AN ANALYSIS OF THE MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (MAPS) PROGRAM AND A VISION FOR ITS INTEGRATION INTO NORTH AMERICAN COORDINATED BIRD MONITORING

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October 24, 2006

A report submitted to

Department of Interior, U.S. Geological Survey, Biological Resources Division
Forest & Rangeland Ecosystem Science Center
Corvallis, OR

for Order No. 4-FRSAH-00012

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EXECUTIVE SUMMARY

Efforts are underway to create a Coordinated Bird Monitoring (CBM) program for North America. The principal metrics to be monitored under this program are abundance and population trends. We argue that a broader suite of population parameters needs to be measured in order to effectively manage for and conserve healthy bird populations. Specifically, we feel that information on survival rates and reproduction is needed to identify proximate causes of population declines and to inform management actions capable of reversing declines.

The only continental-scale demographic monitoring program currently operating in North America that provides survival-rate estimates, as well as measures of productivity, is the Monitoring Avian Productivity and Survivorship (MAPS) program. Here we present an analysis of the MAPS program and provide suggestions for its integration into a CMB program. In particular, we (1) review the various metrics that can be monitored by MAPS, (2) assess the ability of MAPS to provide accurate continental-scale data on population trends and productivity, (3) show examples of how the reproductive index measured by MAPS correlates with weather and habitat variables, (4) assess power to detect differences in survival between populations or changes in survival over time using MAPS data, (5) provide lists of species at continental and regional scales that are currently monitored well enough by MAPS to detect differences in survival between populations or changes in survival over time, (6) assess existing gaps in MAPS coverage, and (7) suggest a strategy for enhancing and growing the MAPS program to optimize its utility as part of continent-wide CBM.

Constant-effort mist-netting and capture-mark-recapture data from MAPS can provide estimates or indices of a variety of population parameters, including: adult population size, reproductive rate (productivity), adult apparent survival rate, recruitment rate, and population growth rate and trends. Strong positive correlations between (1) population trends estimated from MAPS data and trends estimated from North American Breeding Bird Survey (BBS) data and (2) MAPS productivity indices and nest monitoring results from the Breeding Biology Research and Monitoring Database (BBIRD) for wood-warblers (Parulidae) suggest MAPS provides useful continental-scale population and productivity data. At smaller spatial scales, MAPS reproductive indices correlate strongly with landscape-scale habitat and weather variables. Our power analyses suggest that with 20 years of data and the current level of effort and distribution of MAPS stations, the program can detect 20-25% (or smaller) differences in survival between populations (typical differences seen in MAPS data) or analogous linear declines in survival at the continental scale for up to 105 bird species with 80% power (at $\alpha = 0.20$). At MAPS regional scales, the program can currently detect effect sizes of this magnitude for 19 (for Alaska and Boreal Canada) to 47 species (for the Northwest). We estimate that through targeted program enhancement and expansion (which would increase the size of the program by 69%), an additional 41 species could be adequately monitored at the continental scale, and 16 (for the Northwest) to 27 additional species (for the South-central Region) could be adequately monitored at the regional scale. Such future program development could be facilitated through integration into a continent-wide CBM program.

We conclude that the MAPS program integrated into a larger CBM effort will be able to provide demographic information for identifying proximate and ultimate causes of population changes for at least 100 target landbird species; this information will be critical for developing effective conservation and management strategies for these species. We feel that MAPS can serve as a model for future efforts to develop demographic monitoring for species and habitat types that are either not monitored at all or are not monitored well by MAPS.

Introduction

Birds are sensitive indicators of environmental quality and ecosystem health (Morrison 1986, Hutto 1998), and widespread public interest in birds makes them ideal candidates for broad-scale monitoring. Existing continent-wide avian monitoring programs in North America, such as the Breeding Bird Survey (BBS) and Christmas Bird Count (CBC), provide invaluable data for identifying spatial and temporal variation in bird distributions, abundances, and population trends (Rich et al. 2004); and they have formed the foundation of major conservation initiatives (e.g., Partners in Flight, the North American Bird Conservation Initiative, and the Neotropical Migratory Bird Conservation Act). Yet it is widely acknowledged that a number of problems in the design and implementation of existing continental-scale monitoring programs limit their usefulness to conservation biologists and land managers (e.g., Bart et al. 2004, Sauer et al. 2005a). By improving existing continent-wide bird surveys, integrating smaller-scale and species-specific programs, and developing new methods for species not currently well-monitored (e.g., Conway and Gibbs 2005), a more rigorous and comprehensive view of the status of North American birds can be achieved (Rich et al. 2004, Bart 2005). Such an effort is underway and is being promoted as a comprehensive Coordinated Bird Monitoring program (hereafter CBM) for North America (Coordinated Bird Monitoring Working Group 2004, Bart 2005, Bart and Ralph 2005).

The principal metrics to be monitored under CBM are measures (indices or estimates) of abundance and population trend. However, abundance metrics (and trends derived from them) may not always accurately reflect habitat quality (Van Horne 1983). For example, source-sink dynamics (Pulliam 1988) deriving from ecological or evolutionary traps (Gates and Gysel 1978, Schlaepfer et al. 2002) could result in high abundance in low-quality (sink) habitats. Additionally, territorial exclusion by dominant individuals of a population could lead to subordinates aggregating in high abundance in low quality habitats (Fretwell and Lucas 1970). Furthermore, populations of migratory species could be limited by processes acting at times other than those when abundance is measured, which could further obscure the link between abundance and habitat quality (Marra et al. 1998). Indeed, for these and perhaps a host of other reasons, a recent survey of studies that compared avian population density and reproduction between two or more plots, habitats, or landscapes, found that although density and per-capita reproduction were often positively correlated (i.e., high-density areas typically had higher per-capita reproduction than low-density areas), there was a relatively high number of exceptions to this pattern (Bock and Jones 2004). For example, per-capita reproduction of songbirds was lower on high density plots than on low density plots in 30% of the cases considered. In addition, the positive relationship between density and reproduction failed most often in studies of disturbed areas, as would be expected under the ecological trap scenario.

For the above reasons, we feel that it is imperative that efforts to develop a CBM plan consider a broader suite of population parameters than just abundance and trend. We believe that inclusion of demographic rates, particularly survival, reproduction, and recruitment, as monitoring priorities will greatly enhance CBM. Advantages of demographic monitoring are manifold. First, by monitoring demographic rates, rather than abundance, the focus is shifted from the population pattern to the processes that yield the pattern; and as such, demographic rates should be more sensitive indicators of short-term changes in populations. For example, environmental stressors and management actions affect demographic rates directly and without the time lags that can delay detection of effects on abundance (Temple and Wiens 1989, DeSante and George 1994). In addition, information on demographic rates can lend insight into the stages of the life cycle most important for limiting bird populations, particularly for migratory species (Sherry and Holmes 1995, Green 1999, Peach et al. 1999, DeSante et al. 2001). Finally, demographic rate estimates can be incorporated into predictive population models to assess potential effects of a variety of factors (e.g., land use practices or climate change) on population viability (Noon and Sauer 1992). In short, demographic monitoring not only complements abundance monitoring, but has the potential to provide more insightful and timely information for conservation and management applications.

Main objectives of current efforts to develop CBM in North America include an assessment of existing surveys with particular attention to identifying gaps in coverage (http://greatbasin.nbii.gov/CBM_home.htm#Objectives). Here we provide a brief overview of current demographic monitoring efforts in North America and consider one program, Monitoring Avian Productivity and Survivorship (MAPS; DeSante et al. 1995, DeSante et al. 2004), in detail. In particular, we (1) review the various metrics that can be monitored by MAPS, (2) assess the ability of MAPS to provide accurate continental-scale data on population trends and productivity, (3) show examples of how the reproductive index measured by MAPS correlates with weather and habitat variables, (4) assess power to detect differences in survival between populations or changes in survival over time using MAPS data, (5) provide lists of species at continental and regional scales that are currently monitored well enough by MAPS to detect differences in survival between populations or changes in survival over time, (6) assess existing gaps in MAPS coverage, and (7) suggest a strategy for enhancing and growing the MAPS program to optimize its utility as part of continental-scale CBM. We argue that MAPS is a comprehensive solution for simultaneously monitoring a variety of population parameters for many North American landbird species. As such, it can serve as a model for future efforts to develop demographic monitoring programs for species and habitat types that are either not monitored at all or are not monitored well by MAPS.

Overview of demographic monitoring

Demographic monitoring has long been an integral component of avian monitoring programs in Britain (Baillie 1990, Peakall 2000). In North America, however, it has received relatively little attention, despite wide acknowledgement of its importance for developing effective management and conservation plans (DeSante 1995, DeSante and Rosenberg 1998, Bart 2005). Only two major broad-scale demographic monitoring programs are currently operating in North America: (1) the Breeding Biology Research and Monitoring Database (BBIRD) program (Conway and Martin 1999) and (2) the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante et al. 1995, DeSante et al. 2004). Both BBIRD and MAPS provide web-based results query interfaces and downloadable manuals, software, and other materials (follow links at pica.wru.umt.edu/BBIRD/ for BBIRD and www.birdpop.org for MAPS). Both programs focus on small landbird species. Other than long-standing efforts to monitor waterfowl demographics through band recoveries in order to establish hunting regulations (Nichols et al. 1995, Nichols 2000), we are unaware of similar large-scale coordinated efforts for other major avian taxa or habitat types (although development of a Holarctic demographic monitoring network for shorebirds is underway; Robinson et al. 2005).

The BBIRD program.—BBIRD uses standardized intensive nest monitoring studies to measure reproductive success (Martin and Geupel 1993, Martin et al. 1997). Since 1992, BBIRD has accumulated data from nearly 60,000 nests of 210 bird species on 56 study sites (pica.wru.umt.edu/BBIRD/). At each BBIRD study site, nesting success (and abundance from point counts) is typically compared among a series of plots placed in areas that vary according to some research hypothesis. For example, plots might be compared between a large block of undisturbed habitat and a disturbed area (e.g., a highly fragmented landscape or forest receiving silvicultural treatment). Detailed vegetation sampling is also conducted on BBIRD plots to allow analysis of microhabitat requirements for successful nesting. BBIRD studies have been instrumental in contributing to our understanding of factors that affect nesting success, and thus to our understanding of factors that define breeding habitat quality for a variety of species, geographic regions, habitats, and landscapes (e.g., Martin 1993, Donovan et al. 1995, Robinson et al. 1995, Petit and Petit 1995, Tewksbury et al. 1998, Manolis et al. 2002).

Despite the success of BBIRD at identifying factors that affect nesting success, most individual BBIRD studies span only a few years (mean duration of 3.6 years based on 46 studies listed on the BBIRD website), and only one study has lasted more than 10 years. Most BBIRD studies are of short duration because they are designed to address specific research questions and fulfill short-term grants, contracts, and graduate degree programs. BBIRD studies require highly-trained field crews and substantial effort to obtain large enough samples to address research questions. The limited time span covered by most BBIRD studies clearly hinders the ability of the program to meet long-term monitoring objectives. A less intensive, but broadly-based (i.e., more extensive), nest-monitoring effort that engages volunteer "citizen scientists" could enhance the ability of BBIRD to conduct broad-scale monitoring (provided that sufficient samples are obtained annually). Such a volunteer-based program has long existed in Britain (the British Trust for Ornithology's Nest Record Scheme [NRS]; Crick et al. 2003), once existed in the United States (Cornell Laboratory of Ornithology's Nest Record Card Program), and is being developed in Canada (Project NestWatch; www.bsc-eoc.org/national/nestwatch.html).

The MAPS program.—MAPS was established by The Institute for Bird Populations (IBP) in 1989 to assess and monitor the vital rates and population dynamics of over 100 small landbird species. MAPS is largely patterned after the British Trust for Ornithology's Constant Effort Sites (CES) scheme (Baillie et al. 1986, Peach et al. 1996, 1998), which was established in 1981. Following the successes of the British CES scheme and the North American MAPS Program, other constant-effort mist netting schemes have been established in Europe; as of the summer of 2005, there were at least 12 CES schemes in operation in Europe.

MAPS uses constant-effort mist-netting data to index adult population size and productivity (DeSante et al. 1995, Peach et al. 1996, Bart et al. 1999, Silkey et al. 1999) and capture-mark-recapture (CMR) data to estimate apparent adult survival, recruitment, and population growth rates (DeSante 1999, Rosenberg et al. 1999, Nott and DeSante 2002a). MAPS data are collected at a network of about 500 mist-netting and bird-banding stations across the United States and Canada. Most MAPS stations (about 80%) are operated by independent bird banders (i.e., trained "citizen scientists"), governmental agencies, and non-governmental organizations; the remaining stations are operated by biologists and interns recruited and trained through IBP. Aside from an initial investment in nets and banding equipment, MAPS station operation requires relatively little monetary investment and can be accomplished with trained volunteers. A large number of stations that contribute to MAPS (227, or nearly 25% of all stations that have ever registered with the program) have been in operation for ten or more years. Many MAPS stations are operated on public lands, including national forests, national parks, military installations, and wildlife refuges.

The operation of a single MAPS station requires 6-10 days (dependent on variation in the timing of migration and breeding, which relates roughly to latitude) of mist netting and banding during the summer months (see DeSante et al. 2006 for protocol details). Although logistical constraints make it difficult to use a strictly probabilistic sampling strategy to select sites for MAPS stations, at least some element of randomness can be maintained in most circumstances. Each station consists of about ten permanent net-sites within the interior 8 ha of a 20-ha study area. Typically, one 12-m, 36-mm-mesh mist net is operated at each net site for six morning hours per day, for one day during each of six to ten consecutive 10-day periods. Over the course of a MAPS season, this protocol results in the capture of up to 30 species. All birds captured during MAPS netting operations are identified to species, age, and sex using criteria in Pyle (1997) and, if unmarked, are banded with a uniquely numbered aluminum leg band provided by the U.S. Geological Survey/Biological Resources Division (USGS/BRD) Bird Banding Laboratory or the Canadian Wildlife Service/Bird Banding Office.

MAPS protocol (DeSante et al. 2006) also requires station operators to record the probable breeding status of all bird species detected or captured at each station using methods similar to those employed in breeding bird atlas projects, and to assign a composite breeding status for every species at the end of the season based on those records. In addition, a station map and standardized quantitative habitat descriptions are prepared each year for each major habitat type contained in the station by means of the MAPS Habitat Structure Assessment protocol (Nott 2000). Finally, MAPS operators are able to enter or import, verify, edit, and submit all their data to IBP by means of MAPSPROG (Froehlich et al. 2006), a computer program distributed by IBP. MAPSPROG has four modules that deal with banding, effort, breeding status, and habitat assessment data. The program includes within- and between-record verification algorithms that substantially improve the quality of the banding data, particularly age and sex determinations, and allows the people who actually collect the data to also verify and edit them.

What can we monitor with MAPS?

Analyses of MAPS data can yield estimates or indices of many population parameters for frequently captured species. These include:

1) *Adult population size.*— Adult population size can be indexed using adult capture rates (Dunn and Ralph 2004, Silky et al. 1999). It can also be estimated directly by applying Jolly-Seber or Pollock's Robust Design (using within-season sub-samples) models to MAPS CMR data (Pollock et al. 1990, Williams et al. 2002).

2) *Reproductive rate.*— A reproductive index can be calculated using the ratio of young birds to adults captured in mist nets (Peach et al. 1996,1998). This index is typically adjusted prior to analyses to account for missing effort (Peach et al. 1998, Nott and DeSante 2002b). This reproductive index is particularly useful for assessing the role of productivity in driving population changes because it is based on recently fledged birds, and therefore incorporates all aspects of reproductive success—clutch size, nest success, survival to independence from

parents, and number of nesting attempts—into a single parameter. Reproductive indices from constant-effort banding data have proven useful for addressing research questions at a variety of spatial scales, ranging from individual sites (e.g., Nur et al. 1999) to local networks of sites (e.g., Bart et al. 1999), and broader geographic regions (e.g., Nott et al. 2002).

3) *Adult apparent survival rate.*— Survival rates can be estimated via modified Cormack-Jolly-Seber (CJS) models applied to MAPS CMR data (Clobert et al. 1987, Pollock et al. 1990, Lebreton et al. 1992). Because not all individual adult birds captured as part of MAPS protocol are resident in the study areas (i.e., MAPS samples include some "floaters", failed breeders, and post-breeding dispersers), the CJS model assumption of equal survivability of marked birds is violated, leading to survival rate estimates that are biased low (Cilimberg et al. 2002). This problem can largely be overcome, however, by modifying CJS models to account for transient birds (Pradel et al. 1997, Nott and DeSante 2002a, Hines et al. 2003).

4) *Recruitment.*— Recruitment into the adult population can be estimated using reverse-time mark-recapture models (Pradel 1996, Nichols et al. 2000).

5) *Population growth rate (λ)* .—Population growth rate can also be estimated from reverse-time mark-recapture models. Note that λ, as estimated here, differs subtly from the λ of population projection matrix models (see discussion in Cooch and White 2005). Here it refers to the ratio of population sizes between time periods (i.e., it is a retrospective estimate of the rate at which the population changed between two time periods). In contrast, the λ of a projection matrix predicts future growth given that conditions of the underlying model remain constant (Caswell 1989). If we think of λ retrospectively (as we do here), rather than as a projected population parameter, it can be transformed to produce a meaningful estimate of percent population change; in the case of a "time-constant" CJS model, this would translate to an estimate of population *trend* (percent change per year) over the entire study period, where trend = $100 \times (\lambda - 1)$.

In order for MAPS to best meet a variety of monitoring goals, these population parameters must be estimated accurately and precisely at multiple spatial and temporal scales. Thus, it is important to (1) determine the extent to which MAPS currently meets monitoring needs at various temporal and spatial scales and (2) identify geographic areas, habitats, and species for which MAPS is currently under-represented and in need of additional stations to meet demographic monitoring needs of a continental-scale CBM program.

Can MAPS provide reliable continental-scale data?

As a first step in analyzing MAPS, we asked whether the program can provide accurate information about bird populations at the continental scale. In order to address this question, we compared time-constant (i.e., averaged over time) population parameters derived from MAPS to similar parameters measured by independent continental-scale monitoring efforts. Specifically, we compared (1) North American Breeding Bird Survey (BBS) estimates of range-wide population trend and (2) range-wide per-capita productivity estimates derived from direct nest monitoring for various wood-warbler species from 1992-2001 to analogous parameters from MAPS.

BBS trends were estimated using the estimating equations approach of Link and Sauer (1994) and obtained from the BBS website (Sauer et al. 2005b). Estimates of productivity from nest monitoring were derived by combining BBIRD estimates of daily nest mortality (available from the BBIRD website: pica.wru.umt.edu/BBIRD/) and clutch size and nest cycle length data reported in Birds of North America accounts (bna.birds.cornell.edu/BNA/). MAPS estimates of trend were derived by summing time-constant survival and recruitment estimates from Pradel reverse-time mark-recapture models (Pradel 1996) obtained using Program MARK (White and Burnham 1999) and transforming to give an estimate of percent change per year (as described above). MAPS productivity indices were the proportions of young to adult birds in mist net samples averaged over the ten-year time period. For the first comparison (BBS v. MAPS trends), we excluded species with highly imprecise parameter estimates (those with a combined coefficient of variation [CV] for MAPS survival and recruitment > 40% and those with BBS trend estimate SEs > 2.0 [Lucy's Warbler, *Vermivora luciae*, and Virginia's Warbler, *V. virginianae*]). For the second comparison, we included all species for which we had data from both programs because we did not have measures of precision. (See Appendix for a complete list of the species used in each analysis.)

MAPS and BBS estimates of population trend for the 23 warbler species considered were strongly correlated (Fig. 1). Outliers included Mourning Warbler (MOWA in Fig. 1) and Prothonotary Warbler (PROW). Each of these species was represented by relatively few MAPS stations and banded individuals (13 and 230 for MOWA and 20 and 468 for PROW).

MAPS and BBIRD measures of productivity were also strongly correlated (Fig. 2). For many of these species, there are few sites or years represented by the BBIRD data, suggesting that the relationship derives mainly from the life history parameters (clutch size, exposure period). Nevertheless, the strength of the relationship suggests that the MAPS reproductive index provides an accurate relative measure of productivity at this scale.

Utility of the MAPS reproductive index for addressing research questions

The above analyses evaluated the continental-scale accuracy of MAPS data. In order to assess the efficacy of the program at finer scales of resolution (both temporal and spatial), we asked whether MAPS provides data that are useful for testing hypotheses relevant to conservation. Although a variety of population metrics can be derived from constant-effort mist netting and CMR data (as indicated above), a great deal of recent research at IBP has focused specifically on a single metric, the reproductive index (ratio of young to adults). This index is often highly variable across space and time and often correlates strongly with weather and habitat variables. Here we provide a brief summary of recent work in relating productivity to weather and habitat variables.

From data collected at 36 MAPS stations on six national forests in Oregon and Washington, Nott et al. (2002) showed that annual reproductive success of 31 species of landbird (16 Neotropical migrants and 15 short-distant or resident species) are strongly correlated with Pacific and Atlantic Ocean climate phenomena and resulting weather patterns. Furthermore, weather appears to influence reproduction via habitat effects both on the overwintering and breeding grounds. The species-climate models explained between 50% and 90% of annual variation in reproductive success, and for some species, reproduction covaried with invertebrate populations on the breeding grounds. These results corroborate single-species studies that suggest the importance of processes acting during the non-breeding season in affecting reproductive success in Neotropical migratory birds (Marra et al. 1998, Sillett et al. 2000, Sillett and Holmes 2002). Recent extensions of this work are focusing on linking cluster- scale (e.g., six MAPS station on a national forest or park) MAPS reproductive indices to finer-scale remote-sensed habitat (e.g., Normalized Difference Vegetation Index) and weather (rainfall) data.

As an example of how the reproductive index relates to landscape-scale habitat variables, Nott et al. (2003) constructed productivity-habitat models for ten bird species of management concern that breed on U.S. Department of Defense (DoD) lands that have active MAPS stations (data from 78 stations on 13 installations were analyzed). For each of these ten species, landscape-scale habitat variables were found to be strongly related to the reproductive index obtained from constant-effort mist netting data. In general, the reproductive indices of forest-dwelling species were highest in landscapes containing large areas of contiguous forest (> 700 ha in the 2-km-radius circle surrounding each station). Scrub/successional nesting species, on the other hand, seem to require much more heterogeneous landscapes. These landscape-scale analyses of MAPS reproductive indices and abundances have also revealed the existence of ecological traps, i.e., habitat types characterized by high abundance and a low reproductive index value. Productivity (and abundance) models built as part of the MAPS effort on DoD installations have been used to guide management efforts on these installations, and continued monitoring is being used to validate the habitat models.

Power to detect differences in survival between populations and changes in survival in a single population

To determine sample sizes necessary to achieve survival monitoring objectives, we conducted a series of power analyses based on apparent survival rate and recapture probability estimates obtained from MAPS data. Although formal power analyses of other population parameters derived from MAPS data could be instructive, we leave such analyses for a future contribution. Specifically, we investigated the statistical power to detect (1) differences in adult apparent survival rate between populations and (2) linear declines in survival over time for a range of survival and recapture probabilities found in MAPS data (Table 1). We report results for two alpha-levels (0.10 and 0.20) that encompass a range reported by other studies that have evaluated power of monitoring data (e.g., Bart et al. 2004).

For each combination of survival and recapture probabilities, we considered 15- and 20-yr time windows for detecting trends or differences between populations. We considered five effect sizes spanning the interval 5-25%. For the two-population scenario (1 above), effect sizes represent percent differences in survival rates between two equal-sized populations. For the linear decline scenario (2 above), effect sizes represent incremental proportional changes in survival that would halve the population in the same number of time periods as a population whose survival initially declined by the effect size percentage and then remained constant. For example, a population with an initial survival rate of 0.50 and a decrease in survival of 5% after the initial time period (to 0.475) would halve in 28 years. The corresponding linear "5%" decline for such a population (that would halve the population in 28 years) would be a proportional annual decrease in survival of 0.00373. Our calculations assume initially stable populations (i.e., $\lambda = 1$) and constant recruitment at a level that would balance losses at the start of the study. The number of years needed to halve populations under each scenario (given the assumed constant recruitment rate) and annual proportional changes used for the linear decline models are given in Table 2. Although the larger effect sizes could (potentially) halve populations over very short time intervals (Table 2), these magnitudes of differences among populations are typical of what we see in MAPS data. For example, the largest effect size (25%) is similar to the mean maximum difference in survival rates between MAPS regions for 89 species for which we were able to obtain 10-yr time-constant estimates of survival in multiple regions (mean difference = 23%; see www.birdpop.org/nbii/surv/default.asp for survival estimates used for these calculations).

For each scenario (two populations or a single declining population) and combination of survival and recapture probabilities, we simulated data sets of various sizes using program GENCAPH1 (written by J. E. Hines; www.mbr-pwrc.usgs.gov/software.html). For all sets of simulations we chose an initial sample size of 10 individual marked birds released per year. We repeated this process for a series of sample sizes ranging from 20-2,000 annual releases of marked birds. We input the simulated capture histories into Program MARK (White and Burnham 1999) and computed estimates of survival under null hypotheses (equal survival between populations or time constant survival) and under models representing the "true" alternative hypotheses. Power was estimated for each scenario, combination of initial survival rate and recapture probability, and sample size by calculating χ^2 statistics from a likelihood-ratio test comparing null and true models and then entering these values and their associated degrees of freedom into program POWER (written by J. E. Hines; www.mbr-pwrc.usgs.gov/software.html). We plotted power curves (sample size v. power) to determine the numbers of individuals needed to achieve 80% power of rejecting null hypotheses (i.e., $1 - \beta = 0.80$). Needed sample sizes were calculated using inverse prediction (i.e., we predicted the x values at $y = 0.80$) from a line connecting the two power estimates that bracketed power of 0.80. Because power curves were concave (particularly near 0.80 power), predicted needed sample sizes from straight lines are biased slightly high.

We estimated the numbers of species that MAPS currently samples in sufficient numbers to reject null hypotheses (no difference between populations or no change in a population) for each of the five effect sizes by tallying the number of species with current sample sizes equivalent to or greater than those needed to achieve 80% power at program-wide (i.e., continental) and MAPS-regional scales, given their estimated survival rates and recapture probabilities at each scale (see Fig. 3 for MAPS Region boundaries; note: the Alaska Region and the Boreal and Arctic Canada Region were combined for regional summaries into a single region called Alaska and Boreal Canada). We also estimated the numbers of species that MAPS samples in sufficient numbers to detect differences in survival among "clusters" of six stations on six national forests in Oregon and Washington. MAPS stations are often set up in this manner (clusters of six) on particular landholdings (e.g., a national park, national forest, or military installation) for logistical reasons, as a team of two bird banders can operate six stations in each 10-day period, even accounting for 2-3 days of rain.

