THE 2002 ANNUAL REPORT OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM ON FLATHEAD NATIONAL FOREST AND THE FLATHEAD RESERVATION OF THE CONFEDERATED SALISH AND KOOTENAI TRIBES

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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 some 500 constant-effort mist-netting and banding stations. The purpose of the MAPS program is to provide annual indices of adult population size and post-fledging productivity, as well as annual estimates of adult survivorship, recruitment into the adult population, and population growth rate at multiple spatial scales for many 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 forests provides a group of ideal locations for this large-scale, long-term monitoring, because they provide large areas of breeding habitat for year-round resident and Neotropical migratory landbirds that are subject to varying management practices.

A second objective of the MAPS program is to provide standardized population and demographic data for the landbirds found in local areas or on federally managed public lands, such as national forests, national parks, and military installations. In this vein, it is expected that population and demographic data on the landbirds found on any given national forest will aid research and management efforts on the forest to protect and enhance the forest's avifauna and ecological integrity while allowing it to serve its multi-use purposes.

In this 2002 report of the eleventh year of the MAPS program on the Flathead National Forest, and tenth year on the Flathead Reservation of the Confederated Salish and Kootenai Tribes, we: (1) assess populations of target landbird species and their vital rates on these lands, (2) identify declining landbird species, (3) identify likely proximate demographic causes (productivity or survival) for those population declines, and (4) describe current work designed to confirm those causes and identify relationships between the vital rate(s) and demographic parameter (s) causing the declines and station-specific and landscape-level habitat characteristics. Based on these on-going analyses, we plan to identify general management guidelines and formulate specific management actions that we hope can begin to be implemented in 2004 on the Flathead National Forest and elsewhere to reverse the population declines.

We operated nine MAPS stations in 2002 on the Flathead National Forest and the Flathead Reservation. Eight of these stations were in the exact same locations at which they were operated from 1992 (or 1993) to 2001. We also added a new station in 2002, Jocko River, on the Flathead Reservation. With few exceptions, the ten net sites per station were operated for six morning hours per day on one day per 10-day period for seven consecutive 10-day periods between May 31 and August 8 in all eleven years, 1992-2002. A total of 1132 captures of 53 landbird species was recorded at the nine stations during the summer of 2002.

Adult Population Sizes and Productivity

Constant-effort comparisons between 2001 and 2002 indicated that adult population size for all species pooled for all stations combined increased by a very slight and non-significant +1.7%, whereas captures of young birds decreased by a significant -44.1%. Productivity (the proportion of young in the catch) showed a non-significant decrease of -0.067 from 0.164 in 2001 to 0.097 in 2002 for all species pooled and all stations combined. Neither the significant decrease in number of young nor the non-significant decrease in productivity, however, was truly station- or species-wide. Interestingly, both numbers of young and productivity tended to decrease in 2002 at the six more open and less forested stations that, over the ten years 1993-2002, generally have had higher productivity, and increased in 2002 at the two more densely forested stations that generally have tended to have lower productivity.

Despite the relatively stable population sizes on the Flathead National Forest and Flathead Reservation during 2001-2002, 11-year (1992-2002) analyses of adult population size indicated a substantial and nearly significant (*P*=0.085) decline of -1.5% per year for all species pooled and all stations combined. These analyses further revealed that six species, (ATraillôs≅, Hammondôs, and Dusky flycatchers, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat) showed substantial ($r \leq -0.5$) declines, with those for all but Hammondôs Flycatcher being significant, whereas only two species (Yellow Warbler and Northern Waterthrush) showed substantial ($r \geq 0.5$) increases that were significant or nearly significant for both species. In contrast, 11-year trends in productivity were fairly stable, with 18 of 23 species showing no substantial productivity trend, three species (Hammondôs Flycatcher Northern Waterthrush, and MacGillivrayôs Warbler) showing significantly declining productivity trends, and two species (Dusky Flycatcher and Chipping Sparrow) showing significantly increasing productivity trends.

In contrast to observations from other regions of the continent, global climate patterns (as measured by the Southern Oscillation Index, SOI) did not appear to have a substantial impact on productivity on the Flathead National Forest and Flathead Reservation during the 11-year period, 1992-2002, although there was a very weak negative correlation between productivity and SOI with a tendency toward slightly higher productivity during El Niño years. Other analyses of productivity vs. SOI using MAPS data from across the continent have revealed stronger effects in Pacific coastal areas than in interior areas. For example, both observed and predicted productivity trends on Forest Service Region Six national forests indicated that the El Niño/ Southern Oscillation has a greater effect on avian productivity on those forests than on the Flathead National Forest. Other recent work at IBP suggests that the North Atlantic Oscillation (NAO) can also influence productivity across the northern part of the U.S., including the Flathead region. Perhaps further analysis will show that effects related to NAO can account for the substantial fluctuations in productivity at Flathead and that productivity can best be modeled by simultaneously considering both SOI and NAO. We will be investigating this more thoroughly in future years.

To further investigate how productivity affects breeding population size, we regressed constant-effort changes in adult captures during one between-year comparison on changes in productivity during the preceding between-year comparison for each target species and for all species pooled. This ñproductivity-population correlationò was positive for 17 of 23 species and for all species pooled. This supports the concept that changes in productivity one year bring about corresponding changes in population size the next year. This does not necessarily mean, however, that productivity is driving the longer-term population trends; it is possible that low (or high) adult survival rates could be driving long-term population decreases (or increases), despite the fact that annual changes in productivity appear to be driving the annual changes in adult population size.

Apparent Adult Survival Rates

We were able to obtain survivorship estimates for 21 target species on Flathead National Forest and Flathead Reservation using 11 years of data. Relatively little interannual variation in survival was detected for most species occurring at Flathead; substantial interannual variation was detected in only two species, Black-capped Chickadee and Yellow Warbler. The general lack of time-dependent survival for the other 19 species, most of which are neotropical migrants, probably reflects the relatively stable climatic conditions on tropical wintering grounds.

As mentioned in previous reports, increased years of data have resulted in increased numbers of species for which survival rate estimates can be obtained as well as increased precision of the survival estimates themselves. Indeed, the mean precision (CV(φ)) of the time-constant survival estimates for the 21 species improved from 27.3% using ten years of data to 25.2% using 11 years of data, while that for the 14 species with CVs < 30% improved from 19.1% using ten years of data to 17.6% using 11 years of data. This supports the suggestion that maximum precision may not be obtained until 12 or more years of data are available.

Causes of Population Trends in Flathead Birds

In order to help determine the causes of changes in landbird populations on the Flathead National Forest and the Flathead Reservation, one of the primary goals of MAPS, we have examined patterns of productivity and survival as a function of body mass for 21 target species to evaluate which of the two factors may be unexpectedly low or high and, thus, which factor is likely to be more influential in driving population trends. Species with larger body mass generally show lower productivity and higher survival than species with smaller body mass, which explains the negative and positive slopes, respectively, of the regression lines. We found that the relationship between body mass and productivity at Flathead was similar in slope to that for North America as a whole, but overall productivity appears to be substantially lower at Flathead than in North America as a whole. For survival, the two lines were similar in magnitude and slope.

Based on all demographic data it appears that, for four of six species with substantial declines (ñTraillôsò Flycatcher, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat), low productivity appears to be the sole driving force contributing to the decline. For Hammondôs Flycatcher, low and declining productivity appears to be the primary contributing factor, although low adult survivorship may also be contributing to the decline. Only for the sixth species, Dusky Flycatcher, does the evidence suggests that low survival is the primary contributing factor to the decline, while low but increasing productivity may also have contributed to the problem. Thus, it appears that low productivity may be primarily responsible for the eleven-year declines in breeding populations of all species pooled at Flathead. Interestingly, it appears as though low productivity may be driving the generally negative population trends on all six national forests in Forest Service Region Six (Washington and Oregon), as well. In contrast, for the two species with increasing population trends (Yellow Warbler and Northern Waterthrush), high survival appears to be the primary factor contributing to the increase.

Current and Future Analyses

We have recently initiated two additional broad-scale analyses to help us further understand the population dynamics of landbirds and formulate potential management strategies to assist their populations. First, we have demonstrated that modeling spatial variation in vital rates as a function of spatial variation in population trends can allow us to identify the proximate demographic cause(s) of population declines. Second, we have demonstrated how MAPS data can be used in conjunction with station-specific and landscape-level habitat data and spatially explicit weather data to describe relationships between habitat characteristics and the particular vital rates that are responsible for the population declines. The completion of such analyses can provide extremely powerful tools for formulating multi-use management strategies for reversing population declines and for maintaining stable or increasing populations.

