.9	und.	3.7	1.8	0.50				1.0	2.3	2.25
Western Tanager				11.0	15.8	1.43	3.9	1.3	0.33	4.6	1.8	0.40	1.4	1.4	1.00	4.2	3.6	0.88
Spotted Towhee										1.8	3.7	2.00	4.2	2.8	0.67	1.3	1.6	1.20
Chipping Sparrow	1.6	1.6	1.00				2.6	0.0	0.00							0.8	0.3	0.33
Fox Sparrow				0.0	1.6	und.							0.0	1.4	und.	0.0	0.5	und.
Brown Creeper	4.7	7.8	1.67	1.6	11.0	7.00	3.9	2.6	0.67	0.9	0.9	1.00	2.8	1.4	0.50	2.6	4.2	1.60

Table 3. (cont.) 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 2005.

Species	White Wolf			Gin Flat East Meadow			Crane Flat			Hodgdon Meadow			Big Meadow			All five stations combined		
	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index	Ad.	Yg.	Repr. index
Song Sparrow										23.8	22.0	0.92	4.2	4.2	1.00	7.5	7.0	0.93
Lincoln's Sparrow	7.8	15.5	2.00	26.8	11.0	0.41	27.6	19.7	0.71	18.3	10.1	0.55	0.0	2.8	und.	16.4	11.7	0.71
Dark-eyed Junco	26.4	40.4	1.53	17.4	126.2	7.27	43.3	81.4	1.88	16.5	14.7	0.89				20.6	47.9	2.33
Black-headed Grosbeak				4.7	4.7	1.00	1.3	0.0	0.00	6.4	3.7	0.57	5.6	54.7	9.75	3.9	12.0	3.07
Lazuli Bunting							0.0	1.3	und.				21.0	12.6	0.60	3.9	2.6	0.67
Red-winged Blackbird										2.7	0.0	0.00				0.8	0.0	0.00
Brewer's Blackbird													1.4	0.0	0.00	0.3	0.0	0.00
Bullock's Oriole													2.8	1.4	0.50	0.5	0.3	0.50
Purple Finch	0.0	1.6	und.				1.3	0.0	0.00	5.5	0.0	0.00	7.0	26.6	3.80	3.1	5.2	1.67
Cassin's Finch	6.2	0.0	0.00	1.6	0.0	0.00				3.7	1.8	0.50	7.0	8.4	1.20	3.6	2.1	0.57
House Finch										0.0	0.9	und.				0.0	0.3	und.
Pine Siskin	6.2	0.0	0.00	7.9	1.6	0.20	1.3	0.0	0.00	0.9	0.0	0.00	1.4	0.0	0.00	3.1	0.3	0.08
Lesser Goldfinch				1.6	1.6	1.00							9.8	18.2	1.86	2.1	3.6	1.75
Evening Grosbeak				1.6	0.0	0.00										0.3	0.0	0.00
ALL SPECIES POOLED	115.0	156.9	1.37	162.5	489.0	3.01	231.1	240.3	1.04	191.5	153.1	0.80	136.0	197.7	1.45	171.5	234.4	1.37
Number of Species	16	17		27	23		26	20		31	29		30	28		53	48	
Total Number of Species		25			31			30			37			38			60	

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

Table 4. Percentage changes between 2004 and 2005 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

| | | | | | | | All five stations combined | | | |
| | | | | | | | Number of adults | | | |
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2004	2005	Percent change	SE[2]
Williamson's Sapsucker	-50.0					1	2	1	-50.0	
Red-breasted Sapsucker	-100.0	-33.3	-33.3	-66.7		4	23	9	-60.9	8.3 ***
Downy Woodpecker				-100.0	+ +++[3]	2	1	1	0.0	200.0
Hairy Woodpecker		-100.0	+ +++[3]		++++	3	1	2	100.0	300.0
White-headed Woodpecker		+ +++[3]	-66.7		-100.0	3	4	2	-50.0	37.5
Northern Flicker	0.0	-100.0	-100.0	-100.0	-100.0	5	5	1	-80.0	20.0 **
Western Wood-Pewee	++++[3]	++++	++++	-80.0	33.3	5	8	10	25.0	84.6
Willow Flycatcher					-100.0	1	2	0	-100.0	
Hammond's Flycatcher		0.0	0.0			2	2	2	0.0	88.9
Dusky Flycatcher	200.0	-66.7	14.3	-66.7	-100.0	5	18	14	-22.2	28.4
"Western" Flycatcher	0.0	++++	28.6	-25.0		4	16	17	6.3	22.5
Black Phoebe		++++	-100.0		-33.3	3	4	3	-25.0	39.0
Ash-throated Flycatcher					++++	1	0	1	++++	
Cassin's Vireo		0.0	50.0	-66.7	++++	4	6	8	33.3	82.2
Hutton's Vireo						0	0	0		
Warbling Vireo	++++	-33.3	-7.7	-31.6	0.0	5	38	32	-15.8	11.2
Steller's Jay			-100.0	-50.0		2	3	1	-66.7	22.2
Western Scrub-Jay				-100.0		1	1	0	-100.0	
N. Rough-winged Swallow						0	0	0		
Mountain Chickadee	200.0	18.2	600.0	150.0		4	15	28	86.7	71.4
Chestnut-backed Chickadee				++++ [3]		1	0	1	++++	
Oak Titmouse						0	0	0		
Bushtit					-75.0	1	12	3	-75.0	
Red-breasted Nuthatch		0.0	-33.3	200.0		3	7	8	14.3	41.7
White-breasted Nuthatch		++++			-50.0	2	2	2	0.0	100.0
Brown Creeper	200.0	-75.0	50.0	0.0	100.0	5	9	10	11.1	51.0

Table 4. (cont.) Percentage changes between 2004 and 2005 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	Number of adults 2004	Number of adults 2005	Percent change	SE[2]
Bewick's Wren					-100.0	1	1	0	-100.0	
House Wren					50.0	1	2	3	50.0	
Winter Wren				++++		1	0	1	++++	
Golden-crowned Kinglet	-100.0	-66.7	100.0			3	10	11	10.0	67.5
Ruby-crowned Kinglet						0	0	0		
Western Bluebird					++++	1	0	1	++++	
Townsend's Solitaire		++++				1	0	1	++++	
Swainson's Thrush				++++		1	0	1	++++	
Hermit Thrush	-100.0		100.0	-100.0	-100.0	4	6	4	-33.3	60.2
American Robin	100.0	0.0	++++	-50.0	50.0	5	12	13	8.3	39.4
Wrentit					200.0	1	3	9	200.0	
European Starling						0	0	0		
Nashville Warbler				150.0	-90.0	2	12	6	-50.0	66.7
Yellow Warbler				-66.7	-14.3	2	10	7	-30.0	22.0
Yellow-rumped Warbler	122.2	-29.2	-47.6	20.0	0.0	5	60	55	-8.3	28.5
Black-throated Gray Warb.			++++	++++	0.0	3	1	3	200.0	300.0
Hermit Warbler	0.0	-50.0	40.0	0.0		4	25	26	4.0	22.4
MacGillivray's Warbler		-88.9	-29.4	2.6	-66.7	4	68	54	-20.6	18.9
Wilson's Warbler				++++		1	0	4	++++	
Western Tanager		40.0	++++	33.3	-66.7	4	11	15	36.4	45.3
Green-tailed Towhee		-100.0	-100.0			2	4	0	-100.0	88.9
Spotted Towhee				-33.3	-25.0	2	7	5	-28.6	4.1
Chipping Sparrow	++++		-33.3			2	3	3	0.0	66.7
Fox Sparrow						0	0	0		
Song Sparrow				4.5	0.0	2	25	26	4.0	1.0
Lincoln's Sparrow	-37.5	-48.5	-9.1	90.0		4	73	61	-16.4	24.0

Table 4. (cont.) Percentage changes between 2004 and 2005 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

| | | | | | | | All five stations combined | | | |
| | | | | | | | Number of adults | | | |
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2004	2005	Percent change	SE[2]
Dark-eyed Junco	-62.5	-45.0	-45.5	-23.5	-100.0	5	134	69	-48.5	6.1 ***
Black-headed Grosbeak		++++	++++	-30.0	33.3	4	13	15	15.4	49.4
Lazuli Bunting			-100.0		550.0	2	3	13	333.3	288.9
Red-winged Blackbird				++++		1	0	3	++++	
Brewer's Blackbird					0.0	1	1	1	0.0	
Brown-headed Cowbird					-100.0	1	1	0	-100.0	
Bullock's Oriole					0.0	1	2	2	0.0	
Pine Grosbeak						0	0	0		
Purple Finch			0.0	500.0	66.7	3	5	12	140.0	108.9
Cassin's Finch	300.0	-50.0	-100.0	++++	++++	5	4	13	225.0	239.4
House Finch						0	0	0		
Pine Siskin	++++	-44.4	0.0	++++	++++	5	10	12	20.0	80.4
Lesser Goldfinch		++++			200.0	2	2	7	250.0	100.0
Evening Grosbeak		++++				1	0	1	++++	
ALL SPECIES POOLED	-5.6	-30.9	-13.4	-1.0	3.4	5	687	613	-10.8	6.2
No. species that increased[4]	10(4)	11(9)	14(6)	17(8)	16(7)				30(9)	
No. species that decreased[5]	6(3)	15(3)	15(6)	15(3)	17(9)				22(5)	
No. species remained same	3	4	3	2	6				6	
Total Number of Species	19	30	32	34	39				58	
Proportion of increasing (decreasing) species	(0.316)	(0.500)	(0.469)	(0.441)	0.410				(0.379)	
Sig. of increase (decrease)[6]	(0.968)	(0.572)	(0.702)	(0.804)	0.900				(0.976)	

Table 4. (cont.) Percentage changes between 2004 and 2005 in the numbers of individual ADULT birds captured at five constant-effort MAPS stations in Yosemite National Park.

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[1] Number of stations lying within the breeding range of the species at which at least one individual adult bird of the species was captured in either year.
[2] Standard error of the percent change in the number of individual adults captured.
[3] Increase indeterminate (infinite) because no adult was captured during 2004.
[4] No. of species for which adults were captured in 2005 but not in 2004 are in parentheses.
[5] No. of species for which adults were captured in 2004 but not in 2005 are in parentheses.
[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.
*** $P < 0.01$; ** $0.01 < P < 0.05$; * $0.05 < P < 0.10$.

Table 5. Percentage changes between 2004 and 2005 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

| | | | | | | | All five stations combined | | | |
| | | | | | | | Number of young | | | |
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2004	2005	Percent change	SE[2]
Williamson's Sapsucker	-100.0					1	1	0	-100.0	
Red-breasted Sapsucker		0.0	0.0	-40.0	-100.0	4	10	5	-50.0	20.0 *
Downy Woodpecker				++++[3]		1	0	1	++++[3]	
Hairy Woodpecker		-50.0				1	2	1	-50.0	
White-headed Woodpecker			-100.0		-100.0	2	3	0	-100.0	88.9
Northern Flicker		++++[3]			-100.0	2	1	1	0.0	200.0
Western Wood-Pewee		++++	-100.0	0.0	++++[3]	4	2	4	100.0	182.6
Willow Flycatcher						0	0	0		
Hammond's Flycatcher	-50.0	50.0	-50.0	0.0		4	7	6	-14.3	27.1
Dusky Flycatcher	++++[3]	200.0	++++[3]			3	1	7	600.0	600.0
"Western" Flycatcher		500.0	-100.0	-50.0	++++	4	18	13	-27.8	44.9
Black Phoebe		-100.0			-50.0	2	8	3	-62.5	18.8
Ash-throated Flycatcher						0	0	0		
Cassin's Vireo	++++		-100.0	0.0		3	3	2	-33.3	69.4
Hutton's Vireo			-100.0	++++		2	1	1	0.0	200.0
Warbling Vireo			0.0	-54.5	++++	3	15	10	-33.3	23.4
Steller's Jay						0	0	0		
Western Scrub-Jay						0	0	0		
N. Rough-winged Swallow					++++	1	0	2	++++	
Mountain Chickadee	-100.0	-11.1	57.1	400.0		4	18	24	33.3	37.4
Chestnut-backed Chickadee				-100.0		1	1	0	-100.0	
Oak Titmouse					++++	1	0	1	++++	
Bushtit				-100.0	-80.0	2	13	1	-92.3	9.5
Red-breasted Nuthatch	0.0	-50.0	-56.3	25.0		4	26	16	-38.5	17.4
White-breasted Nuthatch						0	0	0		
Brown Creeper	-16.7	40.0	-50.0	-83.3	-66.7	5	24	16	-33.3	23.2

Table 5. (cont.) Percentage changes between 2004 and 2005 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	Number of young 2004	Number of young 2005	Percent change	SE[2]	
Bewick's Wren					-100.0	1	2	0	-100.0		
House Wren					100.0	1	1	2	100.0		
Winter Wren			++++	-50.0	++++	3	2	3	50.0	150.0	
Golden-crowned Kinglet	++++	850.0	-27.3	-75.0		4	23	52	126.1	187.7	
Ruby-crowned Kinglet	++++					1	0	1	++++		
Western Bluebird						0	0	0			
Townsend's Solitaire						0	0	0			
Swainson's Thrush						0	0	0			
Hermit Thrush			++++	++++	++++	3	0	4	++++		
American Robin		0.0	0.0	100.0		3	4	6	50.0	37.5	
Wrentit					700.0	1	1	8	700.0		
European Starling				++++		1	0	1	++++		
Nashville Warbler				40.0	-80.0	2	20	16	-20.0	60.0	
Yellow Warbler			++++	350.0	266.7	3	5	22	340.0	73.0	**
Yellow-rumped Warbler	475.0	-6.5	-43.2	-50.0		4	169	162	-4.1	16.6	
Black-throated Gray Warb.		-100.0	-100.0	-100.0	0.0	4	9	1	-88.9	13.8	***
Hermit Warbler	++++	-48.1	-63.0	33.3		4	79	52	-34.2	28.3	
MacGillivray's Warbler	++++	-75.0	30.8	13.6	0.0	5	44	49	11.4	11.3	
Wilson's Warbler	0.0	-83.3	-50.0	-33.3	-100.0	5	17	7	-58.8	12.4	***
Western Tanager		400.0	-75.0	0.0	++++	4	8	14	75.0	130.3	
Green-tailed Towhee						0	0	0			
Spotted Towhee				++++	-60.0	2	5	6	20.0	160.0	
Chipping Sparrow	++++		-100.0			2	1	1	0.0	200.0	
Fox Sparrow	-100.0	-50.0			++++	3	3	2	-33.3	50.9	
Song Sparrow				-25.0	0.0	2	34	26	-23.5	2.8	
Lincoln's Sparrow	60.0	-56.3	-48.3	175.0	++++	5	54	43	-20.4	27.8	

Table 5. (cont.) Percentage changes between 2004 and 2005 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.

| | | | | | | | All five stations combined | | | |
| | | | | | | | Number of young | | | |
Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	2004	2005	Percent change	SE[2]
Dark-eyed Junco	33.3	212.0	56.4	-5.9		4	99	179	80.8	44.5
Black-headed Grosbeak		++++		-25.0	60.9	3	27	43	59.3	20.5
Lazuli Bunting			-50.0		200.0	2	5	10	100.0	120.0
Red-winged Blackbird				-100.0		1	1	0	-100.0	
Brewer's Blackbird			-100.0			1	1	0	-100.0	
Brown-headed Cowbird						0	0	0		
Bullock's Oriole					++++	1	0	1	++++	
Pine Grosbeak	-100.0					1	1	0	-100.0	
Purple Finch					-41.9	1	31	18	-41.9	
Cassin's Finch				++++	50.0	2	2	5	150.0	200.0
House Finch				++++		1	0	1	++++	
Pine Siskin		-83.3		-100.0		2	8	1	-87.5	6.3
Lesser Goldfinch		0.0			350.0	2	3	10	233.3	155.6
Evening Grosbeak						0	0	0		
ALL SPECIES POOLED	107.1	24.4	-25.8	-7.5	15.3	5	813	860	5.8	14.0
No. species that increased[4]	10(7)	10(3)	7(4)	14(6)	19(12)				25(8)	
No. species that decreased[5]	6(4)	12(2)	18(8)	16(5)	11(5)				27(7)	
No. species remained same	2	3	3	4	3				3	
Total Number of Species	18	25	28	34	33				55	
Proportion of increasing (decreasing) species	0.556	0.400	(0.643)	(0.471)	0.576				0.455	
Sig. of increase (decrease)[6]	0.407	0.885	(0.092)	(0.696)	0.243				0.791	
			*							

Table 5. (cont.) Percentage changes between 2004 and 2005 in the numbers of individual YOUNG birds captured at five constant-effort MAPS stations in Yosemite National Park.
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[1] Number of stations lying within the breeding range of the species at which at least one individual young bird of the species was captured in either year.