Current sample sizes at each spatial scale (for the species tallies) were determined by estimating the numbers of marked resident birds of each species released per year under a stable MAPS program its current level of effort. To obtain these estimates, we first estimated the proportions of resident birds among newly-banded birds of unknown residency status (i.e., birds caught once in the season in which they were banded or birds caught more than once but < 7 d apart) in the 10-yr (1992-2001) data set using time-constant *ad hoc* Robust Design models (Hines et al. 2003). We multiplied these proportions by the numbers of unknown-status birds in the data set and then added to these the numbers of known residents (i.e., birds caught more than once > 7 d apart in their initial year of capture) to obtain estimates of the total numbers of resident birds (for each species and spatial scale) released from 1992-2001. Although these totals could simply be divided by 10 (for the 10 years in the data set) to obtain estimates of the mean numbers of birds released annually by MAPS, such estimates would underestimate current MAPS sample sizes because the program was growing rapidly during 1992-1997 (from 179 to 459 stations). MAPS has remained relatively constant since 1997 (with an annual mean of about 478 stations), and we inflated our estimated total numbers of resident birds prior to obtaining per-year averages to reflect this stable MAPS program.

We determined inflation factors for each region and at the continental scale through a two-step process. First we calculated the proportion of stations that were usable for survival analyses (i.e., that were operated for four consecutive years) for each of the ten years 1992-2001. These proportions, shown for continental-scale data in Fig. 4, increased during the first three years 1992-1994 (because *all* stations for which any of those three years was its last year of operation could not be included in survival analyses, regardless of whether or not they were operated for four or more years), stayed constant during the middle four years 1995-1998 (at the stable proportion of stations that operated for at least four consecutive years), and then decreased during the final three years 1999-2001 (because *all* stations that started operation during any of those three years could not be included in survival analyses of the ten-year 1992-2001 data set, regardless of whether or not they were operated for four or more years). As would be expected from a growing program, the 1992, 1993, and 1994 proportions were each slightly higher than the corresponding 2001, 2000, and 1999 proportions, respectively. We then multiplied the actual total number of stations operated in each of the final three years of the 10-year time period (1999-2001) by the mean proportion of stations usable for survival analyses during the middle four-year period (1995-1998) to estimate the number of stations usable for survival analyses during each of those three years for the on-going MAPS program.

In the second step in this calculation, which we also repeated for each region and for the continental scale, we summed the numbers of stations usable for survival analyses during the stable latter half of the ten-year period (i.e., the actual numbers of stations during 1997 and 1998 plus the estimated numbers of stations during 1999, 2000, and 2001), and multiplied this sum by 2 to estimate the total number of station-years useable for survival over any ten-year period of the current-sized MAPS Program. Finally, we divided this number by the actual number of station-years useable for survival analyses during the period 1992-2001 to provide the appropriate inflation factor. Then, for each region and for the continental-scale program, we multiplied the actual numbers of resident birds released during the 10-year period by the corresponding inflation factors, and divided these products by 10 to obtain the numbers of residents released per year in the current MAPS Program. The continental-scale inflation factor was 1.30, while regional inflation factors ranged from 1.13 for Alaska and Boreal Canada to 1.67 for the Southwest (regional mean = 1.30).

Finally, whether a particular species is captured in sufficient numbers to detect differences in survival between populations or changes in survival within a given population depends to some degree on the annual variation in survival rates. As such, our calculations of the numbers of species for which survival may be effectively monitored (i.e., monitorable species, defined as those for which differences in survival between populations or linear change in survival of 25% or less can be detected with 80% power at alpha = 0.20) at particular spatial scales may be slightly overestimated. Nevertheless, we rarely find strong evidence of time-dependent survival in MAPS data. In fact, only 46 of 411 species/region combinations for which we were able to obtain survival rate estimates with the 10-yr 1992-2001 data set (11%) showed strong evidence of time dependence (i.e., models with temporally varying survival were within 2 AIC units of time-constant models in only 11% of these cases). Thus, our estimates of numbers of currently monitorable species are likely reasonable.

Results

Sample sizes needed to detect the smallest effect sizes (5%) with 80% power were quite large, ranging from more than 100 to thousands of resident birds released per year, depending on the alpha-level and combination of survival and recapture probabilities (see Figs. 5 and 6 for a range of values typical of MAPS data). Larger effect sizes were much more easily detected, with effect sizes of 15% and higher typically requiring from just a few individuals to tens of individuals released per year. The ability to reject null hypotheses was strongly dependent on recapture probabilities (Figs. 5-6); the biggest gains in power came from increasing p at the low end of the range considered, particularly between $p = 0.05$-0.35, suggesting that intensive color-band resighting efforts would not greatly increase power for those ground- or shrub-inhabiting species for which p is already > 0.5. In general, sample sizes required to detect large effect sizes were smaller for the linear decline models than for the two-population comparisons, while small effect sizes were more easily detected in the two-population scenarios. In all cases, results were quite similar for the $\alpha = 0.10$, 20-yr simulations and the $\alpha = 0.20$, 15-yr simulations.

Our estimates of the numbers of species that MAPS currently monitors sufficiently to detect differences in survival between populations or linear declines in survival with 80% power at continental and regional scales are summarized in Figs. 7-10, and lists of these "currently monitorable" species are presented in Tables 3-10. Cluster-scale estimates of the numbers of currently monitorable species on Pacific Northwest national forests are presented in Fig. 11. Results are presented for the entire range of effect sizes (5-25%), for alpha levels of 0.10 and 0.20, and for 15- and 20-yr time frames. Below we provide a brief summary of these results.

Continental-scale power of MAPS.—Our estimates of the numbers of resident birds released per year as part of the MAPS program at the continental scale suggest that we can detect differences between populations or linear declines in populations with 15-20 years of data for 105 species. About 1/3 of these species (36) are Partners in Flight Species of Continental Importance ("Watch List" or "Additional Stewardship" species). Current MAPS sample sizes suggest we can detect 5% differences in survival between populations and/or 5% declines in survival for nine species: Veery, Swainson's Thrush, Gray Catbird, Yellow Warbler, Ovenbird, MacGillivray's Warbler, Common Yellowthroat, Song Sparrow, and Northern Cardinal (Table 3). Numbers of species for which larger effect sizes can likely be detected at the continental scale (for $\alpha = 0.20$) include an additional 38 species at the 10% level, 33 species at the 15% level, 13 species at the 20% level, and 12 species at the 25% level. Increasing the alpha-level from 0.10 to 0.20 resulted in relatively small increases in the numbers of species for which we can reject null hypotheses (Figs. 7-10).

Regional-scale power of MAPS.—MAPS program coverage is greatest in the Northwest Region, and our species tally for this region suggests that we can detect differences in survival between populations or linear declines in survival with 80% power for 47 species (Table 4, Figs 7-10). Five-percent effect sizes (for at least one of the hypothesis tests, 20 years of data, and $\alpha = 0.20$) can be detected for four of these species in the Northwest Region (Swainson's Thrush, Song

Sparrow, Yellow Warbler, and MacGillivray's Warbler), while larger effect sizes can be detected for an additional 14 species at the10% level, 21 species at the 15% level, six species at the 20% level, and two species at the 25% level.

Numbers of currently monitorable species were similar for the Southwest and Northeast Regions, with tallies of 42 and 38 species, respectively (Tables 5 and 8). Current sample sizes are sufficient to detect a 5% difference in survival between Veery populations with $\alpha = 0.20$ and 20 years of data in the Northeast Region (Table 8), but are insufficient to detect 5% effect sizes for any other species or scenario in either of these two regions. At the 10% effect size, nine species are currently monitorable in the Southwest Region (Table 5), and an additional seven species are monitorable in the Northeast Region (Table 8). The remaining species are only sampled in sufficient numbers to detect larger effect sizes. Currently monitorable species in the remaining MAPS regions ranged from 19 in the combined Alaska and Boreal Canada Region to 25 in the North-central Region. No species is sampled sufficiently to detect 5% effect sizes with 80% power in any of these remaining regions.

Cluster-scale power of MAPS.—We were able to obtain survival rate estimates on at least two of the six Pacific Northwest national forests for 21 species. With 20 years of data and alpha = 0.2, we found we could detect 10% differences in survival for one species (Swainson's Thrush), 15% differences in survival for five other species (American Robin, MacGillivray's Warbler, Wilson's Warbler, Lincoln's Sparrow, and Dark-eyed Junco), 20% differences for three other species (Dusky Flycatcher, Warbling Vireo, and Song Sparrow), and 25% differences for six other species (Hammond's Flycatcher, "Western" Flycatcher, Winter Wren, Yellow Warbler, Yellow-rumped Warbler, and Common Yellowthroat), for a total of 15 of the 21 species (Fig. 11). Interestingly, the mean maximum difference in survival between forests for the 13 species with $CV(\phi) < 20\%$ at both forests was 14.8%; the mean maximum difference for all 21 species (regardless of $CV(\phi)$ was 25.5%. It is not surprising, therefore, that we found we had 80% power to detect the magnitude of the difference in survival that actually existed between the two national forests for eight of the 15 species for which we could at least detect a 25% difference in survival.

As was the case for differences in survival at the continental and regional (i.e., within-region) scales, 20 years of data for alpha = 0.1 gave very similar results to 15 years of data for alpha = 0.2. In each of these two cases, we achieved 80% power to detect 25% differences in survival for 10 of the 21 species, and could detect the magnitude of the difference in survival that actually existed between the two national forests for four of those 10 species. With 15 years of data and alpha=0.1, we detected achieved 80% power to detect 25% differences in survival for eight of the 21 species, and could still detect the magnitude of the difference in survival that actually existed between the two national forests for four of those eight species.

Gaps in MAPS coverage and recommended program expansion

The number of stations operated annually in the current MAPS Program that have operated for at least four years (and are thus able to be included in survival analyses) are presented for each of the seven MAPS regions in Table 11. The Northwest Region currently hosts the largest number of MAPS stations, followed by the Southeast, Southwest, and Northeast regions, with barely over half the number of stations as in the Northwest Region. The South-central Region has fewer stations still while the North-central Region and Alaska and Boreal Canada Region have the fewest stations. We suggest that, in order for MAPS to contribute optimally to a continental-scale CBM effort, coverage should be increased, especially in under-represented MAPS Regions. We suggest that 20 additional stations could be established and maintained in the Northwest Region, and that the number of stations in the Southwest, Southeast, and Northeast Regions could be increased to equal the current level of coverage in the Northwest Region (i.e., 128 stations operated annually with a history of 4+ years of operation). We also suggest that the numbers of stations in the remaining three regions (South-central, North-central, and Alaska and Boreal Canada), which have considerably smaller human population densities, substantially more grassland habitat (which is unfavorable for fixed-net mist netting), or both, could be increased to the average current level of coverage in the Southwest, Northeast, and Southeast Regions, which is 67 stations. Such a program expansion would increase the number of MAPS stations by 300 to a total of 733 stations operated annually with a history of 4+ years of operation, a 69% increase.

We used two methods to identify species for which survival could potentially be monitored effectively under an expanded MAPS program. In the first method, which we call the expanded (non-targeted) program, we assumed that, within each region, the relative geographic and habitat coverages and effectiveness of capturing birds in the expanded program would remain essentially the same as in the current program. Under this method, new monitorable species were identified as those for which expected sample size increases (calculated as a proportional increase in annual releases of residents equal to the proportional increase in the number of stations in that region) reach a level that our power analyses suggest we can detect at least a 25% difference in survival between populations or a 25% decline in survival over time with 80% power, 20 years of data, and $\alpha = 0.20$. We did not apply this method to the Northwest Region as we believe that the current number and distribution of stations there is sufficient to effectively monitor an adequate number of species in the habitats sampled.

In the second method, which we call the expanded and targeted program, we assumed that new MAPS stations would be sited specifically to target species that are currently not well-represented in the MAPS database, including species that were identified as monitorable species in the expanded (but non-targeted) program. For all but the Northwest Region, target species were selected as those thought to be monitorable, based on their habitat, ecology, and behavior, given an expanded and targeted MAPS program.

For the Northwest Region, target species were selected based on a formal analysis of the MAPS program in this region funded by the U.S. Bureau of Land Management (Pyle et al. 2005). This analysis was primarily focused on identifying priority species and habitats in Oregon and Washington, but we also considered areas of Alaska, British Columbia, Alberta, Idaho, Montana, Wyoming, Nevada, and California that lie within the MAPS Northwest Region. This area encompasses four Bird Conservation Regions (BCRs). Target species were selected based on (1) their being identified as focal or priority species in at least one of the 13 published PIF bird conservation plans for the Northwest Region or (2) their having negative population trends according to BBS and/or MAPS data in one or more states or BCRs in the Northwest Region. Certain species with positive population trends were also selected for comparison. Priority habitats were identified by examining PIF habitat designations for Physiographic Areas in the Pacific Northwest and selecting those that can be effectively sampled by MAPS (in general, forested and scrub areas). Because we do not envision much opportunity for substantial program growth in the Northwest Region, potential new target species for MAPS in this region would be targeted by increasing the total number of stations by no more than 20 and by redistributing the current level of effort. To achieve this latter end, we examined capture data from 224 MAPS stations that operated between 1989 and 2003. For these stations, we determined how effectively each station sampled priority habitats and priority species and made suggestions for redistributing some existing stations (i.e., discontinuing them and replacing some of them with new stations) and re-establishing some discontinued stations.

A summary of the current MAPS program and results of the two sets of expanded program scenarios, hereafter referred to as the "expanded program" and "expanded and targeted program", respectively, are presented in Table 11. A list of species for which apparent survival rates have been estimated from the current program, and additional species for which survival can likely be effectively monitored under the expanded or the expanded and targeted programs, are presented in Table 12 for the continental scale. Also presented in Table 12 are the parameter estimates (ϕ and p) that have been obtained by MAPS, the effect sizes detectable under the expanded program, and, for species not currently adequately monitored, a designation of the program-expansion scenarios in which they would likely be included (i.e., in both the expanded and the expanded and targeted scenarios versus only in the targeted scenario). Regional species lists that summarize the results of these same program expansion scenarios are presented in Tables 13-19.

Under the expanded (i.e., non-targeted) program, the number of species whose survival would be monitorable by MAPS would increase by an average of only 22% over the six expanded regions (ranging from 9% in the South-central Region to 37% in the Alaska and Boreal Canada Region), despite the number of stations increasing by an average of 104% over these regions (ranging from 34% in the South-central Region to 205% in the Alaska and Boreal Canada Region). At the continental scale, the number of monitorable species increased by only 13% (to 119 species) with an overall increase in the number of stations of 65% (to 713 stations). Despite low overall gain in monitorable species, the numbers of species monitorable at smaller effect sizes than in the current program increased markedly under the expanded program (Figs. 12-13). For example, the number of species for which 5% linear declines would likely be detectable under the expanded program increased by 160% (from 5 to 13 species).

Under the expanded and targeted program scenario, the survival rates of many additional species could likely be effectively monitored by MAPS. Such a program would increase the number of monitorable species by an average of 96% in the six expanded and targeted regions (ranging from 55% in the Southwest Region to 132% in the South-central Region). Targeting with an expansion of only 20 stations in the Northwest Region (16% increase in stations) would provide a 34% increase the number of effectively monitored species there. Some of these targeted increases will involve additional stations in shrub-steppe habitats in the Northwest Region, desert scrub and desert riparian habitats of the Southwest Region, and both bottomland and upland forest habitats in the South-central and Southeast regions. A major increase in targeted stations will also be required in boreal forest habitat of Canada and Alaska. This latter effort could best be accomplished by including MAPS stations in the Boreal Songbird Initiative (www.borealbirds.org/about.html). Again, the inclusion of MAPS into a continent-wide CBM program would be extremely helpful for achieving all these objectives.

At the continental scale, the expanded and targeted scenario would result in a 39% increase in monitorable species (from 105 to 146 species), and a 23% increase over the expanded program (from 119 to 146 species). We briefly describe below the 27 new species likely to be effectively monitored with a targeted MAPS program expansion. Species for which we can currently obtain continental-scale survival-rate estimates, but for which we do not have sufficient data to monitor effectively (i.e., for which sample sizes are too small to detect differences in survival between populations or declines in survival at the 25% level) are indicated by an asterisk. Additional species for which survival at the continental scale is potentially monitorable via a targeted MAPS program expansion include: (1) five species typical of oak woodland or pinyon-juniper habitat of the west and southwest (Gray Flycatcher, *Plumbeous Vireo, *Hutton's Vireo, *Bridled Titmouse, *Black-throated Gray Warbler); (2) seven species typical of shrub-steppe, desert scrub, and canyons of the west and southwest (*Verdin, Sage Thrasher, Canyon Towhee, Brewer's Sparrow, *Vesper Sparrow, *Black-throated Sparrow, *Sage Sparrow); (3) nine species that breed extensively in the boreal forests of Canada and Alaska (*Yellow-bellied Sapsucker, Yellow-bellied Flycatcher, *Blue-headed Vireo, Philadelphia Vireo, *Gray Jay, *Ruby-crowned Kinglet, Tennessee Warbler, Palm Warbler, and Bay-breasted Warbler); and (4) six species representative of various geographic areas in central and eastern North America (*Blue Jay, *Bicknell's Thrush, *Black-throated Blue Warbler, *Swainson's Warbler, *Clay-colored Sparrow, and *Dickcissel). An additional group of six species that inhabit relatively dense grasslands or marshes (Marsh Wren, Le Conte's Sparrow, Nelson's Sharp-tailed Sparrow, Bobolink, *Eastern Meadowlark, and Western Meadowlark) could potentially be monitored via a modified protocol that could involve driving birds toward lines of mist nets (Plentovich et al. 1998). These species are not included in the 146 species enumerated above.

Landbird species that are unlikely to be effectively monitored by MAPS fall into several groups. First is a group of 16 relatively common and widespread species that appear to have poor site-fidelity or high temporary emigration and thus are typically characterized by low recapture probabilities. These include: *Red-breasted Nuthatch, Bohemian Waxwing, *Cedar Waxwing, Cassin's Sparrow, Tricolored Blackbird, *Pine Grosbeak, *Cassin's Finch, *House Finch, Red Crossbill, White-winged Crossbill, *Common Redpoll, Hoary Redpoll, *Pine Siskin, *Lesser Goldfinch, Lawrence's Goldfinch, and Evening Grosbeak. A second group includes 14 upperstory- or canopy-inhabiting species whose recapture probability is apparently too low to allow them to be effectively monitored by MAPS: *Red-bellied Woodpecker, *Yellow-throated Vireo, Pygmy Nuthatch, Brown-headed Nuthatch, *Brown Creeper, *Golden-crowned Kinglet, *Blue-gray Gnatcatcher, Cape May Warbler, *Hermit Warbler, *Blackburnian Warbler, Yellow-throated Warbler, Pine Warbler, Cerulean Warbler, and *Scarlet Tanager. The intrinsically low survival rates of the creeper, kinglet, and gnatcatcher, and the rarity of Cerulean Warbler also hinder their ability to be monitored by MAPS. A third group includes 21 species that, while potentially relatively easily captured, are probably too uncommon or sparsely distributed to provide large enough sample sizes for their survival to be effectively monitored: Black-billed Cuckoo, *Yellow-billed Cuckoo, *Williamson's Sapsucker, Red-cockaded Woodpecker, White-headed Woodpecker, *Three-toed Woodpecker, Black-backed Woodpecker, Gray Vireo, Sedge Wren, Black-tailed Gnatcatcher, *California Thrasher, Crissal Thrasher, *Golden-winged Warbler, Connecticut Warbler, Bachman's Sparrow, Black-chinned Sparrow, Baird's Sparrow, Henslow's Sparrow, Pyrrhuloxia, *Rusty Blackbird, and *Orchard Oriole.

Other species of landbirds whose survival in unlikely to be monitored effectively by MAPS include: (1) 49 generally open-country species not easily captured in fixed-location mist nets, including *Common Ground-Dove, *Belted Kingfisher, *Golden-fronted Woodpecker, *Northern Flicker, *Vermilion Flycatcher, *Eastern Kingbird, *Eastern Bluebird, *Western Bluebird, *Townsend's Solitaire, *Mockingbird, *European Starling, *Brewer's Blackbird, *Bronzed Cowbird, and other species with similar foraging beats, as well as larks, pipits, and longspurs; (2) ten species of aerial foraging swifts and swallows, including *Violet-green Swallow and *Northern Rough-winged Swallow; (3) three species of New World vultures and 31 species of diurnal raptors that generally are too large to be captured in MAPS nets; (4) 22 other large species that are difficult to capture in the small mesh nets used by MAPS, including *Western Scrub-Jay, *Mexican Jay, and *Common Grackle; (5) five range- or habitat-restricted species including Black-capped Vireo, Golden-cheeked Warbler, Kirtland's Warbler, Salt Marsh Sharp-tailed Sparrow, and Seaside Sparrow which, if intensively targeted, could possibly be monitored by MAPS, as well as 59 other range-restricted species which are primarily limited to extreme southern United States; (6) 27 mostly nocturnal species of owls and nightjars; and (7) 16 hummingbird species and 23 species of gallinaceous birds, which most bird banders are not permitted to band.

Discussion

Although our power analyses demonstrate the difficulty of detecting small (5-10%) differences in survival between populations or linear declines in survival in a single population given sample sizes currently being obtained by MAPS, the typical effect sizes seen in MAPS data are often of a much larger magnitude for most species. Indeed, analyses presented above indicate that we can detect differences and declines in survival of the magnitudes of differences typically seen between MAPS regions or between clusters of MAPS stations with 80% power for 84 and 105 species, respectively, at the continental scale, and for 40 and 47 species, respectively, in the Northwest Region, the region having the largest number of MAPS stations. For the other six regions, the numbers of species for which we can detect such differences and declines varies from 32 and 40, respectively, in the Southwest Region to 12 and 19, respectively, in the Alaska and Boreal Canada Region. Clearly, MAPS needs to be expanded in these regions in order to increase the number of species for which such differences and declines in survival can be effectively monitored.

Based on our enumerations of effectively-monitored species under the hypothetical expanded and expanded and targeted MAPS programs, it is clear that a focused approach that targets under-represented species and habitats will be required to maximize the number of species and habitats adequately monitored by MAPS. We suggest that target species be selected based not only on their habitats and ecology (and thus their inherent monitorability), but also on their status as species of conservation concern or whether they represent habitats of special management concern. This is exactly the approach we followed in identifying the 16 target species listed in Table 13 for the targeted MAPS Program in the Northwest Region. We strongly recommend that similar analyses be conducted for each MAPS region to better direct future program development and expansion. Both the addition and redistribution of stations in the Pacific Northwest and the undertaking of analyses to guide MAPS in the remaining six regions would be facilitated through the integration of MAPS into a broader CBM effort. This effort would also benefit from integrating MAPS into existing regional or larger-scale avian habitat conservation efforts, such as those in boreal forest (www.borealbirds.org/about.html) and sagebrush shrub-steppe habitats (www.sagebrushbird.org/index.html).

We also suggest that a target-species approach that examines a limited number of habitats (or management regimes) or simple habitat (or management) gradients will prove most useful for addressing finer-scale monitoring needs. For example, in the analysis of Pacific Northwest national forests (see the cluster-scale power analysis results above), we were able to compare survival rate estimates for 21 species between various 6-station clusters of stations. We found we had 80% power to detect 25% differences in survival between clusters for 15 of the 21 species, and to detect the magnitude of the difference in survival that actually existed between the two national forests for eight of those 15 species. This was despite the fact that on the two forests where each individual species was most abundant, the species were summer residents (and thus amenable to mark-recapture analyses) on an average of only 9.1 of the 12 possible stations. Furthermore, each species was typically rare on at least two of those nine stations and on at least three of the remaining four forests. The principal reason for this is that these sets of stations were established to monitor a wide variety of habitats, and thus they encompassed a broad range of bird communities. A more targeted strategy for designing a study with two clusters of six stations each would be to focus on a particular species (or set of species) of conservation concern and sample just two habitats (e.g., three stations in each habitat type in each cluster) or sample along a single habitat gradient. Such a hypothesis-driven study design would require just two teams of banders (each operating six stations) and should be capable of providing strong inferences regarding habitat factors that influence survival and reproduction for a range of species. Such a targeted approach should form the basis of integrating demographic monitoring into a CBM effort.

The targeted hypothesis-driven sampling strategy described above lends itself well to management, as it provides testable hypotheses regarding habitat types or characteristics that promote better survival (or productivity) in populations of species of conservation concern. A similar sampling strategy can be employed to monitor demographic responses to management actions (i.e., effectiveness monitoring). Each of these targeted hypothesis-driven monitoring efforts directly supports management, has been referred to as “management-based” monitoring by the Coordinated Bird Monitoring Working Group (2004) or “targeted” monitoring by the NABCI Monitoring Subcommittee (2006), and was distinguished in those reports from “surveillance” (Coordinated Bird Monitoring Working Group 2004) or “broad-scale” (NABCI Monitoring Subcommittee 2006) monitoring, for which the goals were, among others, to provide essential information for prioritizing species for conservation actions and to identify emerging conservation issues. We feel that the distinction between “management-based” monitoring and “surveillance” monitoring is somewhat artificial, and suggest that they reflect, to some extent, the spatio-temporal continuum of questions that monitoring data can address. What is usually considered to be “management-based” monitoring typically requires a spatially intensive sampling effort that can assess changes over relatively short time frames, while what is usually considered to be “surveillance” monitoring typically requires a spatially extensive sampling effort over a long time scale.

We argue that the MAPS program is well-suited to fulfilling both “management-based” and “surveillance” monitoring goals. Indeed, the optimal sampling design of the overall MAPS program can be envisioned as collections of targeted, hypothesis-driven sampling strategies at local spatial scales that are integrated into larger regional sampling schemes, which, in turn, can provide much of the necessary effort required for “surveillance” monitoring at the regional and continental scales. In such an overall strategy, each local hypothesis-driven sampling scheme of about 12 stations would aim for the 15- to 20-year time horizon, which according to the power analyses presented above, would likely provide statistically significant results at the local scale. Such sets of stations would not need to be operated indefinitely into the future to achieve the targeted monitoring objective they were designed to address. Moreover, if a number of such hypothesis-driven sampling schemes were integrated through a CBM framework, the termination of some of stations after four or five (but less than 15) years of sampling would still provide important data for the broader-scale program, provided that new stations were initiated in similar habitats within the region of interest. This is, in large part, how the current MAPS program operates – as a collection of smaller scale studies – although little direction (aside from the Pacific Northwest analysis; Pyle et al. 2005) has been given to the establishment of new stations in such a way as to maximize the ability to address monitoring questions at broader spatial scales.