We have received partial funding from the USDA Forest Service, through a challenge grant from the National Fish and Wildlife Foundation, to undertake these analyses using 11 years (1992-2002) of MAPS data from 44 stations on the Flathead Reservation, Flathead National Forest, and six national forests in Region Six (Washington and Oregon), as well as from other appropriate locations in the Northwestern Region of North America. We are currently seeking the remainder of the necessary private matching funds to complete these analyses. The first major objective of this work is to include station-specific and landscape-level habitat data into the analytical models described above to provide comprehensive analyses of the manner in which these variables affect landbird demographics, including population size, population trends, and productivity. This will provide the critical information needed to complete the second major objective of this work, which is to identify, for a suite of target species, generalized management guidelines and formulate specific management actions for altering habitat characteristics from those associated with low values for population size, population trends, and/or productivity to those associated with high values for these demographic parameters. Our goal is to complete these analyses and the formulation of management guidelines and actions early in 2004.

The third and final major objective for this proposed work will then be to implement these generalized management guidelines and specific management actions on select districts on select Region 1 and Region 6 national forests beginning in 2004. Continued monitoring of the demographic parameters and trends in the populations targeted for management will enable us to track the effectiveness of the guidelines and actions implemented, and to modify them as appropriate. In this way we can evaluate the effectiveness of the management actions and implement them in a truly adaptive management framework. Our goal for this final objective is to begin integrating our avian management guidelines into actual management actions beginning in 2004. We envision that, when the management guidelines and actions to be identified by this project are fully implemented, we will continue operating some 14 to 21 of the 42 current Forest Service stations as controls, will have discontinued operation of the other approximately 21 to 28 current stations, and will have replaced them with an equal number of new stations designed specifically to monitor the effectiveness of the management actions. Indeed, we have already established four new stations on the Flathead Reservation to monitor the effects of riparian restoration there. In order to achieve this final major objective on Forest Service lands in a timely manner, we will need to work very closely with district foresters and natural resource managers on the Region 1 and Region 6 national forests during the latter part of 2003 and early in 2004 to identify opportunities where the management guidelines and actions we propose can be integrated into existing or new actions designed to manage or harvest forest products or enhance the forestós wildlife or other natural resources.

Conclusions

The data collected at the MAPS stations at Flathead National Forest and Flathead Reservation during their first eleven years have revealed that the population dynamics of the breeding birds are complex, as apparently are the causes for population changes and, for those deemed problematic, their likely solutions. This complexity, in turn, underscores the importance of standardized, long-term data. In general, the analyses of MAPS data from national forests in the Pacific Northwest, including those from the Flathead National Forest and the Flathead Reservation, indicate that bird populations there are declining substantially and often significantly, and that these declines appear to be caused more by deficiencies in productivity on the breeding grounds than by deficiencies in survival on the winter grounds or migration routes. Because these population declines are primarily caused by low productivity on the breeding grounds, they are potentially within the ability of the Forest Service to correct. We have demonstrated elsewhere how MAPS data can be used in conjunction with station-specific and landscape-level habitat data to describe relationships between habitat characteristics and the demographic parameter(s) that is(are) responsible for the population declines. Such analyses can lead to the identification of general management guidelines and the formulation of specific management actions that, if implemented, can lead to the reversal of population declines and the maintenance of stable or increasing populations.

We suggest, therefore, that the indices and estimates of primary demographic parameters produced by MAPS are extremely useful for the management and conservation of landbirds on the national forests throughout the Pacific Northwest and, in combination with similar data from other areas, across all of North America. We conclude that the MAPS protocol is well-suited to provide a critical component of natural resource management and monitoring on the national forests. Thus, we recommended that, beginning in 2004, the Forest Service should: (1) begin to integrate the avian management guidelines we will have formulated into new or on-going forest management actions; (2) establish a number of new MAPS stations to evaluate the effectiveness of those management actions; (3) discontinue the operation of a roughly equal number of MAPS stations; and (4) continue the operation of the remaining currently operated MAPS stations to serve as critical controls for the newly established experimental stations. The Confederated Salish and Kootenai Tribes have already initiated such a program with the establishment of four new MAPS stations on the Flathead Reservation to monitor the effectiveness of on-going riparian restoration efforts there.

INTRODUCTION

The USDA Forest Service has been charged with responsibility for managing the natural resources on their lands in such a manner that, as much as possible considering the multi-use purposes of these lands, conserves them unimpaired for future generations. The Forest Service has been further charged with responsibility for maintaining the ecological integrity and species diversity of the ecosystems present on those lands. The Flathead Reservation of the Confederated Salish and Kootenai Tribes has taken on similar responsibilities. In order to carry out these responsibilities successfully, integrated long-term programs are needed to monitor the natural resources on national forests and reservations and to monitor the effects of varying management practices on those resources.

The development and implementation of effective long-term biomonitoring programs on the national forests and reservations can be of even wider importance than aiding the Forest Service and the Tribes in the management of their natural resources. Because national forest and tribal lands provide large areas of multiple ecosystems subject to varying management practices, studies conducted on those lands can provide invaluable information for understanding natural ecological processes and for evaluating the effects of both local and large-scale, even global, environmental changes. Thus, long-term monitoring data from national forests and reservations can provide information that is crucial for efforts to preserve natural resources and biodiversity on a continental or even global scale.

Landbirds

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

Recent analyses of data from several of these programs, particularly the BBS, suggest that populations of many landbirds, including forest-, scrubland-, and grassland-inhabiting species, appear to be in serious decline (Peterjohn et al. 1995). Indeed, populations of most landbird species appear to be declining on a global basis. Nearctic-Neotropical migratory landbirds (species that breed in North America and winter in Central and South America and the West Indies; hereafter, Neotropical migratory birds) constitute one group for which pronounced population declines have been documented (Robbins et al. 1989, Terborgh 1989). In response to these declines, the Neotropical Migratory Bird Conservation Program, "Partners in Flight - Aves de las Americas," was initiated in 1991 (Finch and Stangel 1993). The major goal of Partners in Flight (PIF) is to reverse the declines in Neotropical migratory birds through a coordinated program of monitoring, research, management, education, and international cooperation. As one of the major cooperating agencies in PIF, the USDA Forest Service has defined its role in the program to include the establishment of long-term avian monitoring programs on national forest lands using protocols developed by the Monitoring Working Group of PIF. Clearly, the long-term avian monitoring goals of the Forest Service and the monitoring and research goals of PIF share many common elements.

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).

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

The MAPS Program

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

Now in its 14th year (11th year of standardized protocol and extensive distribution of stations), the MAPS program has expanded greatly from 178 stations in 1992 to over 500 stations in 2002. The substantial growth of the Program since 1992 was caused by its endorsement by PIF and the subsequent involvement of various federal agencies in PIF, including the USDA Forest Service, National Park Service, Department of Defense, Department of the Navy, Texas Army National Guard, and US Fish and Wildlife Service. Within the past ten years, for example, IBP has been contracted to operate over 150 MAPS stations on federal lands, including six stations on the Flathead National Forest and six stations on each of six national forests in Forest Service Region 6. In addition, for the past nine years, IBP has been contracted to operate two stations on the Flathead Reservation of the Confederated Salish and Kootenai Tribes.

Goals and Objectives of MAPS

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

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

  (A) annual indices of adult population size and post-fledging productivity from data on the numbers and proportions of young and adult birds captured; and

  (B) annual estimates of adult population size, adult survival rates, proportions of residents, recruitment rates into the adult population, and population growth rates from modified Cormack-Jolly-Seber (CJS) analyses of mark-recapture data on adult birds.

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

  (1) temporal and spatial patterns in these demographic indices and estimates at a variety of spatial scales ranging from the local landscape to the entire continent; and

(2) relationships between these patterns and ecological characteristics of the target species, population trends of the target species, station-specific and landscape-level habitat characteristics, and spatially-explicit weather variables.

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

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

The overall objectives of MAPS are to achieve the above-outlined goals by means of long-term monitoring at two major spatial scales. The first is a very large scale X effectively the entire North American continent divided into eight geographical regions. It is envisioned that national forest lands, along with national parks, DoD military installations, and other publicly owned lands, and the tribal reservations can 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 tribal reservations, national forests, national parks, or military installations) to aid research and management efforts within the reservations, forests, parks, or installations to protect and enhance their avifauna and ecological integrity. The sampling strategy utilized at these smaller scales should be hypothesis-driven and should be integrated with other research and monitoring efforts.