[2] Standard error of the percent change in the number of individual young captured.

[3] Increase indeterminate (infinite) because no young bird was captured during 2004.

[4] No. of species for which young birds were captured in 2005 but not in 2004 are in parentheses.

[5] No. of species for which young birds were captured in 2004 but not in 2005 are in parentheses.

[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.

*** $P < 0.01$; ** $0.01 < P < 0.05$; * $0.05 < P < 0.10$.

Table 6. Changes between 2004 and 2005 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	Reproductive Index 2004	2005	Change	SE[2]	
Williamson's Sapsucker	-0.500					1	0.500	0.000	-0.500		
Red-breasted Sapsucker	+-+-+[3]	0.167	0.167	0.267	+-+-+[3]	5	0.435	0.556	0.121	0.174	
Downy Woodpecker				+-+-+[3]	+-+-+	2	0.000	1.000	1.000	2.000	
Hairy Woodpecker		+-+-+[3]	+-+-+[3]		+-+-+	3	2.000	0.500	-1.500	0.750	
White-headed Woodpecker		+-+-+	-0.667		+-+-+	3	0.750	0.000	-0.750	0.108	**
Northern Flicker	0.000	+-+-+	+-+-+	+-+-+	+-+-+	5	0.200	1.000	0.800	1.594	
Western Wood-Pewee	+-+-+	+-+-+	+-+-+	0.800	0.250	5	0.250	0.400	0.150	0.262	
Willow Flycatcher					+-+-+	1	0.000	und.[4]	+-+-+[3]		
Hammond's Flycatcher	+-+-+	1.000	-1.000	+-+-+		4	3.500	3.000	-0.500	2.273	
Dusky Flycatcher	0.667	1.333	0.250	0.000	+-+-+	5	0.056	0.500	0.444	0.238	
"Western" Flycatcher	0.000	+-+-+	-0.714	-0.500	+-+-+	5	1.125	0.765	-0.360	0.659	
Black Phoebe		+-+-+	+-+-+		-0.500	3	2.000	1.000	-1.000	1.041	
Ash-throated Flycatcher					+-+-+	1	und.[4]	0.000	+-+-+		
Cassin's Vireo	+-+-+	0.000	-1.000	0.667	+-+-+	5	0.500	0.250	-0.250	0.325	
Hutton's Vireo			+-+-+	+-+-+		2	und.	und.	+-+-+		
Warbling Vireo	+-+-+	0.000	0.026	-0.194	0.333	5	0.395	0.313	-0.082	0.127	
Steller's Jay			+-+-+	0.000		2	0.000	0.000	0.000	0.000	
Western Scrub-Jay					+-+-+	1	0.000	und.	+-+-+		
N. Rough-winged Swallow					+-+-+	1	und.	und.	+-+-+		
Mountain Chickadee	-1.000	-0.203	-5.429	0.500		4	1.200	0.857	-0.343	0.622	
Chestnut-backed Chickadee				+-+-+		1	und.	0.000	+-+-+		
Oak Titmouse					+-+-+	1	und.	und.	+-+-+		
Bushtit				+-+-+	-0.083	2	1.083	0.333	-0.750		
Red-breasted Nuthatch	+-+-+	-0.667	-1.833	-2.333		4	3.714	2.000	-1.714	1.663	
White-breasted Nuthatch		+-+-+			0.000	2	0.000	0.000	0.000	0.000	
Brown Creeper	-4.333	5.750	-1.333	-5.000	-2.500	5	2.667	1.600	-1.067	1.181	

Table 6. (cont.) Changes between 2004 and 2005 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	Reproductive Index 2004	2005	Change	SE[2]
Bewick's Wren					+-+-+	1	2.000	und.	+-+-+	
House Wren					0.167	1	0.500	0.667	0.167	
Winter Wren			+-+-+	+-+-+	+-+-+	3	und.	3.000	+-+-+	
Golden-crowned Kinglet	+-+-+	36.667	-1.400	+-+-+		4	2.300	4.727	2.427	5.538
Ruby-crowned Kinglet	+-+-+					1	und.	und.	+-+-+	
Western Bluebird					+-+-+	1	und.	0.000	+-+-+	
Townsend's Solitaire		+-+-+				1	und.	0.000	+-+-+	
Swainson's Thrush				+-+-+		1	und.	0.000	+-+-+	
Hermit Thrush	+-+-+		0.500	+-+-+	+-+-+	4	0.000	1.000	1.000	0.707
American Robin	0.000	0.000	+-+-+	1.000	0.000	5	0.333	0.462	0.128	0.293
Wrentit					0.556	1	0.333	0.889	0.556	
European Starling					+-+-+	1	und.	und.	+-+-+	
Nashville Warbler				-2.200	1.000	2	1.667	2.667	1.000	1.133
Yellow Warbler			+-+-+	8.333	1.405	3	0.500	3.143	2.643	1.752
Yellow-rumped Warbler	0.706	1.657	0.147	-0.467	0.000	5	2.817	2.946	0.129	1.990
Black-throated Gray Warb.		+-+-+	+-+-+	+-+-+	0.000	4	9.000	0.333	-8.667	11.200
Hermit Warbler	13.000	0.167	-3.386	0.250		4	3.160	2.000	-1.160	1.458
MacGillivray's Warbler	+-+-+	0.556	0.652	0.061	3.333	5	0.647	0.907	0.260	0.293
Wilson's Warbler	+-+-+	+-+-+	+-+-+	+-+-+	+-+-+	5	und.	1.750	+-+-+	
Western Tanager		1.029	+-+-+	-0.167	1.000	4	0.727	0.933	0.206	0.606
Green-tailed Towhee		+-+-+	+-+-+			2	0.000	und.	+-+-+	
Spotted Towhee				2.000	-0.583	2	0.714	1.200	0.486	0.886
Chipping Sparrow	+-+-+		-0.333			2	0.333	0.333	0.000	
Fox Sparrow	+-+-+	+-+-+			+-+-+	3	und.	und.	+-+-+	
Song Sparrow				-0.411	0.000	2	1.360	1.000	-0.360	0.183
Lincoln's Sparrow	0.975	-0.073	-0.568	0.179	+-+-+	5	0.740	0.705	-0.035	0.276

Table 6. (cont.) Changes between 2004 and 2005 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.

Species	White Wolf	Gin Flat E. Mead.	Crane Flat	Hodgdon Meadow	Big Meadow	n[1]	Reproductive Index 2004	Reproductive Index 2005	Change	SE[2]
							All five stations combined			
Dark-eyed Junco	1.150	5.841	1.324	0.231	+-+-+	5	0.739	2.594	1.855	0.936
Black-headed Grosbeak		+-+-+	+-+-+	0.029	1.583	4	2.077	2.867	0.790	3.203
Lazuli Bunting			+-+-+		-0.808	2	1.667	0.769	-0.897	0.270
Red-winged Blackbird				+-+-+		1	und.	0.000	+-+-+	
Brewer's Blackbird			+-+-+		0.000	2	1.000	0.000	-1.000	2.000
Brown-headed Cowbird				+-+-+		1	0.000	und.	+-+-+	
Bullock's Oriole					0.500	1	0.000	0.500	0.500	
Pine Grosbeak	+-+-+					1	und.	und.	+-+-+	
Purple Finch			0.000	0.000	-6.733	3	6.200	1.500	-4.700	3.982
Cassin's Finch	0.000	0.000	+-+-+	+-+-+	+-+-+	5	0.500	0.385	-0.115	0.682
House Finch				+-+-+		1	und.	und.	+-+-+	
Pine Siskin	+-+-+	-0.467	0.000	+-+-+	+-+-+	5	0.800	0.083	-0.717	0.283 *
Lesser Goldfinch		+-+-+			0.500	2	1.500	1.429	-0.071	1.007
Evening Grosbeak		+-+-+				1	und.	0.000	+-+-+	
ALL SPECIES POOLED	0.696	1.320	-0.185	-0.059	0.146	5	1.183	1.403	0.220	0.398
No. species that increased	5	10	7	12	11				19	
No. species that decreased	3	4	11	8	6				22	
No. species remained same	4	4	2	3	6				3	
Total Number of Species[5]	12	18	20	23	23				44	
Proportion of increasing (decreasing) species	0.417	0.556	(0.550)	(0.348)	0.478				0.432	
Sig. of increase (decrease)[6]	0.806	0.407	(0.412)	(0.953)	0.661				0.854	

Table 6. (cont.) Changes between 2004 and 2005 in the REPRODUCTIVE INDEX (young/adult) at five constant-effort MAPS stations in Yosemite National Park.
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[1] Number of stations lying within the breeding range of the species at which at least one individual aged bird of the species was captured in either year.

[2] Standard error of the change in the reproductive index.

[3] The change in reproductive index is undefined at this station because no adult individual of the species was captured in one of the two years.

[4] Reproductive index not given because no adult individual of the species was captured in the year shown.

[5] Species for which the change in the reproductive index is undefined are not included.

[6] Statistical significance of the one-sided binomial test that the proportion of increasing (decreasing) species is not greater than 0.50.

*** $P < 0.01$; ** $0.01 \leq P < 0.05$; * $0.05 \leq P < 0.10$

Table 7. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 13 years, 1993-2005 (1998-2005 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 16 years, 1990-2005. Data for each species are included only from stations that lie within the breeding range of the species.

Species	White Wolf			Gin Flat E. Mead. (1998-2005)			Crane Flat			Hodgdon Meadow (1993-2005)			Big Meadow			All stations pooled (1993-2005)[1,3]			Hodgdon Meadow (1990-2005)		
	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]
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	5.1	0.8	0.13	0.0	0.2	und.[4]										0.8	0.2	0.13			
Red-breasted Sapsucker	0.8	0.5	0.25	5.3	3.4	0.92	2.2	0.6	0.29	7.0	3.3	0.61	1.3	0.7	0.71	3.5	1.7	0.52	6.2	3.0	0.58
Downy Woodpecker										0.5	0.2	0.00	1.9	0.7	0.20	0.6	0.2	0.33	0.4	0.2	0.00
Hairy Woodpecker	0.1	0.1	0.00	0.6	0.6	0.67	0.8	0.1	0.00	0.2	0.7	0.50	2.1	0.8	0.28	0.8	0.5	0.89	0.2	0.6	0.63
White-headed Woodp.				1.2	0.4	0.40	1.0	0.2	0.10	0.6	0.1	0.00	0.8	0.1	0.25	0.7	0.1	0.15	0.5	0.1	0.00
Northern Flicker	0.4	0.2	0.00	0.4	0.2	0.00	0.4	0.1	0.33	0.9	0.4	0.50	2.0	0.2	0.18	0.9	0.2	0.27	0.7	0.3	0.45
Olive-sided Flycatcher				0.4	0.0	0.00				0.5	0.0	0.00	0.2	0.0	0.00	0.3	0.0	0.00	0.5	0.0	0.00
Western Wood-Pewee	1.5	0.3	0.00	1.4	0.8	0.33	0.1	0.1	0.00	3.5	0.8	0.34	6.0	0.8	0.13	2.8	0.6	0.25	3.2	0.7	0.28
Willow Flycatcher							0.4	0.1	0.00	1.6	0.5	0.41	1.1	0.0	0.00	0.9	0.2	0.23	1.5	0.4	0.34
Hammond's Flycatcher	0.0	2.4	und.[4]	1.8	9.9	7.10	3.0	1.7	0.88	1.6	0.9	0.48	0.2	0.1	0.50	1.4	2.1	2.33	1.5	0.7	0.39
Dusky Flycatcher	2.1	0.5	0.11	4.0	1.9	0.54	17.1	2.3	0.14	13.8	1.9	0.12	1.3	0.1	0.00	9.2	1.4	0.18	13.0	1.9	0.14
"Western" Flycatcher	0.5	0.1	0.33	0.4	2.0	3.00	4.3	1.8	0.36	4.5	3.8	1.16	0.4	0.4	0.25	2.5	1.8	0.78	3.8	3.2	1.09
Black Phoebe				0.2	0.4	0.00	0.1	0.1	0.00	0.2	0.6	0.33	5.6	7.0	1.99	1.3	1.8	2.28	0.2	0.5	0.33
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.	0.8	0.2	0.00	1.7	0.3	0.19	4.8	2.9	0.65	1.4	0.1	0.13	2.3	1.1	0.53	4.2	2.7	0.69
Hutton's Vireo							0.0	0.1	und.[4]	0.0	0.1	und.[4]				*0.0*	*0.0*	*und.[4]*	0.0	0.1	und.[4]
Warbling Vireo	2.7	0.3	0.06	2.3	0.2	0.00	16.7	1.8	0.10	23.6	11.0	0.52	8.3	1.1	0.16	13.5	4.1	0.31	21.4	9.7	0.52
Steller's Jay	0.1	0.0	0.00	0.2	0.2	0.00	0.1	0.0	0.00	1.3	0.2	0.20	0.2	0.1	0.00	0.5	0.1	0.25	1.0	0.1	0.20
Western Scrub-Jay													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Tree Swallow													0.0	0.1	und.[4]	*0.0*	*0.0*	*und.*			
N. Rough-winged Swal.													0.1	0.2	0.00	*0.0*	*0.0*	*0.00*			
Mountain Chickadee	5.2	2.7	0.59	12.8	10.6	1.14	5.7	5.1	1.63	1.4	0.7	0.50	0.2	0.0	0.00	3.9	2.8	0.87	1.3	0.6	0.50
Chestnut-backed Chick.	0.0	0.1	und.				0.0	0.1	und.	0.7	0.4	0.14				0.2	0.2	0.29	0.6	0.3	0.14

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 13 years, 1993-2005 (1998-2005 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 16 years, 1990-2005. Data for each species are included only from stations that lie within the breeding range of the species.