We suggest that three important tasks be completed to best guide the development of a truly coordinated continent-wide landbird demographic monitoring effort based on the MAPS Program. These tasks include (1) an analysis of priority landbird species, priority habitats, and the monitoring effectiveness of current and discontinued MAPS stations (similar to that completed for the Pacific Northwest) in the remaining MAPS regions, (2) increased modeling efforts aimed at understanding temporal and spatial variation in adult apparent survival and other demographic parameters obtained from MAPS data, and (3) the development of guidelines for optimal sampling strategies and priorities for each MAPS region (or major PIF working group regions, i.e., Northeast, Southeast, Mid-west, Western, and Boreal) based on the results of (1) and (2). We suggest that these tasks should be high priorities for the demographic monitoring component of a CBM program.

We also suggest, however, that collections of integrated hypothesis-driven sampling schemes for target species and habitats involving 15- to 20-year time horizons, even when fully coordinated at regional and continental scales, may *not* provide all of the broad-scale, long-term needs of a coordinated demographic monitoring program. The reason for this is that the priority species and habitats and the specific hypotheses driving any current sampling scheme may need to change as new and unforeseen threats and environmental driving forces arise through large-scale processes such as global climate change, soil and water acidification, and airborne environmental contamination that may affect or otherwise interact with efforts to monitor the habitat-specific demographic rates or the demographic effects of habitat management. We suggest that some level of spatially extensive, long-term "surveillance"-type monitoring should be a critical part of the optimal strategy for demographic monitoring, and that some number MAPS stations designed to operate indefinitely into the future should be sited in several select critical habitat types across the continent. We further suggest that national parks, research natural areas, and other protected areas be utilized for this monitoring, as they tend to be relatively pristine and not subject to the complicating effects of on-going land management.

As indicated earlier (see *Introduction*), demographic monitoring, rather than simple abundance monitoring, is better suited to addressing management questions at all spatial and temporal scales, because it targets the demographic processes that not only are driving population declines, but that are also directly affected by management actions. In addition, monitoring and basing management on vital rates (as well as abundance and population trends) allows management to be directed to the particular stage(s) of the life cycle and, for migratory species, the particular geographic area at which population change is being effected. This enables habitat management to be based on true measures of habitat quality, unaffected by the potential confounding influences of population sources and sinks.

It should also be mentioned that although MAPS is currently the only comprehensive standardized program aimed at generating broad-scale demographic data for small landbirds in North America, there is no reason why researchers collecting mist-netting and CMR data during the breeding season, but following protocols that differ from MAPS, cannot contribute meaningfully to a continental-scale coordinated demographic monitoring effort. Indeed non-MAPS data could likely be incorporated fairly easily into MAPS survival analyses (perhaps just requiring extra recapture probability parameters), and may be able to be used in productivity analyses as well. Furthermore, in the event that non-MAPS data cannot easily be combined into single analyses, these studies could still provide additional evidence for patterns found in MAPS data and also aid in directing future MAPS sampling efforts. Finally, some level of broad-scale demographic information (although not as comprehensive as MAPS) can also be obtained from coordinated programs conducted outside of the breeding season. For example, regional or larger-scale indices of annual productivity (age ratios) could be obtained from networks of standardized migration monitoring stations (e.g., Dunn et al. 2004), and annual survival rates can be obtained with networks of banding stations on the wintering grounds (e.g., for Neotropical wintering species see DeSante et al. 2005). Although such efforts show promise, they have not yet proven themselves in terms of being successfully adopted and implemented by a large, diverse group of cooperators and the production of consistent meaningful results for a large suite of species at broad spatial scales. As such, such efforts are probably not appropriate for adoption by a CBM program at this time.

Once vital rates have been monitored via MAPS, a variety of analytical approaches can be used to assess proximate (demographic) causes of population declines, including modeling spatial variation in trends (for a single species) or variation in trends among species as functions of vital rates. Additionally, ultimate causes of declines can be identified by modeling vital rates and trends as functions of habitat and weather variables (e.g., Nott et al. 2002, 2003). Once such steps have been taken, appropriate habitat management guidelines for increasing deficient vital rates can be formulated. Such guidelines are likely to be effective at reversing population declines and maintaining stable healthy populations because they target the deficient vital rates that are responsible for the declines. In summary, we conclude that a MAPS program that is integrated at multiple spatial scales into a continent-wide CBM effort will provide appropriate demographic data for (1) identifying proximate demographic causes of population trends for at least 100 target landbird species; (2) formulating conservation strategies and management actions to reverse declines; and (3) monitoring the effectiveness of the conservation strategies and management actions that are actually implemented to reverse the declines.

Acknowledgements

We thank the U.S. Geological Survey, Biological Resources Division, Forest and Rangeland Ecosystem Science Center, Corvallis, OR, for financial support to initiate the analyses presented in this report. We thank the many colleagues who have provided constructive criticism and stimulating insights into the science of demographic monitoring and have shaped much of our thinking regarding these issues, especially Jon Bart, Jim Nichols, Andy Royle, John Sauer, and Peter Pyle. We thank the IBP staff biologists who have provided rigorous verification and vetting of the massive amount of data used in the analyses presented here, and we especially thank the hundreds of MAPS station operators and their assistants and interns, without whom, MAPS would not exist. This is Contribution No. 282 of The Institute for Bird Populations.

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Table 1. Combinations of apparent survival and recapture probabilities (ranges for inclusion shown in parentheses) considered in power analyses, and numbers of species represented by these combinations of parameter estimates in MAPS continent-wide time-constant analyses of 10 years of data (1992-2001). We also considered a recapture probability of 0.95 in power analyses, which is never achieved by MAPS, but might be representative of a study incorporating color banding and intensive resighting effort.

	Recapture (p)						
Survival (ϕ)	0.05 (0.000-0.125)	0.20 (0.125-0.275)	0.35 (0.275-0.425)	0.50 (0.425-0.575)	0.65 (0.575-0.725)	0.80 (0.725-0.875)	Total
0.20 (0.15-0.25)	1	2	1	1	0	0	5
0.30 (0.25-0.35)	1	6	3	1	1	2	14
0.40 (0.35-0.45)	4	14	5	13	2	1	39
0.50 (0.45-0.55)	3	12	37	19	7	1	79
0.60 (0.55-0.65)	7	7	9	3	1	0	27
0.70 (0.65-0.75)	4	5	4	0	0	0	13
0.80 (0.75-0.85)	0	1	1	0	0	0	2
Total	20	47	60	37	11	4	179

Table 2. Summary of effect sizes for each survival rate considered in simulations.

Higher ϕ (or starting ϕ for linear decline scenarios)	Effect size -- % difference in ϕ (or “% change in ϕ”)	Lower ϕ	No. years (t) to halve population with lower ϕ	% of population remaining after t years	Prop. annual change for linear decline scenarios
0.3	5	0.285	46	50	0.00229
	10	0.270	23	48	0.00961
	15	0.255	16	48	0.02076
	20	0.240	12	50	0.03887
	25	0.225	9	48	0.07444
0.4	5	0.380	35	50	0.00297
	10	0.360	17	48	0.01332
	15	0.340	12	47	0.02803
	20	0.320	9	48	0.05274
	25	0.300	7	50	0.09344
0.5	5	0.475	28	49	0.00373
	10	0.450	14	50	0.01579
	15	0.425	9	48	0.04087
	20	0.400	7	45	0.07153
	25	0.375	6	49	0.10186
0.6	5	0.570	23	48	0.00463
	10	0.540	12	47	0.01801
	15	0.510	8	46	0.04315
	20	0.480	6	44	0.08204
	25	0.450	5	49	0.12511
0.7	5	0.665	20	48	0.00527
	10	0.630	10	46	0.02249
	15	0.595	7	47	0.04874
	20	0.560	5	46	0.10411
	25	0.525	4	50	0.17654
0.8	5	0.760	17	47	0.00642
	10	0.720	9	46	0.02442
	15	0.680	6	50	0.05911
	20	0.640	4	41	0.15007
	25	0.600	4	49	0.30614
0.9	5	0.855	16	48	0.00644
	10	0.810	8	47	0.02771
	15	0.765	5	48	0.07799
	20	0.720	4	47	0.13054
	25	0.675	3	50	0.26328

Table 3. Effect sizes detectable by MAPS with 80% power for 105 species at the program-wide (i.e., continental) scale. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20.

Common name	Scientific name	Sta[1]	Ind[2]	Res[3]	ϕ[4]	p[5]	15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
							2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]
Red-naped Sapsucker	*Sphyrapicus nuchalis*	32	489	55	0.413	0.602	25	20	25	20	25	15	20	15
Red-breasted Sapsucker	*Sphyrapicus ruber*	49	701	77	0.458	0.369	25	20	20	15	20	15	20	15
Ladder-backed Woodpecker	*Picoides scalaris*	16	98	10	0.552	0.292								25
Nuttall's Woodpecker	*Picoides nuttallii*	16	195	22	0.551	0.381				25		20	25	15
Downy Woodpecker	*Picoides pubescens*	227	1915	137	0.500	0.354	20	15	15	15	15	15	15	10
Hairy Woodpecker	*Picoides villosus*	154	630	59	0.665	0.208	25	20	20	20	20	15	15	10
Western Wood-Pewee	*Contopus sordidulus*	73	1456	135	0.486	0.362	20	15	15	15	15	15	15	10
Eastern Wood-Pewee	*Contopus virens*	101	616	44	0.494	0.278		25		20		20	25	15
Acadian Flycatcher	*Empidonax virescens*	66	2285	183	0.508	0.518	15	15	10	10	10	10	10	10
"Traill's" Flycatcher	*Empidonax alnorum/traillii*	80	3105	198	0.485	0.491	15	15	10	10	10	10	10	10
Least Flycatcher	*Empidonax minimus*	24	1044	73	0.379	0.435		20	25	20	25	15	20	15
Hammond's Flycatcher	*Empidonax hammondii*	56	1155	114	0.452	0.403	20	15	20	15	20	15	15	15
Dusky Flycatcher	*Empidonax oberholseri*	52	1986	147	0.485	0.425	15	15	15	15	15	10	10	10
"Western" Flycatcher	*E. difficilis/occidentalis*	69	2573	161	0.504	0.282	20	15	15	15	15	15	15	10
Black Phoebe	*Sayornis nigricans*	16	195	12	0.460	0.481								20
Ash-throated Flycatcher	*Myiarchus cinerascens*	35	723	63	0.666	0.135	20	20	20	15	15	15	15	10
Great Crested Flycatcher	*Myiarchus crinitus*	96	574	33	0.615	0.216								20
Brown-crested Flycatcher	*Myiarchus tyrannulus*	4	225	30	0.492	0.276				25		20		20
White-eyed Vireo	*Vireo griseus*	82	2719	267	0.537	0.509	10	10	10	10	10	10	10	10
Bell's Vireo	*Vireo bellii*	17	562	57	0.581	0.404	20	20	20	15	20	15	15	10
Warbling Vireo	*Vireo gilvus*	118	5017	379	0.483	0.428	10	10	10	10	10	10	10	10
Red-eyed Vireo	*Vireo olivaceus*	159	4798	427	0.595	0.253	10	15	10	10	10	10	10	10
Steller's Jay	*Cyanocitta stelleri*	60	303	20	0.731	0.184							25	25

Table 3 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta[1]	Ind[2]	Res[3]	ϕ[4]	p[5]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]
Carolina Chickadee	*Poecile carolinensis*	121	1312	95	0.499	0.229				25		20	25	15
Black-capped Chickadee	*Poecile atricapilla*	144	3069	294	0.468	0.367	15	15	10	10	10	10	10	10
Mountain Chickadee	*Poecile gambeli*	51	1145	93	0.452	0.385	25	20	20	15	20	15	15	15
Chestnut-backed Chickadee	*Poecile rufescens*	51	1043	88	0.419	0.396		25		25		20	25	20
Boreal Chickadee	*Poecile hudsonica*	10	132	19	0.492	0.365								25
Tufted Titmouse	*Baeolophus bicolor*	137	1840	189	0.491	0.386	15	15	15	15	15	10	10	10
Bushtit	*Psaltriparus minimus*	43	1117	152	0.295	0.146								25
White-breasted Nuthatch	*Sitta carolinensis*	88	358	20	0.477	0.306								20
Carolina Wren	*Thryothorus ludovicianus*	124	2713	270	0.397	0.541	15	15	15	15	15	10	10	10
Bewick's Wren	*Thryomanes bewickii*	72	1695	180	0.430	0.515	20	15	15	15	15	15	15	10
House Wren	*Troglodytes aedon*	97	2863	267	0.341	0.420	25	25	25	20	25	20	20	15
Winter Wren	*Troglodytes troglodytes*	46	967	78	0.376	0.506	25	20	25	20	25	15	20	15
Arctic Warbler	*Phylloscopus borealis*	2	249	29	0.339	0.605						25		25
Veery	*Catharus fuscescens*	54	2274	290	0.581	0.566	10	10	10	10	10	10	5	10
Gray-cheeked Thrush	*Catharus minimus*	6	253	31	0.459	0.683	25	20	20	15	20	15	20	15
Swainson's Thrush	*Catharus ustulatus*	109	10175	1113	0.581	0.624	5	5	5	5	5	5	5	5
Hermit Thrush	*Catharus guttatus*	75	2170	229	0.474	0.607	10	10	10	10	10	10	10	10
Wood Thrush	*Hylocichla mustelina*	128	4973	455	0.440	0.490	10	15	10	10	10	10	10	10
American Robin	*Turdus migratorius*	269	7874	682	0.523	0.275	10	10	10	10	10	10	10	10
Varied Thrush	*Ixoreus naevius*	40	493	34	0.471	0.394				25		20	25	15
Wrentit	*Chamaea fasciata*	37	1325	145	0.534	0.627	15	15	10	10	10	10	10	10
Gray Catbird	*Dumetella carolinensis*	121	9446	874	0.511	0.464	5	10	5	10	5	10	5	5
Brown Thrasher	*Toxostoma rufum*	58	643	48	0.522	0.292	25		25	20	25	15	25	15
Long-billed Thrasher	*Toxostoma longirostre*	3	133	14	0.628	0.396								20
Blue-winged Warbler	*Vermivora pinus*	35	994	79	0.521	0.394	25	20	20	15	20	15	20	15

Table 3 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta[1]	Ind[2]	Res[3]	ϕ[4]	p[5]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]
Orange-crowned Warbler	*Vermivora celata*	72	3875	268	0.441	0.435	15	15	15	15	15	10	10	10
Nashville Warbler	*Vermivora ruficapilla*	34	1111	60	0.338	0.331								25
Virginia's Warbler	*Vermivora virginiae*	12	463	30	0.473	0.339				25		20		20
Yellow Warbler	*Dendroica petechia*	123	9049	816	0.534	0.474	10	10	5	10	5	10	5	10
Chestnut-sided Warbler	*Dendroica pensylvanica*	22	839	88	0.431	0.545	25	20	20	20	20	15	20	15
Magnolia Warbler	*Dendroica magnolia*	15	514	39	0.321	0.769		25		25		20	25	20
Yellow-rumped Warbler	*Dendroica coronata*	97	4216	328	0.451	0.276	15	15	10	10	10	10	10	10
Black-thr. Green Warbler	*Dendroica virens*	19	372	39	0.396	0.557		25		25		20	25	20
Townsend's Warbler	*Dendroica townsendi*	27	978	101	0.428	0.224						25		25
Blackpoll Warbler	*Dendroica striata*	7	177	14	0.313	0.735								25
Black-and-white Warbler	*Mniotilta varia*	75	1105	91	0.518	0.298	25	20	20	15	20	15	15	15
American Redstart	*Setophaga ruticilla*	60	3204	264	0.509	0.338	15	15	10	15	10	10	10	10
Prothonotary Warbler	*Protonotaria citrea*	20	479	49	0.509	0.206								25
Worm-eating Warbler	*Helmitheros vermivorus*	30	781	60	0.529	0.402		20	25	20	25	15	20	15
Ovenbird	*Seiurus aurocapillus*	112	3873	324	0.550	0.430	10	10	5	10	5	10	5	5
Northern Waterthrush	*Seiurus noveboracensis*	20	491	37	0.498	0.550		20	25	20	25	15	20	15
Louisiana Waterthrush	*Seiurus motacilla*	35	561	50	0.514	0.583	20	15	20	15	20	15	15	10
Kentucky Warbler	*Oporornis formosus*	53	1834	197	0.539	0.585	10	10	10	10	10	10	10	10
Mourning Warbler	*Oporornis philadelphia*	7	230	30	0.444	0.389								25
MacGillivray's Warbler	*Oporornis tolmiei*	92	5887	596	0.477	0.612	10	10	5	10	5	10	5	10
Common Yellowthroat	*Geothlypis trichas*	175	8523	777	0.481	0.500	10	10	5	10	5	10	5	10
Hooded Warbler	*Wilsonia citrina*	47	1221	109	0.489	0.536	15	15	15	15	15	10	15	10
Wilson's Warbler	*Wilsonia pusilla*	82	9116	593	0.416	0.530	10	10	10	10	10	10	10	10
Canada Warbler	*Wilsonia canadensis*	10	314	23	0.443	0.544						25		20
Yellow-breasted Chat	*Icteria virens*	74	3044	328	0.468	0.474	10	10	10	10	10	10	10	10

Table 3 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta[1]	Ind[2]	Res[3]	ϕ[4]	p[5]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]
Summer Tanager	*Piranga rubra*	57	566	49	0.486	0.417	25		25	20	25	15	25	15
Western Tanager	*Piranga ludoviciana*	86	1769	120	0.542	0.141	25		25	20	25	20	25	15
Olive Sparrow	*Arremonops rufivirgatus*	3	208	27	0.510	0.738	25	20	20	15	20	15	20	15
Green-tailed Towhee	*Pipilo chlorurus*	13	297	28	0.541	0.355						20		20
Spotted Towhee	*Pipilo maculatus*	78	2125	223	0.487	0.465	10	15	10	10	10	10	10	10
Eastern Towhee	*Pipilo erythrophthalmus*	97	907	98	0.484	0.331	20	15	20	15	20	15	15	15
California Towhee	*Pipilo crissalis*	18	398	49	0.539	0.353		25	25	20	25	15	25	15
Rufous-crowned Sparrow	*Aimophila ruficeps*	14	175	17	0.545	0.334								25
American Tree Sparrow	*Spizella arborea*	7	199	17	0.483	0.500				25		20		20
Chipping Sparrow	*Spizella passerina*	77	1326	129	0.410	0.231						25		20
Field Sparrow	*Spizella pusilla*	67	2032	219	0.447	0.350	20	20	20	15	20	15	15	15
Lark Sparrow	*Chondestes grammacus*	17	422	17	0.522	0.275								25
Savannah Sparrow	*Passerculus sandwichensis*	12	504	43	0.536	0.360		25		20		20	25	15
Fox Sparrow	*Passerella iliaca*	41	991	92	0.534	0.502	20	15	15	15	15	15	15	10
Song Sparrow	*Melospiza melodia*	185	10465	1160	0.465	0.560	5	10	5	10	5	10	5	5
Lincoln's Sparrow	*Melospiza lincolnii*	52	2528	329	0.424	0.634	10	15	10	10	10	10	10	10
Swamp Sparrow	*Melospiza georgiana*	14	332	29	0.402	0.748		25	25	20	25	20	25	15
White-throated Sparrow	*Zonotrichia albicollis*	19	992	97	0.351	0.532	25	20	20	20	20	15	20	15
White-crowned Sparrow	*Zonotrichia leucophrys*	30	1260	140	0.459	0.479	15	15	15	15	15	10	10	10
Golden-crowned Sparrow	*Zonotrichia atricapilla*	5	279	34	0.533	0.490		20	25	20	25	15	20	15
Dark-eyed Junco	*Junco hyemalis*	121	6505	722	0.442	0.503	10	10	10	10	10	10	10	10
Northern Cardinal	*Cardinalis cardinalis*	177	6027	631	0.568	0.370	10	10	5	10	5	10	5	5
Black-headed Grosbeak	*Pheucticus melanocephalus*	104	3796	295	0.550	0.303	10	10	10	10	10	10	10	10
Lazuli Bunting	*Passerina amoena*	47	1719	99	0.496	0.297	20	15	20	15	20	15	15	15
Indigo Bunting	*Passerina cyanea*	112	3698	352	0.490	0.371	15	15	10	10	10	10	10	10

Table 3 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta[1]	Ind[2]	Res[3]	ϕ[4]	p[5]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]	2P[6]	LD[7]
Painted Bunting	*Passerina ciris*	32	1592	115	0.558	0.439	15	10	10	10	10	10	10	10
Red-winged Blackbird	*Agelaius phoeniceus*	69	1934	96	0.612	0.200	25	20	20	20	20	15	20	15
Brown-headed Cowbird	*Molothrus ater*	210	2023	180	0.473	0.460	15	15	10	10	10	10	10	10
Baltimore Oriole	*Icterus galbula*	43	687	46	0.534	0.287		25		20	25	15	25	15
Bullock's Oriole	*Icterus bullockii*	39	1141	68	0.469	0.365		20	25	20	25	15	20	15
Purple Finch	*Carpodacus purpureus*	51	3459	259	0.460	0.340	15	15	15	15	10	10	10	10
American Goldfinch	*Carduelis tristis*	135	6624	514	0.430	0.266	20	20	20	20	20	15	15	15

[1] Number of stations that were operated for at least four consecutive years during the ten-year period 1992-2001 at which (a) at least one adult individual of the species was captured and (b) the species was a regular or usual breeder. Stations within 1 km of each other were merged into a single "super-station" to prevent individuals whose home range encompassed parts of both stations from being treated as two individuals.

[2] Total number of individual adult birds captured during the ten years 1992-2001 at stations where the species was a regular or usual breeder; thus the total number of capture histories upon which the estimate of survival probability was based.

[3] Estimated number of resident birds released per year as part of a stable MAPS program at the current level of effort. See text for detail.

[4] Estimated time-constant annual apparent survival rate from MAPS data pooled across all stations from 1992-2001.

[5] Estimated time-constant recapture probability from MAPS data pooled across all stations from 1992-2001.

[6] Effect size (% difference) that can be detected when comparing the adult apparent survival rates two populations, based on results of simulated data and current MAPS sample sizes and parameter estimates.

[7] Effect size (% change) that can be detected for a population experiencing a linear decline in adult apparent survival, based on results of simulated data and current MAPS sample sizes and parameter estimates.

Table 4. Effect sizes detectable with 80% power by MAPS for 47 species in the Northwest Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							α = 0.10		α = 0.20		α = 0.10		α = 0.20	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Red-naped Sapsucker	*Sphyrapicus nuchalis*	28	370	36	0.366	0.544		25		25		20		20
Red-breasted Sapsucker	*Sphyrapicus ruber*	47	671	70	0.449	0.371		25		25		20		20
Hairy Woodpecker	*Picoides villosus*	56	249	25	0.550	0.286		25		20		20	25	15
Western Wood-Pewee	*Contopus sordidulus*	54	1015	86	0.513	0.336	25	20	20	15	20	15	20	15
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	32	1115	77	0.524	0.460	20	15	20	15	20	15	15	10
Hammond's Flycatcher	*Empidonax hammondii*	53	1142	105	0.453	0.404	20	15	20	15	20	15	15	15
Dusky Flycatcher	*Empidonax oberholseri*	47	1903	133	0.488	0.421	20	15	15	15	15	15	15	10
“Western” Flycatcher	*E. difficilis/occidentalis*	54	1681	118	0.481	0.314	20	15	20	15	20	15	15	15
Warbling Vireo	*Vireo gilvus*	86	3560	306	0.479	0.422	15	15	10	10	10	10	10	10
Black-capped Chickadee	*Poecile atricapilla*	43	831	73	0.466	0.443	20	15	20	15	20	15	15	15
Mountain Chickadee	*Poecile gambeli*	41	891	60	0.471	0.414		20	25	20	25	15	20	15
Bewick's Wren	*Thryomanes bewickii*	13	168	22	0.452	0.461		25		20		20	25	15
House Wren	*Troglodytes aedon*	27	597	57	0.278	0.373								25
Winter Wren	*Troglodytes troglodytes*	37	926	70	0.375	0.521		20	25	20	25	20	20	15
Ruby-crowned Kinglet	*Regulus calendula*	14	628	50	0.255	0.275								25
Veery	*Catharus fuscescens*	4	92	12	0.714	0.386						25	25	20
Swainson's Thrush	*Catharus ustulatus*	78	7394	856	0.586	0.629	5	5	5	5	5	5	5	5
Hermit Thrush	*Catharus guttatus*	35	808	66	0.461	0.537	20	15	20	15	20	15	15	15
American Robin	*Turdus migratorius*	116	3947	370	0.575	0.258	15	15	10	10	10	10	10	10
Varied Thrush	*Ixoreus naevius*	30	388	26	0.494	0.407						25		20
Wrentit	*Chamaea fasciata*	21	487	58	0.527	0.637	20	15	15	15	15	15	15	10
Gray Catbird	*Dumetella carolinensis*	12	584	51	0.561	0.450	20	15	15	15	15	10	15	10
Orange-crowned Warbler	*Vermivora celata*	40	1468	94	0.481	0.418	25	20	20	15	20	15	15	15

Table 4 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Yellow Warbler	*Dendroica petechia*	49	4086	363	0.571	0.493	10	10	5	10	5	10	5	5
Yellow-rumped Warbler	*Dendroica coronata*	60	2906	217	0.486	0.208	25	20	20	15	20	15	15	15
Townsend's Warbler	*Dendroica townsendi*	23	823	82	0.451	0.216						20		20
American Redstart	*Setophaga ruticilla*	7	304	24	0.443	0.526				25		25		20
MacGillivray's Warbler	*Oporornis tolmiei*	85	5763	542	0.479	0.614	10	10	5	10	5	10	5	10
Common Yellowthroat	*Geothlypis trichas*	27	1452	153	0.499	0.556	15	15	15	15	15	10	10	10
Wilson's Warbler	*Wilsonia pusilla*	56	3638	265	0.438	0.526	15	15	15	15	15	10	10	10
Yellow-breasted Chat	*Icteria virens*	15	873	89	0.448	0.560	25	20	20	20	20	15	20	15
Western Tanager	*Piranga ludoviciana*	73	1386	100	0.538	0.129				25		20	25	15
Green-tailed Towhee	*Pipilo chlorurus*	5	209	21	0.602	0.360				25		20	25	15
Spotted Towhee	*Pipilo maculatus*	42	955	88	0.476	0.508	20	15	15	15	15	15	15	10
Savannah Sparrow	*Passerculus sandwichensis*	2	321	31	0.585	0.285	25	20	25	20	25	15	20	15
Fox Sparrow	*Passerella iliaca*	25	505	44	0.553	0.451	20	15	15	15	15	10	15	10
Song Sparrow	*Melospiza melodia*	98	5868	643	0.470	0.598	5	10	5	10	5	10	5	5
Lincoln's Sparrow	*Melospiza lincolnii*	37	2091	267	0.432	0.631	15	15	10	10	10	10	10	10
White-crowned Sparrow	*Zonotrichia leucophrys*	14	598	61	0.474	0.544	25	15	20	15	20	15	15	15
Dark-eyed Junco	*Junco hyemalis*	83	5217	533	0.461	0.500	10	10	10	10	10	10	5	10
Black-headed Grosbeak	*Pheucticus melanocephalus*	68	2057	155	0.568	0.280	15	15	10	10	10	10	10	10
Lazuli Bunting	*Passerina amoena*	25	1074	62	0.552	0.245				25	25	20	25	15
Red-winged Blackbird	*Agelaius phoeniceus*	18	799	42	0.784	0.148	15	20	15	15	15	10	10	10
Brown-headed Cowbird	*Molothrus ater*	60	748	68	0.486	0.485	20	15	20	15	20	15	15	15
Bullock's Oriole	*Icterus bullockii*	19	497	25	0.454	0.429		25		20		15	25	15
Purple Finch	*Carpodacus purpureus*	32	2386	155	0.434	0.364	25	20	20	20	20	15	20	15
American Goldfinch	*Carduelis tristis*	20	1434	108	0.470	0.328	20	15	20	15	20	15	15	15