The MAPS Program on the Flathead National Forest and Flathead Reservation

Both of the long-term objectives of MAPS, as described above, were found to be in agreement with objectives of the Forest Serviceҫs PIF program, with the Forest Serviceҫs own avian monitoring efforts, and with ecological objectives on the Flathead Reservation. Accordingly, the MAPS Program was initiated in Forest Service Region One in 1992, with six stations being established on the Flathead National Forest, and on the Flathead Reservation in 1993, with two stations being established there. The overall goal of the initial establishment of the MAPS program on the Flathead National Forest and Flathead Reservation was to provide high quality information on the demographics of landbirds that could be used to aid research and management efforts on the forest and reservation to protect and enhance the forest and reservationҫs avifauna and ecological integrity, while allowing them each to fulfill their multi-use purposes.

Three major objectives have been articulated to achieve this goal. The first was to assure the continued operation of all six stations on the Flathead National Forest for at least 10 years, 1992-

2001, as well as the two reservation stations for at least nine years, 1993-2001. With the completion of data collection in 2001, that first objective has been accomplished. The second objective was to provide a comprehensive analysis of the ten years of demographic data from these eight stations, in conjunction with analogous data from six stations on each of six additional national forests in Region 6, as a function of station-specific and landscape-level habitat characteristics and spatially explicit weather data. Important analytical techniques have been developed and evaluated to accomplish these latter analyses, and funding has been secured to achieve this second objective. Indeed, we are well on the way toward completing these analyses. An additional aspect of this second objective was to continue the operation of all stations during 2002 and 2003 so as some of them could serve as control stations for new stations to be established to achieve the third objective. This report documents the achievement of this aspect of the second objective for 2002. The third objective is to use the relationships between demographic parameters and landscape-level habitat characteristics developed as part of the second objective to identify general management guidelines and formulate specific management actions to reverse population declines and maintain stable or increasing populations of landbirds. We suggest that we aim to begin implementing these management strategies on the Flathead National Forest and Flathead Reservation, as well as on Region Six national forests, in 2004.

The 2002 Report

In this report we summarize results of the MAPS program at six stations on the Flathead National Forest in Region One from 1992 through 2002 and at three stations on the Flathead Reservation from 1993 through 2002. The addition of one new station on Flathead Reservation is described. For each station and for all nine stations pooled, we present indices of adult population size and productivity, and present constant-effort changes between 2001 and 2002 (for the eight stations operated in 2001). We then present 11-year means for indices of adult population size and productivity for each species and for all species pooled, estimates of annual adult survivorship for 21 target species, and eleven-year trends in adult population size and productivity for those target species and for all species pooled from the eight long-running stations. Using these data, we then identify both declining and increasing landbird species on the Flathead National Forest and Flathead Reservation, identify probable proximate demographic causes (low productivity or low adult survival) for these population changes, and suggest future analyses to confirm these causes.

METHODS

Six 20-ha MAPS stations on Flathead National Forest and two on Flathead Reservation were re-established in 2002 at the exact same locations at which they were originally established in 1992 (Forest) or 1993 (Reservation). In addition, one new station, Jocko River, was established on Flathead Reservation. The six stations on the Flathead National Forest are located (from highest to lowest elevation) as follows: (1) the Coram Experimental Forest station in the Coram Experimental Forest at 1244 m; (2) the Simpson Creek station on Plum Creek Timber Company property at 1195 m; (3) the Hillary Meadow station at 1109 m; (4) the Six-mile Mountain station at 1067 m; (5) the Swan Research Natural Area station in the Swan Research Natural Area at 943 m; and (6) the Swan Oxbow station on The Nature Conservancy's Swan Oxbow Preserve at 939 m. The three stations on the Flathead Reservation are: (7) the Safe Harbor Marsh station located at 881 m elevation, (8), the Jocko River station established in 2002 at 850 m elevation, and (9) the Crow Creek station located at 786 m elevation. The stations were re-established and operated by three field biologist interns of The Institute for Bird Populations (Helen Bommarito, Michelle Meier, and Jessica Gardner), who received intensive training from Institute staff field biologists Melissa Winfield, Sara Martin, and Tim Pitz, and part-time supervision from Melissa Winfield.

On each day of operation, one 12-m long, 30-mm mesh, 4-tier nylon mist net was erected at each of ten fixed net sites within the interior eight ha of each station. These ten nets at each station were operated for six morning hours per day (beginning at local sunrise), and for one day in each of seven consecutive 10-day periods between May 31 and August 8. With very few exceptions, the operation of all stations occurred on schedule in each of the ten-day periods.

The operation of each of the nine stations during 2002, and during all preceding years, followed the highly standardized protocols developed by The Institute for Bird Populations for use by the MAPS Program throughout North America and spelled out in the MAPS Manual (DeSante et al. 2002). An overview of the field and analytical techniques is presented here.

Data Collection

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

(1) capture code (newly banded, recaptured, band changed, unbanded);
(2) band number;
(3) species;
(4) age and how aged;
(5) sex (if possible) and how sexed (if applicable);

(6) extent of skull pneumaticization;
(7) breeding condition of adults (i.e., presence or absence of a cloacal protuberance or brood patch);
(8) extent of juvenal plumage in young birds;
(9) extent of body and flight-feather molt;
(10) extent of primary-feather wear;
(11) wing chord;
(12) fat class and weight;
(13) date and time of capture (net-run time); and
(14) station and net site where captured.

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

For each of the nine stations operated, simple habitat maps were prepared on which up to four major habitat types, as well as the locations of all structures, roads, trails, and streams, were identified and delineated; when suitable maps from previous years were available, these were used. The pattern and extent of cover of each major habitat type identified at each station, as well as the pattern and extent of cover of each of four major vertical layers of vegetation (upperstory, midstory, understory, and ground cover) in each major habitat type were classified into one of twelve pattern types and eleven cover categories according to guidelines spelled out in the MAPS Habitat Structure Assessment Protocol, developed by IBP Landscape Ecologist, M. Philip Nott and the IBP staff (Nott 2002).

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 effort and breeding status 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 (summer residency) status. Each species was classified as one of the following: a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during all years* that the station was operated; a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during more than half but not all of the years* that the station was operated; an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station *during half or fewer of the years* that the station was operated; a transient (T) if the species was *never* a breeder or summer resident at the station, but the station was within the overall breeding range of the species; and a migrant (M) if the station was not located within the overall breeding range of the species. All data for a given species from a given station were included in year-specific or mean population size and productivity analyses for the species (e.g., Tables 3, 4-6, and 7) unless the species was classified as a migrant (M) at the station. For survivorship estimates (Tables 8 and 9), population size and productivity trends (Figures 1 and 2), and analyses derived from these survivorship estimates and population or productivity trends (Figures 3-5), data for a given species from a given station were included only if the species was classified as a regular (B) or usual (U) breeder and summer resident at the station. Thus, data from a station for a species classified as a migrant (M) at the station were included only in year-specific summaries of the total numbers of captures (Table 2).

A. Population-size and productivity analyses X The proofed, verified, and corrected banding data from 2002 were run through a series of analysis programs that calculated for each species and for all species pooled at each station and for all stations pooled:

(1) the numbers of newly banded birds, recaptured birds, and birds released unbanded;
(2) the numbers and capture rates (per 600 net-hours) of first captures (in 2002) of individual adult and young birds; and
(3) the proportion of young in the catch.

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

For each of the eight stations run in both 2001 and 2002 and for all stations pooled, we calculated percent changes between 2001 and 2002 in the numbers of adult and young birds captured and actual changes between the two years in post-fledging productivity. These year-to-year comparisons were made in a "constant-effort" manner by means of a specially designed analysis program that used actual net-run (capture) times and net-opening and -closing times on a net-by-net and period-by- period basis to exclude captures that occurred in a given net in a given period in one year during the time when that net was not operated in that period in the other year. For species captured at several stations on Flathead National Forest or Flathead Reservation, we followed the methods developed by the BTO in their CES scheme (Peach et al. 1996) and inferred the statistical significance of overall changes in the indices of population size and productivity 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, but we use the term Anear-significant≅ or Anearly significant≅ for differences for which $0.05 \leq P < 0.10$.