Species	White Wolf			Gin Flat E. Mead. (1998-2005)			Crane Flat			Hodgdon Meadow (1993-2005)			Big Meadow			All stations pooled (1993-2005)[1,3]			Hodgdon Meadow (1990-2005)		
	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]
Oak Titmouse													0.1	0.1	0.00	*0.0*	*0.0*	*0.00*			
Bushtit										0.8	2.4	3.00	3.3	4.8	2.61	0.8	1.7	2.36	0.6	2.0	3.00
Red-breasted Nuthatch	0.3	1.6	1.00	2.5	10.1	2.70	4.6	6.1	1.87	0.9	1.6	0.95				1.6	3.1	2.26	0.8	1.4	0.96
White-breasted Nuthatch				0.4	0.0	0.00				0.0	0.1	und.	1.1	0.1	0.00	0.3	0.0	0.00	0.0	0.1	und.
Brown Creeper	3.6	5.9	1.61	3.3	4.9	2.14	3.7	6.0	2.55	0.8	2.7	2.81	2.2	2.1	1.26	2.4	4.0	2.03	0.9	2.4	2.41
Bewick's Wren													1.4	1.0	0.81	0.3	0.2	0.81			
House Wren													5.0	6.5	1.72	1.1	1.4	1.72			
Winter Wren	0.0	0.1	und.				0.2	0.7	0.50	0.3	1.0	1.33	0.2	0.2	0.50	0.2	0.5	1.58	0.3	0.8	1.25
American Dipper													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Golden-crowned Kinglet	1.9	7.6	2.05	4.5	28.6	8.85	15.7	21.6	1.37	1.5	2.7	1.11				4.6	9.9	2.31	1.2	2.2	0.99
Ruby-crowned Kinglet	0.7	0.1	0.00													0.1	0.0	0.00			
Western Bluebird													2.2	0.7	0.08	0.4	0.1	0.08			
Townsend's Solitaire				0.2	0.2	0.00				0.1	0.4	0.00				0.1	0.1	0.00	0.1	0.3	0.00
Swainson's Thrush										0.4	0.0	0.00				0.1	0.0	0.00	0.3	0.0	0.00
Hermit Thrush	1.8	0.3	0.11	0.4	0.0	0.00	4.1	0.7	0.25	1.5	0.7	0.47	0.2	0.1	0.00	1.8	0.4	0.36	1.3	0.6	0.42
American Robin	6.4	0.9	0.08	5.5	1.8	0.36	2.8	0.2	0.03	3.6	1.2	0.51	4.3	0.3	0.12	4.2	0.8	0.21	3.2	1.0	0.41
Wrentit													2.5	1.7	0.77	0.5	0.3	0.77			
European Starling													0.0	0.1	und.	*0.0*	*0.0*	*und.*			
Nashville Warbler										5.7	12.6	2.10	3.9	7.2	2.83	2.5	5.4	1.80	5.1	11.2	2.45
Yellow Warbler							1.2	0.4	0.04	4.6	2.6	1.64	7.4	5.9	1.16	3.2	2.1	0.84	4.4	2.5	1.48
Yellow-rumped Warbler	25.4	25.7	0.94	34.1	130.7	4.08	29.4	22.3	0.81	5.0	2.7	0.59	1.6	0.0	0.00	15.6	23.6	1.36	4.6	2.2	0.50
Black-thrtd. Gray Warb.	0.0	0.1	und.	0.0	0.8	und.	0.1	1.3	0.00	0.1	1.8	2.50	0.2	0.8	1.00	0.1	1.1	6.11	0.3	1.7	2.63
Hermit Warbler	2.4	11.1	3.89	3.5	15.0	2.74	22.0	21.7	1.14	9.5	9.4	1.55	0.1	0.0	0.00	8.4	10.9	1.39	8.4	7.9	1.31
MacGillivray's Warbler	0.0	0.8	und.	6.7	3.8	0.53	14.7	11.5	0.75	33.7	20.1	0.60	7.4	9.3	2.29	15.9	11.3	0.73	29.7	17.6	0.60
Wilson's Warbler	0.0	1.2	und.	0.2	2.3	1.00	1.5	4.1	2.42	3.3	1.2	0.51	1.0	0.8	0.48	1.7	1.8	1.36	2.9	1.2	0.55
Western Tanager	0.5	0.4	0.17	11.3	7.1	0.55	3.0	0.7	0.14	5.0	3.0	0.52	3.3	0.1	0.10	4.2	1.9	0.46	4.4	2.6	0.52
Green-tailed Towhee				0.8	0.0	0.00	0.3	0.0	0.00	0.0	0.1	und.	0.1	0.1	0.00	0.2	0.0	0.00	0.0	0.1	und.

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 13 years, 1993-2005 (1998-2005 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 16 years, 1990-2005. Data for each species are included only from stations that lie within the breeding range of the species.

Species	White Wolf			Gin Flat E. Mead. (1998-2005)			Crane Flat			Hodgdon Meadow (1993-2005)			Big Meadow			All stations pooled (1993-2005)[1,3]			Hodgdon Meadow (1990-2005)		
	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]	Ad.	Yg.	Repr. Ind.[2]
Spotted Towhee										0.7	0.5	0.75	6.7	2.0	0.32	1.5	0.5	0.33	0.6	0.4	0.75
Chipping Sparrow	1.0	0.1	0.20	0.6	0.2	0.00	5.3	0.6	0.13	3.3	0.8	0.20	8.8	2.9	0.54	4.5	1.1	0.32	2.9	0.7	0.17
Sage Sparrow													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
Fox Sparrow	0.0	0.1	und.	1.0	0.6	0.00	0.3	0.1	0.50	0.1	0.0	0.00	0.1	0.2	0.00	0.2	0.1	0.20	0.1	0.0	0.00
Song Sparrow	0.3	0.0	0.00	0.0	1.3	und.	2.0	2.1	1.08	21.9	23.7	1.12	6.0	4.0	0.62	8.5	8.7	1.06	18.4	19.8	1.09
Lincoln's Sparrow	5.2	3.6	0.51	26.3	13.4	0.55	27.0	27.1	1.02	17.8	10.6	0.61	1.0	1.8	1.45	15.2	11.7	0.78	15.2	9.0	0.60
Dark-eyed Junco	38.3	28.9	0.84	29.8	41.7	1.72	56.0	59.4	1.05	16.5	20.3	1.26	3.5	1.9	0.66	27.2	28.8	1.07	14.1	17.0	1.29
Black-headed Grosbeak	0.2	0.1	0.50	1.0	1.0	0.75	0.6	0.3	0.33	11.6	2.3	0.27	11.1	10.3	1.97	6.4	2.9	0.73	9.9	1.9	0.22
Lazuli Bunting	0.0	0.3	und.	0.2	0.0	0.00	6.7	1.0	0.28	0.6	0.1	0.17	33.7	15.7	0.57	9.1	3.8	0.51	0.5	0.1	0.11
Red-winged Blackbird										3.0	0.2	0.04				0.9	0.1	0.04	2.4	0.2	0.04
Brewer's Blackbird	0.7	0.1	0.17	0.0	0.2	und.	0.0	0.1	und.	0.7	0.0	0.00	3.0	0.2	0.03	1.0	0.1	0.13	0.6	0.0	0.00
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	0.3	0.0	0.00
Bullock's Oriole													2.4	0.2	0.13	0.5	0.0	0.13			
Pine Grosbeak	4.1	0.1	0.00													0.7	0.0	0.00			
Purple Finch	0.4	0.4	0.00	0.9	0.0	0.00	6.5	2.2	0.36	10.5	2.5	0.23	9.5	10.8	1.46	6.9	3.4	0.89	10.7	2.7	0.25
Cassin's Finch	12.4	0.7	0.03	2.3	0.6	0.24	2.1	0.2	0.06	1.8	0.4	0.12	1.3	1.0	0.44	3.5	0.5	0.18	1.6	0.4	0.13
House Finch							0.1	0.0	0.00	0.0	0.2	und.				0.0	0.1	und.	0.0	0.2	und.
Red Crossbill	0.1	0.0	0.00							0.6	0.1	0.25	0.2	0.0	0.00	0.2	0.0	0.10	0.5	0.1	0.25
Pine Siskin	6.3	0.7	0.10	8.1	15.2	5.07	4.5	0.2	0.06	1.9	0.8	0.21	0.7	0.2	0.08	3.7	2.1	0.58	1.8	0.7	0.16
Lesser Goldfinch				1.8	2.6	1.30	0.5	0.3	1.00	0.5	0.2	0.22	12.0	7.8	0.75	3.1	2.0	0.81	0.4	0.2	0.22
Lawrence's Goldfinch				0.2	0.2	1.00							2.1	0.1	0.00	0.5	0.0	0.02	0.1	0.0	0.00
Evening Grosbeak	0.3	0.0	0.00	0.2	0.0	0.00				0.1	0.0	0.00	1.4	0.3	0.17	0.4	0.1	0.14	0.1	0.0	0.00
House Sparrow													0.1	0.0	0.00	*0.0*	*0.0*	*0.00*			
ALL SPECIES POOLED	131.0	99.5	0.79	177.9	312.9	1.76	268.7	205.5	0.76	235.2	157.5	0.67	186.5	114.5	0.68	211.1	166.0	0.80	208.7	136.0	0.64
Number of Species	31	36		41	36		41	40		51	49		63	51		73	58		52	49	
Total Number of Species		40			45			44			55			65			77			56	

Table 7. (cont.) Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the five individual MAPS stations, and for all five stations pooled[1], operated in Yosemite National Park averaged over the 13 years, 1993-2005 (1998-2005 for Gin Flat East Meadow) and for Hodgdon Meadow alone averaged over 16 years, 1990-2005. Data for each species are included only from stations that lie within the breeding range of the species.

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[1] Analysis of all stations pooled include data from 1993-2005 from the White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow stations as well as data from 1998-2005 from the Gin Flat East Meadow station.

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

[3] For numbers presented in italics, the mean number of adults or young is greater than 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.

[4] 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 8. Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents in transient models using 13 years (1993-2005)[1] of mark-recapture data from five MAPS stations in Yosemite National Park. $QAIC_C$[2] and (GOF)[3] are presented for all models.

	Transient Models								
Species	$\varphi p\tau$ [4]	$\varphi_t p\tau$ [5]	$\varphi p_t\tau$ [6]	$\varphi p\tau_t$ [7]	$\varphi_t p_t\tau$ [8]	$\varphi_t p\tau_t$ [9]	$\varphi p_t\tau_t$ [10]	$\varphi_t p_t\tau_t$ [11]	$\Delta QAIC_C$ [12]
Williamson's Sapsucker	45.88* (1.000)	77.99 (1.000)	70.95 (1.000)	78.35 (1.000)	174.40 (1.000)	203.90 (1.000)	194.80 (1.000)	2460.00 (1.000)	32.11
Red-breasted Sapsucker	74.42* (1.000)	96.28 (1.000)	91.69 (1.000)	88.64 (1.000)	107.30 (1.000)	115.10 (1.000)	109.80 (1.000)	130.80 (1.000)	21.86
Hairy Woodpecker	37.60* (1.000)	73.03 (1.000)	69.02 (1.000)	73.27 (1.000)	233.30 (1.000)	278.80 (1.000)	272.30 (1.000)	n/a	35.43
Northern Flicker	31.65* (1.000)	62.90 (1.000)	63.20 (1.000)	63.35 (1.000)	152.40 (1.000)	168.70 (1.000)	167.50 (1.000)	867.40 (1.000)	31.25
Western Wood-Pewee	93.40* (1.000)	111.70 (1.000)	109.30 (1.000)	100.40 (1.000)	133.50 (1.000)	126.80 (1.000)	124.90 (1.000)	155.00 (1.000)	18.30
Hammond's Flycatcher	20.13* (1.000)	47.43 (1.000)	47.04 (1.000)	49.86 (1.000)	104.40 (1.000)	114.70 (1.000)	112.50 (1.000)	254.20 (1.000)	27.30
Dusky Flycatcher	144.50* (1.000)	155.50 (1.000)	155.10 (1.000)	146.60 (1.000)	168.10 (1.000)	161.90 (1.000)	159.80 (1.000)	175.00 (1.000)	11.00
Black Phoebe	40.61* (1.000)	61.99 (1.000)	61.61 (1.000)	60.34 (1.000)	117.70 (1.000)	121.80 (1.000)	119.70 (1.000)	259.10 (1.000)	21.38
Cassin's Vireo	33.37* (1.000)	49.78 (1.000)	52.08 (1.000)	50.48 (1.000)	94.75 (1.000)	84.12 (1.000)	82.30 (1.000)	141.40 n/a	16.41

Table 8. (cont.) Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents in transient models using 13 years (1993-2005)[1] of mark-recapture data from five MAPS stations in Yosemite National Park. $QAIC_C$[2] and (GOF)[3] are presented for all models.

Species	$\varphi p \tau$ [4]	$\varphi_t p \tau$ [5]	$\varphi p_t \tau$ [6]	$\varphi p \tau_t$ [7]	$\varphi_t p_t \tau$ [8]	$\varphi_t p \tau_t$ [9]	$\varphi p_t \tau_t$ [10]	$\varphi_t p_t \tau_t$ [11]	$\Delta QAIC_C$ [12]
Warbling Vireo	164.80 (1.000)	175.70 (1.000)	167.10 (1.000)	159.50* (1.000)	170.50 (1.000)	165.10 (1.000)	168.70 (1.000)	168.70 (1.000)	10.90
Mountain Chickadee	55.75* (1.000)	63.19 (1.000)	65.78 (1.000)	71.17 (1.000)	87.38 (1.000)	92.36 (1.000)	93.03 (1.000)	117.90 (1.000)	7.44
Brown Creeper	51.59* (1.000)	65.34 (1.000)	67.89 (1.000)	67.82 (1.000)	92.65 (1.000)	94.19 (1.000)	95.53 (1.000)	128.40 (1.000)	13.75
Golden-crowned Kinglet	39.56* (1.000)	63.92 (1.000)	54.33 (1.000)	57.39 (1.000)	75.60 (1.000)	85.27 (n/a)	74.15 (1.000)	100.70 (1.000)	24.36
Hermit Thrush	39.17* (1.000)	56.46 (1.000)	60.16 (1.000)	56.72 (1.000)	94.28 (1.000)	98.08 (1.000)	98.76 (1.000)	156.00 (1.000)	17.29
American Robin	117.70* (1.000)	128.80 (1.000)	131.20 (1.000)	127.10 (1.000)	151.10 (1.000)	146.60 (1.000)	148.30 (1.000)	170.30 (1.000)	11.10
Yellow Warbler	114.30* (1.000)	131.80 (1.000)	130.10 (1.000)	128.00 (1.000)	148.80 (1.000)	148.80 (1.000)	146.90 (1.000)	167.60 (1.000)	17.50
Yellow-rumped Warbler	117.90* (1.000)	128.00 (1.000)	132.50 (1.000)	130.40 (1.000)	139.50 (1.000)	139.70 (1.000)	144.70 (1.000)	154.60 (1.000)	10.10
Hermit Warbler	100.80* (1.000)	117.40 (1.000)	113.20 (1.000)	111.20 (1.000)	125.30 (1.000)	132.50 (1.000)	125.70 (1.000)	142.90 (1.000)	16.60

Table 8. (cont.) Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents in transient models using 13 years (1993-2005)[1] of mark-recapture data from five MAPS stations in Yosemite National Park. $QAIC_C$[2] and (GOF)[3] are presented for all models.