Table 5. Effect sizes detectable with 80% power by MAPS for 42 species in the Southwest Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Red-naped Sapsucker	*Sphyrapicus nuchalis*	4	119	23	0.494	0.665	20		25	20	25	15	20	15
Nuttall's Woodpecker	*Picoides nuttallii*	16	195	28	0.551	0.381	25		25	20	25	15	20	15
Downy Woodpecker	*Picoides pubescens*	20	217	24	0.605	0.431	25	20	20	15	20	15	20	15
Olive-sided Flycatcher	*Contopus cooperi*	2	55	3	0.870	0.724	25		20		25	20	20	15
Western Wood-Pewee	*Contopus sordidulus*	15	278	27	0.384	0.446				25		25		20
“Western” Flycatcher	*E. difficilis/occidentalis*	15	892	43	0.595	0.183						25	25	20
Ash-throated Flycatcher	*Myiarchus cinerascens*	31	676	80	0.659	0.137	20	20	15	15	15	15	15	10
Bell's Vireo	*Vireo bellii*	5	112	15	0.482	0.596		25		20		20		15
Warbling Vireo	*Vireo gilvus*	15	1253	52	0.539	0.460	25	20	20	15	20	15	20	15
Steller's Jay	*Cyanocitta stelleri*	9	98	13	0.762	0.234							25	
Black-capped Chickadee	*Poecile atricapilla*	7	110	17	0.366	0.600				25		25		20
Mountain Chickadee	*Poecile gambeli*	10	254	39	0.408	0.292						25		25
Chestnut-backed Chickadee	*Poecile rufescens*	6	259	41	0.501	0.512	25	20	25	15	25	15	20	15
Oak Titmouse	*Baeolophus inornatus*	11	153	18	0.514	0.358								25
Juniper Titmouse	*Baeolophus ridgwayi*	4	44	9	0.655	0.409								25
Bushtit	*Psaltriparus minimus*	30	975	171	0.300	0.152								25
Bewick's Wren	*Thryomanes bewickii*	38	1047	137	0.424	0.538	20	20	20	15	15	15	15	15
House Wren	*Troglodytes aedon*	27	941	113	0.388	0.439	20	20	20	20	20	15	15	15
Swainson's Thrush	*Catharus ustulatus*	8	1819	121	0.619	0.578	10	10	10	10	10	10	10	10
Hermit Thrush	*Catharus guttatus*	9	410	75	0.450	0.400	25	20	25	20	25	15	20	15
American Robin	*Turdus migratorius*	27	706	90	0.529	0.309	25	20	20	15	20	15	15	15
Wrentit	*Chamaea fasciata*	16	838	106	0.540	0.618	15	15	15	15	15	10	10	10
Orange-crowned Warbler	*Vermivora celata*	15	1076	79	0.413	0.318		25		25		20	25	20

Table 5 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Virginia's Warbler	*Vermivora virginiae*	9	283	23	0.484	0.395						25		20
Yellow Warbler	*Dendroica petechia*	18	1097	110	0.479	0.526	15	15	15	15	15	10	15	10
Common Yellowthroat	*Geothlypis trichas*	22	1624	178	0.525	0.426	15	15	10	10	10	10	10	10
Wilson's Warbler	*Wilsonia pusilla*	9	2609	124	0.446	0.510	20	20	20	15	20	15	15	15
Yellow-breasted Chat	*Icteria virens*	17	750	108	0.522	0.521	15	15	15	15	15	10	15	10
Summer Tanager	*Piranga rubra*	6	125	23	0.506	0.451		25		20		20	25	15
Spotted Towhee	*Pipilo maculatus*	36	1170	165	0.496	0.430	15	15	10	10	10	10	10	10
California Towhee	*Pipilo crissalis*	17	392	62	0.536	0.356		20	25	20	25	15	20	15
Fox Sparrow	*Passerella iliaca*	3	95	11	0.519	0.551								20
Song Sparrow	*Melospiza melodia*	26	2101	288	0.520	0.479	10	10	10	10	10	10	10	10
Lincoln's Sparrow	*Melospiza lincolnii*	3	112	18	0.437	0.876		25		20		20	25	20
Dark-eyed Junco	*Junco hyemalis*	8	336	49	0.387	0.560		25		20	20		25	15
Black-headed Grosbeak	*Pheucticus melanocephalus*	35	1684	157	0.526	0.345	20	15	15	15	15	15	15	10
Blue Grosbeak	*Guiraca caerulea*	11	187	17	0.409	0.408								25
Lazuli Bunting	*Passerina amoena*	21	643	41	0.372	0.473		25		25		20	25	20
Red-winged Blackbird	*Agelaius phoeniceus*	9	232	41	0.880	0.037							20	
Brown-headed Cowbird	*Molothrus ater*	30	275	38	0.463	0.568	20		25	20	25	15	20	15
Bullock's Oriole	*Icterus bullockii*	18	566	46	0.458	0.377		25		20	15		25	15
Purple Finch	*Carpodacus purpureus*	7	932	96	0.531	0.304	25	20	20	15	20	15	15	15

Table 6. Effect sizes detectable with 80% power by MAPS for 25 species in the North-central Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							α = 0.10		α = 0.20		α = 0.10		α = 0.20	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	12	649	49	0.484	0.509	25	20	20	15	20	15	20	15
Least Flycatcher	*Empidonax minimus*	12	847	68	0.368	0.431		20	25	20	25	20	20	15
Red-eyed Vireo	*Vireo olivaceus*	24	631	42	0.534	0.391		25		20		20	25	15
Black-capped Chickadee	*Poecile atricapilla*	28	654	50	0.417	0.394				25		25		20
Tufted Titmouse	*Baeolophus bicolor*	10	163	17	0.555	0.407						20		20
House Wren	*Troglodytes aedon*	18	892	83	0.322	0.440		25		25		20	25	20
Veery	*Catharus fuscescens*	9	390	45	0.575	0.586	15	15	15	15	15	10	10	10
Wood Thrush	*Hylocichla mustelina*	12	263	31	0.453	0.317				25		20		20
American Robin	*Turdus migratorius*	26	787	39	0.380	0.423						25		25
Gray Catbird	*Dumetella carolinensis*	23	2196	196	0.497	0.478	15	15	10	10	10	10	10	10
Yellow Warbler	*Dendroica petechia*	15	1336	123	0.548	0.398	20	15	20	15	15	15	15	10
Chestnut-sided Warbler	*Dendroica pensylvanica*	4	380	42	0.378	0.572		25		25		20	25	20
American Redstart	*Setophaga ruticilla*	11	605	44	0.454	0.282		25		20		20	25	15
Kentucky Warbler	*Oporornis formosus*	2	88	12	0.610	0.698		25		20		15	25	15
Mourning Warbler	*Oporornis philadelphia*	3	122	15	0.421	0.608						25		25
Common Yellowthroat	*Geothlypis trichas*	24	1299	117	0.433	0.498	20	20	20	15	20	15	15	15
Field Sparrow	*Spizella pusilla*	8	593	61	0.426	0.392				25		20		20
Song Sparrow	*Melospiza melodia*	22	1137	117	0.444	0.517	20	20	20	15	20	15	15	15
Swamp Sparrow	*Melospiza georgiana*	6	201	14	0.386	0.776				25		25		20
White-throated Sparrow	*Zonotrichia albicollis*	3	309	33	0.383	0.621		25		20		20	25	15
Northern Cardinal	*Cardinalis cardinalis*	18	603	50	0.539	0.355		25	25	20	25	15	25	15
Indigo Bunting	*Passerina cyanea*	16	793	70	0.518	0.312		20	25	20	25	15	20	15
Brown-headed Cowbird	*Molothrus ater*	22	219	18	0.487	0.411								25

Table 6 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Baltimore Oriole	*Icterus galbula*	14	309	29	0.615	0.184								25
American Goldfinch	*Carduelis tristis*	21	1635	164	0.347	0.360		25		25		20	25	20

Table 7. Effect sizes detectable with 80% power by MAPS for 22 species in the South-central Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							α = 0.10		α = 0.20		α = 0.10		α = 0.20	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Acadian Flycatcher	*Empidonax virescens*	6	349	27	0.583	0.478	25	20	20	15	20	15	20	15
White-eyed Vireo	*Vireo griseus*	24	1380	117	0.601	0.498	15	10	10	10	10	10	10	10
Bell's Vireo	*Vireo bellii*	12	450	41	0.593	0.377	25	20	20	15	20	15	20	15
Red-eyed Vireo	*Vireo olivaceus*	15	328	30	0.575	0.221								25
Tufted Titmouse	*Baeolophus bicolor*	24	318	36	0.486	0.296				25		20	25	15
Carolina Wren	*Thryothorus ludovicianus*	31	888	79	0.459	0.517	20	15	20	15	15	15	15	10
Bewick's Wren	*Thryomanes bewickii*	21	480	44	0.431	0.498		25		25		20	25	20
Gray Catbird	*Dumetella carolinensis*	9	741	57	0.581	0.467	15	15	15	15	15	10	15	10
Brown Thrasher	*Toxostoma rufum*	15	288	15	0.408	0.572								25
Long-billed Thrasher	*Toxostoma longirostre*	3	133	12	0.628	0.396								25
Blue-winged Warbler	*Vermivora pinus*	4	244	18	0.555	0.490		20	25	20	25	15	20	15
Yellow Warbler	*Dendroica petechia*	3	103	13	0.353	0.515								25
Kentucky Warbler	*Oporornis formosus*	11	457	41	0.608	0.535	20	15	15	15	15	15	15	10
Common Yellowthroat	*Geothlypis trichas*	14	440	36	0.471	0.478		20	25	20	25	15	20	15
Yellow-breasted Chat	*Icteria virens*	8	651	72	0.521	0.391	25	20	25	20	25	15	20	15
Summer Tanager	*Piranga rubra*	19	223	17	0.531	0.377								25
Olive Sparrow	*Arremonops rufivirgatus*	3	208	24	0.510	0.738	25	20	20	15	20	15	20	15
Field Sparrow	*Spizella pusilla*	31	1108	108	0.482	0.343	20	15	20	15	20	15	15	15
Northern Cardinal	*Cardinalis cardinalis*	48	2475	245	0.581	0.356	10	10	10	10	10	10	10	10
Indigo Bunting	*Passerina cyanea*	23	1181	111	0.459	0.422	20	15	20	15	20	15	15	15
Painted Bunting	*Passerina ciris*	31	1591	103	0.558	0.439	15	15	10	10	10	10	10	10
Brown-headed Cowbird	*Molothrus ater*	39	477	40	0.474	0.364		25		20		20	25	15

Table 8. Effect sizes detectable with 80% power by MAPS for 38 species in the Northeast Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							α = 0.10		α = 0.20		α = 0.10		α = 0.20	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Downy Woodpecker	*Picoides pubescens*	49	414	28	0.445	0.525				25		25		20
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	17	636	30	0.502	0.541	20		25	20	25	15	25	15
Eastern Phoebe	*Sayornis phoebe*	24	238	11	0.571	0.405								25
White-eyed Vireo	*Vireo griseus*	13	295	37	0.479	0.396				25		20	25	15
Red-eyed Vireo	*Vireo olivaceus*	55	1459	130	0.582	0.295	15	15	15	15	10	10	10	10
Blue Jay	*Cyanocitta cristata*	43	268	7	0.869	0.164					25		20	
Carolina Chickadee	*Poecile carolinensis*	19	187	9	0.484	0.449								25
Black-capped Chickadee	*Poecile atricapilla*	50	1099	114	0.514	0.294	20	15	20	15	20	15	15	15
Tufted Titmouse	*Baeolophus bicolor*	36	411	51	0.393	0.298				25		25		20
Veery	*Catharus fuscescens*	41	1792	244	0.577	0.574	10	10	10	10	10	10	5	10
Swainson's Thrush	*Catharus ustulatus*	6	91	13	0.621	0.686		20	25	20	25	15	25	15
Hermit Thrush	*Catharus guttatus*	21	328	47	0.457	0.631	20	15	20	15	20	15	15	15
Wood Thrush	*Hylocichla mustelina*	53	1981	177	0.424	0.403	25	20	20	20	20	15	15	15
American Robin	*Turdus migratorius*	54	1479	115	0.429	0.329		25	25	20	25	20	20	15
Gray Catbird	*Dumetella carolinensis*	50	4849	495	0.515	0.460	10	10	10	10	10	10	5	10
Blue-winged Warbler	*Vermivora pinus*	18	352	26	0.442	0.387								25
Yellow Warbler	*Dendroica petechia*	28	1268	108	0.509	0.475	15	15	15	15	15	10	15	10
Chestnut-sided Warbler	*Dendroica pensylvanica*	18	459	47	0.475	0.527	25	20	20	15	20	15	20	15
Magnolia Warbler	*Dendroica magnolia*	11	401	31	0.346	0.738		25		25		25		20
Yellow-rumped Warbler	*Dendroica coronata*	11	292	31	0.460	0.501		20	25	20	25	15	20	15
Black-thr. Green Warbler	*Dendroica virens*	17	337	39	0.402	0.589		25	25	20	25	20	25	15
Black-and-white Warbler	*Mniotilta varia*	40	667	72	0.502	0.301	25	20	25	20	25	15	20	15
American Redstart	*Setophaga ruticilla*	36	1943	171	0.525	0.331	15	15	15	15	15	10	15	10

Table 8 continued.

							15-yr				20-yr			
							$\alpha = 0.10$		$\alpha = 0.20$		$\alpha = 0.10$		$\alpha = 0.20$	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Worm-eating Warbler	*Helmitheros vermivorus*	12	405	32	0.520	0.395				25		20		20
Ovenbird	*Seiurus aurocapillus*	51	1752	166	0.557	0.425	10	10	10	10	10	10	10	10
Louisiana Waterthrush	*Seiurus motacilla*	11	185	13	0.477	0.745		25		20		20	25	15
Common Yellowthroat	*Geothlypis trichas*	45	2263	209	0.502	0.493	15	15	10	10	10	10	10	10
Hooded Warbler	*Wilsonia citrina*	15	499	45	0.460	0.610	20	15	20	15	20	15	15	15
Yellow-breasted Chat	*Icteria virens*	7	214	22	0.501	0.356						25		20
Eastern Towhee	*Pipilo erythrophthalmus*	35	543	61	0.489	0.331		20	25	20	25	15	20	15
Song Sparrow	*Melospiza melodia*	37	1192	117	0.336	0.511		25	25	25	25	20	20	20
Swamp Sparrow	*Melospiza georgiana*	8	131	15	0.422	0.721						25		25
White-throated Sparrow	*Zonotrichia albicollis*	14	537	58	0.289	0.583		25		25		20	25	20
Northern Cardinal	*Cardinalis cardinalis*	41	826	76	0.618	0.365	20	15	15	15	15	15	15	10
Indigo Bunting	*Passerina cyanea*	26	504	41	0.465	0.543	25	20	25	15	25	15	20	15
Red-winged Blackbird	*Agelaius phoeniceus*	20	471	24	0.587	0.320				20		20	25	15
Baltimore Oriole	*Icterus galbula*	22	305	18	0.418	0.476								25
American Goldfinch	*Carduelis tristis*	39	1780	102	0.442	0.209						25		25

Table 9. Effect sizes detectable with 80% power by MAPS for 21 species in the Southeast Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							α = 0.10		α = 0.20		α = 0.10		α = 0.20	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
Downy Woodpecker	*Picoides pubescens*	61	381	16	0.620	0.344						25		20
Acadian Flycatcher	*Empidonax virescens*	47	1786	150	0.483	0.556	15	15	15	15	15	10	10	10
White-eyed Vireo	*Vireo griseus*	43	1012	103	0.465	0.561	15	15	15	15	15	10	15	10
Red-eyed Vireo	*Vireo olivaceus*	56	2230	224	0.620	0.212	15	15	15	15	15	10	10	10
Carolina Chickadee	*Poecile carolinensis*	65	569	44	0.493	0.282		25		20		20	25	15
Tufted Titmouse	*Baeolophus bicolor*	67	948	93	0.511	0.434	20	15	15	15	15	15	15	10
Carolina Wren	*Thryothorus ludovicianus*	65	1367	149	0.369	0.582	15	15	15	15	15	10	15	10
Gray Catbird	*Dumetella carolinensis*	25	1054	86	0.428	0.477	25	20	20	20	20	15	20	15
Wood Thrush	*Hylocichla mustelina*	56	2635	258	0.455	0.552	10	10	10	10	10	10	10	10
Blue-winged Warbler	*Vermivora pinus*	9	286	31	0.558	0.279	25	20	25	20	25	15	20	15
Worm-eating Warbler	*Helmitheros vermivorus*	16	309	28	0.529	0.404				25		20		20
Louisiana Waterthrush	*Seiurus motacilla*	19	295	31	0.520	0.516		20	25	20	25	15	25	15
Ovenbird	*Seiurus aurocapillus*	46	1588	136	0.528	0.480	15	15	15	15	15	10	10	10
Kentucky Warbler	*Oporornis formosus*	35	1232	137	0.507	0.600	15	15	10	10	10	10	10	10
Hooded Warbler	*Wilsonia citrina*	29	619	59	0.514	0.525	25	15	20	15	20	15	15	15
Common Yellowthroat	*Geothlypis trichas*	41	1422	116	0.439	0.503	20	20	20	15	20	15	15	15
Yellow-breasted Chat	*Icteria virens*	24	524	65	0.292	0.323								25
Eastern Towhee	*Pipilo erythrophthalmus*	45	279	31	0.472	0.344				25		20		20
Song Sparrow	*Melospiza melodia*	2	167	15	0.410	0.520								25
Northern Cardinal	*Cardinalis cardinalis*	69	2105	237	0.543	0.392	15	15	15	15	15	10	10	10
Indigo Bunting	*Passerina cyanea*	47	1220	120	0.521	0.306	20	15	20	15	20	15	15	15

Table 10. Effect sizes detectable with 80% power by MAPS for 19 species in the Alaska and Boreal Canada Region. Two effect types were considered: (1) a two population comparison of survival (2P), and (2) a population with linearly declining survival (LD). Effect sizes are given for both 15- and 20-yr time windows and for two alpha-levels, 0.10 and 0.20. See Table 3 for field definitions.

							15-yr				20-yr			
							α = 0.10		α = 0.20		α = 0.10		α = 0.20	
Common name	Scientific name	Sta	Ind	Res	ϕ	p	2P	LD	2P	LD	2P	LD	2P	LD
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	13	584	28	0.383	0.506				25		25		20
Black-capped Chickadee	*Poecile atricapilla*	10	244	28	0.426	0.401								25
Boreal Chickadee	*Poecile hudsonica*	10	132	16	0.492	0.365								25
Arctic Warbler	*Phylloscopus borealis*	2	249	25	0.339	0.605						25		25
Gray-cheeked Thrush	*Catharus minimus*	6	253	27	0.459	0.683		20	25	20	25	15	20	15
Swainson's Thrush	*Catharus ustulatus*	16	837	76	0.456	0.590	20	15	15	15	15	10	15	10
Hermit Thrush	*Catharus guttatus*	9	611	57	0.499	0.766	20	15	15	15	15	10	15	10
Orange-crowned Warbler	*Vermivora celata*	16	1324	96	0.413	0.504	25	20	20	20	20	15	20	15
Yellow Warbler	*Dendroica petechia*	9	1114	80	0.445	0.456	25	20	25	20	25	15	20	15
Yellow-rumped Warbler	*Dendroica coronata*	16	680	48	0.367	0.432		25		20		20	25	20
American Redstart	*Setophaga ruticilla*	2	256	21	0.571	0.308				25		20	25	15
Northern Waterthrush	*Seiurus noveboracensis*	9	213	15	0.528	0.725		20		20		15	25	15
Wilson's Warbler	*Wilsonia pusilla*	15	2861	182	0.366	0.565	20	15	15	15	15	15	15	10
Canada Warbler	*Wilsonia canadensis*	2	149	14	0.462	0.475						20		25
American Tree Sparrow	*Spizella arborea*	7	199	15	0.483	0.500						20		25
Fox Sparrow	*Passerella iliaca*	13	391	31	0.518	0.556		20	25	20	25	15	20	15
White-crowned Sparrow	*Zonotrichia leucophrys*	13	626	65	0.435	0.412				25		20		20
Golden-crowned Sparrow	*Zonotrichia atricapilla*	5	279	30	0.533	0.490		20	25	20	25	15	25	15
Dark-eyed Junco	*Junco hyemalis*	15	630	67	0.309	0.636		25		25		20	25	20

Table 11. Summary of the current MAPS program and expected numbers of monitorable species under an expanded MAPS program.

	Region[1]							
	NW	SW	N-C	S-C	NE	SE	AK/B&AC	Continental
Current program								
No. of stations[2]	128	66	32	50	65	70	22	433
No. of species[3]	47	42	25	22	38	21	19	105
Expanded (non-targeted) program								
No. of stations[2]	128	128	67	67	128	128	67	713
No. of species[3]	47	50	34	24	47	23	26	119
Expanded and targeted program								
No. of stations[2]	148	128	67	67	128	128	67	733
No. of species[3]	63	65	49	49	62	40	43	146

[1] See Fig. 3 for region definitions.

[2] Number of stations operated annually that are operated for at least four years.

[3] Number of species for which survival can be monitored effectively (i.e., for which 25% differences in survival between two populations or a "25%" linear decline in survival in a single population can be detected with 80% power at alpha = 0.2 with 20 years of data).

Table 12. Species in continent-wide MAPS Program for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code “T”; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code ”E.” (Note: effect sizes are not shown for “target species” for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Common Ground-Dove	*Columbina passerina*	12	51	0.555	0.051					
Yellow-billed Cuckoo	*Coccyzus americanus*	128	30	0.540	0.141					
Belted Kingfisher	*Ceryle alcyon*	18	7	0.310	0.403					
Golden-fronted Woodpecker	*Melanerpes aurifrons*	7	24	0.199	0.345					
Red-bellied Woodpecker	*Melanerpes carolinus*	133	67	0.285	0.199					
Williamson's Sapsucker	*Sphyrapicus thyroideus*	21	24	0.439	0.241					
Yellow-bellied Sapsucker	*Sphyrapicus varius*	25	27	0.415	0.253					T
Red-naped Sapsucker	*Sphyrapicus nuchalis*	53	91	0.413	0.602	20	15	15	15	
Red-breasted Sapsucker	*Sphyrapicus ruber*	81	127	0.458	0.369	15	15	15	10	
Ladder-backed Woodpecker	*Picoides scalaris*	26	17	0.552	0.292		25		20	
Nuttall's Woodpecker	*Picoides nuttallii*	26	36	0.551	0.381	25	15	20	15	
Downy Woodpecker	*Picoides pubescens*	374	226	0.500	0.354	15	10	10	10	
Hairy Woodpecker	*Picoides villosus*	254	97	0.665	0.208	15	10	10	10	
Three-toed Woodpecker	*Picoides tridactylus*	7	3	0.736	0.354					
Northern Flicker	*Colaptes auratus*	229	59	0.420	0.147					
Olive-sided Flycatcher	*Contopus cooperi*	30	7	0.763	0.345			20	15	E
Western Wood-Pewee	*Contopus sordidulus*	120	222	0.486	0.362	15	10	10	10	
Eastern Wood-Pewee	*Contopus virens*	166	72	0.494	0.278	25	15	20	15	
Yellow-bellied Flycatcher	*Empidonax flaviventris*									T
Acadian Flycatcher	*Empidonax virescens*	109	301	0.508	0.518	10	10	10	10	
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	132	327	0.485	0.491	10	10	10	10	

Table 12 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Least Flycatcher	*Empidonax minimus*	40	120	0.379	0.435	20	15	15	15	
Hammond's Flycatcher	*Empidonax hammondii*	92	187	0.452	0.403	15	10	10	10	
Gray Flycatcher	*Empidonax wrightii*									T
Dusky Flycatcher	*Empidonax oberholseri*	86	242	0.485	0.425	10	10	10	10	
"Western" Flycatcher	*Empidonax difficilis/occidentalis*	114	264	0.504	0.282	10	10	10	10	
Black Phoebe	*Sayornis nigricans*	26	19	0.460	0.481		20		15	
Eastern Phoebe	*Sayornis phoebe*	69	21	0.530	0.381		25		20	E
Vermilion Flycatcher	*Pyrocephalus rubinus*	5	13	0.359	0.185					
Ash-throated Flycatcher	*Myiarchus cinerascens*	58	104	0.666	0.135	15	10	10	10	
Great Crested Flycatcher	*Myiarchus crinitus*	158	55	0.615	0.216		20	25	15	
Brown-crested Flycatcher	*Myiarchus tyrannulus*	7	50	0.492	0.276	25	15	20	15	
Eastern Kingbird	*Tyrannus tyrannus*	59	12	0.524	0.420					
White-eyed Vireo	*Vireo griseus*	135	440	0.537	0.509	10	10	10	10	
Bell's Vireo	*Vireo bellii*	28	94	0.581	0.404	15	10	10	10	
Yellow-throated Vireo	*Vireo flavifrons*	25	4	0.576	0.319					
Plumbeous Vireo	*Vireo plumbeus*	18	9	0.660	0.219					T
Cassin's Vireo	*Vireo cassinii*	48	52	0.544	0.162				25	E
Blue-headed Vireo	*Vireo solitarius*	21	19	0.366	0.265					T
Hutton's Vireo	*Vireo huttoni*	31	15	0.400	0.274					T
Warbling Vireo	*Vireo gilvus*	194	624	0.483	0.428	5	10	5	10	
Philadelphia Vireo	*Vireo philadelphicus*									T
Red-eyed Vireo	*Vireo olivaceus*	262	703	0.595	0.253	10	10	10	10	
Gray Jay	*Perisoreus canadensis*	40	28	0.643	0.258					T
Steller's Jay	*Cyanocitta stelleri*	99	33	0.731	0.184	25	20	20	15	
Blue Jay	*Cyanocitta cristata*	226	97	0.649	0.107					T
Western Scrub-Jay	*Aphelocoma californica*	40	16	0.607	0.218					
Mexican Jay	*Aphelocoma ultramarina*	5	4	0.531	0.166					