<u>B. Analyses of trends in adult population size and productivity</u> X We examined 11-year (1992-2002) trends in indices of adult population size and productivity for species for which we recorded an average of six or more adult captures per year at the eight long-running stations combined. For trends in adult population size, we first calculated adult population indices for each species for each of the 11 years based on an arbitrary starting index of 1.0 in 1992 (or 1993 if adults of the species were not captured in 1992). Constant-effort changes (as defined above) were used to calculate these Achain≅ indices in each subsequent year by multiplying the proportional change (percent change divided by 100) between the two years times the index of the previous year and adding that figure to the index of the previous year, or simply:

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

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

(actual 1992 value of *PSI* / predicted 1992 value of *PSI* based on the regression) * *PT*.

We present the *APC*, the standard error of the slope (*SE*), the correlation coefficient (*r),* and the significance of the correlation (*P*) to describe each trend. Again, we use an alpha level of 0.05 for statistical significance. For purposes of discussion, however, we use the terms Anearly significant≅ or Anear-significant≅ for trends for which $0.05 \leq P < 0.10$. Species for which $r \geq 0.5$ are considered to have a substantially increasing trend; those for which $r \leq -0.5$ are considered to have a substantially decreasing trend; those for which $-0.5 < r < 0.5$ and $SE \leq 0.029$ for 11-year trends are considered to have a stable trend; and those for which $-0.5 < r < 0.5$ and $SE > 0.029$ for 11-year trends are considered to have widely fluctuating values but no substantial trend.

Trends in productivity, *PrT*, were calculated in an analogous manner by starting with actual productivity values in 1992 (or 1993 if adults of the species were not captured in 1992) and calculating each successive year=s value based on the actual constant-effort changes in productivity between each pair of consecutive years. For trends in productivity, the slope (*PrT*) and its standard error (*SE*) are presented, along with the correlation coefficient (*r),* and the significance of the correlation (*P*). Productivity trends are characterized in a manner analogous to that for population trends, except that productivity trends are considered to be highly fluctuating if the SE of the slope > 0.017 for 11-year productivity trends.

To evaluate the extent to which productivity in one year has a direct effect on adult population size the following year, we regressed changes in adult population size during one between-year comparison on changes in productivity during the previous between-year comparison.

C. Comparisons of productivity with Southern Oscillation Index X To assess the degree to which global climate patterns may be affecting landbird productivity, we compared annual productivity values (mean value for all species pooled over the eight long-running stations) with the standardized Southern Oscillation Index (SOI), a measure of global climate based on the strength/weakness of El Niño and La Niña events in the tropical Pacific Ocean. SOI, calculated using pressure differentials between Tahiti and Darwin, Australia, has been used by climatologists as an index of relative global climate throughout the Pacific and North America; low negative SOI=s indicate El Niño years and high positive SOI=s indicate La Niña years. This SOI index has recently been correlated with productivity and survival in a migratory, eastern North American landbird (Sillett *et al.* 2000). For this report we use mean of the monthly SOI=s for January-December of the year in question.

D. Survivorship analyses X Modified Cormack-Jolly-Seber (CJS) mark-recapture analyses (Pollock et al.1990, Lebreton et al.1992) were conducted on select target species using 11 years (1992-2002) of capture histories of adult birds. Target species were those for which, on average, at least six individual adults per year were recorded from the eight long-running stations pooled at which the species was a regular (B) or usual (U) breeder. Using the computer program SURVIV (White 1983), we calculated, for each target species, maximum-likelihood estimates and standard errors (*SE*s) for adult survival probability (φ), adult recapture probability (p), and the proportion of residents among newly captured adults (τ) using both a between-year and within-year transient model (Pradel et al. 1997, Nott and DeSante 2002). 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 11 years of data, 1992-2002, available for using the transient model allowed us to consider all possible combinations of both time-constant and time-dependent models for each of the three parameters estimated, 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 $\varphi QAIC_C$ 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, $\varphi QAIC_C$ was calculated as $QAIC_C(\varphi_t p \tau)$-$QAIC_C(\varphi p \tau)$, with lower (or more negative) $\varphi QAIC_C$ values indicating stronger interannual variation in survival.

<u>E. Relationships of survival and productivity with body mass</u> X In birds, both survival and productivity vary with body mass: on average, the larger the bird the higher the survival and the lower the productivity. Thus, in order to assess whether or not survival or productivity in a given species is higher or lower than expected, body mass needs to be accounted for. We thus regressed both mean productivity indices and time-constant annual survival rate estimates on body mass (log transformed to normalize the values), both for species throughout North America and for species on the Flathead National Forest and Flathead Reservation, and compared individual survival and productivity rates with the regression lines produced by these fits. We used the log of mean body mass values given by Dunning (1993). In this way we could assess whether or not productivity or survival of a given species at Flathead was as expected, lower than expected, or higher than expected based on body mass.

Finally, based on all of the above demographic data, we made assessments as to whether overall population changes on the Flathead National Forest and Flathead Reservation appeared to be caused by poor productivity on the breeding grounds, poor survival during migration and/or on the winter grounds, both, or neither. For all stations combined, we list both declining and increasing species, along with assessments as to whether productivity and/or survival has been as expected, lower than expected, or higher than expected based on body mass. Assessments for each species were based on a synthesis of actual productivity indices, productivity trends, productivity-population correlations, actual survival values, φQAIC$_C$ values, and values of productivity and survival in relation to body mass during the ten years of data collection.

RESULTS

A total of 3158.8 net-hours was accumulated at the nine MAPS stations operated on the Flathead National Forest and Flathead Reservation in 2002, of which 2449.0 net-hours could be compared with data from 2001 in a constant-effort manner (Table 1)

Indices of Adult Population Size and Post-fledging Productivity

A. 2002 values -- The 2002 capture summary of the numbers of newly-banded, unbanded, and recaptured birds is presented for each species and all species pooled at each of the six stations on Flathead National Forest in Table 2a and at the three stations on the Flathead Reservation, as well as for all nine stations combined, in Table 2b. A total of 1132 captures of 53 species was recorded during the summer of 2002. Newly banded birds comprised 62.0% of the total captures. The greatest number of total captures (211) was recorded at the newly established Jocko River station and the smallest number of total captures (20) was recorded at the Coram Experimental Forest station. The highest species richness occurred at Swan Oxbow (30 species) and the lowest species richness occurred at Coram Experimental Forest (8 species).

The capture rates (per 600 net-hours) of individual adult and young birds and the percentage of young in the catch during 2002 are presented for each species and for all species pooled at each of the six stations on Flathead National Forest in Table 3a and at the three stations on the Flathead Reservation, as well as for all nine stations combined, in Table 3b. We present capture rates (captures per 600 net-hours) of adults and young in these tables so that the data can be compared among stations which, because of the vagaries of weather and accidental net damage, can differ from one another in effort expended (see Table 1). These capture indices indicate that the total adult population size in 2002 was greatest at Swan Oxbow, followed in descending order by Jocko River, Swan Research Natural Area, Six-mile Mountain, Hillary Meadow, Safe Harbor Marsh, Simpson Creek, Crow Creek, and Coram Experimental Forest.

The capture rate of young (Tables 3a and 3b) of all species pooled at each station in 2002 followed a sequence entirely different from that of adults: the three Flathead Reservation stations, Jocko River, Safe Harbor Marsh, and Crow Creek in that order, had the highest totals followed by the six Flathead Forest stations, in descending order, Swan Oxbow, Six-mile Mountain, Hillary Meadow, Simpson Creek, Coram Experimental Forest, and Swan Research Natural Area. The index of productivity at the stations in 2002 (Tables 3a and 3b), i.e., the proportion of young in the catch, was also highest at the three reservation stations, Jocko River (0.27), Safe Harbor Marsh (0.22), and Crow Creek (0.20), followed by the six Flathead Forest stations, Coram Experimental Forest (0.11), Six-mile Mountain (0.10), Swan Oxbow (0.09), Hillary Meadow (0.07), Simpson Creek (0.06), and Swan Research Natural Area (0.02).