Species	Transient Models								$\Delta QAIC_C$[12]
	$\varphi p \tau$[4]	$\varphi_t p \tau$[5]	$\varphi p_t \tau$[6]	$\varphi p \tau_t$[7]	$\varphi_t p_t \tau$[8]	$\varphi_t p \tau_t$[9]	$\varphi p_t \tau_t$[10]	$\varphi_t p_t \tau_t$[11]	
MacGillivray's Warbler	196.80*	210.00	214.90	214.00	225.40	227.10	232.90	244.70	13.20
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Western Tanager	43.72*	53.53	54.30	54.14	73.55	76.15	72.07	126.90	9.81
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	n/a	
Spotted Towhee	35.38*	56.44	58.77	58.25	100.00	104.50	104.80	183.00	21.06
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Chipping Sparrow	89.90*	105.30	107.40	108.10	118.90	126.10	123.40	137.00	15.40
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Song Sparrow	179.90*	191.70	187.00	192.70	203.00	206.90	205.00	220.20	11.80
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Lincoln's Sparrow	213.80	216.90	209.50*	224.60	216.80	235.10	224.10	235.50	3.10
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Dark-eyed Junco	253.70*	253.10*	254.80*	267.20	266.60	271.30	272.10	283.50	-0.60
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Black-headed Grosbeak	130.50*	140.00	142.80	137.50	157.20	156.30	156.90	173.70	9.50
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	
Lazuli Bunting	109.20*	118.70	115.90	121.70	132.00	138.40	133.80	150.70	9.50
	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	

Table 8. (cont.) Summary statistics for survival analyses with temporally variable survival and recapture probabilities and proportion of residents in transient models using 13 years (1993-2005)[1] of mark-recapture data from five MAPS stations in Yosemite National Park. $QAIC_C$[2] and (GOF)[3] are presented for all models.

Species	Transient Models								$\Delta QAIC_C$[12]
	$\varphi p\tau$[4]	$\varphi_t p\tau$[5]	$\varphi p_t\tau$[6]	$\varphi p\tau_t$[7]	$\varphi_t p_t\tau$[8]	$\varphi_t p\tau_t$[9]	$\varphi p_t\tau_t$[10]	$\varphi_t p_t\tau_t$[11]	
Red-winged Blackbird	25.24* (1.000)	56.67 (1.000)	54.45 (1.000)	58.43 (1.000)	141.70 (1.000)	160.60 (1.000)	156.80 (1.000)	669.30 (1.000)	31.43
Purple Finch	46.43* (1.000)	69.75 (1.000)	56.65 (1.000)	60.06 (1.000)	75.66 (1.000)	95.08 (1.000)	77.17 (1.000)	97.83 (1.000)	23.32
Cassin's Finch	29.38* (1.000)	58.49 (1.000)	46.76 (1.000)	47.90 (1.000)	86.33 (n/a)	90.95 (1.000)	73.36 (1.000)	140.80 (n/a)	29.11

[1] Analysis of all stations pooled include data from 1993-2005 from the White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow stations as well as data from 1998-2005 from the Gin Flat East Meadow station.

[2] Akaike Information Criterion ($QAIC_C$) given as -2(log-likelihood) + 2(number of estimable parameters) with corrections for small sample sizes and overdispersion of data.

[3] Goodness-of-fit is a measure of how well the actual distribution of data fits the theoretical distribution calculated using the estimates provided by the model. The larger the value provided by the GOF test the better the model describes the data.

[4] $\varphi p\tau$ Model: Transient model with temporally-constant survival probability, recapture probability, and proportion of residents (invariable from year to year).

[5] $\varphi_t p\tau$ Model: Transient model with temporally-variable survival probability; and temporally-constant recapture probability and proportion of residents.

[6] $\varphi p_t\tau$ Model: Transient model with temporally-variable recapture probability; and temporally-constant survival probability and proportion of residents.

[7] $\varphi p\tau_t$ Model: Transient model with temporally-variable proportion of residents; and temporally-constant survival and recapture probabilities.

[8] $\varphi_t p_t\tau$ Model: Transient model with temporally-variable survival and recapture probabilities; and temporally-constant proportion of residents.

[9] $\varphi_t p\tau_t$ Model: Transient model with temporally-variable survival probability and proportion of residents; and temporally-constant recapture probability.

[10] $\varphi p_t\tau_t$ Model: Transient model with temporally-variable recapture probability and proportion of residents; and temporally-constant survival probability.

[11] $\varphi_t p_t\tau_t$ Model: Transient model with temporally-variable survival probability, recapture probability, and proportion of residents.

[12] $\Delta QAIC_C$ is defined as the difference in $\Delta QAIC_C$ between the $\varphi p\tau$ model and the $\varphi_t p\tau$ model.

* The chosen models are the model with the lowest $QAIC_C$ and the models with $QAIC_C$s within 2.0 units of the model with the lowest $QAIC_C$.

Table 9. Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at MAPS stations in Yosemite National Park obtained from 13 years (1993-2005)[1] of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.[5]	Model[6]	$QAIC_c$[7]	Survival probability[8]	Surv. C.V.[9]	Recapture probability[10]	Proportion of residents[11]
Williamson's Sapsucker †	1	32	42	5	φpτ	45.88	0.702 (0.160)	22.8	0.080 (0.078)	1.000 (0.991)
Red-breasted Sapsucker	3	123	170	20	φpτ	74.42	0.426 (0.099)	23.3	0.287 (0.124)	0.875 (0.415)
Hairy Woodpecker ‡	5	30	36	4	φpτ	37.60	0.642 (0.183)	28.5	0.121 (0.126)	0.735 (0.776)
Northern Flicker ‡†	5	35	40	4	φpτ	31.65	0.462 (0.237)	51.3	0.152 (0.221)	1.000 (1.597)
Western Wood-Pewee	5	107	146	16	φpτ	93.40	0.685 (0.088)	12.8	0.145 (0.063)	0.549 (0.256)
Hammond's Flycatcher ‡	2	47	54	2	φpτ	20.13	0.501 (0.289)	57.7	0.264 (0.299)	0.114 (0.152)
Dusky Flycatcher	4	321	507	59	φpτ	144.50	0.425 (0.050)	11.6	0.445 (0.080)	0.508 (0.119)
Black Phoebe	1	44	59	7	φpτ	40.61	0.432 (0.163)	37.8	0.679 (0.251)	0.304 (0.203)
Cassin's Vireo ‡†	3	89	98	4	φpτ	33.37	0.488 (0.202)	41.5	0.056 (0.111)	1.000 (2.012)
Warbling Vireo	5	531	762	57	φpτ*	164.80	0.474 (0.051)	10.8	0.280 (0.060)	0.390 (0.096)
					φpτ$_t$	159.50	0.464 (0.050)	10.8	0.291 (0.061)	a0.530 (0.243)
										b0.766 (0.319)
										c0.538 (0.272)
										d0.166 (0.166)
										e0.566 (0.259)
										f0.996 (0.362)
										g0.131 (0.132)
										h0.000 (0.000)
										i0.187 (0.186)
										j0.000 (0.000)
										k0.243 (0.241)
										l0.000 (0.000)
Mountain Chickadee †	5	165	200	17	φpτ	55.75	0.265 (0.101)	37.9	0.360 (0.199)	1.000 (0.639)
Brown Creeper	5	97	125	10	φpτ	51.59	0.384 (0.128)	33.4	0.335 (0.188)	0.530 (0.338)

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at MAPS stations in Yosemite National Park obtained from 13 years (1993-2005)[1] of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.	Model[6]	QAIC$_c$[7]	Survival probability[8]	Surv. C.V.[9]	Recapture probability[10]	Proportion of residents[11]
Golden-crowned Kinglet	4	195	230	7	φpτ	39.56	0.264 (0.120)	45.6	0.508 (0.293)	0.119 (0.087)
Hermit Thrush	3	66	78	6	φpτ	39.17	0.413 (0.160)	38.9	0.356 (0.241)	0.355 (0.283)
American Robin †	5	165	213	24	φpτ	117.70	0.615 (0.079)	12.9	0.118 (0.052)	1.000 (0.453)
Yellow Warbler	3	110	221	31	φpτ	114.30	0.647 (0.063)	9.7	0.379 (0.080)	0.301 (0.106)
Yellow-rumped Warbler	4	658	765	46	φpτ	117.90	0.360 (0.061)	17.0	0.284 (0.087)	0.472 (0.158)
Hermit Warbler	4	350	388	20	φpτ	100.80	0.630 (0.084)	13.4	0.075 (0.044)	0.549 (0.326)
MacGillivray's Warbler	4	536	1170	168	φpτ	196.80	0.550 (0.030)	5.5	0.613 (0.045)	0.341 (0.050)
Western Tanager †	4	179	192	6	φpτ	43.72	0.684 (0.167)	24.5	0.021 (0.041)	1.000 (1.956)
Spotted Towhee	1	53	69	8	φpτ	35.38	0.374 (0.152)	40.7	0.657 (0.261)	0.381 (0.246)
Chipping Sparrow	4	158	228	24	φpτ	89.90	0.440 (0.079)	18.1	0.213 (0.088)	0.943 (0.414)
Song Sparrow	3	279	585	94	φpτ	179.90	0.455 (0.041)	9.1	0.490 (0.064)	0.930 (0.164)
Lincoln's Sparrow	4	505	1310	166	φpτ*	213.80	0.482 (0.030)	6.3	0.643 (0.049)	0.484 (0.070)
					φp$_t$τ	209.50	0.498 (0.029)	5.8	a0.649 (0.194)	0.493 (0.071)
									b0.382 (0.119)	
									c0.217 (0.100)	
									d0.616 (0.129)	
									e0.316 (0.110)	
									f0.598 (0.115)	
									g0.687 (0.120)	
									h0.660 (0.112)	
									i0.735 (0.114)	
									j0.575 (0.115)	
									k1.000 (0.000)	
									l0.671 (0.137)	

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at MAPS stations in Yosemite National Park obtained from 13 years (1993-2005)[1] of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.	Model[6]	$QAIC_c$[7]	Survival probability[8]	Surv. C.V.[9]	Recapture probability[10]	Proportion of residents[11]
Dark-eyed Junco	5	957	1764	251	φpτ	253.70	0.470 (0.025)	5.4	0.512 (0.039)	0.573 (0.063)
					φ$_t$pτ	253.10	a0.434 (0.105)	24.2	0.518 (0.040)	0.588 (0.065)
							b0.312 (0.068)	21.8		
							c0.682 (0.114)	16.7		
							d0.537 (0.090)	16.8		
							e0.366 (0.079)	21.6		
							f0.370 (0.077)	20.8		
							g0.535 (0.098)	18.3		
							h0.315 (0.061)	19.4		
							i0.525 (0.090)	17.1		
							j0.609 (0.088)	14.4		
							k0.562 (0.093)	16.5		
							l0.391 (0.075)	19.2		
					φp$_t$τ	254.80	0.468 (0.025)	5.3	a0.621 (0.125)	0.585 (0.065)
									b0.301 (0.083)	
									c0.604 (0.108)	
									d0.591 (0.100)	
									e0.465 (0.101)	
									f0.460 (0.094)	
									g0.563 (0.103)	
									h0.319 (0.073)	
									i0.437 (0.088)	
									j0.615 (0.091)	
									k0.716 (0.110)	
									l0.479 (0.093)	
Black-headed Grosbeak	3	226	290	37	φpτ	130.50	0.579 (0.064)	11.0	0.279 (0.073)	0.455 (0.141)
Lazuli Bunting	2	346	421	25	φpτ	109.20	0.610 (0.070)	11.4	0.171 (0.058)	0.239 (0.090)

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at MAPS stations in Yosemite National Park obtained from 13 years (1993-2005)[1] of mark-recapture data.

Species	Num. sta2.[2]	Num. ind.[3]	Num. caps.[4]	Num. ret.[5]	Model[6]	QAIC$_c$[7]	Survival probability[8]	Surv. C.V.[9]	Recapture probability[10]	Proportion of residents[11]
Red-winged Blackbird ‡	1	38	46	4	φpτ	25.24	0.319 (0.193)	60.4	0.357 (0.336)	0.656 (0.706)
Purple Finch ‡	3	282	307	11	φpτ	46.43	0.206 (0.108)	52.6	0.229 (0.219)	0.691 (0.705)
Cassin's Finch ‡†	2	104	108	3	φpτ	29.38	0.791 (0.224)	28.3	0.010 (0.032)	1.000 (3.037)

[1] Analysis of all stations pooled include data from 1993-2005 from the White Wolf, Crane Flat, Hodgdon Meadow, and Big Meadow stations as well as data from 1998-2005 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] Models included are those chosen by QAIC$_C$ (those models marked with * in Table 8) plus the φpτ model in all cases. See Table 8 for definitions of the models.
[7] Akaike Information Criterion (QAIC$_C$) given as -2(log-likelihood) + 2(number of estimable parameters) with corrections for small sample size and over dispersion of data.
[8] Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate).
　　　a The survival probability between the years 1993-1994 in a temporally variable model.
　　　b The survival probability between the years 1994-1995 in a temporally variable model.
　　　c The survival probability between the years 1995-1996 in a temporally variable model.
　　　d The survival probability between the years 1996-1997 in a temporally variable model.
　　　e The survival probability between the years 1997-1998 in a temporally variable model.
　　　f The survival probability between the years 1998-1999 in a temporally variable model.
　　　g The survival probability between the years 1999-2000 in a temporally variable model.
　　　h The survival probability between the years 2000-2001 in a temporally variable model.
　　　i The survival probability between the years 2001-2002 in a temporally variable model.
　　　j The survival probability between the years 2002-2003 in a temporally variable model.
　　　k The survival probability between the years 2003-2004 in a temporally variable model.
　　　l The survival probability between the years 2004-2005 in a temporally variable model.
[9] The coefficient of variation for survival probability, CV(φ).

Table 9. (cont.) Estimates of adult annual survival and recapture probabilities and proportion of residents among newly captured adults using both temporally variable and time-constant models for 30 species breeding at MAPS stations in Yosemite National Park obtained from 13 years (1993-2005)[1] of mark-recapture data.

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[10] Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate).
  a The recapture probability in 1994 in a temporally variable model.
  b The recapture probability in 1995 in a temporally variable model.
  c The recapture probability in 1996 in a temporally variable model.
  d The recapture probability in 1997 in a temporally variable model.
  e The recapture probability in 1998 in a temporally variable model.
  f The recapture probability in 1999 in a temporally variable model.
  g The recapture probability in 2000 in a temporally variable model.
  h The recapture probability in 2001 in a temporally variable model.
  i The recapture probability in 2002 in a temporally variable model.
  j The recapture probability in 2003 in a temporally variable model.
  k The recapture probability in 2004 in a temporally variable model.
  l The recapture probability in 2005 in a temporally variable model.
[11] The proportion of residents among newly captured adults (τ) presented as the maximum likelihood estimate (standard error of the estimate).
  a The proportion of residents in the adult population in 1993 in a temporally variable model.
  b The proportion of residents in the adult population in 1994 in a temporally variable model.
  c The proportion of residents in the adult population in 1995 in a temporally variable model.
  d The proportion of residents in the adult population in 1996 in a temporally variable model.
  e The proportion of residents in the adult population in 1997 in a temporally variable model.
  f The proportion of residents in the adult population in 1998 in a temporally variable model.
  g The proportion of residents in the adult population in 1999 in a temporally variable model.
  h The proportion of residents in the adult population in 2000 in a temporally variable model.
  i The proportion of residents in the adult population in 2001 in a temporally variable model.
  j The proportion of residents in the adult population in 2002 in a temporally variable model.
  k The proportion of residents in the adult population in 2003 in a temporally variable model.
  k The proportion of residents in the adult population in 2004 in a temporally variable model.

* The time-constant model was not selected by $QAIC_C$, but is presented to allow the parameter values to be compared with other species.
‡ 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(φ)>0.200 or CV(φ)>50.0%).
† The estimate for recapture probability (and possibly survival probability as well) may be biased low because the estimate for τ was 1.000.

Table 10. Assessment of vital rates for 16 target species showing substantially decreasing or increasing 13-year (1993-2005) population trends at the four long-running stations in Yosemite National Park.