Table 12 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Tree Swallow	*Tachycineta bicolor*	56	101	0.409	0.269		25		25	E
Violet-green Swallow	*Tachycineta thalassina*	13	18	0.514	0.220					
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	26	4	0.473	0.599					
Barn Swallow	*Hirundo rustica*	20	52	0.507	0.181				25	E
Carolina Chickadee	*Poecile carolinensis*	199	157	0.499	0.229	25	15	20	15	
Black-capped Chickadee	*Poecile atricapilla*	237	484	0.468	0.367	10	10	10	10	
Mountain Chickadee	*Poecile gambeli*	84	154	0.452	0.385	15	15	15	10	
Chestnut-backed Chickadee	*Poecile rufescens*	84	145	0.419	0.396	20	15	20	15	
Boreal Chickadee	*Poecile hudsonica*	16	31	0.492	0.365		20		20	
Bridled Titmouse	*Baeolophus wollweberi*	7	6	0.714	0.344					T
Oak Titmouse	*Baeolophus inornatus*	20	23	0.515	0.357		25		20	E
Juniper Titmouse	*Baeolophus ridgwayi*	7	11	0.655	0.409		25	25	20	E
Black-crested Titmouse	*Baeolophus b. atricristatus*	30	58	0.484	0.237				20	E
Tufted Titmouse	*Baeolophus bicolor*	226	311	0.491	0.386	10	10	10	10	
Verdin	*Auriparus flaviceps*	5	7	0.640	0.143					T
Bushtit	*Psaltriparus minimus*	71	251	0.295	0.146		25		25	
Red-breasted Nuthatch	*Sitta canadensis*	137	82	0.319	0.173					
White-breasted Nuthatch	*Sitta carolinensis*	145	33	0.477	0.306		20		20	
Brown Creeper	*Certhia americana*	110	119	0.324	0.237					
Carolina Wren	*Thryothorus ludovicianus*	204	444	0.397	0.541	10	10	10	10	
Bewick's Wren	*Thryomanes bewickii*	119	296	0.430	0.515	15	10	10	10	
House Wren	*Troglodytes aedon*	160	439	0.341	0.420	20	15	15	15	
Winter Wren	*Troglodytes troglodytes*	76	129	0.376	0.506	20	15	15	15	
Golden-crowned Kinglet	*Regulus satrapa*	110	86	0.168	0.269					
Ruby-crowned Kinglet	*Regulus calendula*	48	118	0.233	0.263					T
Arctic Warbler	*Phylloscopus borealis*	3	48	0.339	0.605		20	25	20	
Blue-gray Gnatcatcher	*Polioptila caerulea*	145	91	0.380	0.061					

Table 12 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Eastern Bluebird	*Sialia sialis*	53	22	0.388	0.319					
Western Bluebird	*Sialia mexicana*	25	12	0.361	0.529					
Townsend's Solitaire	*Myadestes townsendi*	8	5	0.636	0.234					
Veery	*Catharus fuscescens*	89	478	0.581	0.566	5	5	5	5	
Gray-cheeked Thrush	*Catharus minimus*	10	51	0.459	0.683	20	15	15	10	
Bicknell's Thrush	*Catharus bicknelli*	2	7	0.632	0.300					T
Swainson's Thrush	*Catharus ustulatus*	179	1833	0.581	0.624	5	5	5	5	
Hermit Thrush	*Catharus guttatus*	123	376	0.474	0.607	10	10	5	10	
Wood Thrush	*Hylocichla mustelina*	211	749	0.440	0.490	10	10	10	10	
American Robin	*Turdus migratorius*	443	1123	0.523	0.275	5	10	5	10	
Varied Thrush	*Ixoreus naevius*	66	56	0.471	0.394	25	15	20	15	
Wrentit	*Chamaea fasciata*	61	239	0.534	0.627	10	10	10	10	
Gray Catbird	*Dumetella carolinensis*	199	1440	0.511	0.464	5	5	5	5	
Northern Mockingbird	*Mimus polyglottos*	48	66	0.302	0.155					
Sage Thrasher	*Oreoscoptus montanus*									T
Brown Thrasher	*Toxostoma rufum*	96	78	0.522	0.292	20	15	20	15	
Long-billed Thrasher	*Toxostoma longirostre*	5	23	0.628	0.396		20	25	15	
California Thrasher	*Toxostoma redivivum*	13	15	0.687	0.115					
European Starling	*Sturnus vulgaris*	38	38	0.410	0.028					
Cedar Waxwing	*Bombycilla cedrorum*	117	173	0.678	0.014					
Blue-winged Warbler	*Vermivora pinus*	58	131	0.521	0.394	15	15	15	10	
Golden-winged Warbler	*Vermivora chrysoptera*	3	2	0.785	0.224					
Tennessee Warbler	*Vermivora peregrina*									T
Orange-crowned Warbler	*Vermivora celata*	119	441	0.441	0.435	10	10	10	10	
Nashville Warbler	*Vermivora ruficapilla*	56	98	0.338	0.331		25		25	
Virginia's Warbler	*Vermivora virginiae*	20	49	0.473	0.339	25	15	25	15	
Lucy's Warbler	*Vermivora luciae*	8	46	0.507	0.260				25	E

Table 12 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Northern Parula	*Parula americana*	53	47	0.248	0.504				25	E
Yellow Warbler	*Dendroica petechia*	203	1343	0.534	0.474	5	5	5	5	
Chestnut-sided Warbler	*Dendroica pensylvanica*	36	144	0.431	0.545	15	15	15	15	
Magnolia Warbler	*Dendroica magnolia*	25	63	0.321	0.769	25	20	20	20	
Black-throated Blue Warbler	*Dendroica caerulescens*	13	16	0.549	0.387					T
Yellow-rumped Warbler	*Dendroica coronata*	160	539	0.451	0.276	10	10	10	10	
Black-throated Gray Warbler	*Dendroica nigrescens*	30	29	0.483	0.078					T
Black-throated Green Warbler	*Dendroica virens*	31	65	0.396	0.557	25	20	20	15	
Townsend's Warbler	*Dendroica townsendi*	44	166	0.428	0.224		20		20	
Hermit Warbler	*Dendroica occidentalis*	56	92	0.599	0.069					
Blackburnian Warbler	*Dendroica fusca*	8	8	0.641	0.117					
Prairie Warbler	*Dendroica discolor*	40	85	0.434	0.242				25	E
Palm Warbler	*Dendroica palmarum*									T
Bay-breasted Warbler	*Dendroica castanea*									T
Blackpoll Warbler	*Dendroica striata*	12	22	0.313	0.735		25		25	
Black-and-white Warbler	*Mniotilta varia*	123	150	0.518	0.298	15	15	15	10	
American Redstart	*Setophaga ruticilla*	99	435	0.509	0.338	10	10	10	10	
Prothonotary Warbler	*Protonotaria citrea*	33	80	0.509	0.206		20		20	
Worm-eating Warbler	*Helmitheros vermivorus*	49	99	0.529	0.402	20	15	15	15	
Swainson's Warbler	*Limnothlypis swainsonii*	12	16	0.669	0.147					T
Ovenbird	*Seiurus aurocapillus*	184	533	0.550	0.430	5	5	5	5	
Northern Waterthrush	*Seiurus noveboracensis*	33	60	0.498	0.550	20	15	15	15	
Louisiana Waterthrush	*Seiurus motacilla*	58	82	0.514	0.583	15	10	15	10	
Kentucky Warbler	*Oporornis formosus*	87	324	0.539	0.585	10	10	5	10	
Mourning Warbler	*Oporornis philadelphia*	12	49	0.444	0.389		25		20	
MacGillivray's Warbler	*Oporornis tolmiei*	151	981	0.477	0.612	5	5	5	5	
Common Yellowthroat	*Geothlypis trichas*	288	1280	0.481	0.500	5	5	5	5	

Table 12 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Hooded Warbler	*Wilsonia citrina*	77	180	0.489	0.536	10	10	10	10	
Wilson's Warbler	*Wilsonia pusilla*	135	976	0.416	0.530	10	10	5	10	
Canada Warbler	*Wilsonia canadensis*	16	38	0.443	0.544		20	25	20	
Yellow-breasted Chat	*Icteria virens*	122	541	0.468	0.474	10	10	5	10	
Summer Tanager	*Piranga rubra*	94	81	0.486	0.417	20	15	20	15	
Scarlet Tanager	*Piranga olivacea*	138	102	0.586	0.085					
Western Tanager	*Piranga ludoviciana*	142	198	0.542	0.141	20	15	20	15	
Olive Sparrow	*Arremonops rufivirgatus*	5	44	0.510	0.738	15	15	15	10	
Green-tailed Towhee	*Pipilo chlorurus*	21	46	0.541	0.355		15	25	15	
Spotted Towhee	*Pipilo maculatus*	128	367	0.487	0.465	10	10	10	10	
Eastern Towhee	*Pipilo erythrophthalmus*	160	161	0.484	0.331	15	15	15	10	
Canyon Towhee	*Pipilo fuscus*									T
California Towhee	*Pipilo crissalis*	30	81	0.539	0.353	20	15	20	15	
Rufous-crowned Sparrow	*Aimophila ruficeps*	23	28	0.545	0.334		20		20	
American Tree Sparrow	*Spizella arborea*	12	27	0.483	0.500		15	25	15	
Chipping Sparrow	*Spizella passerina*	127	213	0.410	0.231		20	25	20	
Clay-colored Sparrow	*Spizella pallida*	10	30	0.568	0.059					T
Brewer’s Sparrow	*Spizella breweri*									T
Field Sparrow	*Spizella pusilla*	110	361	0.447	0.350	15	15	15	10	
Vesper Sparrow	*Pooecetes gramineus*	8	7	0.688	0.317					T
Lark Sparrow	*Chondestes grammacus*	28	27	0.522	0.275		20		20	
Black-throated Sparrow	*Amphispiza bilineata*	12	4	0.743	0.103					T
Sage Sparrow	*Amphispiza belli*	5	26	0.587	0.033					T
Savannah Sparrow	*Passerculus sandwichensis*	20	70	0.536	0.360	25	15	20	15	
Grasshopper Sparrow	*Ammodramus savannarum*	15	38	0.334	0.458		25		25	E
Fox Sparrow	*Passerella iliaca*	68	152	0.534	0.502	15	10	10	10	
Song Sparrow	*Melospiza melodia*	305	1910	0.465	0.560	5	5	5	5	

Table 12 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Lincoln's Sparrow	*Melospiza lincolnii*	86	542	0.424	0.634	10	10	10	10	
Swamp Sparrow	*Melospiza georgiana*	23	47	0.402	0.748	20	15	20	15	
White-throated Sparrow	*Zonotrichia albicollis*	31	159	0.351	0.532	15	15	15	10	
White-crowned Sparrow	*Zonotrichia leucophrys*	49	231	0.459	0.479	10	10	10	10	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	8	57	0.533	0.490	20	15	15	15	
Dark-eyed Junco	*Junco hyemalis*	199	1189	0.442	0.503	5	10	5	10	
Northern Cardinal	*Cardinalis cardinalis*	291	1039	0.568	0.370	5	5	5	5	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	74	61	0.457	0.241				20	E
Black-headed Grosbeak	*Pheucticus melanocephalus*	171	486	0.550	0.303	5	10	5	10	
Blue Grosbeak	*Passerina caerulea*	31	35	0.363	0.389		25		25	E
Lazuli Bunting	*Passerina amoena*	77	163	0.496	0.297	15	10	15	10	
Indigo Bunting	*Passerina cyanea*	184	580	0.490	0.371	10	10	10	10	
Painted Bunting	*Passerina ciris*	53	189	0.558	0.439	10	10	10	10	
Dickcissel	*Spiza americana*	25	51	0.440	0.209					T
Red-winged Blackbird	*Agelaius phoeniceus*	114	158	0.612	0.200	15	15	15	10	
Eastern Meadowlark	*Sturnella magna*	20	4	0.594	0.347					
Rusty Blackbird	*Euphagus carolinus*	3	6	0.676	0.077					
Brewer's Blackbird	*Euphagus cyanocephalus*	21	14	0.468	0.065					
Common Grackle	*Quiscalus quiscula*	92	110	0.291	0.117					
Bronzed Cowbird	*Molothrus aeneus*	3	17	0.436	0.233					
Brown-headed Cowbird	*Molothrus ater*	346	296	0.473	0.460	10	10	10	10	
Orchard Oriole	*Icterus spurius*	26	42	0.380	0.148					
Baltimore Oriole	*Icterus galbula*	71	76	0.534	0.287	20	15	20	15	
Bullock's Oriole	*Icterus bullockii*	64	111	0.469	0.365	20	15	15	15	
Pine Grosbeak	*Pinicola enucleator*	13	12	0.479	0.269					
Purple Finch	*Carpodacus purpureus*	84	426	0.460	0.340	10	10	10	10	
Cassin's Finch	*Carpodacus cassinii*	38	65	0.332	0.134					

Table 12 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
House Finch	*Carpodacus mexicanus*	72	141	0.435	0.045					
Common Redpoll	*Carduelis flammea*	23	282	0.437	0.023					
Pine Siskin	*Carduelis pinus*	87	496	0.174	0.039					
Lesser Goldfinch	*Carduelis psaltria*	53	149	0.393	0.105					
American Goldfinch	*Carduelis tristis*	222	847	0.430	0.266	15	15	15	10	

Table 13. Species in the Northwest Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code “T”; see text) for which survival could likely be effectively monitored under a **targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **current** MAPS program (we used Region 1 as the benchmark for a regional program and did not consider an expanded (non-targeted) program in this region). (Note: effect sizes are not shown for “target species” for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Williamson's Sapsucker	*Sphyrapicus thyroideus*	8	9	0.324	0.341					
Red-naped Sapsucker	*Sphyrapicus nuchalis*	28	36	0.366	0.544		20		20	
Red-breasted Sapsucker	*Sphyrapicus ruber*	47	70	0.449	0.371		20		20	
Downy Woodpecker	*Picoides pubescens*	45	44	0.319	0.213					T
Hairy Woodpecker	*Picoides villosus*	56	25	0.550	0.286		20	25	15	
Northern Flicker	*Colaptes auratus*	46	13	0.436	0.096					
Western Wood-Pewee	*Contopus sordidulus*	54	86	0.513	0.336	20	15	20	15	
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	32	77	0.524	0.460	20	15	15	10	
Hammond's Flycatcher	*Empidonax hammondii*	53	105	0.453	0.404	20	15	15	15	
Gray Flycatcher	*Empidonax wrightii*									T
Dusky Flycatcher	*Empidonax oberholseri*	47	133	0.488	0.421	15	15	15	10	
“Western” Flycatcher	*Empidonax difficilis/occidentalis*	54	118	0.481	0.314	20	15	15	15	
Cassin's Vireo	*Vireo cassinii*	29	29	0.544	0.162					T
Hutton's Vireo	*Vireo huttoni*	11	3	0.585	0.337					T
Warbling Vireo	*Vireo gilvus*	86	306	0.479	0.422	10	10	10	10	
Red-eyed Vireo	*Vireo olivaceus*	7	8	0.664	0.198					T
Gray Jay	*Perisoreus canadensis*	12	7	0.754	0.232					
Steller's Jay	*Cyanocitta stelleri*	50	15	0.659	0.094					
Western Scrub-Jay	*Aphelocoma californica*	9	3	0.624	0.207					
Tree Swallow	*Tachycineta bicolor*	15	39	0.447	0.272					
Barn Swallow	*Hirundo rustica*	4	26	0.524	0.185					

Table 13 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Black-capped Chickadee	*Poecile atricapilla*	43	73	0.466	0.443	20	15	15	15	
Mountain Chickadee	*Poecile gambeli*	41	60	0.471	0.414	25	15	20	15	
Chestnut-backed Chickadee	*Poecile rufescens*	45	100	0.325	0.180					T
Bushtit	*Psaltriparus minimus*	13	18	0.256	0.102					T
Red-breasted Nuthatch	*Sitta canadensis*	64	40	0.336	0.170					
Brown Creeper	*Certhia americana*	48	55	0.328	0.252					
Bewick's Wren	*Thryomanes bewickii*	13	22	0.452	0.461		20	25	15	
House Wren	*Troglodytes aedon*	27	57	0.278	0.373				25	
Winter Wren	*Troglodytes troglodytes*	37	70	0.375	0.521	25	20	20	15	
Golden-crowned Kinglet	*Regulus satrapa*	54	37	0.128	0.358					
Ruby-crowned Kinglet	*Regulus calendula*	14	50	0.255	0.275				25	
Veery	*Catharus fuscescens*	4	12	0.714	0.386		25	25	20	
Swainson's Thrush	*Catharus ustulatus*	78	856	0.586	0.629	5	5	5	5	
Hermit Thrush	*Catharus guttatus*	35	66	0.461	0.537	20	15	15	15	
American Robin	*Turdus migratorius*	116	370	0.575	0.258	10	10	10	10	
Varied Thrush	*Ixoreus naevius*	30	26	0.494	0.407		25		20	
Wrentit	*Chamaea fasciata*	21	58	0.527	0.637	15	15	15	10	
Gray Catbird	*Dumetella carolinensis*	12	51	0.561	0.450	15	10	15	10	
Sage Thrasher	*Oreoscoptus montanus*									T
Cedar Waxwing	*Bombycilla cedrorum*	24	56	0.639	0.022					
Orange-crowned Warbler	*Vermivora celata*	40	94	0.481	0.418	20	15	15	15	
Nashville Warbler	*Vermivora ruficapilla*	21	35	0.334	0.371					T
Virginia's Warbler	*Vermivora virginiae*	3	16	0.443	0.171					T
Yellow Warbler	*Dendroica petechia*	49	363	0.571	0.493	5	10	5	5	
Yellow-rumped Warbler	*Dendroica coronata*	60	217	0.486	0.208	20	15	15	15	
Black-throated Gray Warbler	*Dendroica nigrescens*	17	10	0.487	0.092					T
Townsend's Warbler	*Dendroica townsendi*	23	82	0.451	0.216		20		20	

Table 13 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Hermit Warbler	*Dendroica occidentalis*	34	52	0.599	0.069					
American Redstart	*Setophaga ruticilla*	7	24	0.443	0.526		25		20	
Northern Waterthrush	*Seiurus noveboracensis*	5	8	0.626	0.257					T
MacGillivray's Warbler	*Oporornis tolmiei*	85	542	0.479	0.614	5	10	5	10	
Common Yellowthroat	*Geothlypis trichas*	27	153	0.499	0.556	15	10	10	10	
Wilson's Warbler	*Wilsonia pusilla*	56	265	0.438	0.526	15	10	10	10	
Yellow-breasted Chat	*Icteria virens*	15	89	0.448	0.560	20	15	20	15	
Western Tanager	*Piranga ludoviciana*	73	100	0.538	0.129		20	25	15	
Green-tailed Towhee	*Pipilo chlorurus*	5	21	0.602	0.360		20	25	15	
Spotted Towhee	*Pipilo maculatus*	42	88	0.476	0.508	15	15	15	10	
Chipping Sparrow	*Spizella passerina*	37	71	0.403	0.203					T
Brewer’s Sparrow	*Spizella breweri*									T
Vesper Sparrow	*Pooecetes gramineus*	3	3	0.688	0.346					T
Sage Sparrow	*Amphispiza belli*									T
Savannah Sparrow	*Passerculus sandwichensis*	2	31	0.585	0.285	25	15	20	15	
Fox Sparrow	*Passerella iliaca*	25	44	0.553	0.451	15	10	15	10	
Song Sparrow	*Melospiza melodia*	98	643	0.470	0.598	5	10	5	5	
Lincoln's Sparrow	*Melospiza lincolnii*	37	267	0.432	0.631	10	10	10	10	
White-crowned Sparrow	*Zonotrichia leucophrys*	14	61	0.474	0.544	20	15	15	15	
Dark-eyed Junco	*Junco hyemalis*	83	533	0.461	0.500	10	10	5	10	
Black-headed Grosbeak	*Pheucticus melanocephalus*	68	155	0.568	0.280	10	10	10	10	
Lazuli Bunting	*Passerina amoena*	25	62	0.552	0.245	25	20	25	15	
Red-winged Blackbird	*Agelaius phoeniceus*	18	42	0.784	0.148	15	10	10	10	
Brewer's Blackbird	*Euphagus cyanocephalus*	10	6	0.586	0.032					
Brown-headed Cowbird	*Molothrus ater*	60	68	0.486	0.485	20	15	15	15	
Bullock's Oriole	*Icterus bullockii*	19	25	0.454	0.429		15	25	15	
Purple Finch	*Carpodacus purpureus*	32	155	0.434	0.364	20	15	20	15	

Table 13 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Cassin's Finch	*Carpodacus cassinii*	18	18	0.345	0.181					
House Finch	*Carpodacus mexicanus*	5	38	0.477	0.070					
Pine Siskin	*Carduelis pinus*	46	263	0.175	0.041					
Lesser Goldfinch	*Carduelis psaltria*	9	33	0.297	0.082					
American Goldfinch	*Carduelis tristis*	20	108	0.470	0.328	20	15	15	15	

Table 14. Species in the Southwest Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code "T"; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code "E." (Note: effect sizes are not shown for "target species" for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Williamson's Sapsucker	*Sphyrapicus thyroideus*	10	13	0.572	0.171					
Red-naped Sapsucker	*Sphyrapicus nuchalis*	8	44	0.494	0.665	20	15	15	15	
Red-breasted Sapsucker	*Sphyrapicus ruber*	4	5	0.689	0.452				25	E
Nuttall's Woodpecker	*Picoides nuttallii*	31	54	0.551	0.381	20	15	15	15	
Downy Woodpecker	*Picoides pubescens*	39	47	0.605	0.431	15	10	15	10	
Hairy Woodpecker	*Picoides villosus*	19	17	0.834	0.182	25		20	20	E
Northern Flicker	*Colaptes auratus*	41	33	0.310	0.191					
Olive-sided Flycatcher	*Contopus cooperi*	4	5	0.870	0.724	15	10	10	10	
Western Wood-Pewee	*Contopus sordidulus*	29	53	0.384	0.446	25	20	25	15	
"Traill's" Flycatcher	*Empidonax alnorum/traillii*	10	8	0.615	0.306					
Gray Flycatcher	*Empidonax wrightii*									T
"Western" Flycatcher	*Empidonax difficilis/occidentalis*	29	83	0.595	0.183	25	15	20	15	
Black Phoebe	*Sayornis nigricans*	25	21	0.522	0.369				20	E
Ash-throated Flycatcher	*Myiarchus cinerascens*	60	154	0.659	0.137	10	10	10	10	
Bell's Vireo	*Vireo bellii*	10	30	0.482	0.596	25	15	20	15	
Plumbeous Vireo	*Vireo plumbeus*	16	14	0.722	0.206					T
Hutton's Vireo	*Vireo huttoni*									T
Warbling Vireo	*Vireo gilvus*	29	101	0.539	0.460	15	10	15	10	
Steller's Jay	*Cyanocitta stelleri*	17	25	0.762	0.234	20	15	15	15	
Western Scrub-Jay	*Aphelocoma californica*	25	16	0.643	0.084					
Mexican Jay	*Aphelocoma ultramarina*	6	5	0.531	0.166					

Table 14 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Tree Swallow	*Tachycineta bicolor*	10	8	0.556	0.320					
Violet-green Swallow	*Tachycineta thalassina*	10	20	0.570	0.248					
Black-capped Chickadee	*Poecile atricapilla*	14	33	0.366	0.600		20	25	15	
Mountain Chickadee	*Poecile gambeli*	19	76	0.408	0.292		20	25	20	
Chestnut-backed Chickadee	*Poecile rufescens*	12	79	0.501	0.512	15	15	15	10	
Bridled Titmouse	*Baeolophus wollweberi*	8	10	0.714	0.344				20	E
Oak Titmouse	*Baeolophus inornatus*	21	35	0.514	0.358		20	25	15	
Juniper Titmouse	*Baeolophus ridgwayi*	8	17	0.655	0.409	25	15	20	15	
Verdin	*Auriparus flaviceps*									T
Bushtit	*Psaltriparus minimus*	58	332	0.300	0.152		25		20	
White-breasted Nuthatch	*Sitta carolinensis*	27	17	0.486	0.396				25	E
Brown Creeper	*Certhia americana*	17	21	0.317	0.177					
Bewick's Wren	*Thryomanes bewickii*	74	265	0.424	0.538	15	10	10	10	
House Wren	*Troglodytes aedon*	52	220	0.388	0.439	15	10	15	10	
Golden-crowned Kinglet	*Regulus satrapa*	10	14	0.342	0.292					
Western Bluebird	*Sialia mexicana*	19	15	0.380	0.355					
Swainson's Thrush	*Catharus ustulatus*	16	235	0.619	0.578	5	10	5	5	
Hermit Thrush	*Catharus guttatus*	17	145	0.450	0.400	15	15	15	10	
American Robin	*Turdus migratorius*	52	174	0.529	0.309	15	10	15	10	
Wrentit	*Chamaea fasciata*	31	205	0.540	0.618	10	10	10	10	
Sage Thrasher	*Oreoscoptus montanus*									T
California Thrasher	*Toxostoma redivivum*	16	23	0.687	0.115					
Orange-crowned Warbler	*Vermivora celata*	29	153	0.413	0.318	20	15	20	15	
Virginia's Warbler	*Vermivora virginiae*	17	45	0.484	0.395		15	25	15	
Lucy's Warbler	*Vermivora luciae*	10	69	0.507	0.260		25		20	E
Yellow Warbler	*Dendroica petechia*	35	214	0.479	0.526	10	10	10	10	
Yellow-rumped Warbler	*Dendroica coronata*	17	58	0.285	0.231					T