Among individual species, Swainson's Thrush was the most frequently captured species at the nine stations in 2002, followed by Black-capped Chickadee, MacGillivray's Warbler, Song Sparrow, Gray Catbird and Common Yellowthroat, Yellow Warbler, and Cedar Waxwing (Table 2b). The most abundant breeding species, having a capture rate of at least 4.0 adults per 600 net-hours, in decreasing order, were Swainson's Thrush, MacGillivrayôs Warbler, Cedar Waxwing, Common Yellowthroat, Black-capped Chickadee, Gray Catbird and Song Sparrow, American Redstart, and Chipping Sparrow (Table 3b). The following is a list of the common breeding species (captured at a rate of at least 6.0 adults per 600 net-hours), in decreasing order, at each station in 2002:

Coram Exp. Forest
Swainsonôs Thrush

Simpson Creek
Swainsonôs Thrush
MacGillivrayôs Warbler

Hillary Meadow
Swainsonôs Thrush
MacGillivrayôs Warbler
Cedar Waxwing
Townsendôs Warbler
Dark-eyed Junco

Six-mile Mountain
Swainsonôs Thrush
MacGillivrayôs Warbler
Black-capped Chickadee
Orange-crowned Warbler
Western Tanager
Dark-eyed Junco
Warbling Vireo

Swan Research NA
Common Yellowthroat
MacGillivrayôs Warbler
Chipping Sparrow
Cedar Waxwing
Song Sparrow
Black-headed Grosbeak

Swan Oxbow
Swainsonôs Thrush
American Redstart
Northern Waterthrush
Yellow Warbler
Common Yellowthroat
Song Sparrow
MacGillivrayôs Warbler
Hammondôs Flycatcher
Red-eyed Vireo
American Robin
Gray Catbird

Safe Harbor Marsh
Cedar Waxwing
Black-capped Chickadee
Song Sparrow
American Robin
Hammondôs Flycatcher

Jocko River
Gray Catbird
Yellow Warbler
Black-capped Chickadee
Swainsonôs Thrush
Song Sparrow
Cedar Waxwing
Red-eyed Vireo

Crow Creek
Yellow Warbler
Song Sparrow
Black-capped Chickadee
American Robin
Gray Catbird

B. Comparisons between 2001 and 2002 -- Constant-effort comparisons between 2001 and 2002 were undertaken at all eight long-running stations for numbers of adult birds captured (adult population size; Table 4), young birds captured (Table 5), and proportion of young in the catch (productivity; Table 6). Adult population size for all species pooled for all stations combined increased by a very slight and non-significant +1.7% (Table 4). Increases between 2001 and 2002 were recorded for 19 of 53 species, a proportion that was not significantly greater than 0.50. The overall adult population size for all species pooled increased at five of the eight stations by amounts ranging from +16.4% at Hillary Meadow to +50.0% at Simpson Creek, and decreased at three stations by amounts ranging from -12.0% at Swan Oxbow to -31.8% at Crow Creek. The proportion of increasing (or decreasing) species was not significantly greater than 0.50 at any station. A near-significant increase in the number of adults captured for all stations combined was recorded for Swainsonôs Thrush, whereas significant decreases were recorded for Traillôs Flycatcher and Northern Waterthrush.

Captures of young birds for all species pooled for all stations combined decreased by a significant -44.1% (Table 5). Decreases between 2001 and 2002 were recorded for 17 of 30 species, a proportion that was not significantly greater than 0.50. Number of young captured for all species pooled decreased at five of the eight stations by amounts ranging from -28.6% at Swan Oxbow to -88.9% at Swan Research Natural Area, remained unchanged at Safe Harbor Marsh, and increased at two stations by an undeterminable amount at Coram Experimental Forest (no young were captured in 2001) and by 200% at Simpson Creek. The proportion of decreasing species was significantly greater than 0.50 at Swan Research Natural Area. A near-significant decrease in the number of adults captured for all stations combined was recorded for Red-breasted Nuthatch, whereas no species showed a significant or near-significant increase across stations.

Productivity (the proportion of young in the catch) showed a non-significant decrease of -0.067 from 0.164 in 2001 to 0.097 in 2002 for all species pooled and all stations combined (Table 6). Decreases were recorded for 17 of 38 species, a proportion not significantly greater than 0.50. Decreases in productivity were observed at six of the eight stations ranging from -0.017 at Swan Oxbow to -0.172 and Hillary Meadow, and increased at Simpson Creek (by +0.029) and Coram Experimental Forest (by +0.105). No station recorded a proportion of decreasing (or increasing) species that was significantly greater than 0.50, and no species showed significant or near-significant increases or decreases across stations.

Thus, in general, population sizes of adults remained relatively constant between 2001 and 2002, while numbers of young and productivity decreased substantially between 2001 and 2002, although the decreases were neither station- nor species-wide.

<u>C. Ten-year mean population size and productivity values</u> -- Tables 7a and 7b give mean annual numbers of individual adults captured (an index of adult population size), numbers of young captured, and proportions of young in the catch (an index of productivity) during the ten-year period 1993-2002 for each of the eight long running stations (Table 7a for Flathead National Forest and 7b for Flathead Reservation and for all stations combined). We exclude 1992 from these values because the two stations on the Flathead Reservation were not operated in 1992. Examination of all-species-pooled values indicates that adult population sizes were highest at Swan Oxbow, followed in descending order by Swan Research Natural Area, Six-mile Mountain, Safe Haven Marsh, Hillary Meadow, Crow Creek, Simpson Creek, and Coram Experimental Meadow. Productivity showed a somewhat different order, Six-mile Mountain having the highest productivity (0.27), followed by Safe Harbor Marsh, Swan Research Natural Area, Hillary Meadow, Swan Oxbow and Crow Creek, Simpson Creek and Coram Experimental Forest (0.08). Generally, Coram Experimental Forest and Simpson Creek had substantially lower values for breeding population sizes and productivity than the other six stations. Consideration of elevation and habitat (Table 1) indicates that these are both the highest two stations and the two stations in closed-canopy forests, whereas the other six stations are at slightly lower elevations and are located in more open forest habitat that includes a larger component of meadows, marshes, and riparian habitat. The low productivity values at the two closed-canopy forest stations help account for the overall productivity value of 0.20, which is low for stations at the latitude of

Flathead. Interestingly, numbers of young and productivity tended to increase in 2002 at the two highest elevation, more densely forested stations (Coram Experimental Forest and Simpson Creek; Tables 5 and 6) that generally tend to have lower productivity, and decreased at the remaining six lower elevation, more open or less forested stations with larger meadow or riparian components, that generally tend to have higher productivity.

Eleven-year Trends in Adult Population Size and Productivity

AChain" indices of adult population size for each of the 11 years, 1992-2002, for 23 target species and for all species pooled (ten years, 1993-2002, for two of the species), are shown in Figure 1. We include 1992 in these analyses because, although the two stations on the Flathead Reservation were not operated in 1992, six stations were operated on the Flathead National Forest in 1992 allowing chain indices based on constant-effort comparisons between 1992 and 1993 to be made based on those six stations. Note, however, that graphs for Gray Catbird and Yellow Warbler show ten-year trends beginning in 1993 because no adults of those species were captured in 1992. For each species, we used the slope of the regression line to calculate the Annual Percentage Change (*APC*) of the population. *APC* along with the standard error of the slope (*SE*), the correlation coefficient (*r)*, and the significance of the correlation (*P*) for each study species and all species pooled are included in Figure 1.

The graphs show consistent and stable population sizes (absolute $r < 0.5$ and *SE* of the slope $\leq$ 0.029 for 11-year trends or $SE \leq 0.035$ for ten-year trends) for nine of the 23 species, Red-naped Sapsucker, Red-eyed Vireo, Swainsonĉs Thrush, American Robin, American Redstart, MacGillivrayĉs Warbler, Western Tanager, Song Sparrow, and Dark-eyed Junco. Populations of six species, Black-capped Chickadee, Golden-crowned Kinglet, Gray Catbird, Cedar Waxwing, Townsendĉs Warbler, and Chipping Sparrow, showed wide interannual fluctuation (SE of the slope > 0.035 or 0.043) but no linear trend (absolute $r < 0.5$). Populations of six species, ATraillĉs≅, Hammondĉs, and Dusky flycatchers, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat, as well as all species pooled, showed declining trends ($r \leq -0.5$); all except that of Hammondĉs Flycatcher were significant or nearly significant. The remaining two species showed substantial increases ($r \geq 0.5$), with that of Yellow Warbler being significant and that of Northern Waterthrush being nearly significant. Overall, a total of 12 species showed negative trends while 11 showed positive trends. For all species pooled the nearly significant declining trend ($P = 0.085$) indicated a decrease in population size of 1.5% per year.