Species	Trend and its significance[1]	Productivity	Survival Probability[2]
A. Decreasing Species			
Red-breasted Sapsucker	- 3.4	slightly high, increasing	slightly low
Western Wood-Pewee	- 5.1 **	low, decreasing	high
Dusky Flycatcher	- 5.3 ***	low, decreasing	slightly low
Warbling Vireo	- 1.5	low, increasing	expected
Golden-crowned Kinglet	- 6.1 **	high	low/high
Hermit Thrush	- 4.0	slightly low, decreasing	slightly low
Yellow Warbler	- 4.1 **	slightly low, increasing	high/as-expected
Hermit Warbler	- 3.6 **	high, increasing	high/as-expected
Chipping Sparrow	- 6.3 **	low, decreasing	as expected/high
Dark-eyed Junco	- 1.6 *	slightly high,	as expected
Black-headed Grosbeak	- 5.4 ***	slightly high, increasing	as expected
Lazuli Bunting	- 7.6 ***	slightly low, increasing	high
B. Increasing Species			
Mountain Chickadee	5.6 **	as expected, increasing	low
Yellow-rumped Warbler	10.7 *	high	slightly low/low
MacGillivray's Warbler	1.9	as expected	slightly high/as expected
Western Tanager	9.7	as expected	high

[1] Significance of the declines in adult population levels (Annual Percent Change value from Figure 1) . *** $P < 0.01$; ** $0.01 \le P < 0.05$; * $0.05 \le P < 0.10$.

[2] Survival assessments are based on two comparisons: (1) with body mass and (2) with survival in the Northwestern Maps region as a whole. When only one assessment is given it indicates that both of these comparisons coincided.
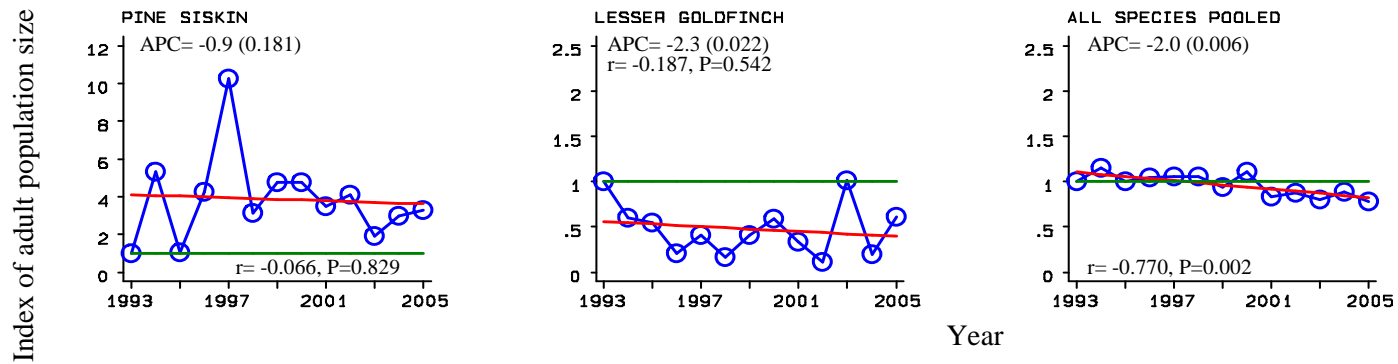
Figure 1. Population trends for 26 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 13 years 1993-2005. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort 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.
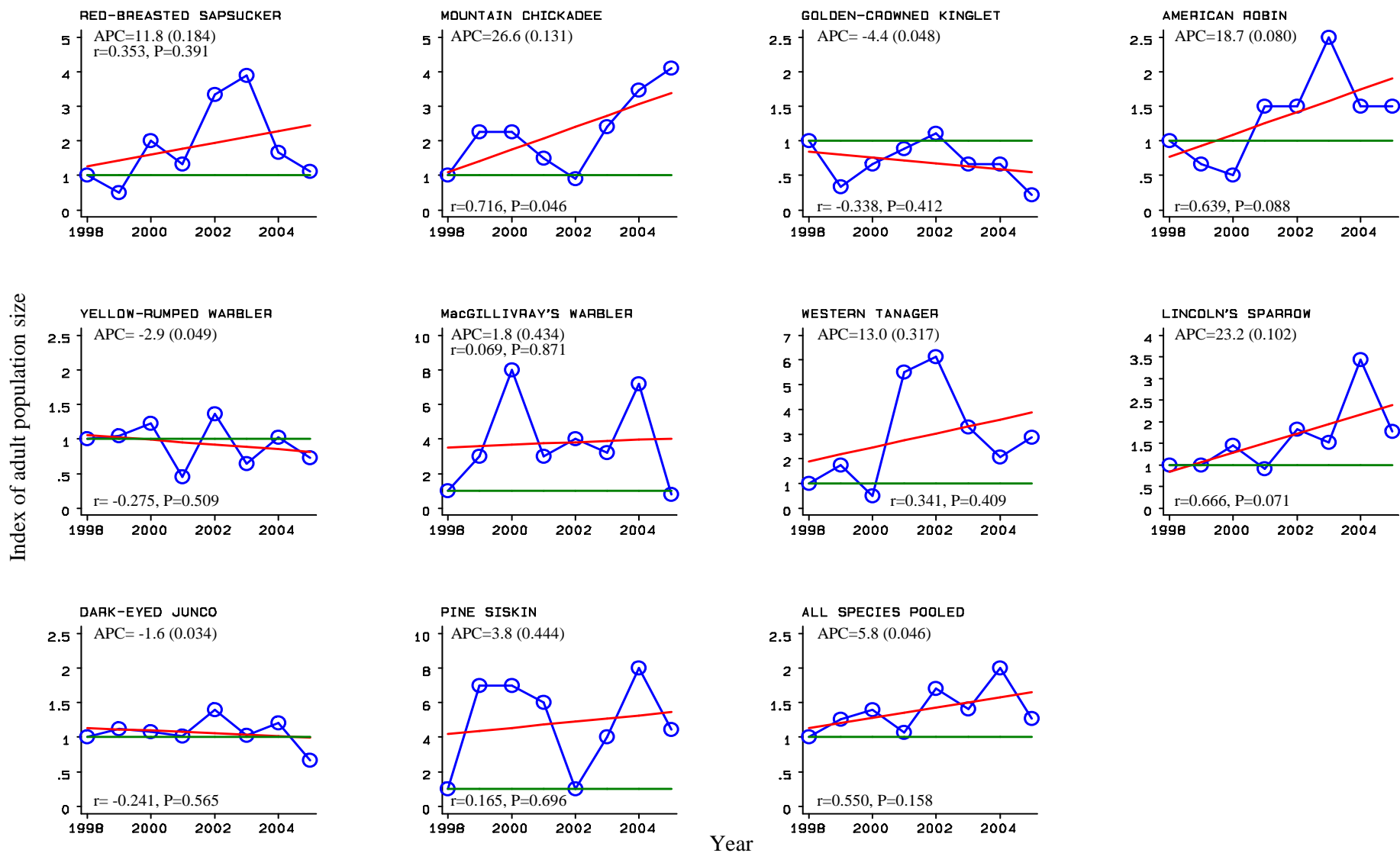
Figure 1. (cont.) Population trends for 26 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 13 years 1993-2005. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort 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.
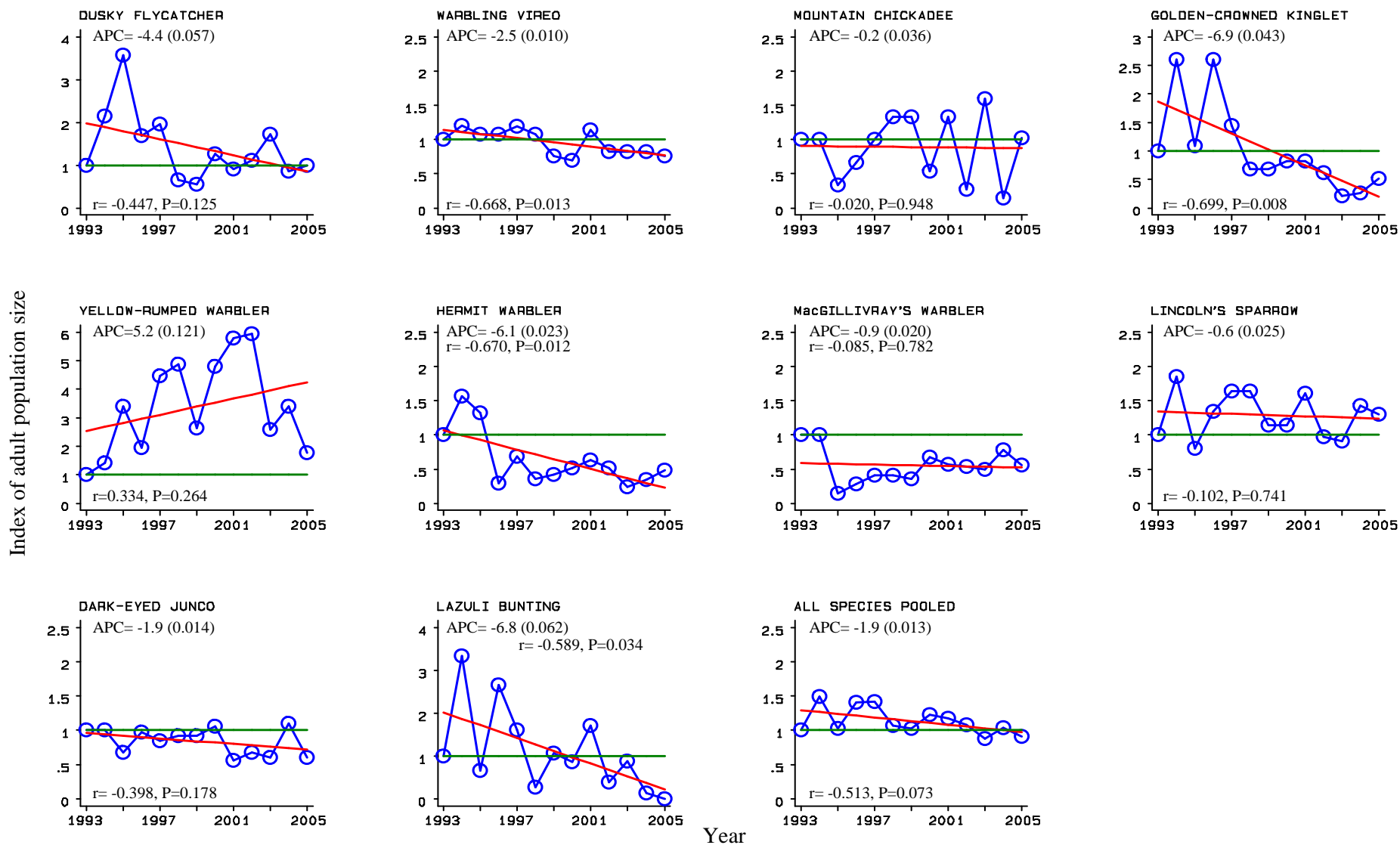
Figure 1. (cont.) Population trends for 26 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 13 years 1993-2005. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort 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. Population trends for two species and all species pooled at the **White Wolf MAPS station** in Yosemite National Park over the 13 years 1993-2005. 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.