Table 14 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Black-throated Gray Warbler	*Dendroica nigrescens*	2	8	0.704	0.082					T
MacGillivray's Warbler	*Oporornis tolmiei*	14	33	0.294	0.329					T
Common Yellowthroat	*Geothlypis trichas*	43	345	0.525	0.426	10	10	10	10	
Wilson's Warbler	*Wilsonia pusilla*	17	241	0.446	0.510	15	10	10	10	
Yellow-breasted Chat	*Icteria virens*	33	210	0.522	0.521	10	10	10	10	
Summer Tanager	*Piranga rubra*	12	44	0.506	0.451	20	15	20	15	
Western Tanager	*Piranga ludoviciana*	23	42	0.558	0.174		25	25	20	E
Spotted Towhee	*Pipilo maculatus*	70	320	0.496	0.430	10	10	10	10	
Canyon Towhee	*Pipilo fuscus*									T
California Towhee	*Pipilo crissalis*	33	120	0.536	0.356	20	15	15	10	
Rufous-crowned Sparrow	*Aimophila ruficeps*	14	27	0.579	0.235					T
Chipping Sparrow	*Spizella passerina*	16	45	0.455	0.098					T
Brewer’s Sparrow	*Spizella breweri*									T
Vesper Sparrow	*Pooecetes gramineus*									T
Lark Sparrow	*Chondestes grammacus*	16	28	0.509	0.324		20		20	E
Black-throated Sparrow	*Amphispiza bilineata*									T
Sage Sparrow	*Amphispiza belli*	6	39	0.587	0.033					T
Fox Sparrow	*Passerella iliaca*	6	22	0.519	0.551		20	25	15	
Song Sparrow	*Melospiza melodia*	50	559	0.520	0.479	10	10	5	10	
Lincoln's Sparrow	*Melospiza lincolnii*	6	34	0.437	0.876	20	15	20	15	
White-crowned Sparrow	*Zonotrichia leucophrys*	6	4	0.688	0.232					
Dark-eyed Junco	*Junco hyemalis*	16	95	0.387	0.560	20	15	20	15	
Black-headed Grosbeak	*Pheucticus melanocephalus*	68	304	0.526	0.345	10	10	10	10	
Blue Grosbeak	*Passerina caerulea*	21	33	0.409	0.488		20		20	
Lazuli Bunting	*Passerina amoena*	41	79	0.372	0.473	25	15	20	15	
Red-winged Blackbird	*Agelaius phoeniceus*	17	79	0.880	0.037	15		15		
Brown-headed Cowbird	*Molothrus ater*	58	73	0.463	0.568	20	15	15	10	

Table 14 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Bullock's Oriole	*Icterus bullockii*	35	89	0.458	0.377	20	15	20	15	
Purple Finch	*Carpodacus purpureus*	14	186	0.531	0.304	15	10	10	10	
Cassin's Finch	*Carpodacus cassinii*	10	48	0.320	0.088					
Lesser Goldfinch	*Carduelis psaltria*	45	136	0.422	0.124					
American Goldfinch	*Carduelis tristis*	27	162	0.407	0.101					

Table 15. Species in the North-central Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code “T”; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code ”E.” (Note: effect sizes are not shown for “target species” for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Red-bellied Woodpecker	*Melanerpes carolinus*	19	8	0.442	0.267					
Downy Woodpecker	*Picoides pubescens*	46	78	0.405	0.229				25	E
Hairy Woodpecker	*Picoides villosus*	34	5	0.471	0.752				25	E
Northern Flicker	*Colaptes auratus*	38	8	0.340	0.340					
Western Wood-Pewee	*Contopus sordidulus*	4	26	0.486	0.388		25		20	E
Eastern Wood-Pewee	*Contopus virens*	31	14	0.522	0.368					T
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	25	102	0.484	0.509	15	10	15	10	
Least Flycatcher	*Empidonax minimus*	25	143	0.368	0.431	15	15	15	15	
Great Crested Flycatcher	*Myiarchus crinitus*	34	12	0.747	0.306		25	25	20	E
White-eyed Vireo	*Vireo griseus*	4	8	0.515	0.569					
Warbling Vireo	*Vireo gilvus*	17	11	0.413	0.216					T
Red-eyed Vireo	*Vireo olivaceus*	50	88	0.534	0.391	20	15	20	15	
Blue Jay	*Cyanocitta cristata*	42	54	0.525	0.083					T
Black-capped Chickadee	*Poecile atricapilla*	59	105	0.417	0.394	25	20	20	15	
Tufted Titmouse	*Baeolophus bicolor*	21	36	0.555	0.407	20	15	20	15	
White-breasted Nuthatch	*Sitta carolinensis*	31	9	0.589	0.187					T
Carolina Wren	*Thryothorus ludovicianus*	15	16	0.357	0.619		25		20	E
House Wren	*Troglodytes aedon*	38	174	0.322	0.440	20	20	20	15	
Veery	*Catharus fuscescens*	19	95	0.575	0.586	10	10	10	10	
Wood Thrush	*Hylocichla mustelina*	25	65	0.453	0.317	25	15	20	15	
American Robin	*Turdus migratorius*	54	81	0.380	0.423		20	25	20	

Table 15 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Gray Catbird	*Dumetella carolinensis*	48	411	0.497	0.478	10	10	10	10	
Brown Thrasher	*Toxostoma rufum*	10	16	0.660	0.169					T
Blue-winged Warbler	*Vermivora pinus*	8	15	0.525	0.495		25		20	E
Nashville Warbler	*Vermivora ruficapilla*	8	13	0.372	0.422					T
Yellow Warbler	*Dendroica petechia*	31	257	0.548	0.398	10	10	10	10	
Chestnut-sided Warbler	*Dendroica pensylvanica*	8	88	0.378	0.572	20	15	20	15	
Magnolia Warbler	*Dendroica magnolia*									T
Yellow-rumped Warbler	*Dendroica coronata*	2	10	0.386	0.097					T
Black-throated Green Warbler	*Dendroica virens*									T
Black-and-white Warbler	*Mniotilta varia*	15	15	0.512	0.514		25		20	E
American Redstart	*Setophaga ruticilla*	23	91	0.454	0.282	20	15	15	15	
Ovenbird	*Seiurus aurocapillus*	17	53	0.575	0.272		20	25	15	E
Northern Waterthrush	*Seiurus noveboracensis*	4	18	0.336	0.270					T
Kentucky Warbler	*Oporornis formosus*	4	25	0.610	0.698	20	15	15	10	
Mourning Warbler	*Oporornis philadelphia*	6	31	0.421	0.608		20	25	20	
Common Yellowthroat	*Geothlypis trichas*	50	244	0.433	0.498	15	10	10	10	
Canada Warbler	*Wilsonia canadensis*									T
Scarlet Tanager	*Piranga olivacea*	23	6	0.352	0.370					
Eastern Towhee	*Pipilo erythrophthalmus*	15	8	0.462	0.443					T
Chipping Sparrow	*Spizella passerina*	19	48	0.400	0.134					T
Clay-colored Sparrow	*Spizella pallida*	13	36	0.568	0.059					T
Field Sparrow	*Spizella pusilla*	17	128	0.426	0.392	25	15	20	15	
Savannah Sparrow	*Passerculus sandwichensis*	6	3	0.479	0.441					
Song Sparrow	*Melospiza melodia*	46	246	0.444	0.517	15	10	10	10	
Lincoln's Sparrow	*Melospiza lincolnii*	4	8	0.426	0.785				25	E
Swamp Sparrow	*Melospiza georgiana*	13	29	0.386	0.776	25	20	25	15	
White-throated Sparrow	*Zonotrichia albicollis*	6	70	0.383	0.621	20	15	20	15	

Table 15 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Northern Cardinal	*Cardinalis cardinalis*	38	104	0.539	0.355	20	15	15	15	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	38	42	0.233	0.317					T
Black-headed Grosbeak	*Pheucticus melanocephalus*	2	12	0.584	0.109					
Indigo Bunting	*Passerina cyanea*	34	147	0.518	0.312	15	15	15	10	
Red-winged Blackbird	*Agelaius phoeniceus*	19	80	0.388	0.035					
Brown-headed Cowbird	*Molothrus ater*	46	37	0.487	0.411		20	25	15	
Orchard Oriole	*Icterus spurius*									
Baltimore Oriole	*Icterus galbula*	29	60	0.615	0.184	25	20	25	15	
Bullock's Oriole	*Icterus bullockii*	2	9	0.778	0.052					
American Goldfinch	*Carduelis tristis*	44	344	0.347	0.360	20	20	15	15	

Table 16. Species in the South-central Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code "T"; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code "E." (Note: effect sizes are not shown for "target species" for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Common Ground-Dove	*Columbina passerina*	8	37	0.553	0.051					
Yellow-billed Cuckoo	*Coccyzus americanus*	60	18	0.574	0.148					
Golden-fronted Woodpecker	*Melanerpes aurifrons*	5	18	0.199	0.345					
Ladder-backed Woodpecker	*Picoides scalaris*	15	8	0.543	0.365					T
Downy Woodpecker	*Picoides pubescens*	38	23	0.598	0.274					T
Eastern Wood-Pewee	*Contopus virens*	19	4	0.741	0.264					T
Acadian Flycatcher	*Empidonax virescens*	8	36	0.583	0.478	20	15	15	10	
Great Crested Flycatcher	*Myiarchus crinitus*	27	13	0.476	0.262					T
Brown-crested Flycatcher	*Myiarchus tyrannulus*	3	37	0.495	0.252					T
Eastern Kingbird	*Tyrannus tyrannus*	15	1	0.832	0.225					
White-eyed Vireo	*Vireo griseus*	32	157	0.601	0.498	10	10	10	10	
Bell's Vireo	*Vireo bellii*	16	55	0.593	0.377	20	15	15	15	
Red-eyed Vireo	*Vireo olivaceus*	20	40	0.575	0.221		25	25	20	
Western Scrub-Jay	*Aphelocoma californica*	3	2	0.649	0.545					
Carolina Chickadee	*Poecile carolinensis*	50	59	0.527	0.124					T
Black-capped Chickadee	*Poecile atricapilla*	8	14	0.471	0.192					
Black-crested Titmouse	*Baeolophus b. atricristatus*	24	43	0.484	0.237					T
Tufted Titmouse	*Baeolophus bicolor*	32	48	0.486	0.296	25	15	25	15	
Carolina Wren	*Thryothorus ludovicianus*	42	105	0.459	0.517	15	10	15	10	
Bewick's Wren	*Thryomanes bewickii*	28	59	0.431	0.498	25	20	25	15	
House Wren	*Troglodytes aedon*	8	13	0.428	0.455				25	E

Table 16 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Blue-gray Gnatcatcher	*Polioptila caerulea*	35	17	0.539	0.078					
Wood Thrush	*Hylocichla mustelina*	9	17	0.382	0.383					T
American Robin	*Turdus migratorius*	17	13	0.376	0.184					T
Gray Catbird	*Dumetella carolinensis*	12	76	0.581	0.467	15	10	10	10	
Northern Mockingbird	*Mimus polyglottos*	21	33	0.323	0.178					
Brown Thrasher	*Toxostoma rufum*	20	21	0.408	0.572		25		25	
Long-billed Thrasher	*Toxostoma longirostre*	4	17	0.628	0.396		25		20	
Blue-winged Warbler	*Vermivora pinus*	5	25	0.555	0.490	20	15	20	15	
Northern Parula	*Parula americana*	8	8	0.345	0.163					T
Yellow Warbler	*Dendroica petechia*	4	18	0.353	0.515				25	
Prairie Warbler	*Dendroica discolor*	4	19	0.508	0.213					T
Black-and-white Warbler	*Mniotilta varia*	16	6	0.709	0.258					T
American Redstart	*Setophaga ruticilla*	1	7	0.394	0.409					T
Prothonotary Warbler	*Protonotaria citrea*	7	20	0.533	0.097					T
Worm-eating Warbler	*Helmitheros vermivorus*	3	4	0.597	0.429					T
Swainson's Warbler	*Limnothlypis swainsonii*	3	5	0.516	0.320					T
Ovenbird	*Seiurus aurocapillus*	7	8	0.649	0.333					T
Louisiana Waterthrush	*Seiurus motacilla*	5	8	0.515	0.519					T
Kentucky Warbler	*Oporornis formosus*	15	55	0.608	0.535	15	10	15	10	
Common Yellowthroat	*Geothlypis trichas*	19	49	0.471	0.478	20	15	20	15	
Hooded Warbler	*Wilsonia citrina*	4	15	0.456	0.195					T
Yellow-breasted Chat	*Icteria virens*	11	96	0.521	0.391	20	15	15	15	
Summer Tanager	*Piranga rubra*	25	22	0.531	0.377		25		20	
Olive Sparrow	*Arremonops rufivirgatus*	4	32	0.510	0.738	20	15	15	15	
Eastern Towhee	*Pipilo erythrophthalmus*	13	6	0.621	0.121					T
Rufous-crowned Sparrow	*Aimophila ruficeps*	9	9	0.523	0.431					T
Field Sparrow	*Spizella pusilla*	42	145	0.482	0.343	15	15	15	10	

Table 16.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Lark Sparrow	*Chondestes grammacus*	8	19	0.536	0.037					T
Grasshopper Sparrow	*Ammodramus savannarum*	8	28	0.336	0.455				25	E
Northern Cardinal	*Cardinalis cardinalis*	64	328	0.581	0.356	10	10	10	10	
Blue Grosbeak	*Passerina caerulea*	9	11	0.343	0.119					T
Indigo Bunting	*Passerina cyanea*	31	149	0.459	0.422	15	15	15	10	
Painted Bunting	*Passerina ciris*	42	138	0.558	0.439	10	10	10	10	
Dickcissel	*Spiza americana*	20	37	0.440	0.209					T
Eastern Meadowlark	*Sturnella magna*	15	3	0.594	0.347					
Bronzed Cowbird	*Molothrus aeneus*	3	12	0.436	0.233					
Brown-headed Cowbird	*Molothrus ater*	52	53	0.474	0.364	25	15	20	15	
Orchard Oriole	*Icterus spurius*	15	13	0.318	0.330					
American Goldfinch	*Carduelis tristis*	25	76	0.339	0.186					T

Table 17. Species in the Northeast Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code “T”; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code ”E.” (Note: effect sizes are not shown for “target species” for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Red-bellied Woodpecker	*Melanerpes carolinus*	28	14	0.399	0.190					
Yellow-bellied Sapsucker	*Sphyrapicus varius*	24	31	0.406	0.252					T
Downy Woodpecker	*Picoides pubescens*	96	56	0.445	0.525	25	20	25	15	
Hairy Woodpecker	*Picoides villosus*	65	35	0.845	0.080					T
Northern Flicker	*Colaptes auratus*	53	16	0.561	0.093					
Eastern Wood-Pewee	*Contopus virens*	59	25	0.532	0.313		25		20	E
Acadian Flycatcher	*Empidonax virescens*	22	16	0.739	0.072					T
“Traill's” Flycatcher	*Empidonax alnorum/traillii*	33	59	0.502	0.541	20	15	15	15	
Eastern Phoebe	*Sayornis phoebe*	47	22	0.571	0.405		20	25	15	
Great Crested Flycatcher	*Myiarchus crinitus*	53	27	0.663	0.102					T
Eastern Kingbird	*Tyrannus tyrannus*	16	8	0.532	0.504					
White-eyed Vireo	*Vireo griseus*	26	73	0.479	0.396	25	15	20	15	
Yellow-throated Vireo	*Vireo flavifrons*	8	2	0.694	0.321					
Blue-headed Vireo	*Vireo solitarius*	26	24	0.366	0.265					T
Red-eyed Vireo	*Vireo olivaceus*	108	257	0.582	0.295	10	10	10	10	
Blue Jay	*Cyanocitta cristata*	85	13	0.869	0.164	15		10	15	
Carolina Chickadee	*Poecile carolinensis*	37	18	0.484	0.449		20		20	
Black-capped Chickadee	*Poecile atricapilla*	98	225	0.514	0.294	15	10	10	10	
Tufted Titmouse	*Baeolophus bicolor*	71	101	0.393	0.298	25	20	20	15	
White-breasted Nuthatch	*Sitta carolinensis*	45	15	0.424	0.328					T
Carolina Wren	*Thryothorus ludovicianus*	41	77	0.264	0.406		25		25	E

Table 17 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
House Wren	*Troglodytes aedon*	33	36	0.250	0.465		25		25	E
Eastern Bluebird	*Sialia sialis*	18	13	0.451	0.349					
Veery	*Catharus fuscescens*	81	481	0.577	0.574	5	5	5	5	
Bicknell's Thrush	*Catharus bicknelli*	2	9	0.632	0.300					T
Swainson's Thrush	*Catharus ustulatus*	12	26	0.621	0.686	20	15	15	10	
Hermit Thrush	*Catharus guttatus*	41	92	0.457	0.631	15	10	10	10	
Wood Thrush	*Hylocichla mustelina*	104	348	0.424	0.403	15	15	15	10	
American Robin	*Turdus migratorius*	106	227	0.429	0.329	20	15	15	15	
Gray Catbird	*Dumetella carolinensis*	98	975	0.515	0.460	5	10	5	5	
Brown Thrasher	*Toxostoma rufum*	28	23	0.472	0.195					T
Cedar Waxwing	*Bombycilla cedrorum*	57	295	0.733	0.001					
Blue-winged Warbler	*Vermivora pinus*	35	51	0.442	0.387		25		20	
Nashville Warbler	*Vermivora ruficapilla*	16	38	0.356	0.162					T
Northern Parula	*Parula americana*	10	16	0.368	0.531				25	E
Yellow Warbler	*Dendroica petechia*	55	213	0.509	0.475	10	10	10	10	
Chestnut-sided Warbler	*Dendroica pensylvanica*	35	93	0.475	0.527	15	15	15	10	
Magnolia Warbler	*Dendroica magnolia*	22	62	0.346	0.738	25	20	20	20	
Black-throated Blue Warbler	*Dendroica caerulescens*	14	19	0.561	0.392		20	25	15	E
Yellow-rumped Warbler	*Dendroica coronata*	22	62	0.460	0.501	20	15	15	15	
Black-throated Green Warbler	*Dendroica virens*	33	77	0.402	0.589	20	15	15	15	
Blackburnian Warbler	*Dendroica fusca*	10	11	0.641	0.117					
Blackpoll Warbler	*Dendroica striata*	4	8	0.339	0.573					T
Black-and-white Warbler	*Mniotilta varia*	79	141	0.502	0.301	15	15	15	10	
American Redstart	*Setophaga ruticilla*	71	336	0.525	0.331	10	10	10	10	
Worm-eating Warbler	*Helmitheros vermivorus*	24	62	0.520	0.395	25	15	20	15	
Ovenbird	*Seiurus aurocapillus*	100	327	0.557	0.425	5	10	5	5	
Northern Waterthrush	*Seiurus noveboracensis*	8	15	0.401	0.498				25	E

Table 17 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Louisiana Waterthrush	*Seiurus motacilla*	22	25	0.477	0.745	20	15	20	15	
Kentucky Warbler	*Oporornis formosus*	10	10	0.569	0.535		20		20	E
Mourning Warbler	*Oporornis philadelphia*	6	15	0.767	0.065					T
Common Yellowthroat	*Geothlypis trichas*	89	412	0.502	0.493	10	10	10	10	
Hooded Warbler	*Wilsonia citrina*	30	89	0.460	0.610	15	10	10	10	
Canada Warbler	*Wilsonia canadensis*	14	13	0.398	0.554					T
Yellow-breasted Chat	*Icteria virens*	14	43	0.501	0.356		20	25	15	
Scarlet Tanager	*Piranga olivacea*	73	85	0.623	0.042					
Eastern Towhee	*Pipilo erythrophthalmus*	69	120	0.489	0.331	20	15	15	10	
Chipping Sparrow	*Spizella passerina*	26	32	0.432	0.399				25	E
Song Sparrow	*Melospiza melodia*	73	230	0.336	0.511	20	15	15	15	
Swamp Sparrow	*Melospiza georgiana*	16	29	0.422	0.721		20	25	20	
White-throated Sparrow	*Zonotrichia albicollis*	28	113	0.289	0.583	20	20	20	15	
Dark-eyed Junco	*Junco hyemalis*	30	79	0.407	0.259				25	E
Northern Cardinal	*Cardinalis cardinalis*	81	150	0.618	0.365	10	10	10	10	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	49	42	0.542	0.241					T
Indigo Bunting	*Passerina cyanea*	51	81	0.465	0.543	15	15	15	10	
Red-winged Blackbird	*Agelaius phoeniceus*	39	47	0.587	0.320	20	15	15	15	
Common Grackle	*Quiscalus quiscula*	41	42	0.316	0.209					
Brown-headed Cowbird	*Molothrus ater*	49	28	0.398	0.257					T
Baltimore Oriole	*Icterus galbula*	43	35	0.418	0.476		20		20	
Purple Finch	*Carpodacus purpureus*	20	36	0.324	0.372					T
American Goldfinch	*Carduelis tristis*	77	201	0.442	0.209		20	25	20	

Table 18. Species in the Southeast Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code "T"; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code "E." (Note: effect sizes are not shown for "target species" for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Red-bellied Woodpecker	*Melanerpes carolinus*	79	37	0.175	0.351					
Downy Woodpecker	*Picoides pubescens*	112	29	0.620	0.344	25	15	20	15	
Hairy Woodpecker	*Picoides villosus*	59	21	0.536	0.189					T
Eastern Wood-Pewee	*Contopus virens*	77	54	0.386	0.194					T
Acadian Flycatcher	*Empidonax virescens*	86	273	0.483	0.556	10	10	10	10	
Great Crested Flycatcher	*Myiarchus crinitus*	60	14	0.534	0.233					T
White-eyed Vireo	*Vireo griseus*	79	189	0.465	0.561	10	10	10	10	
Red-eyed Vireo	*Vireo olivaceus*	102	409	0.620	0.212	10	10	10	10	
Blue Jay	*Cyanocitta cristata*	101	50	0.652	0.116					T
Carolina Chickadee	*Poecile carolinensis*	119	81	0.493	0.282	20	15	20	15	
Tufted Titmouse	*Baeolophus bicolor*	123	170	0.511	0.434	10	10	10	10	
Carolina Wren	*Thryothorus ludovicianus*	119	273	0.369	0.582	10	10	10	10	
House Wren	*Troglodytes aedon*	4	10	0.514	0.155					T
Wood Thrush	*Hylocichla mustelina*	102	471	0.455	0.552	10	10	5	10	
American Robin	*Turdus migratorius*	35	78	0.429	0.103					T
Gray Catbird	*Dumetella carolinensis*	46	157	0.428	0.477	15	15	15	15	
Northern Mockingbird	*Mimus polyglottos*									
Brown Thrasher	*Toxostoma rufum*	44	23	0.635	0.205					T
Blue-winged Warbler	*Vermivora pinus*	16	56	0.558	0.279	20	15	15	10	
Northern Parula	*Parula americana*									T
Yellow Warbler	*Dendroica petechia*	2	13	0.391	0.317					T

Table 18 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Prairie Warbler	*Dendroica discolor*	33	67	0.400	0.253					T
Black-and-white Warbler	*Mniotilta varia*	26	32	0.479	0.103					T
American Redstart	*Setophaga ruticilla*	4	10	0.465	0.149					T
Prothonotary Warbler	*Protonotaria citrea*	26	59	0.512	0.261				20	E
Worm-eating Warbler	*Helmitheros vermivorus*	29	52	0.529	0.404	25	15	20	15	
Swainson's Warbler	*Limnothlypis swainsonii*	9	14	0.743	0.062					T
Ovenbird	*Seiurus aurocapillus*	84	248	0.528	0.480	10	10	10	10	
Louisiana Waterthrush	*Seiurus motacilla*	35	56	0.520	0.516	20	15	15	15	
Kentucky Warbler	*Oporornis formosus*	64	250	0.507	0.600	10	10	10	10	
Common Yellowthroat	*Geothlypis trichas*	75	212	0.439	0.503	15	15	15	10	
Hooded Warbler	*Wilsonia citrina*	53	108	0.514	0.525	15	10	15	10	
Yellow-breasted Chat	*Icteria virens*	44	118	0.292	0.323		25		20	
Summer Tanager	*Piranga rubra*	51	24	0.294	0.504				25	E
Scarlet Tanager	*Piranga olivacea*	66	37	0.616	0.131					
Eastern Towhee	*Pipilo erythrophthalmus*	82	57	0.472	0.344	25	15	20	15	
Field Sparrow	*Spizella pusilla*	29	52	0.367	0.216					T
Song Sparrow	*Melospiza melodia*	4	27	0.410	0.520		25		20	
Northern Cardinal	*Cardinalis cardinalis*	126	433	0.543	0.392	10	10	10	10	
Blue Grosbeak	*Passerina caerulea*									T
Indigo Bunting	*Passerina cyanea*	86	219	0.521	0.306	15	10	10	10	
Common Grackle	*Quiscalus quiscula*	37	142	0.561	0.016					
Brown-headed Cowbird	*Molothrus ater*	62	12	0.321	0.660					T
American Goldfinch	*Carduelis tristis*	40	112	0.582	0.119					T

Table 19. Species in the Alaska and Boreal Canada Region for which adult apparent survival rates and recapture probabilities (parameters ϕ and p) could be estimated from the **current** program, and additional species (indicated by code "T"; see text) for which survival could likely be effectively monitored under an **expanded and targeted** MAPS Program. The numbers of stations and resident birds released annually and the detectable effect sizes with 20 years of data are presented for the **expanded** (non-targeted) MAPS program. Species that can be effectively monitored under the expanded program, but not the current program, are indicated by code "E." (Note: effect sizes are not shown for "target species" for which projected sample sizes and parameter estimates [ϕ and p] were not available.)

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Yellow-bellied Sapsucker	*Sphyrapicus varius*									T
Three-toed Woodpecker	*Picoides tridactylus*	9	5	0.742	0.347					
Western Wood-Pewee	*Contopus sordidulus*	6	15	0.461	0.621		20		15	E
Yellow-bellied Flycatcher	*Empidonax flaviventris*									T
"Traill's" Flycatcher	*Empidonax alnorum/traillii*	40	86	0.383	0.506	20	15	20	15	
Blue-headed Vireo	*Vireo solitarius*									T
Philadelphia Vireo	*Vireo philadelphicus*									T
Gray Jay	*Perisoreus canadensis*	34	21	0.542	0.375		25		20	E
Tree Swallow	*Tachycineta bicolor*	3	29	0.223	0.311					
Black-capped Chickadee	*Poecile atricapilla*	30	86	0.426	0.401		20	25	20	
Boreal Chickadee	*Poecile hudsonica*	30	49	0.492	0.365	25	15	25	15	
Ruby-crowned Kinglet	*Regulus calendula*									T
Arctic Warbler	*Phylloscopus borealis*	6	77	0.339	0.605	25	20	25	20	
Gray-cheeked Thrush	*Catharus minimus*	18	82	0.459	0.683	15	10	15	10	
Swainson's Thrush	*Catharus ustulatus*	49	231	0.456	0.590	10	10	10	10	
Hermit Thrush	*Catharus guttatus*	27	175	0.499	0.766	10	10	10	10	
American Robin	*Turdus migratorius*	43	133	0.354	0.166		25		20	E
Varied Thrush	*Ixoreus naevius*	30	38	0.258	0.157					
Tennessee Warbler	*Vermivora peregrina*									T
Orange-crowned Warbler	*Vermivora celata*	49	292	0.413	0.504	15	10	10	10	

Table 19 continued.