AChain" indices of productivity rates for each of the 11 years, 1992-2002, for the 23 target species and all species pooled (ten years, 1993-2002, for two of the target species) are shown in Figure 2. Three species (Hammondĉs Flycatcher, Northern Waterthrush, and MacGillivrayĉs Warbler) showed significantly declining productivity trends ($r \leq -0.5$). Two species (Dusky Flycatcher and Chipping Sparrow) showed significantly increasing productivity trends ($r \geq 0.5$). The remaining 18 species showed productivity trends with no substantial increases or decreases (absolute $r < 0.5$), with 16 being relatively stable ($SE \leq 0.017$ for 11-year trends or $SE \leq 0.020$ for ten-year trends) and two (Red-eyed Vireo and Townsendĉs Warbler) showing wider inter-annual fluctuations ($SE > 0.017$ for eleven-year trends). Overall, a total of 14 species showed negative productivity trends and nine species showed positive productivity trends. The productivity trend for all species pooled was slightly (*PrT* = -0.006) and non-substantially (*r* = 0.294) negative, and was relatively stable (*SE* = 0.007).

A. Productivity-population correlations -- To see whether or not productivity in a given year has had a direct effect on breeding population size the following year, we regressed constant-effort changes in adult captures during one between-year comparison (φadults(t_{i+2}-t_{i+1})) on changes in productivity during the preceding between-year comparison (φproductivity(t_{i+1}-t_i)) for the 23 target species and all species pooled (Fig. 3). The correlation coefficients (*r*) of the relationships shown in Figure 3, hereafter termed Aproductivity-population correlations≅, are used as indicators of the strength of this relationship. The productivity-population correlation was positive for all species pooled and for 17 of 23 species. The positive correlations for Warbling Vireo and American Robin were significant and that for Red-eyed Vireo was nearly significant; none of the six negative correlations were significant or nearly significant. Thus, overall, this correlation was positive, thereby supporting the concept that changes in productivity one year bring about corresponding changes in population size the next year.

B. Relationship between productivity and a global climate pattern -- Figure 4 shows: (**A**) the relationship between the Southern Oscillation Index (SOI, a measure of global climate indicating the strengths of El Niño and La Niña events) and productivity during the 11-year period, 1992-2001; (**B**) the relationship between SOI and year during the course of the study; (**C**) the expected trend in productivity given the relationships between productivity and SOI and between SOI and year; and (**D)** the actual trend in productivity (from Figure 2). We found a non-significant negative relationship between productivity and SOI at Flathead, with a slight tendency for higher productivity during more El-Niño-like conditions (Fig. 4**A**). Since SOI increased substantially and nearly significantly between 1992 (the first year of a large, two-year El Niño event) and 2002 (the year after three La-Niña-like years, 1999-2001; Fig. 4**B**), we predicted that productivity, based on the effects of SOI, should have decreased during the ten-year period by -0.002 per year (Fig. 4**C**). This compares to an actual decrease in productivity during this time period of -0.006 per year (Fig. 4**D**).

Estimates of Adult Survivorship

Using all 11 years of data (1992-2002), estimates of adult survival and recapture probabilities and proportion of residents were obtained for 21 of the 23 target species breeding in Flathead National Forest and Flathead Reservation (Tables 8-9). Survival estimates could not be calculated for Golden-crowned Kinglet and Chipping Sparrow due to low between-year recapture rates.

Because of the existence of floaters, failed breeders, and dispersing adults, transient models, which account for the proportion of residents in the population, produce less biased estimates of adult survivorship than do non-transient models, provided there are sufficient data (four years or more) to estimate a proportion of residents less than 1.0. Thus, we only present the results of transient models. Table 8 indicates that the time-constant transient model ($\varphi p \tau$) was selected over all time-dependent transient models (by having a $QAIC_C$ that was at least 2.0 $QAIC_C$ units lower than any other model) for 19 of the 21 species. For both Black-capped Chickadee and Yellow Warbler, the model showing time-dependence in survival ($\varphi_t p\tau$) was equivalent to (within 2.0 $QAIC_C$ units of) the fully time-constant model. $\varphi QAIC_C$ (see Methods), a measure of the degree to which adult survival varied with time over the ten-year period, ranged from 1.1 in Yellow Warbler (indicating considerable time-dependence in survival; see below) to 19.9 in Hammondôs Flycatcher (indicating no time dependence in survival), and averaged 10.5 for the 20 species (indicating very little time dependence in survival; Table 8).

Table 9 presents the maximum-likelihood estimates and standard errors for apparent annual adult survival probability, recapture probability, and the proportion of residents for the fully time-constant model and for equivalent time-dependent models selected in Table 8 for each target species, along with precision (Coefficients of Variation, CV(φ)) of the estimates of survival probability. The mean CV(φ) of the time-constant survival estimates for the 21 species using 11 years of data was 25.2%, while the mean CV for the 14 species with CVs < 30% was 17.6%. Analogous values using ten years of data were 27.3% for the same 21 species and 19.1% for the same 14 species with CVs < 30%.

Survivorship estimates for the 21 species (Table 9), using time-constant models, ranged from a low of 0.263 for Dusky Flycatcher to a high of 0.736 for Cedar Waxwing, with a mean of 0.500. Recapture probability ranged from a low of 0.029 for Cedar Waxwing to a high of 0.605 for American Redstart, with a mean of 0.353. Proportion of residents varied from a low of 0.057 for Cedar Waxwing to a high of 1.000 for Warbling Vireo and Western Tanager, with a mean of 0.514.

For Black-capped Chickadee, overwintering survival was low during 1992-93, 1996-97, and 1997-98, and was high during 1993-1994, 1994-1995, 1998-99, and 2000-01 (Table 9). This variation likely reflects overwintering conditions for this resident species (such as amount of snowfall) at Flathead. A different pattern was seen for Yellow Warbler, for which survival was low during the winters of 1994-95, 1998-99, 2000-01, and 2001-02 and high during the winters of 1993-94, 1995-96, 1996-97, 1997-98, and 1999-00. The lack of time-dependent survival in the other species, most of which are neotropical migrants, probably reflects the relatively stable climatic conditions on tropical wintering grounds, at least as regards the survival of adults of most neotropical migrants.

Productivity Indices and Adult Survival Rates as a Function of Body Mass

Figure 5 shows productivity indices and adult survival rate estimates recorded at Flathead as a function of mean body mass (log transformed) for 21 target species (for which survival could be estimated) using data from all eight stations combined. The purpose of this figure is to determine which species at Flathead show 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 all 21 target species at Flathead, and one (dashed) using data from 210 (productivity) and 89 (survival) species for which these parameters could be estimated using MAPS data from stations distributed across the North American continent. Species with larger body mass generally show lower productivity and higher survival than species with smaller body mass, which explains the negative and positive slopes, respectively, of the regression lines.

For productivity, the negative regression line based on data from the 21 species at Flathead was roughly parallel to (but lower than) the line based on data from North America as a whole. Thus, the relationship between mass and productivity at Flathead is similar in slope to that for North America as a whole, but overall productivity appears to be lower at Flathead than in North America as a whole. Because we might expect higher productivity at more northerly latitudes (presumably due to more abundant food resources during the summer and lower brood parasitism and nest predation rates), and because Flathead is at a fairly northerly location within the region of North American MAPS stations, we surmise that overall productivity at Flathead was lower than expected. For survival, the two lines were similar in magnitude and slope.

Thirteen of the 21 species shown in Figure 5 (species alpha codes in lowercase letters) had generally stable population trends over the ten years at Flathead (Fig. 1). With a few exceptions these species either showed as-expected survival and productivity indices, or counterbalanced indices (i.e., high survival counterbalancing low productivity or vice versa). Productivity of Black-capped Chickadee was higher than expected and this was not counterbalanced by low survival, and survival for American Redstart was lower than expected, without counterbalancing high productivity; both of these species showed non-substantial population trends, although the population trend for Black-capped Chickadee was nearly substantially positive (as would be predicted from the higher-than-expected productivity), while the trend for American Redstart was negative (again as would be predicted from the lower-than-expected survival).

Both species with increasing population trends (species alpha codes in uppercase non-bold letters), Yellow Warbler and Northern Waterthrush, showed higher-than expected values for productivity and, especially, survival. All six species with declining population trends (species alpha codes in uppercase bold letters) had lower-than-expected productivity values whereas only two of these (Hammondôs and Dusky flycatchers) had lower than expected survival values as well.