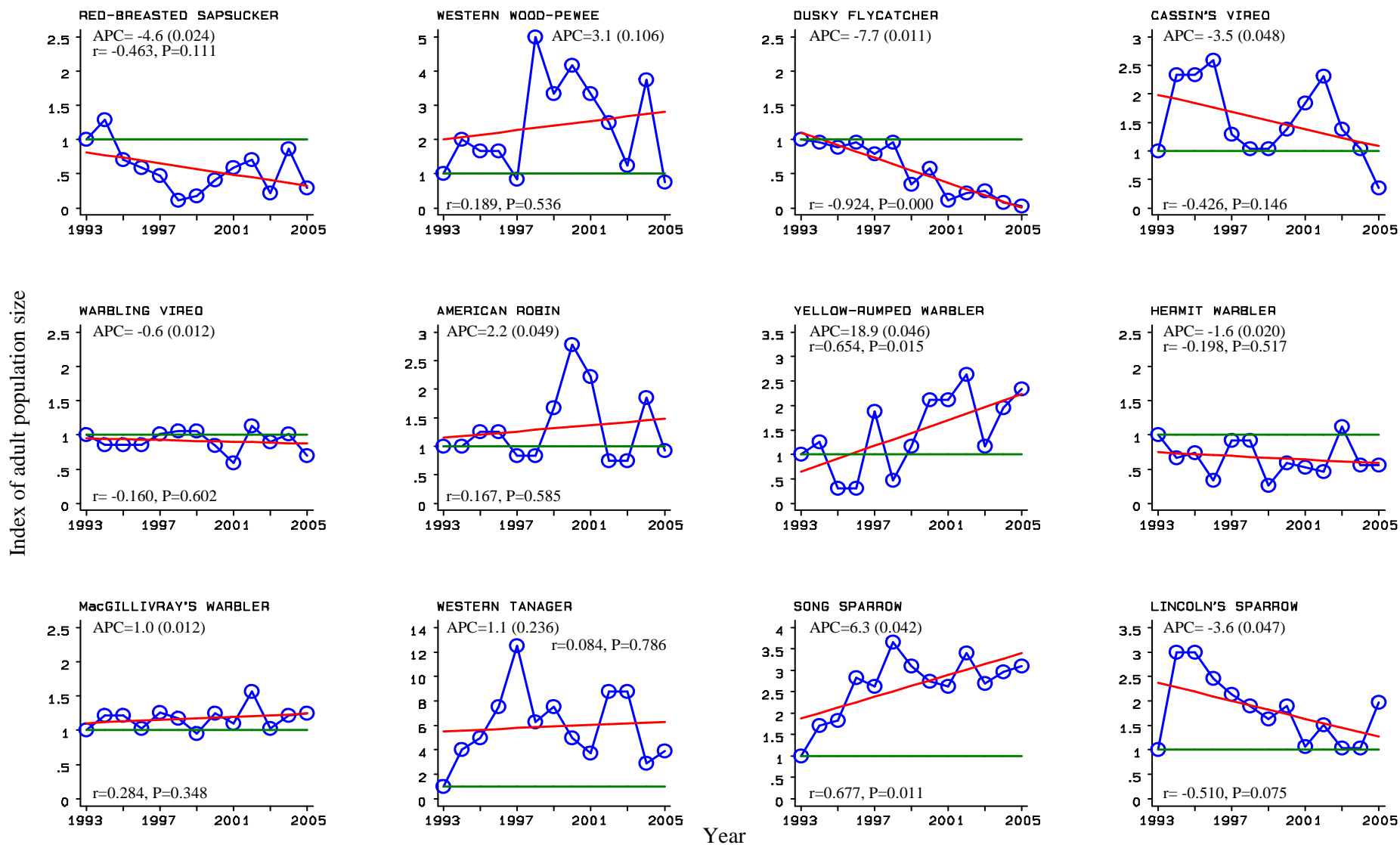Figure 3. Population trends for ten species and all species pooled at the **Gin Flat East Meadow MAPS station** in Yosemite National Park over the eight years 1998-2005. The index of population size was arbitrarily defined as 1.0 in 1998. Indices for subsequent years were determined from constant-effort between-year changes in the number of adult birds captured from stations where the species was a regular or usual breeder and summer resident. The annual percentage change in the index of adult population size was used as the measure of the population trend (APC), and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient (r) and significance of the correlation coefficient (P) are also shown on each graph.
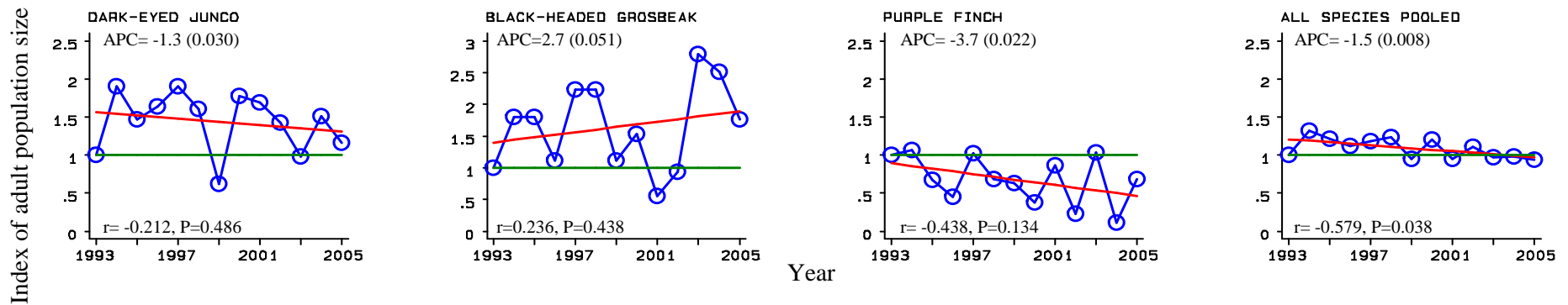
Figure 4. Population trends for ten species and all species pooled at the **Crane Flat MAPS station** in Yosemite National Park over the 13 years 1993-2005. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year 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.
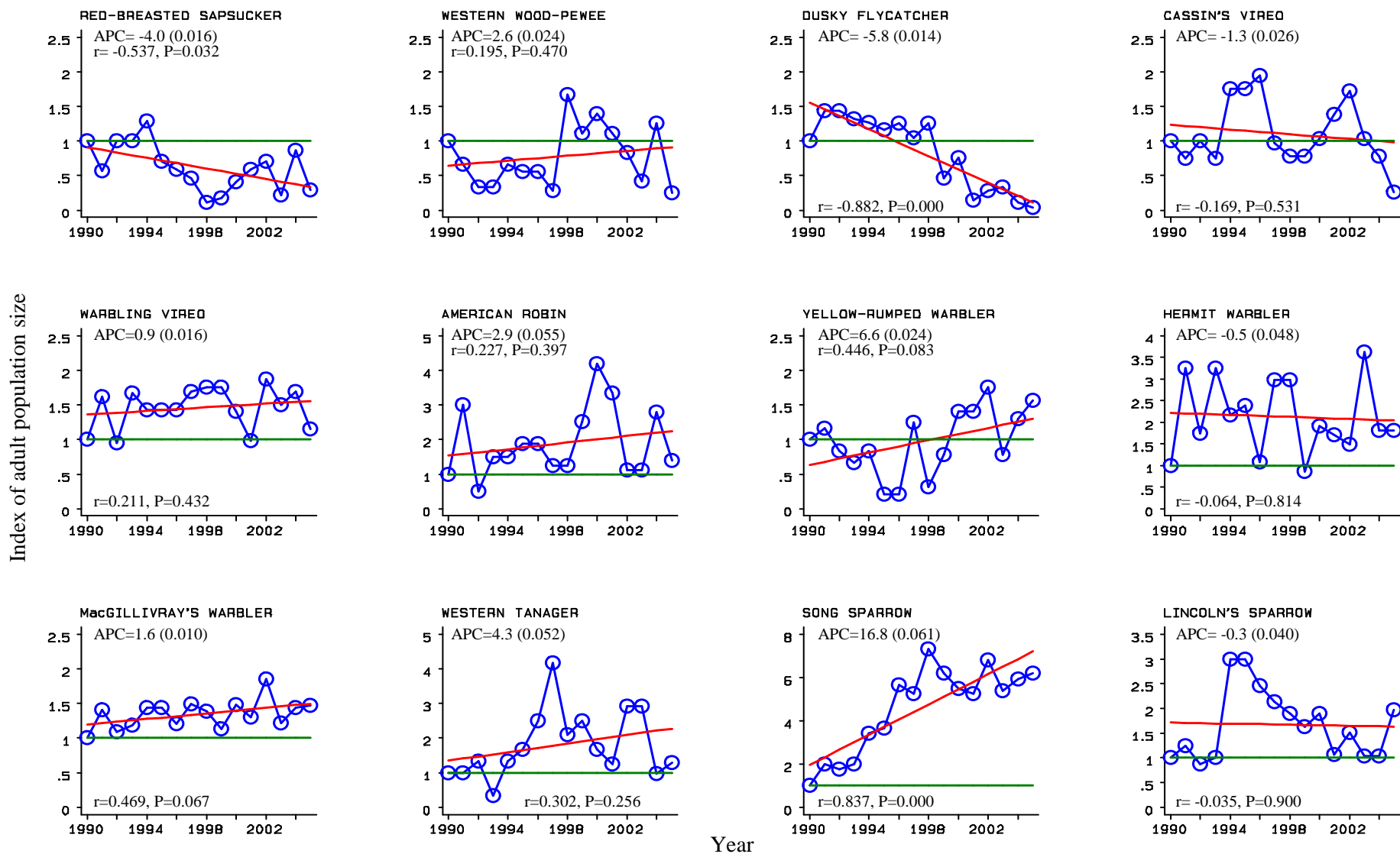
Figure 5. Population trends for 15 species and all species pooled at the **Hodgdon Meadow MAPS stations** in Yosemite National Park over the **13 years 1993-2005**. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort between-year 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.
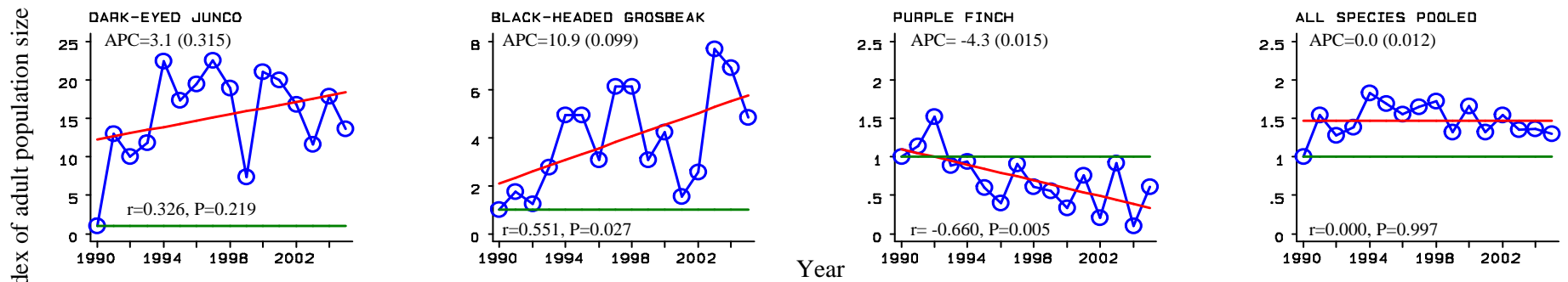
Figure 5. (cont.) Population trends for 15 species and all species pooled at the **Hodgdon Meadow MAPS stations** in Yosemite National Park over the **13 years 1993-2005**. The index of population size was arbitrarily defined as 1.0 in 1993. Indices for subsequent years were determined from constant-effort 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.   1