						$\alpha = 0.10$		$\alpha = 0.20$		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Nashville Warbler	*Vermivora ruficapilla*									T
Yellow Warbler	*Dendroica petechia*	27	242	0.445	0.456	15	10	10	10	
Magnolia Warbler	*Dendroica magnolia*									T
Yellow-rumped Warbler	*Dendroica coronata*	49	145	0.367	0.432	15	15	15	15	
Black-throat. Green Warbler	*Dendroica virens*									T
Townsend's Warbler	*Dendroica townsendi*	12	32	0.201	0.443				25	E
Palm Warbler	*Dendroica palmarum*									T
Bay-breasted Warbler	*Dendroica castanea*									T
Blackpoll Warbler	*Dendroica striata*	15	26	0.312	0.809		25		20	E
Black-and-white Warbler	*Mniotilta varia*									T
American Redstart	*Setophaga ruticilla*	6	64	0.571	0.308	15	15	15	10	
Ovenbird	*Seiurus aurocapillus*	6	7	0.598	0.349					T
Northern Waterthrush	*Seiurus noveboracensis*	27	44	0.528	0.725	15	15	15	10	
Mourning Warbler	*Oporornis philadelphia*	3	22	0.377	0.323					T
Common Yellowthroat	*Geothlypis trichas*									T
Wilson's Warbler	*Wilsonia pusilla*	46	555	0.366	0.565	10	10	10	10	
Canada Warbler	*Wilsonia canadensis*	6	41	0.462	0.475	25	15	20	15	
American Tree Sparrow	*Spizella arborea*	21	44	0.483	0.500	20	15	20	15	
Chipping Sparrow	*Spizella passerina*	9	17	0.360	0.390					T
Savannah Sparrow	*Passerculus sandwichensis*	18	22	0.303	0.716		25		25	E
Fox Sparrow	*Passerella iliaca*	40	95	0.518	0.556	15	10	15	10	
Lincoln's Sparrow	*Melospiza lincolnii*	30	68	0.347	0.368				25	E
White-throated Sparrow	*Zonotrichia albicollis*	6	29	0.503	0.183					T
White-crowned Sparrow	*Zonotrichia leucophrys*	40	199	0.435	0.412	20	15	15	15	
Golden-crowned Sparrow	*Zonotrichia atricapilla*	15	91	0.533	0.490	15	15	15	10	
Dark-eyed Junco	*Junco hyemalis*	46	204	0.309	0.636	15	15	15	15	
Rusty Blackbird	*Euphagus carolinus*	6	9	0.676	0.077					

Table 19 continued.

						α = 0.10		α = 0.20		
Common name	Scientific name	Sta.	Res.	ϕ	p	2P	LD	2P	LD	Code
Pine Grosbeak	*Pinicola enucleator*	15	14	0.473	0.380					
Common Redpoll	*Carduelis flammea*	43	454	0.437	0.023					

Fig. 1. Scatterplot showing the relationship between range-wide 1992-2001 population trends estimated from MAPS data and trends estimated from BBS data for 23 wood-warbler species. Data points are displayed as four-letter species codes (see Appendix for definitions). The reference line indicates a one-to-one relationship. Only species for which we had adequate precision were included (see text for detail).

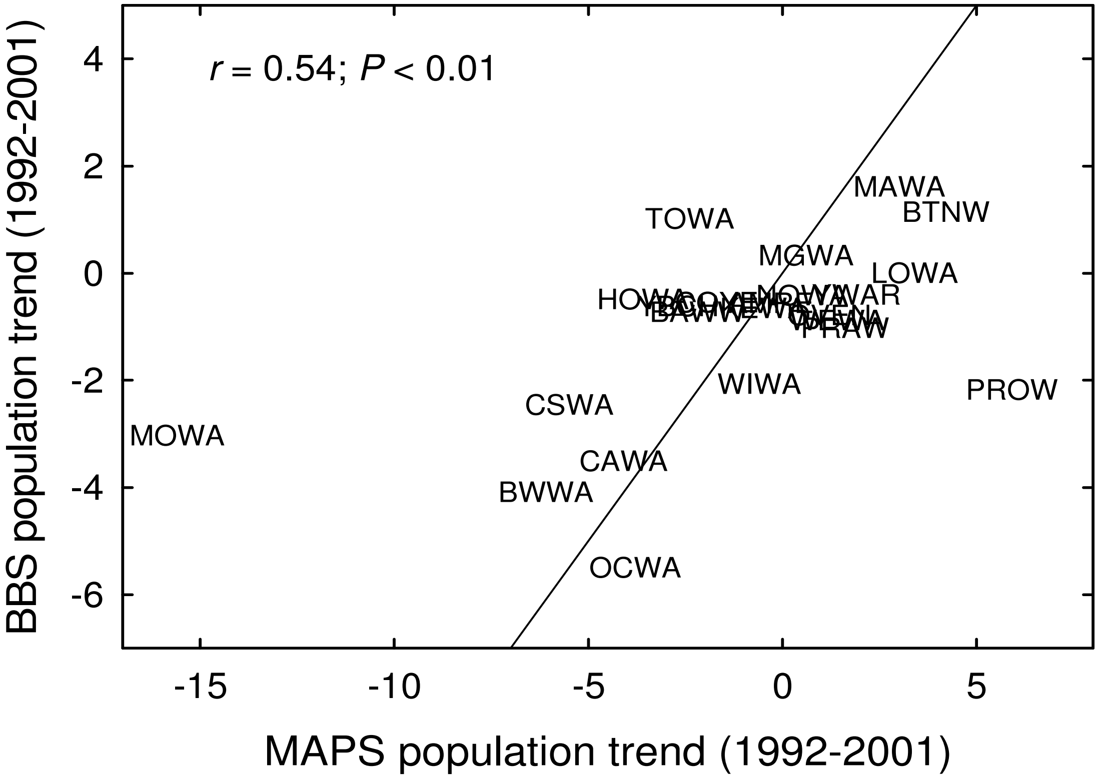


Fig. 2. Scatterplot of MAPS v. BBIRD productivity for 26 wood-warbler species 1992-2001. The MAPS reproductive index is the ratio of young to adult birds captured during constant-effort mist netting. We derived BBIRD productivity from BBIRD daily nest mortality estimates and data on clutch size and exposure period from Birds of North America (BNA) accounts. Data points are displayed as four-letter species codes (see Appendix for definitions).

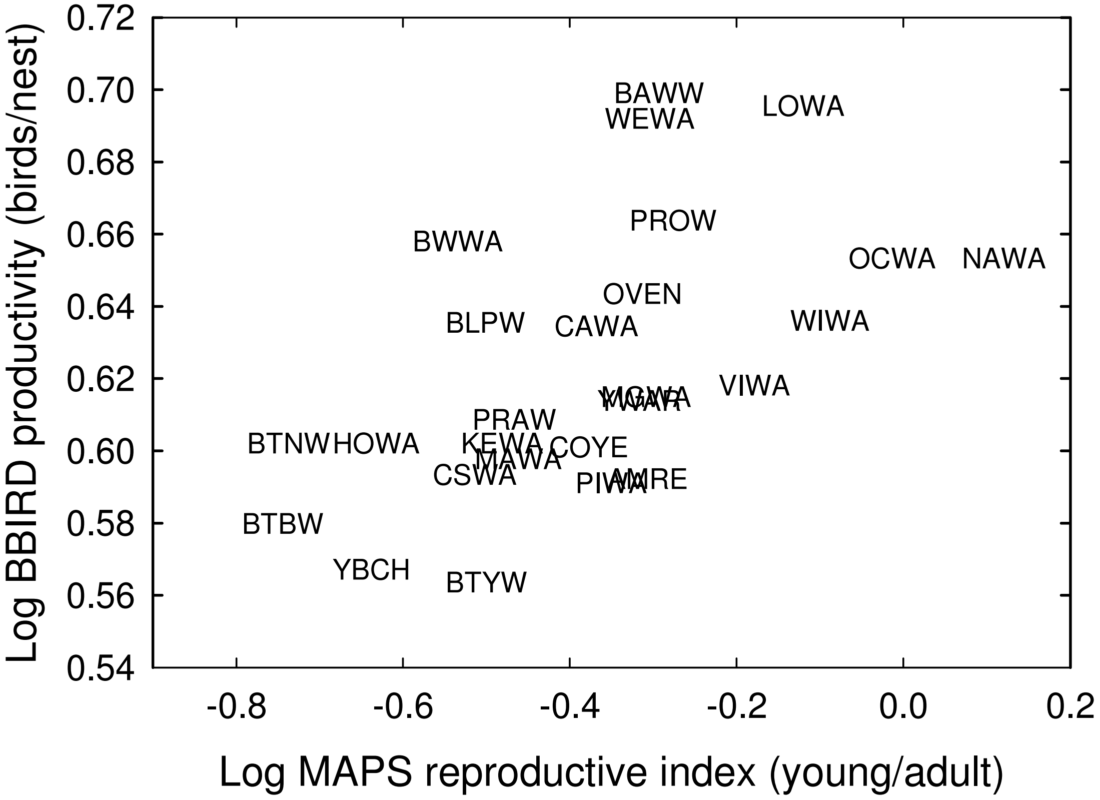


Fig. 3. Eight MAPS regions (AK = Alaska, B&AC = Boreal and Arctic Canada, NW = Northwest, N-C = North-central, NE = Northeast, SW = Southwest, S-C = South-central, and SE = Southeast). Delineation of regions generally follows the boundaries of BBS Physiographic Strata and is based on both biogeographic and meteorological considerations, including the apparent periodicity of the Jet Stream. For our 10-yr (1992-2001) analyses, we grouped the Alaska and Boreal and Arctic Canada regions.

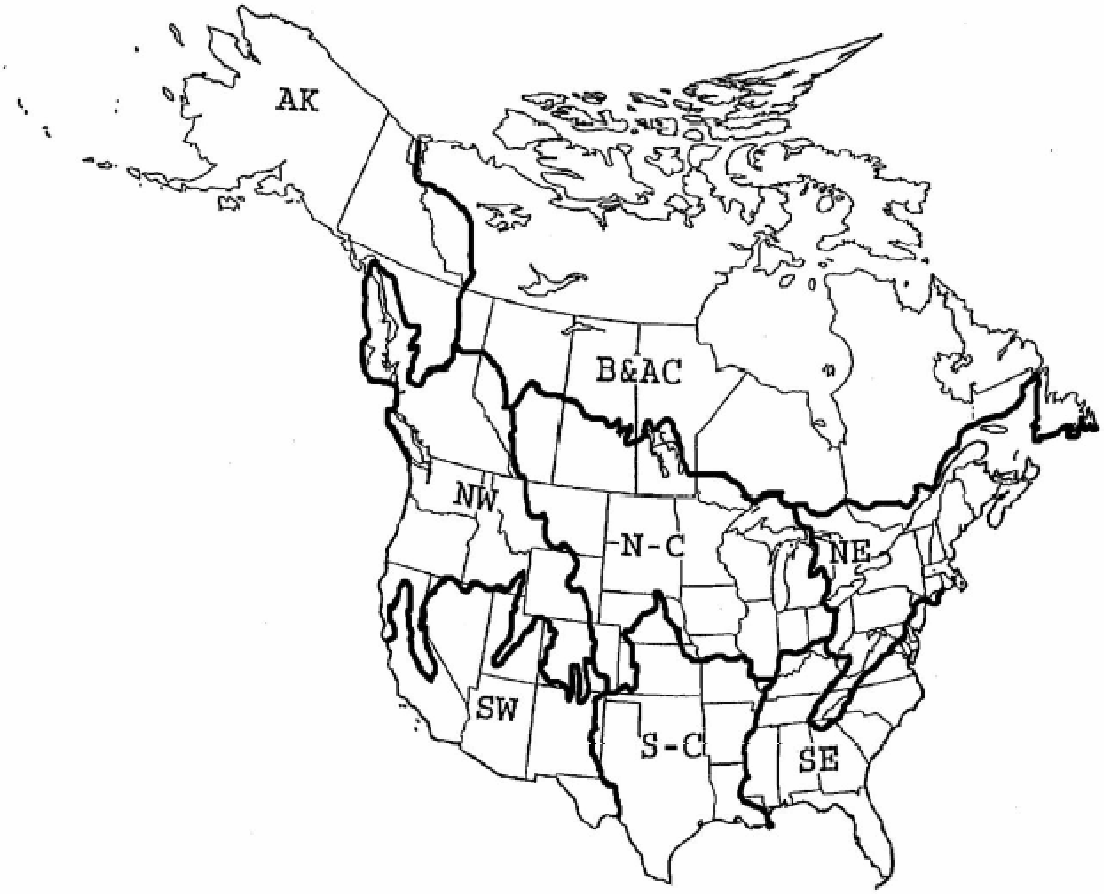


Fig. 4. (A) Numbers of stations that operated as part of the MAPS program from 1992-2001 (black bars), and the numbers (gray bars) and (B) proportions of these stations that were usable for survivorship analyses (i.e., that had at least four years of data during the 10-year period). The large annual increases in number of stations during the first five years represent early program growth (the program was initiated in 1989). Proportions of usable stations during the middle four years are likely to be typical of a stable long-term MAPS program (mean proportion = 0.912 during1995-1998) and represent normal levels of losses and additions to the program. Increasing proportions of usable stations for survivorship analyses during the first three years and decreasing proportions of usable stations during the last three years are artifacts of the 10-year (1992-2001) analysis (i.e., all stations that stopped operation during 1992, 1993, or 1994, or that began operation in 1999, 2000, or 2001 are unusable for the 1992-2001 analysis, regardless of whether or not they actually ran for four or more years).

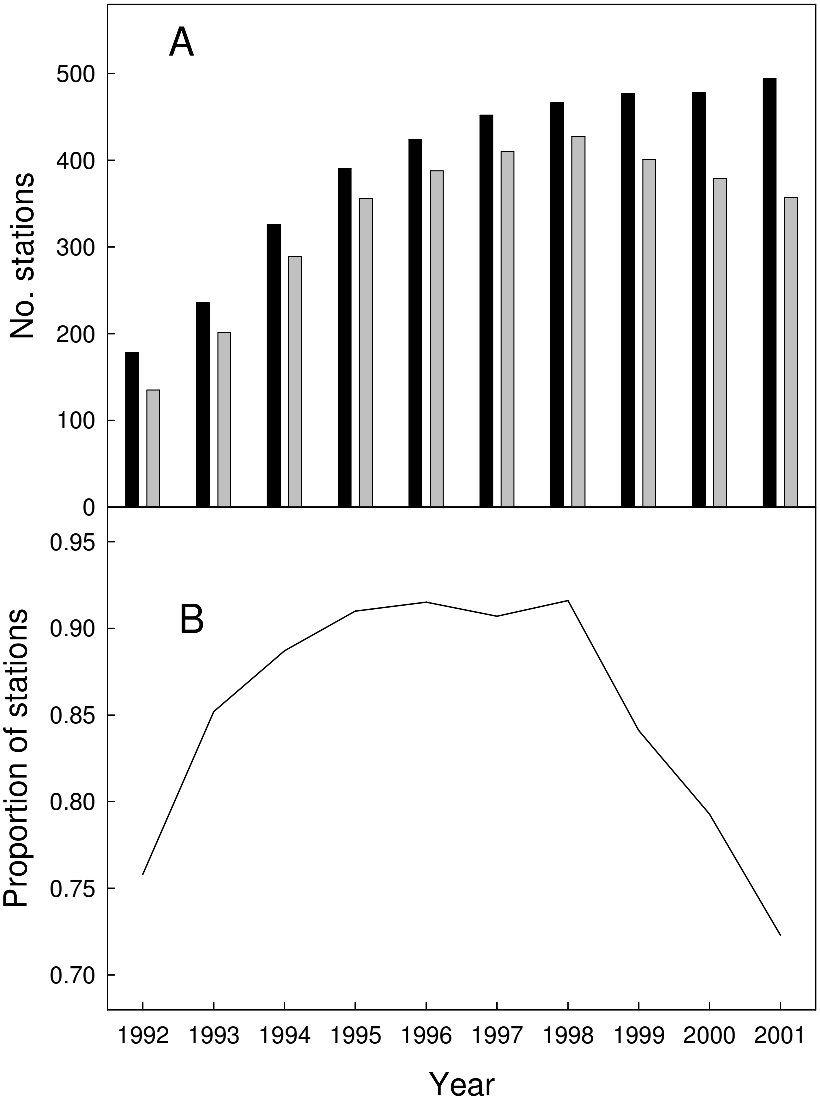


Fig. 5. Numbers of resident birds (in both populations) needed to be released per year to achieve 80% power to detect differences in survival between populations for birds with annual survival rates of 0.40 (top four panels) and 0.60 (bottom four panels). The range of survival rates and recapture probabilities shown here are typical of those found in MAPS data, representing 81% of the species for which could estimate time-constant survival at the continental scale with 10 years of data (see Table 1).

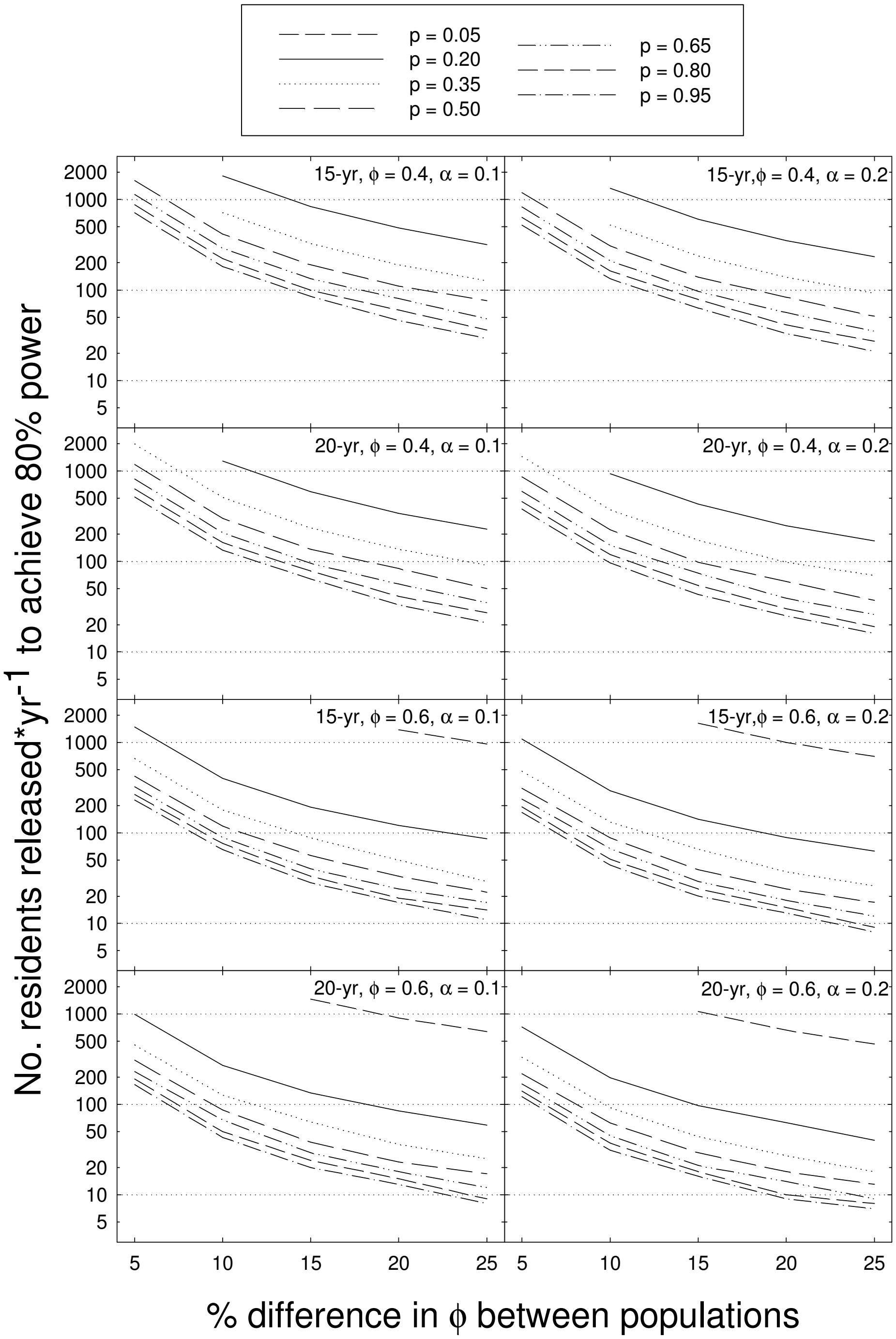


Fig. 6. Numbers of resident birds needed to be released per year to achieve 80% power to detect a declining trend in survival for birds with annual survival rates of 0.40 (top four panels) and 0.60 (bottom four panels). The range of survival rates and recapture probabilities shown here are typical of those found in MAPS data, representing 81% of the species for which could estimate time-constant survival at the continental scale with 10 years of data (see Table 1).

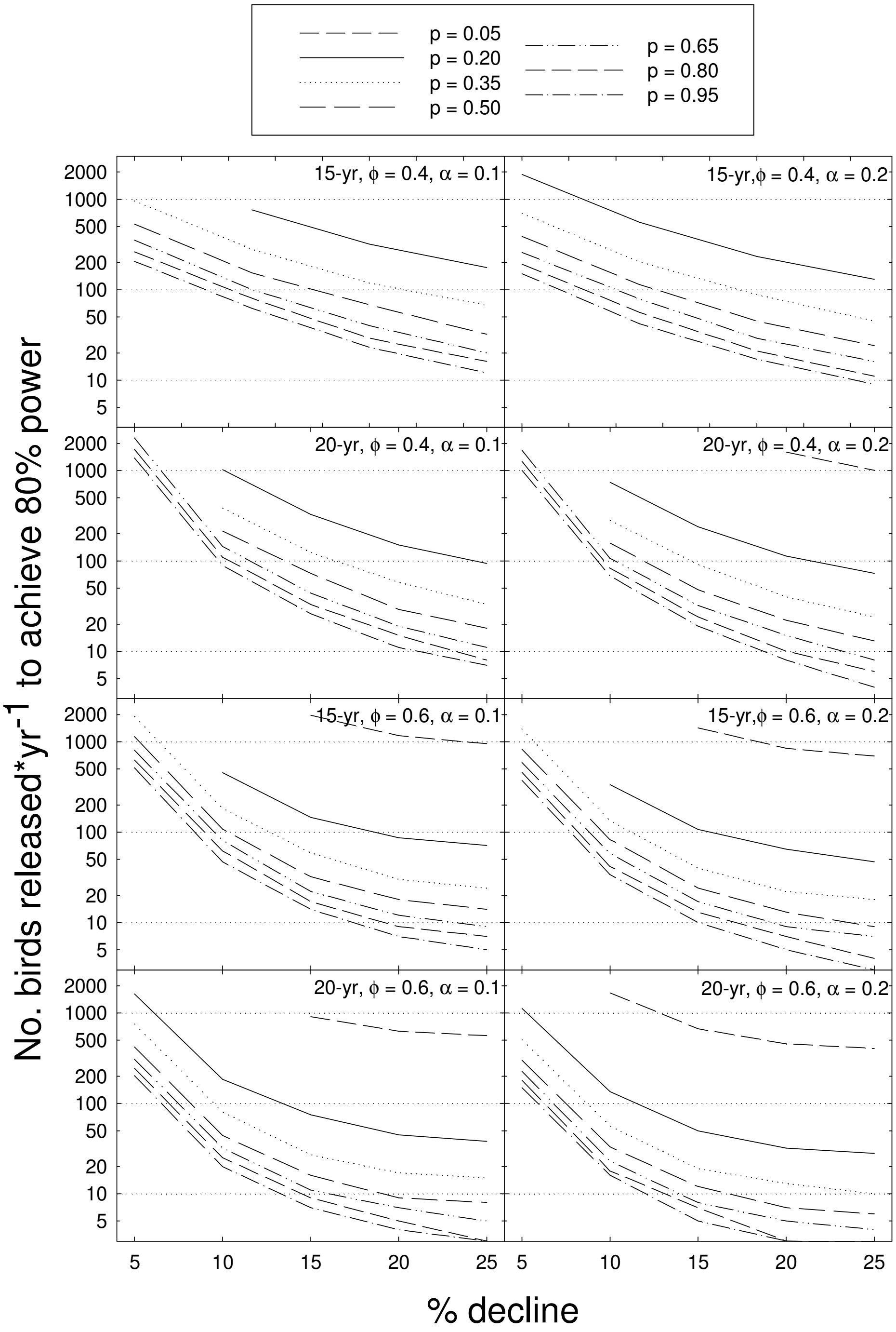


Fig. 7. Numbers of species for which current MAPS sample sizes suggest that we could detect differences in adult apparent survival (ϕ) between populations with 15 years of data.