Causes of Population Declines Based on All Demographic Data

Based on all of the above demographic data, we can make assessments as to whether eleven-year population changes at Flathead (Figure 1) were due to poor productivity on the breeding grounds, low survival on the winter grounds and/or during migration, both, or neither. Assessments for each species are based on a synthesis of actual productivity indices (mean, ten-year values from Table 7) as compared to body mass (Fig. 5), productivity trends (Fig. 2), productivity-population correlations (Fig. 3), φAIC values (Table 8), and actual survival values (Table 9) as compared with body mass (Fig. 5) during the ten years of data collection. As an example, for Warbling Vireo, productivity was low (mean 0.18 during the ten-year period), the productivity trend was negative (-0.010), the productivity-population correlation was substantially and significantly positive (+2.215), φ$QAIC_c$ was high (+9.0), and survival was moderately good (0.528). In this case, the combined evidence suggests that productivity is low and influencing the population dynamics of this species more than survival, which is moderately good; thus, we infer that low productivity is driving the population decline for Warbling Vireo at Flathead.

Using this approach all six species with substantial declines ($r \leq -0.5$) as shown in Figure 1 (ATraill's≅, Hammond's, and Dusky flycatchers, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat) appear to have low productivity as a contributing cause for the decline. Two of these species (Hammond's and Dusky flycatchers) also have low adult survival rates, suggesting that low adult survival may also be contributing to the decline. Examination of other parameters for these two species suggests that the decline in Hammond's Flycatcher may be driven more by low productivity (productivity trend significantly negative and productivity-population correlation substantially positive) than by low survival, whereas the decline in Dusky Flycatcher may be driven more by low survival (productivity trend significantly positive and productivity-population correlation negative) than by low productivity. Thus, it appears that low productivity is the only factor contributing to the decline in four species (Traill's Flycatcher, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat), the predominant factor in a fifth species (Hammond's Flycatcher), and a contributing factor in a sixth species (Dusky Flycatcher), whereas low survival appears to be the predominant factor in one species (Dusky Flycatcher) and a contributing factor in an additional species (Hammond's Flycatcher). For both species with increasing population trends (Yellow Warbler and Northern Waterthrush), it is clear that high survival is the primary factor contributing to the increase, although higher productivity than for other Flathead species (with respect to body mass) may also have contributed to the increase.

DISCUSSION OF RESULTS AND CONCLUSIONS

Indices of Adult Population Size and Post-fledging Productivity

Constant-effort comparisons between 2001 and 2002 indicated that adult population size for all species pooled for all stations combined increased by a very slight and non-significant +1.7%. In contrast, captures of young birds decreased significantly by -44.1% while productivity (the proportion of young in the catch) showed a non-significant decrease of -0.067 from 0.164 in 2001 to 0.097 in 2002 for all species pooled and all stations combined. Neither the significant decrease in number of young nor the non-significant decrease in productivity, however, was station- or species-wide.

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Ten-year mean population size and productivity values indicate that the two stations in closed-canopy forests (that are also the two highest elevation stations, Coram Experimental Forest and Simpson Creek) had both lower adult population sizes and lower productivity indices than the other six stations which were located in more open forest habitat that included a larger component of meadows, marshes, and riparian areas. The low productivity values at the two closed-canopy forest stations help account for the low overall productivity value for all species pooled and all stations combined of 0.20, which is low for stations at the latitude of Flathead. Interestingly, numbers of young and productivity tended to decrease in 2002 at the six more open and less forested stations that generally tend to have higher productivity, and increased in 2002 at the two more densely forested stations that generally tend to have lower productivity.

Despite the relatively stable population sizes on the Flathead National Forest and the Flathead Reservation during 2001-2002, 11-year (1992-2002) analyses of chain indices of adult population size indicated a substantial and nearly significant (*P*=0.085) decline of -1.5% per year for all species pooled and all stations combined. These analyses further revealed that six species, (ATraillôs≅, Hammondôs, and Dusky flycatchers, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat) showed substantial ($r \leq -0.5$) declines, with those for all but Hammondôs Flycatcher being significant, whereas only two species (Yellow Warbler and Northern Waterthrush) showed substantial ($r \geq 0.5$) increases with Yellow Warbler being significant and Northern Waterthrush being nearly significant.

Eleven-year trends in productivity were generally fairly stable, especially as compared to trends in adult population size, with 18 of 23 species showing no substantial productivity trend. Only three species (Hammondôs Flycatcher Northern Waterthrush, and MacGillivrayôs Warbler) showed substantially declining productivity trends ($r \leq -0.5$) and only two species (Dusky Flycatcher and Chipping Sparrow) showed substantially increasing productivity trends ($r \geq 0.5$); the productivity trends for all five of these latter species were significant.

In contrast to observations from other regions of the continent, global climate patterns (as measured by the Southern Oscillation Index, SOI) did not appear to have a substantial impact on productivity at Flathead during the 11-year period, 1992-2002, although there was a very weak negative correlation between productivity and SOI with a tendency toward slightly higher productivity during El Niño years. Moreover, the actual slight decline in productivity over the 11 years was similar to that predicted by the relationships between productivity and SOI and between SOI and year. Other analyses of productivity vs. SOI using MAPS data from across the continent have revealed stronger effects in Pacific coastal areas than in interior areas. For example, both observed and predicted productivity trends on Region Six national forests, most of which are located in central or western Washington and Oregon, indicated that the El Niño/ Southern Oscillation has a greater effect on avian productivity on those forests than on the Flathead National Forest. Other recent work at IBP suggests that the North Atlantic Oscillation (NAO) can also influence productivity across the northern part of the U.S. including the Flathead region. Further analyses may show that productivity trends can best be modeled by considering both SOI and NAO.

To further investigate how productivity affects breeding population size, we regressed constant-effort changes in adult captures during one between-year comparison on changes in productivity during the preceding between-year comparison for each target species and for all species pooled. This ñproductivity-population correlationò was positive for 17 of 23 species and for all species pooled. Moreover, three of the 17 positive correlations, but none of the six negative correlations, were significant or nearly significant. This supports the concept that changes in productivity one year tend to bring about corresponding changes in population size the next year. This does not necessarily mean, however, that productivity is driving the longer-term population trends; it is possible that low (or high) adult survival rates could be driving long-term population decreases (or increases), despite the fact that annual changes in productivity appear to be driving the annual changes in adult population size.

Apparent Adult Survival Rates

We were able to obtain survivorship estimates for 21 target species on Flathead National Forest and Flathead Reservation. $\varphi QAIC_c$ values were high (≥ 8.0) for 15 of these 21 species, indicating that relatively little interannual variation in survival was detected for most species occurring at Flathead. Substantial annual variation in adult survival ($\varphi QAIC_c \leq 2.0$) was detected in only two species, Black-capped Chickadee and Yellow Warbler. The variation found in Black-capped Chickadee likely reflects overwintering conditions for this resident species (such as temperature and amount of snowfall) while a different pattern of variation in survival for the neotropical wintering Yellow Warbler probably reflects different factors (that could occur during migration or in winter). The general lack of time-dependent survival for the other 19 species, most of which are neotropical migrants, probably reflects the relatively stable climatic conditions on tropical wintering grounds.

As mentioned in previous reports, increased years of data have resulted in increased numbers of species for which survival rate estimates can be obtained as well as increased precision of the survival estimates themselves. This latter trend continued into 2002 when 11 years of data were available for survivorship analyses, although survivorship estimates could not be obtained for any additional species than with ten years of data. Indeed, the mean precision ($CV(\varphi)$) of the time-constant survival estimates for the 21 species improved from 27.3% using ten years of data to

25.2% using 11 years of data, while that for the 14 species with CVs < 30% improved from 19.1% using ten years of data to 17.6% using 11 years of data. This supports the suggestion that maximum precision may not be obtained until 12 or more years of data are available (Rosenberg et al. 1996, 1999).

Causes of Population Trends in Flathead Birds

In order to help determine the causes of changes in landbird populations on the Flathead National Forest and the Flathead Reservation, one of the primary goals of MAPS, we have examined patterns of productivity and survival as a function of body mass for 21 target species to evaluate which of the two factors may be unexpectedly low or high and, thus, which factor is likely to be more influential in driving population trends. Species with larger body mass generally show lower productivity and higher survival than species with smaller body mass, which explains the negative and positive slopes, respectively, of the regression lines. We found that the relationship between mass and productivity at Flathead was similar in slope to that for North America as a whole, but overall productivity appears to be lower at Flathead than in North America as a whole. Because we might expect higher productivity at more northerly latitudes (presumably due to more abundant food resources during the summer and lower brood parasitism and nest predation rates), and because Flathead is at a fairly northerly location within the region of North American MAPS stations, we surmise that overall productivity at Flathead was substantially lower than expected. For survival, the two lines were similar in magnitude and slope.