Figure 6. Population trends for 15 species and all species pooled at the **Hodgdon Meadow MAPS station** in Yosemite National Park over the **16 years 1990-2005**. The index of population size was arbitrarily defined as 1.0 in 1990. 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.
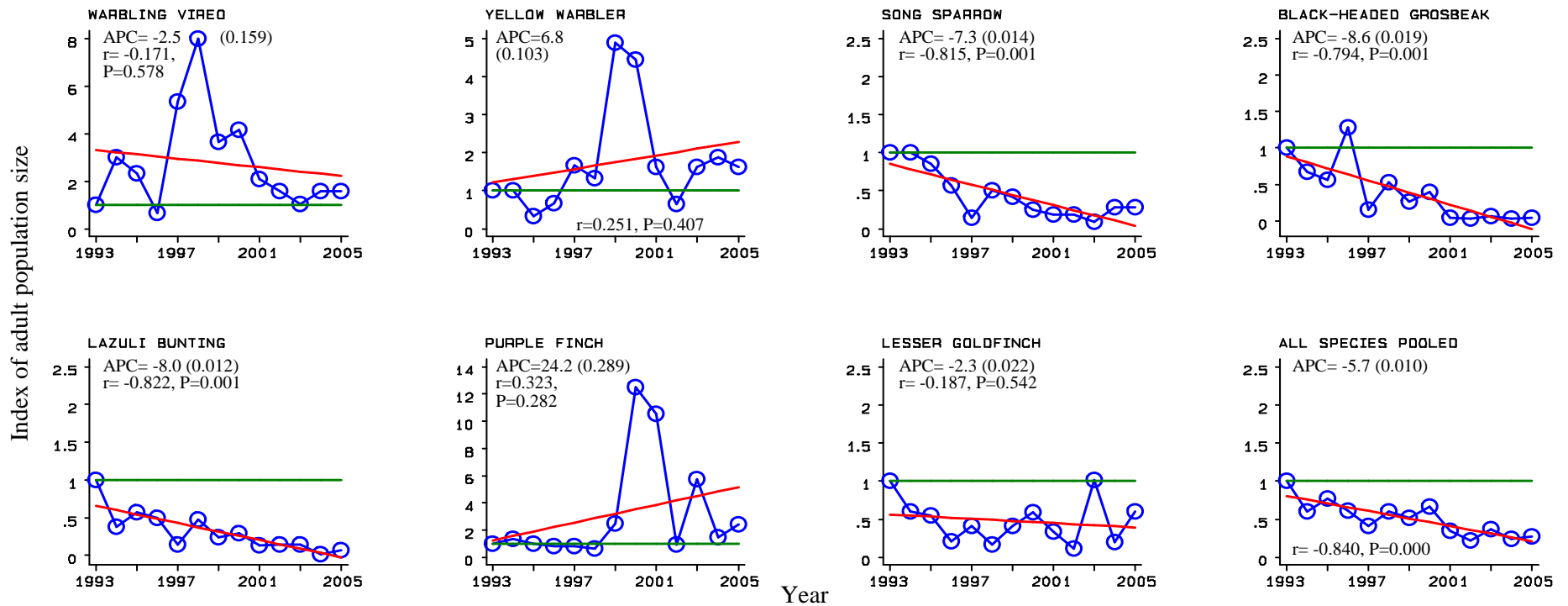
Figure 6. (cont.) Population trends for 15 species and all species pooled at the **Hodgdon Meadow MAPS station** in Yosemite National Park over the **16 years 1990-2005**. The index of population size was arbitrarily defined as 1.0 in 1990. Indices for subsequent years were determined from constant-effort 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 7. Population trends for 7 species and all species pooled at the **Big Meadow MAPS station** in Yosemite National Park over the 13 years 1993-2005. 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.
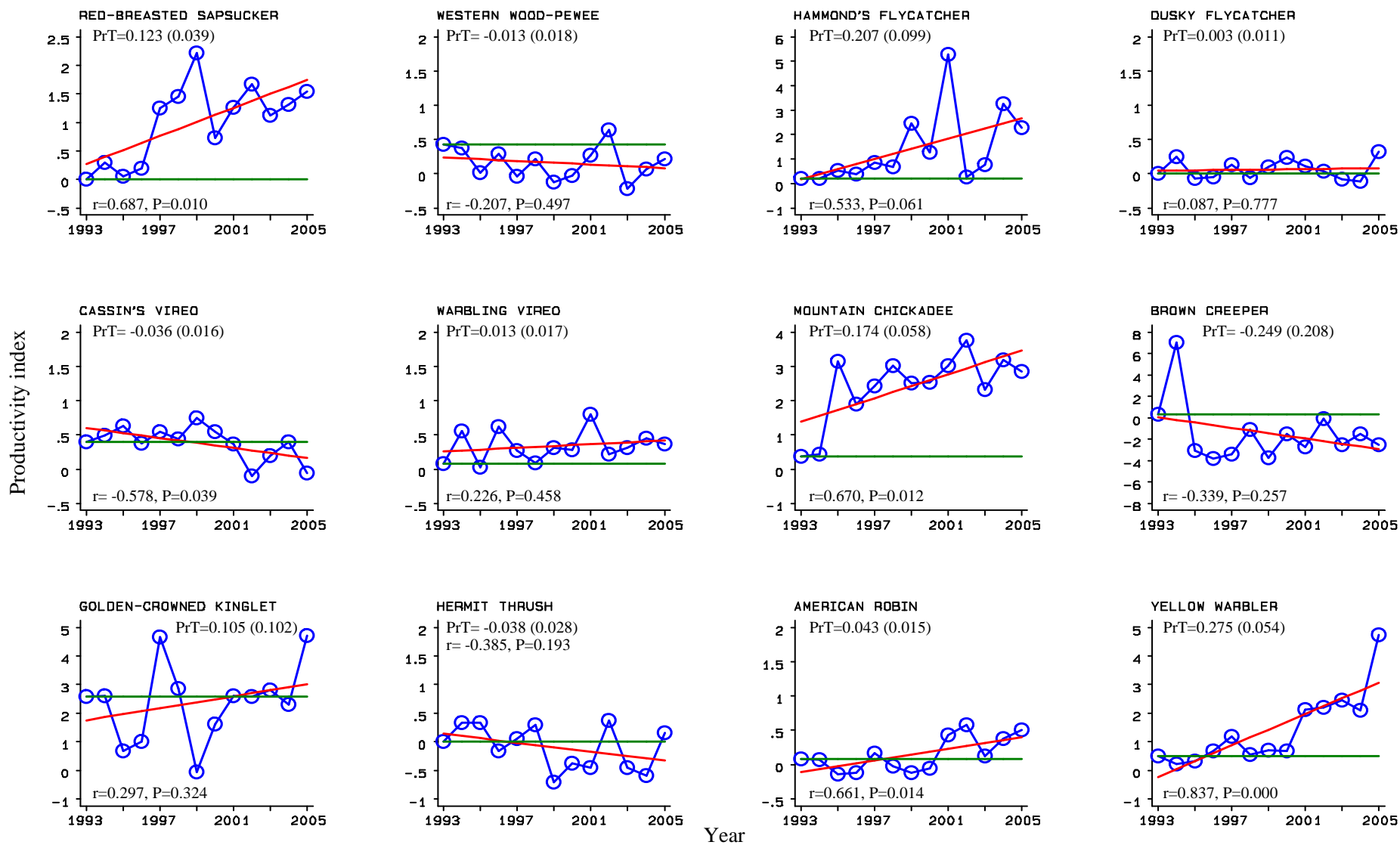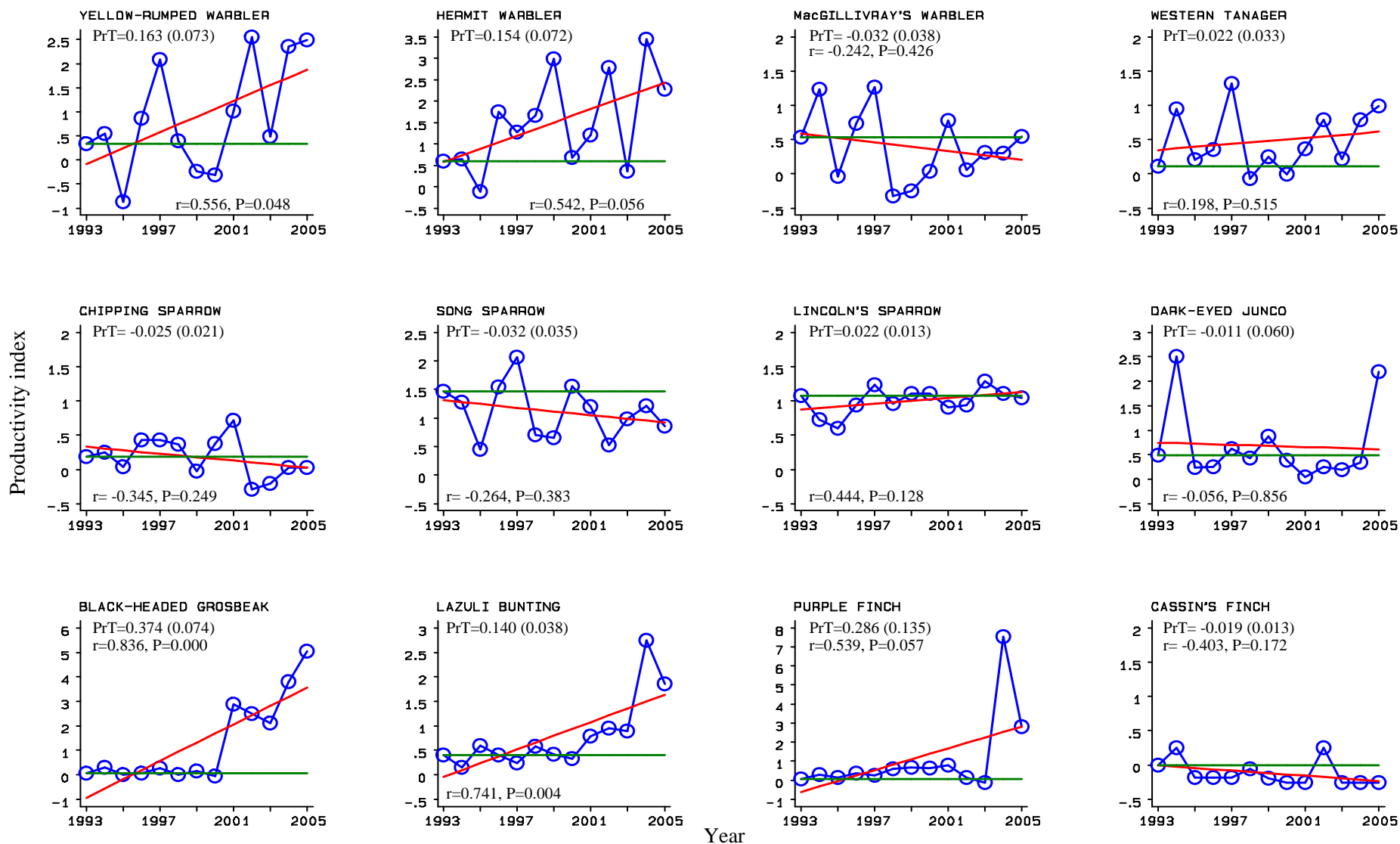
Figure 8. Trend in productivity for 26 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 13 years 1993-2005. The productivity index was defined as the actual productivity value in 1993. Indices for subsequent years were determined from 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 8. (cont.) Trend in productivity for 26 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 13 years 1993-2005. The productivity index was defined as the actual productivity 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.
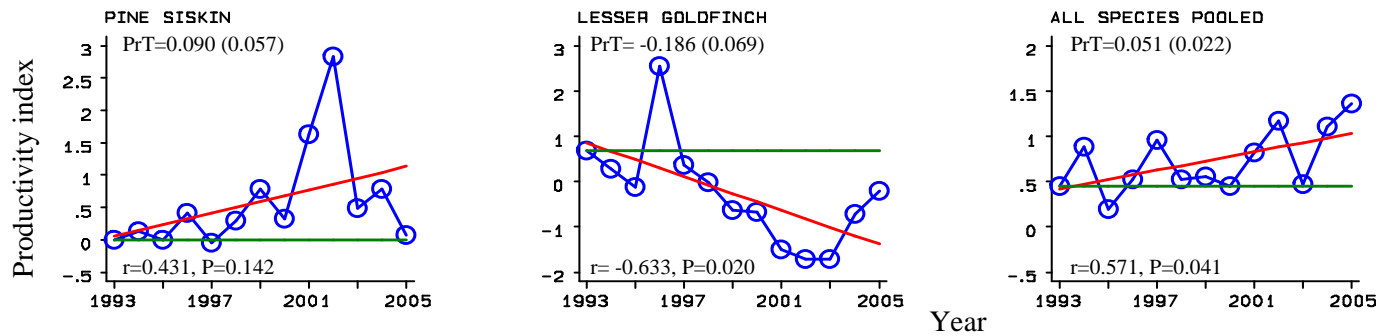
Figure 8. (cont.) Trend in productivity for 26 species and all species pooled at the **five currently operating MAPS stations** in Yosemite National Park over the 13 years 1993-2005. The productivity index was defined as the actual productivity value in 1993. Indices for subsequent years were determined 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.
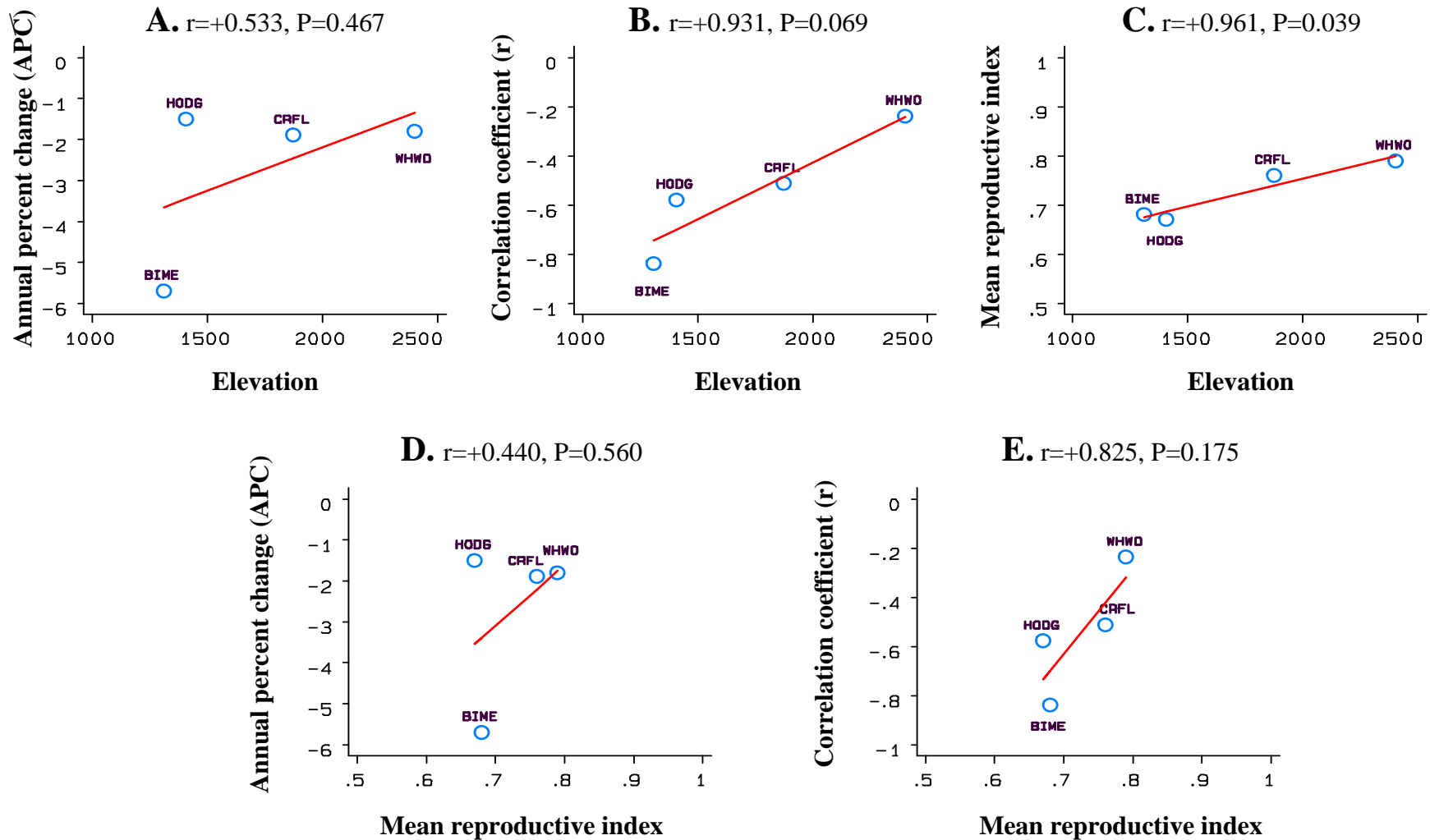
Figure 9. Five correlations of population indices for all species pooled at the four long running MAPS stations at Yosemite National Park over the 13 years 1993-2005. The correlations are: A. the annual percent change (APC) in adult population index against elevation, B. the correlation coefficient of adult population size against elevation, C. the mean reproductive index over all years against elevation, D. the annual percent change (APC) in adult population index against the mean reproductive index over all years, E. the correlation coefficient of adult population size against the mean reproductive index over all years. The correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are shown on each graph. WHWO -White Wolf; CRFL - Crane Flat, HODG - Hodgdon Meadow, BIME - Big Meadow
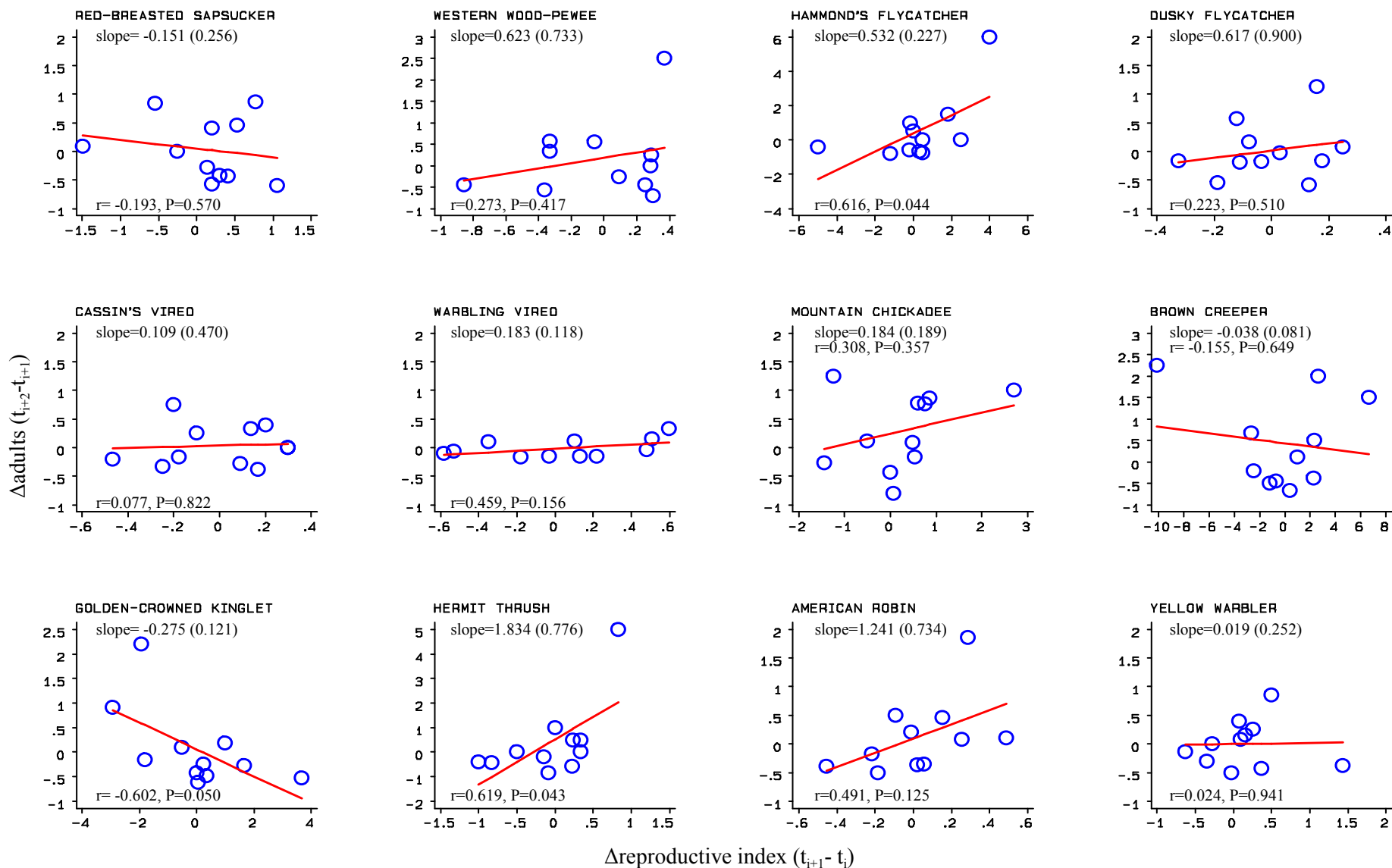
Figure 10. The regression of the proportional change in the number of adults between year i+2 and year i+1 on the change in reproductive index between year i+1 and year i ("reproductive index/population correlation") for 27 species and all species pooled at the five currently operating MAPS stations in Yosemite National Park over the years 1993-2005. The constant-effort between-year changes were obtained from data pooled from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line, the standard error of the slope (in parentheses), the correlation coefficient (r), and significance of the correlation coefficient (P) are presented on each graph.
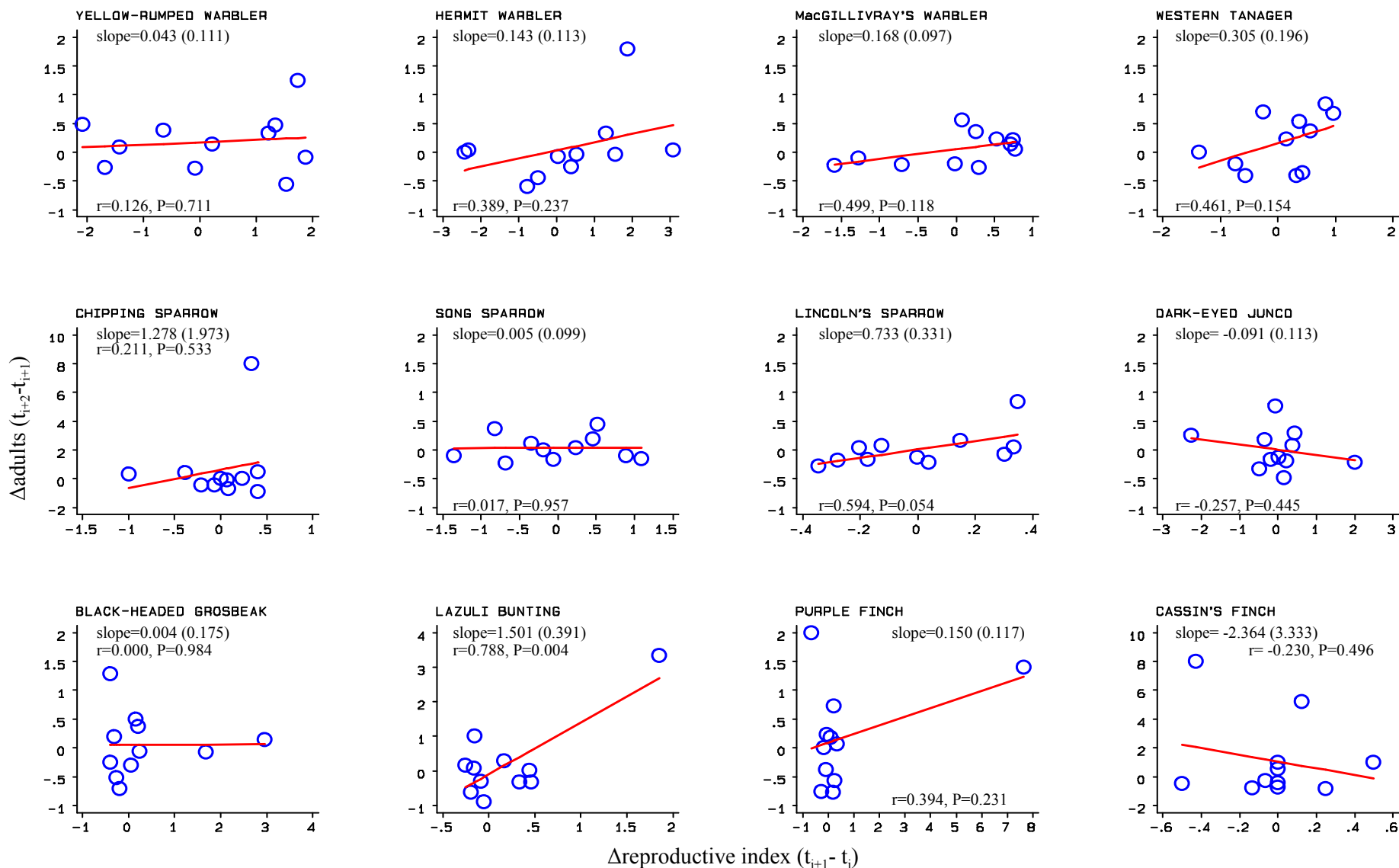
Figure 10. (cont.) The regression of the proportional change in the number of adults between year i+2 and year i+1 on the change in reproductive index between year i+1 and year i ("reproductive index/population correlation") for 27 species and all species pooled at the five currently operating MAPS stations in Yosemite National Park over the years 1993-2005. The constant-effort between-year changes were obtained from data pooled from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line, the standard error of the slope (in parentheses), the correlation coefficient (r), and significance of the correlation coefficient (P) are presented on each graph.
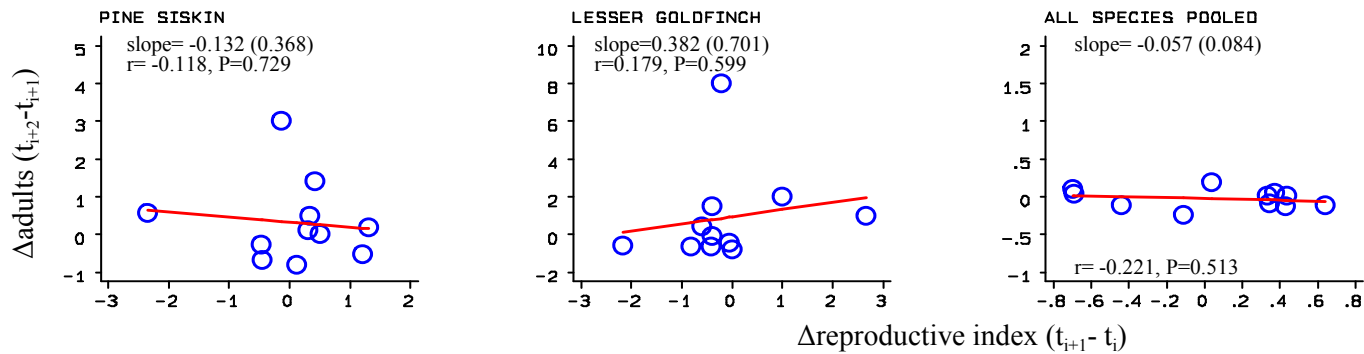
Figure 10. (cont.) The regression of the proportional change in the number of adults between year i+2 and year i+1 on the change in reproductive index between year i+1 and year i ("reproductive index/population correlation") for 26 species and all species pooled at the five currently operating MAPS stations in Yosemite National Park over the years 1993-2005. The constant-effort between-year changes were obtained from data pooled from stations where the species was a regular or usual breeder and summer resident. The slope of the regression line, the standard error of the slope (in parentheses), the correlation coefficient (r), and significance of the correlation coefficient (P) are presented on each graph.
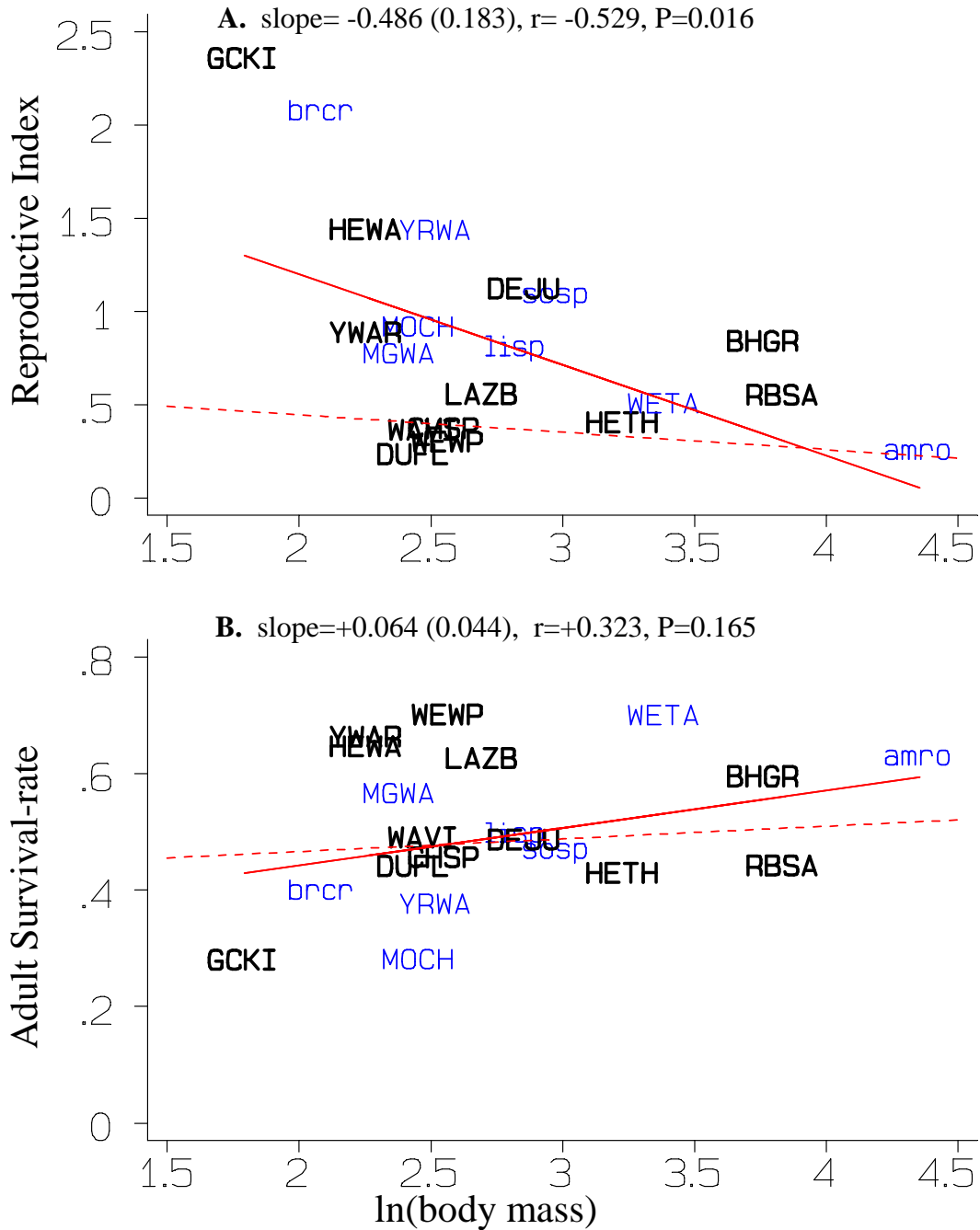
Figure 11. Regressions of mean reproductive index (**A**) and time-constant annual adult survival rate (**B**) at the five currently operating MAPS stations in Yosemite National Park on the natural log of body mass for 20 target species. Target species were included if the survival estimate for the species was reliable (i.e. there were at least 5 returns, SE(phi)≤0.2 and CV(phi)<50% for the 13 years 1993-2005) and if the reproductive index was defined in each of the 12 years (i.e. at least one constant effort adult was captured in every year). Four-letter codes (see Appendix I) in bold upper-case letters represent species that had decreasing population trends (r<-0.300); those in non-bold upper-case letters had increasing trends (r>0.300); and those in lower-case letters had highly fluctuating data without any substantial linear trend (-0.300≥r≥0.300) over all five stations pooled. Regression lines are presented for the 20 target species in Yosemite National Park (solid line) and for all species throughout all of North America (dashed line; see text). The slope, r-value, and P-value are presented for the 20 target species.