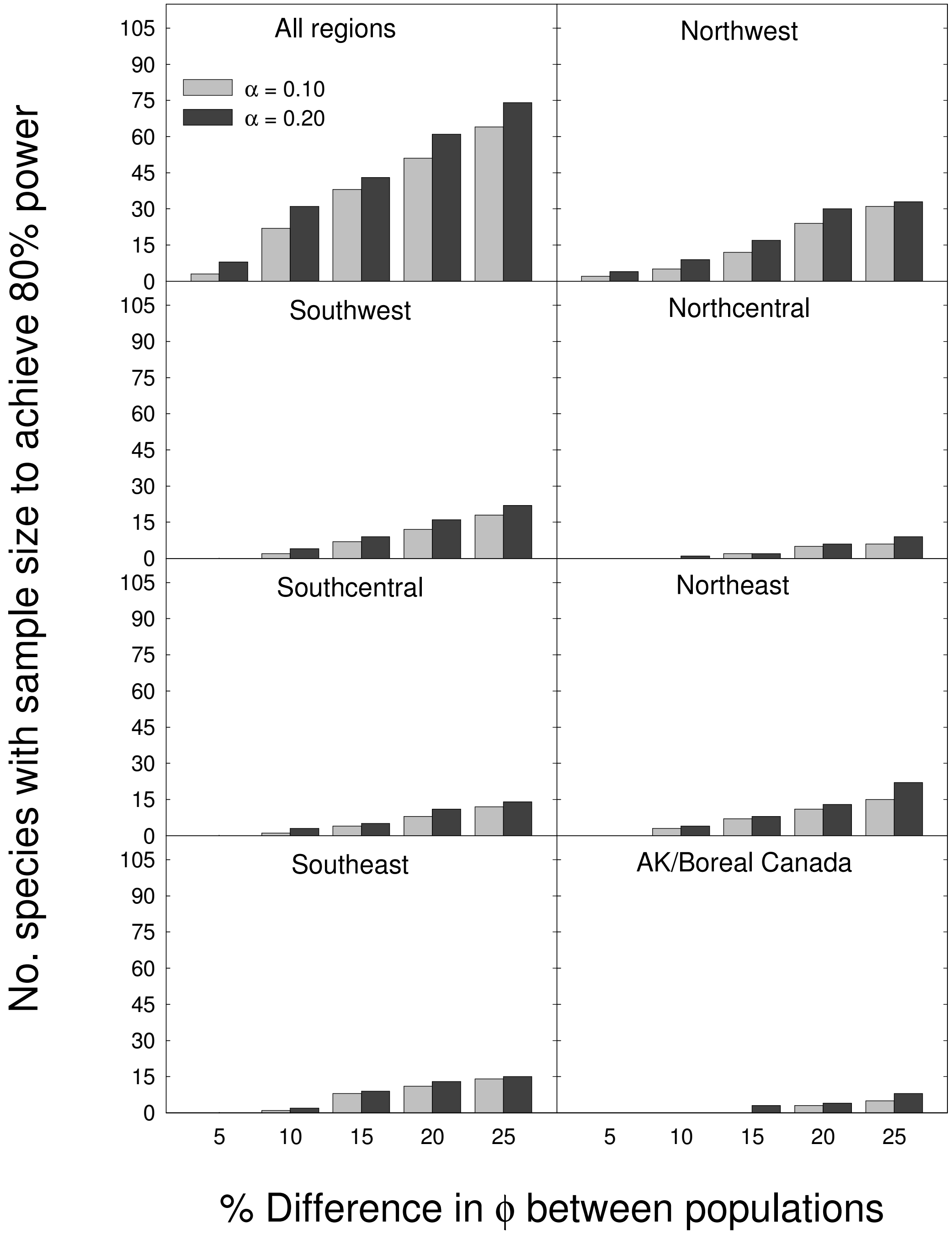


Fig. 8. Numbers of species for which current MAPS sample sizes suggest that we could detect linear declines in adult apparent survival (ϕ) with 15 years of data.

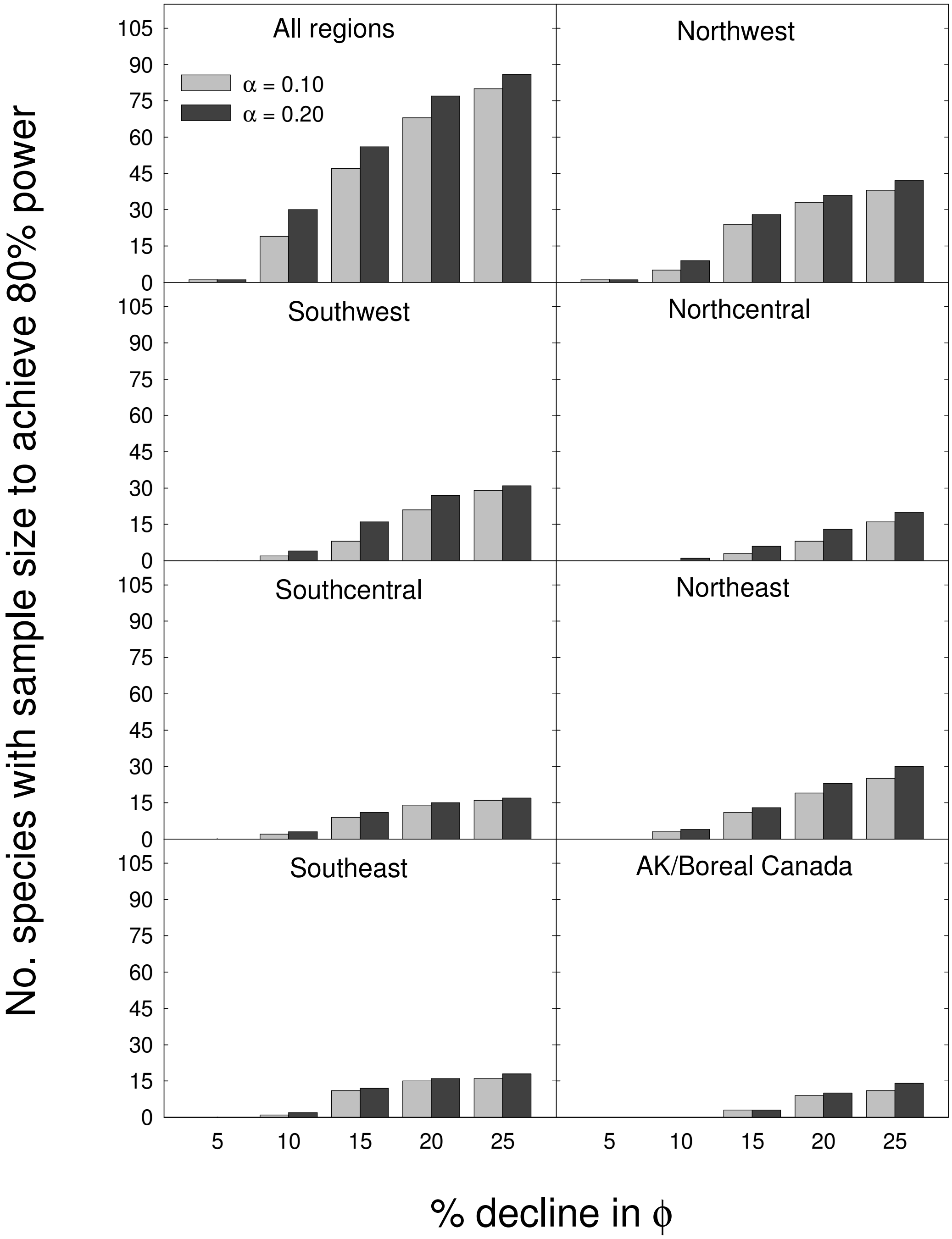


Fig. 9. Numbers of species for which current MAPS sample sizes suggest that we could detect differences in adult apparent survival (ϕ) between populations with 20 years of data.

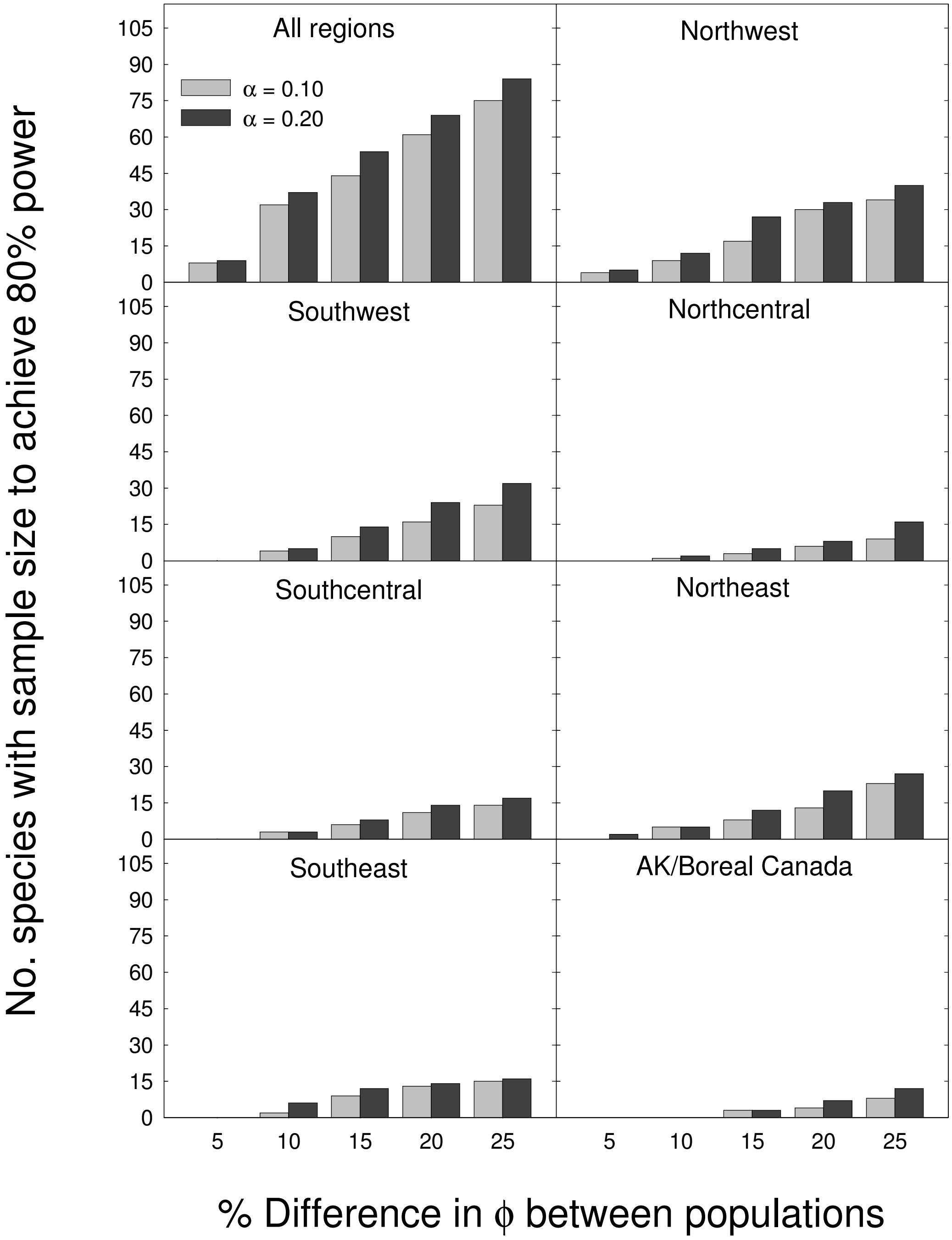


Fig. 10. Numbers of species for which current MAPS sample sizes suggest that we could detect linear declines in adult apparent survival (ϕ) with 20 years of data.

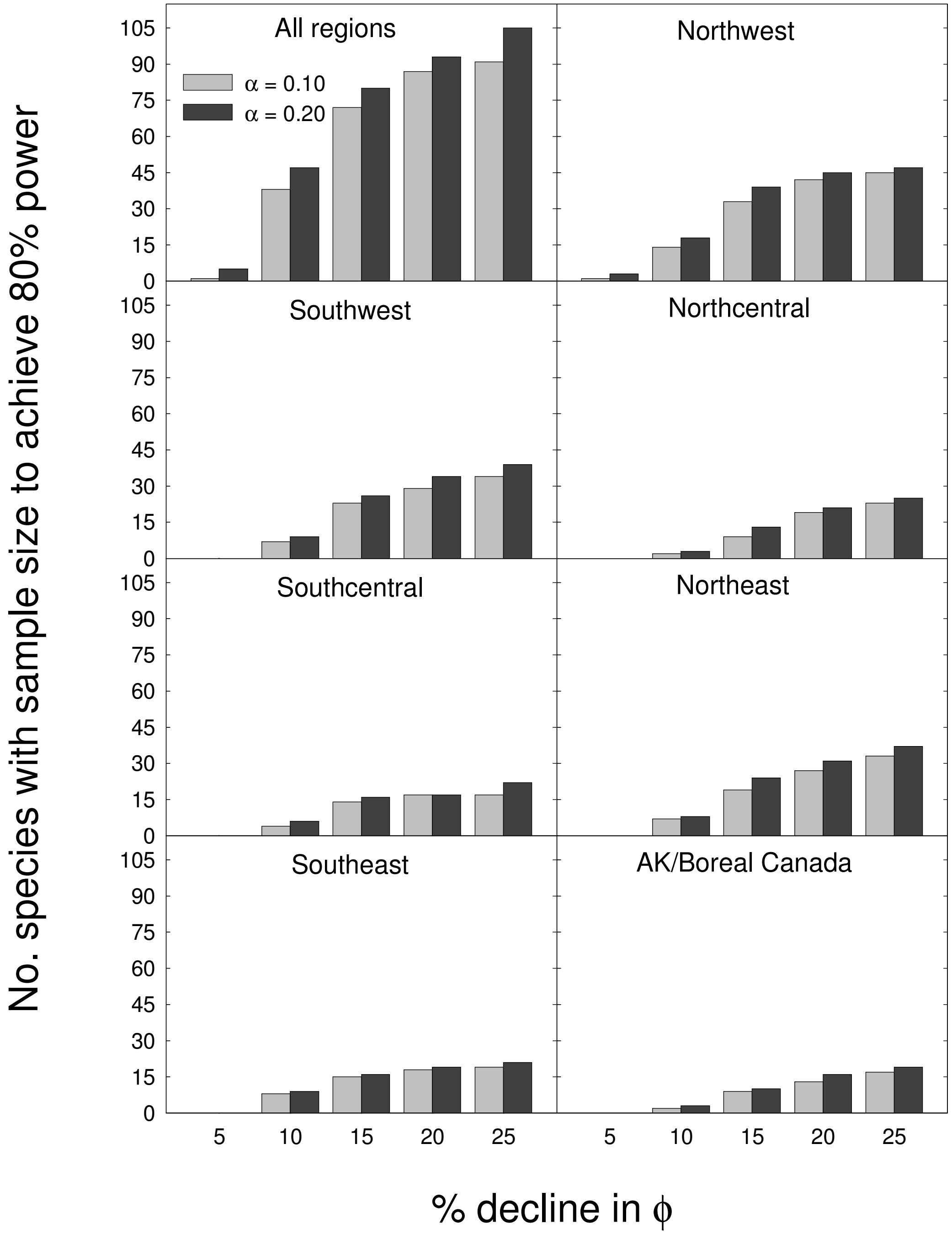


Fig. 11. Numbers of species for which we would be able to detect differences in survival between clusters of six stations on national forest lands in the Pacific Northwest with 80% power over 15- and 20-year time periods. Calculations assume that capture rates, proportions of residents captured, and survival and recapture probabilities all remained as documented on each national forest during the ten years 1992-2001.

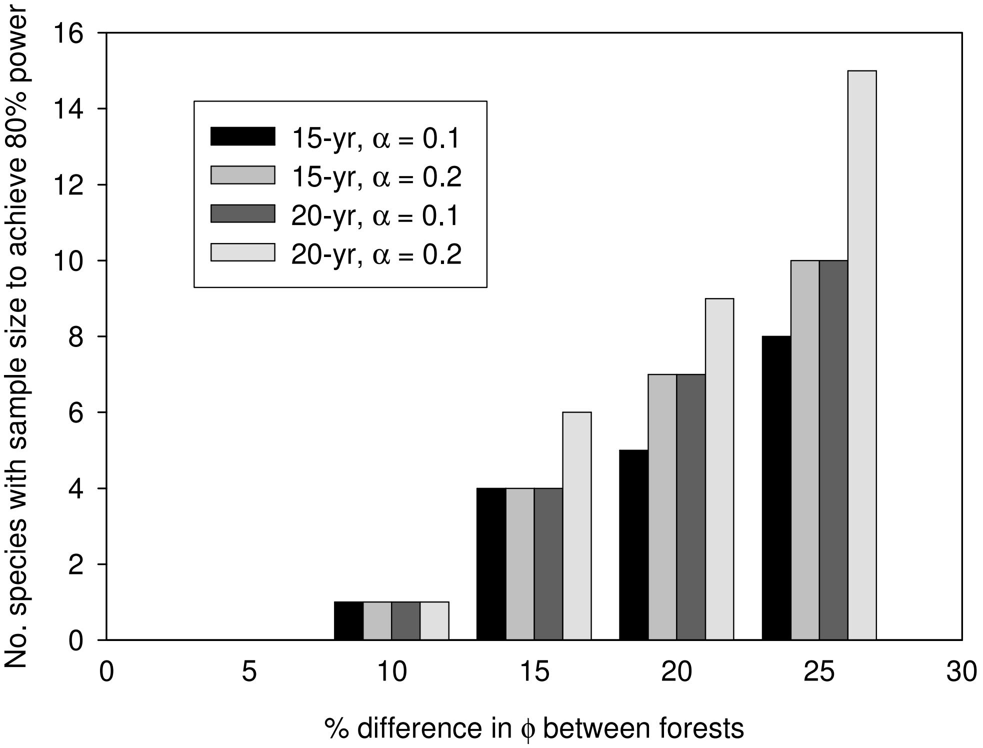


Fig.12. Numbers of new species for which we would likely be able to detect differences in survival between populations with 20 years of data under an expanded (but not targeted) MAPS program.

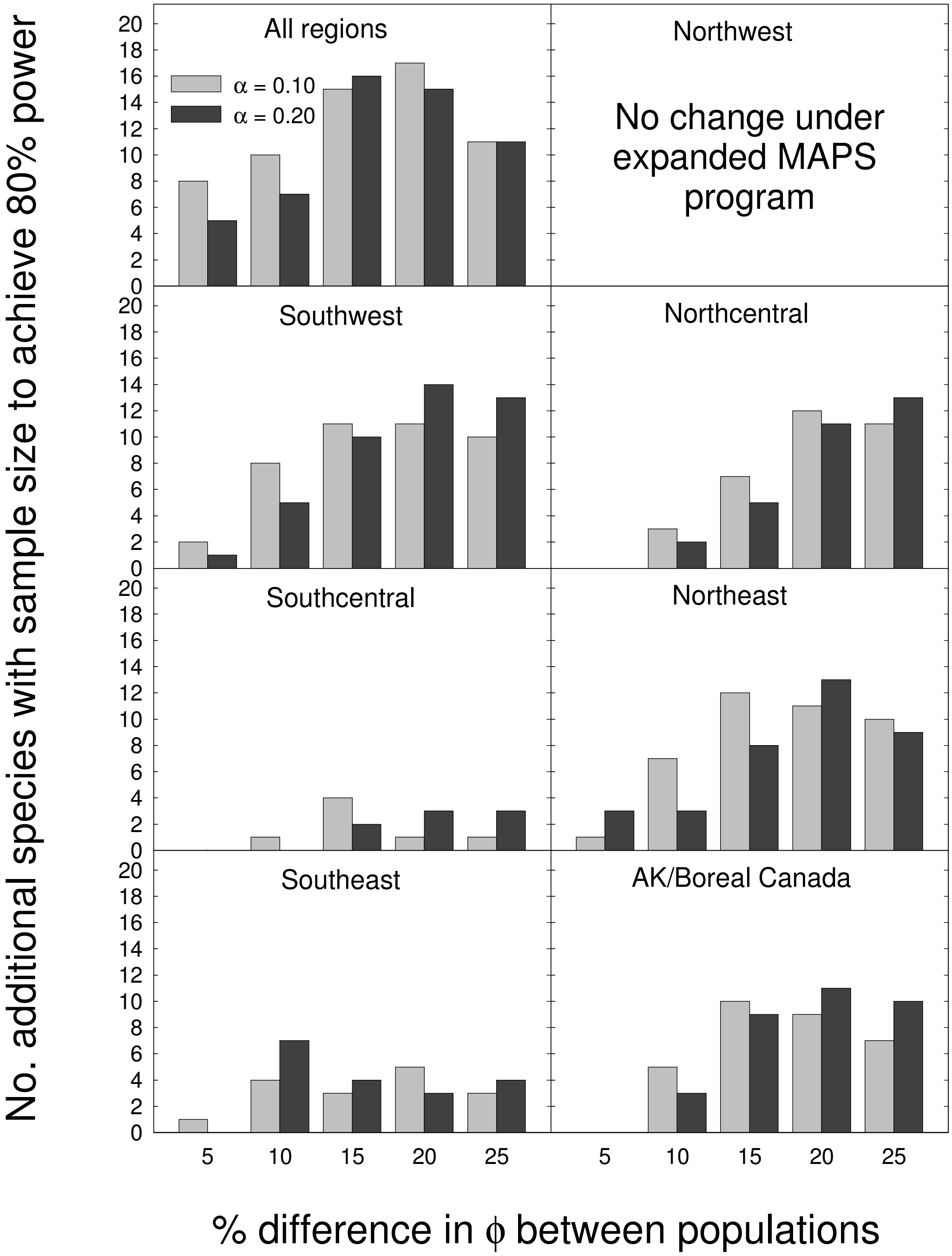
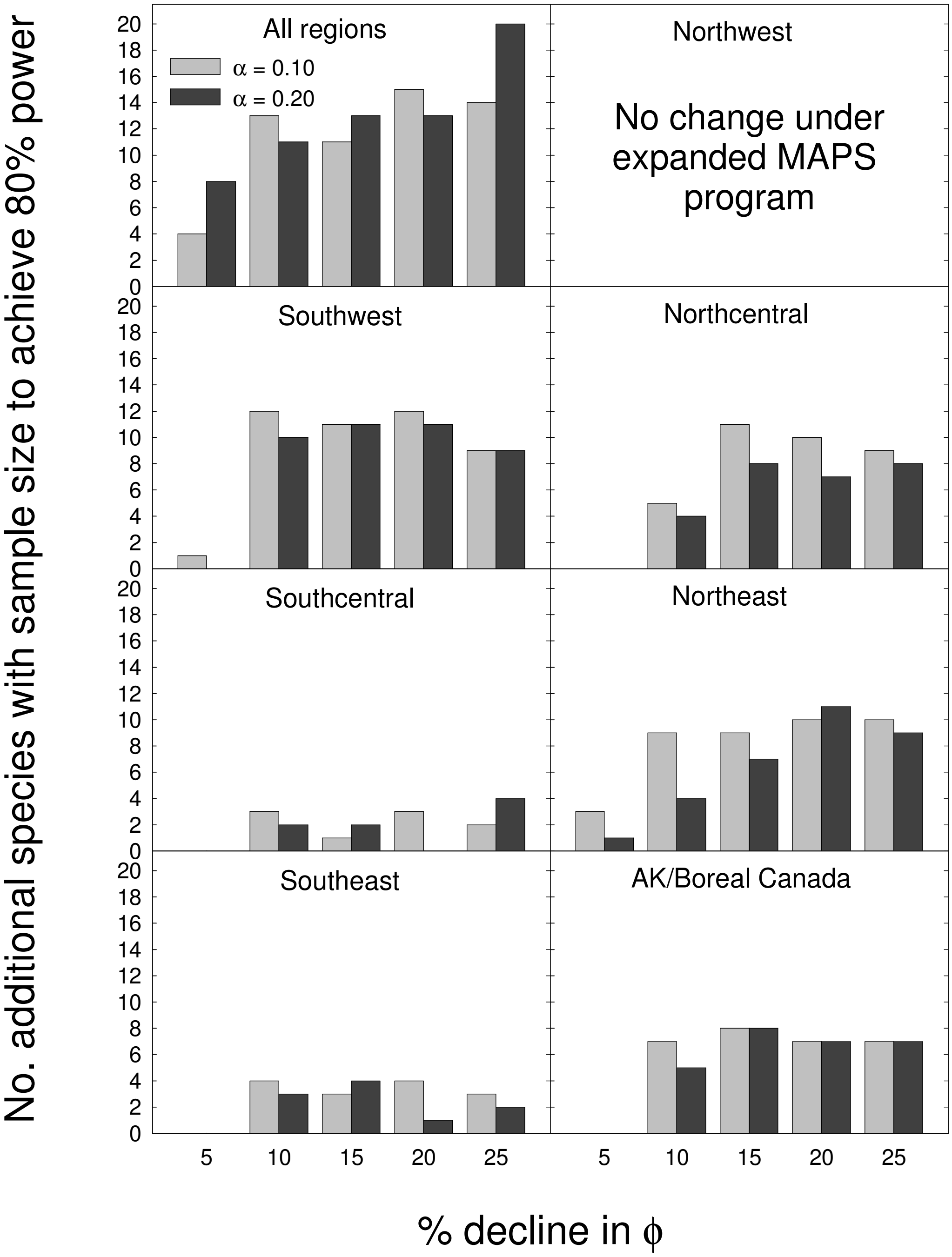


Fig. 13. Numbers of new species for which we would likely be able to detect linear declines in survival with 20 years of data under an expanded (but not targeted) MAPS program.



Appendix. Warbler species included in the continental-scale analyses presented in the section: *MAPS: can it provide reliable continental-scale data?* (✓ = species used in analysis).

Species	Code	MAPS v. BBS	MAPS v. BBIRD
Blue-winged Warbler (*Vermivora pinus*)	BWWA	✓	✓
Golden-winged Warbler (*V. chrysoptera*)	GWWA		
Orange-crowned Warbler (*V. celata*)	OCWA	✓	✓
Nashville Warbler (*V. ruficapilla*)	NAWA		✓
Virginia's Warbler (*V. virginianae*)	VIWA		✓
Lucy's Warbler (*V. luciae*)	LUWA		
Northern Parula (*Parula Americana*)	NOPA		
Yellow Warbler (*Dendroica petechia*)	YWAR	✓	✓
Chestnut-sided Warbler (*D. pensylvanica*)	CSWA	✓	✓
Magnolia Warbler (*D. magnolia*)	MAWA	✓	✓
Black-throated Blue Warbler (*D. caerulescens*)	BTBW		✓
Yellow-rumped Warbler (*D. coronata*)	YRWA		
Black-throated Gray Warbler (*D. nigrescens*)	BTYW		✓
Golden-cheeked Warbler (*D. chrysoparia*)	GCWA		
Black-throated Green Warbler (*D. virens*)	BTNW	✓	✓
Townsend's Warbler (*D. townsendi*)	TOWA	✓	
Hermit Warbler (*D. occidentalis*)	HEWA		
Blackburnian Warbler (*D. fusca*)	BLBW		
Pine Warbler (*D. pinus*)	PIWA		✓
Prairie Warbler (*D. discolor*)	PRAW	✓	✓
Blackpoll Warbler (*D. striata*)	BLPW		✓
Black-and-white Warbler (*Mniotilta varia*)	BAWW	✓	✓
American Redstart (*Setophaga ruticilla*)	AMRE	✓	✓
Prothonotary Warbler (*Protonotaria citrea*)	PROW	✓	✓
Worm-eating Warbler (*Helmitheros vermivorus*)	WEWA	✓	
Swainson's Warbler (*Limmothlypis swainsonii*)	SWWA		
Ovenbird (*Seiurus aurocapilla*)	OVEN	✓	
Northern Waterthrush (*S. noveboracensis*)	NOWA	✓	
Louisiana Waterthrush (*S. motacilla*)	LOWA	✓	✓
Kentucky Warbler (*Oporornis formosus*)	KEWA	✓	✓
Mourning Warbler (*O. philadelphia*)	MOWA	✓	
MacGillivray's Warbler (*O. tolmiei*)	MGWA	✓	✓
Common Yellowthroat (*Geothlypis trichis*)	COYE	✓	✓
Hooded Warbler (*Wilsonia citrina*)	HOWA	✓	✓
Wilson's Warbler (*W. pusilla*)	WIWA	✓	✓
Canada Warbler (*W. canadensis*)	CAWA	✓	✓
Yellow-breasted Chat (*Icteria virens*)	YBCH	✓	✓