Based on all demographic data available from all stations combined for each of the 21 target species, including a synthesis of actual productivity indices, productivity trends, productivity-population correlations, actual survival estimates, $\phi QAIC_C$ values, and productivity and survival values relative to continent-wide relationships for productivity and survivorship as a function of body mass, we made assessments as to whether population declines were due to low productivity on the breeding grounds, low survival (probably during migration and/or on the winter grounds), both, or neither. Results of our analyses suggest that, for four of six species with substantial population declines at Flathead (ATraillôs≅ Flycatcher, Warbling Vireo, Orange-crowned Warbler, and Common Yellowthroat), low productivity appears to be the sole driving force for the decline. For a fifth species (Hammondôs Flycatcher), low and declining productivity appears to be the primary contributing factor, although low adult survivorship may also be contributing to the decline. Only for the sixth species, Dusky Flycatcher, does the evidence suggests that low survival is the primary contributing factor to the decline, while low but increasing productivity may also have contributed to the problem. Thus, it appears that low productivity may be primarily responsible for the eleven-year declines in breeding populations of all species pooled at Flathead. Interestingly, it appears as though low productivity may be driving the generally negative population trends on six national forests in Forest Service Region Six (Washington and Oregon), as well. In contrast, for the two species with increasing population trends (Yellow Warbler and Northern Waterthrush), high survival appears to be the primary factor contributing to the increase, although higher productivity than for other Flathead species (with respect to body mass) may also have contributed to the increase.

Current and Future Analyses

We have recently initiated two additional broad-scale analyses to help us further understand the population dynamics of landbirds and formulate 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 have demonstrated that we can determine the proximate demographic causes of population trends within a species on multiple spatial scales (DeSante et al. 2001). In a series of analyses using data from various spatial scales in eastern North America, we modeled productivity indices and time-constant annual adult survival-rate estimates from MAPS data for six target species for which BBS population trends or MAPS trends in adult captures were significantly negative in one area and positive in another. We found, in each case, that we could identify the proximate demographic cause of population decline, and showed that predicted population trends modeled from MAPS vital rates were significantly positively correlated with actual population trends. Analyses of spatial variation in productivity and survival as a function of spatial variation in population trends, therefore, appear to be very effective in determining the proximate demographic causes of population declines.

Second, we have found that patterns of landscape structure detected within a two- to four-kilometer radius area of each MAPS station are good predictors, not only of the numbers of birds of each species captured but, more importantly, of their productivity levels as well (Nott 2000). This study, based on MAPS data from military installations in the eastern United States, revealed the existence of critical threshold values of woodland/forest patch size above which productivity levels could be maximized for four forest-interior species. 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. By coupling station-specific and landscape-level information on habitat characteristics with spatially explicit weather data and estimates and indices of population trends and vital rates of target species in a GIS-based framework, we will be able to control for large-scale weather and climate effects and identify the landscape-level habitat characteristics associated with both low and high productivity and low and high survival rates for each target species. Then, using these results, we will be able to identify generalized management guidelines, and formulate specific management actions, to reverse the population declines of the target landbird species. By this approach, we aim to develop optimal, multi-use management strategies for reversing population declines and maintaining stable or increasing populations.

We have received partial funding from the USDA Forest Service, through a challenge grant from the National Fish and Wildlife Foundation, to undertake these analyses using 11 years (1992-2002) of MAPS data from 44 stations on the Flathead Reservation, Flathead National Forest, and six national forests in Region Six (Washington and Oregon), as well as from other appropriate locations in the Northwestern Region of North America. We are currently seeking the remainder of the necessary private matching funds to complete these analyses. The first major objective of this work is to include station-specific and landscape-level habitat data into the analytical models described above to provide comprehensive analyses of the manner in which these variables affect landbird demographics, including population size, population trends, and productivity. This will provide the critical information needed to complete the second major objective of this work, which is to identify, for a suite of target species, generalized management guidelines and formulate specific management actions for altering habitat characteristics from those associated with low values for population size, population trends, and/or productivity to those associated with high values for these demographic parameters.

Fortunately, the enhanced analytical models for population size, population trends, and productivity that will include the spatially explicit landscape-level habitat variables mentioned above have already been developed by means of funding from the Department of Defense Legacy Resource Management Program. Moreover, as of this date, the characterization of the landscape variables at multiple scales around each station, as well as the demographic parameters at each station, has also been virtually completed. Thus, we envision that only eight additional months of work will be needed to achieve the first two major objectives. Indeed, our goal is to complete these analyses and the formulation of management guidelines and actions early in 2004.

The third and final major objective for this proposed work will then be to implement these generalized management guidelines and specific management actions on select districts on select Region 1 and Region 6 national forests beginning in 2004. The objective is to modify (or maintain) various landscape-level habitat characteristics in such a manner as to increase the particular demographic parameter (productivity or recruitment rate or both) that is driving the population decline (or increase) in the target species. Continued monitoring of the demographic parameters and trends in the populations targeted for management will enable us to track the effectiveness of the guidelines and actions implemented, and to modify them as appropriate. In this way we can evaluate the effectiveness of the management actions and implement them in a truly adaptive management framework.

Our goal for this final objective is to begin integrating our avian management guidelines with actual management actions beginning in 2004. We envision that, when the management guidelines and actions to be identified by this project are fully implemented, we will continue operating some 14 to 21 of the 42 current Forest Service stations as controls, will have discontinued operation of the other approximately 21 to 28 current stations, and will have replaced them with an equal number of new stations designed specifically to monitor the effectiveness of the management actions. Indeed, we have already established four new stations on the Flathead Reservation to monitor the effects of riparian restoration there. In order to achieve this final major objective on Forest Service lands in a timely manner, we will need to work very closely with district foresters and natural resource managers on the Region 1 and Region 6 national forests during the latter part of 2003 and early in 2004 to identify opportunities where the management guidelines and actions we propose can be integrated into existing or new actions designed to manage or harvest forest products or enhance the forestÕs wildlife or other natural resources.

Conclusions

The data collected at the MAPS stations at Flathead National Forest and Flathead Reservation during their first eleven years have revealed that the population dynamics of the breeding birds are complex, as apparently are the causes for population changes and, for those deemed problematic, their likely solutions. This complexity, in turn, underscores the importance of standardized, long-term data. In general, the analyses of MAPS data from national forests in the Pacific Northwest, including those from the Flathead National Forest and the Flathead Reservation, indicate that bird populations in the Northwest are declining substantially and often significantly, and that these declines appear to be caused more by deficiencies in productivity on the breeding grounds than by deficiencies in survival on the winter grounds or migration routes, although both factors appear to be contributing to the declines of some species. The population declines in landbirds that we have documented on the Flathead National Forest and Flathead Reservation (and on Region 6 national forests), especially those that we have shown to be caused by low productivity on the breeding grounds, are potentially within the ability of the Forest Service and Confederated Tribes to correct. We have demonstrated elsewhere how MAPS data can be used, in conjunction with station-specific and landscape-level habitat data and spatially explicit weather data, to describe relationships between habitat characteristics and the vital rate(s) or demographic parameter(s) that is(are) responsible for the population declines. Such analyses can lead to the identification of general management guidelines and the formulation of specific management actions that, if implemented, can lead to the reversal of population declines and the maintenance of stable or increasing populations.

We suggest, therefore, that the indices and estimates of primary demographic parameters produced by MAPS are extremely useful for the management and conservation of landbirds on the national forests throughout the Pacific Northwest (Forest Service Region 1 and Region 6) and, in combination with similar data from other areas, across all of North America. We conclude that the MAPS protocol is very well-suited to provide a critical component of natural resource management and monitoring on the national forests. Based on the above information, we recommended that, beginning in 2004, the Forest Service should: (1) begin to integrate the avian management guidelines we will have formulated into new or on-going forest management actions; (2) establish a number of new MAPS stations to evaluate the effectiveness of those management actions; (3) discontinue the operation of a roughly equal number of MAPS stations; and (4) continue the operation of the remaining currently operated MAPS stations to serve as critical controls for the newly established experimental stations. The Confederated Salish and Kootenai Tribes have already initiated such a program with the establishment of four new MAPS stations on the Flathead Reservation to monitor the effectiveness of on-going riparian restoration efforts there.

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