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 16 years, 1990-2005, of the MAPS Program on the six stations ever operated in Yosemite National Park.

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NUMB	SPEC	SPECIES NAME
01010	GBHE	Great Blue Heron
01300	TUVU	Turkey Vulture
01630	MALL	Mallard
01980	COME	Common Merganser
02020	OSPR	Osprey
02170	NOHA	Northern Harrier
02200	SSHA	Sharp-shinned Hawk
02210	COHA	Cooper's Hawk
02240	NOGO	Northern Goshawk
02380	RSHA	Red-shouldered Hawk
02460	RTHA	Red-tailed Hawk
02510	GOEA	Golden Eagle
02545	UNHA	Unidentified Hawk
02630	AMKE	American Kestrel
03000	BLUG	Blue Grouse
03040	WITU	Wild Turkey
03100	MOUQ	Mountain Quail
03130	CAQU	California Quail
03370	VIRA	Virginia Rail
05440	BTPI	Band-tailed Pigeon
05570	MODO	Mourning Dove
06670	WESO	Western Screech-Owl
06800	GHOW	Great Horned Owl
06830	NOPO	Northern Pygmy-Owl
06940	SPOW	Spotted Owl
06970	GGOW	Great Gray Owl
07040	NSWO	Northern Saw-whet Owl
07330	BLSW	Black Swift
07410	VASW	Vaux's Swift
07530	WTSW	White-throated Swift
08640	BCHU	Black-chinned Hummingbird
08670	ANHU	Anna's Hummingbird
08690	CAHU	Calliope Hummingbird
08730	RUHU	Rufous Hummingbird
08774	USHU	Unidentified Selasphorus Hummingbird
08775	UNHU	Unidentified Hummingbird
09110	BEKI	Belted Kingfisher
09390	LEWO	Lewis's Woodpecker
09430	ACWO	Acorn Woodpecker

NUMB	SPEC	SPECIES NAME
09570	WISA	Williamson's Sapsucker
09600	RBSA	Red-breasted Sapsucker
09640	NUWO	Nuttall's Woodpecker
09650	DOWO	Downy Woodpecker
09660	HAWO	Hairy Woodpecker
09690	WHWO	White-headed Woodpecker
09800	RSFL	Red-shafted Flicker
09860	PIWO	Pileated Woodpecker
09915	UNWO	Unidentified Woodpecker
11340	OSFL	Olive-sided Flycatcher
11380	WEWP	Western Wood-Pewee
11475	TRFL	Traill's Flycatcher
11475	WIFL	Willow Flycatcher
11510	HAFL	Hammond's Flycatcher
11515	HDFL	Hammond's/Dusky Flycatcher
11520	GRFL	Gray Flycatcher
11530	DUFL	Dusky Flycatcher
11555	PSFL	Pacific-slope Flycatcher
11555	WEFL	Western Flycatcher
11595	UEFL	Unidentified Empidonax Flycatcher
11600	BLPH	Black Phoebe
11740	ATFL	Ash-throated Flycatcher
12020	WEKI	Western Kingbird
12085	UNFL	Unidentified Flycatcher
12710	CAVI	Cassin's Vireo
12740	HUVI	Hutton's Vireo
12760	WAVI	Warbling Vireo
12790	REVI	Red-eyed Vireo
12920	STJA	Steller's Jay
13110	WESJ	Western Scrub-Jay
13150	CLNU	Clark's Nutcracker
13190	AMCR	American Crow
13300	CORA	Common Raven
13410	TRES	Tree Swallow
13440	VGSW	Violet-green Swallow
13490	NRWS	Northern Rough-winged Swallow
13540	BARS	Barn Swallow
13555	UNSW	Unidentified Swallow
13580	MOCH	Mountain Chickadee
13600	CBCH	Chestnut-backed Chickadee
13640	OATI	Oak Titmouse
13680	BUSH	Bushtit

NUMB	SPEC	SPECIES NAME
13690	RBNU	Red-breasted Nuthatch
13700	WBNU	White-breasted Nuthatch
13710	PYNU	Pygmy Nuthatch
13730	BRCR	Brown Creeper
14040	BEWR	Bewick's Wren
14070	HOWR	House Wren
14110	WIWR	Winter Wren
14205	UNWR	Unidentified Wren
14210	AMDI	American Dipper
14240	GCKI	Golden-crowned Kinglet
14250	RCKI	Ruby-crowned Kinglet
14570	WEBL	Western Bluebird
14590	TOSO	Townsend's Solitaire
14810	SWTH	Swainson's Thrush
14820	HETH	Hermit Thrush
15000	AMRO	American Robin
15110	WREN	Wrentit
15370	EUST	European Starling
15550	CEDW	Cedar Waxwing
15660	OCWA	Orange-crowned Warbler
15670	NAWA	Nashville Warbler
15750	YWAR	Yellow Warbler
15800	AUWA	Audubon's Warbler
15810	BTYW	Black-throated Gray Warbler
15840	TOWA	Townsend's Warbler
15850	HEWA	Hermit Warbler
16040	AMRE	American Redstart
16090	NOWA	Northern Waterthrush
16140	MGWA	MacGillivray's Warbler
16150	COYE	Common Yellowthroat
16280	HOWA	Hooded Warbler
16290	WIWA	Wilson's Warbler
16460	YBCH	Yellow-breasted Chat
16495	UNWA	Unidentified Warbler
16840	WETA	Western Tanager
17790	GTTO	Green-tailed Towhee
17810	SPTO	Spotted Towhee
17850	CALT	California Towhee
18020	CHSP	Chipping Sparrow
18110	SAGS	Sage Sparrow
18130	SAVS	Savannah Sparrow
18220	FOSP	Fox Sparrow

NUMB	SPEC	SPECIES NAME
18230	SOSP	Song Sparrow
18240	LISP	Lincoln's Sparrow
18290	MWCS	Mountain White-crowned Sparrow
18320	ORJU	Oregon Junco
18335	UNSP	Unidentified Sparrow
18600	RBGR	Rose-breasted Grosbeak
18610	BHGR	Black-headed Grosbeak
18660	LAZB	Lazuli Bunting
18670	INBU	Indigo Bunting
18730	RWBL	Red-winged Blackbird
18810	WEME	Western Meadowlark
18820	YHBL	Yellow-headed Blackbird
18860	BRBL	Brewer's Blackbird
18960	BHCO	Brown-headed Cowbird
19105	BUOR	Bullock's Oriole
19330	PIGR	Pine Grosbeak
19350	PUFI	Purple Finch
19360	CAFI	Cassin's Finch
19370	HOFI	House Finch
19375	UCFI	Unidentified Carpodacus Finch
19380	RECR	Red Crossbill
19430	PISI	Pine Siskin
19490	LEGO	Lesser Goldfinch
19500	LAGO	Lawrence's Goldfinch
19510	AMGO	American Goldfinch
19580	EVGR	Evening Grosbeak
19920	HOSP	House Sparrow
20085	UNBI	Unidentified Bird