# Monitoring Avian Productivity and Survivorship (MAPS) at Inglewood Bird Sanctuary, Calgary, Alberta (1992-2008)

*Least flycatcher in the net. Photo credit: Rainer Ebel.*

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## Executive Summary

The objective of this report is to detect and compare trends in populations, productivity and survival of target species at the Inglewood Bird Sanctuary in Calgary, Alberta. This MAPS banding station was operated from 1992-2008 (except for 1994 and 2005) in accordance with the standardized banding protocols developed for the Monitoring Avian Productivity and Survivorship (MAPS) program throughout North America. The station is still operating.

A total of 1642 captures of 52 species were recorded at INBS between 1992 and 2008. There were 1048 new bandings of adult birds. Newly banded birds comprised 64% of the total captures. The most abundant species, with overall capture rates greater than 4.0 adults/600 net-hours were, in descending order: American Robin, Yellow Warbler, Cedar Waxwing, House Wren, Gray Catbird, Warbling Vireo, Baltimore Oriole and Least Flycatcher. Total species richness was 48 species, while the mean number of adults captured was 113.6 per 600 net-hours, and the mean reproductive index was 0.55 young per adult over the entire period.

Populations of adult birds of nine species pooled indicated a nearly-substantial, highly fluctuating but not significant increasing population trend. All nine species showed substantially fluctuating trends (SE of the slope $\geq 0.021$). Adult populations of four of nine target species showed substantially declining trends, which was offset by substantially increasing trends in four other species. Declines were shown by: Warbling Vireo, Black-capped Chickadee and Least Flycatcher. Increases were shown by: House Wren, American Robin and Gray Catbird.

Short-term (same period as INBS operation) population trends of the same nine target species, taken from Breeding Bird Survey (BBS) routes in Alberta, were compared to the INBS results. Two (Least Flycatcher and Warbling Vireo) of the three species showing declining populations at INBS also showed declines on the BBS routes, while the trend for Black-capped Chickadee was opposite, with the BBS showing an increasing trend. Two (House Wren and Gray Catbird) of the three species showing increasing populations at the MAPS stations also showed an increase on the BBS routes, while one species (American Robin) had an opposite trend, although the BBS decline was insignificant. Cedar Waxwing, Yellow Warbler and Baltimore Oriole all showed no trends at INBS, but declining trends (-11.03, -1.79 and -6.27, respectively) on BBS routes.

Productivity trends were assessed for nine species. Only American Robin showed a substantially declining trend ($r \leq -0.3$), but it was not significant ($P > 0.05$). Both Black-capped Chickadee and House Wren showed substantially increasing trends ($r \geq 0.3$), but former was significant and the latter was not significant. Populations of Gray Catbird, Cedar Waxwing, Yellow Warbler and Baltimore Oriole showed non-substantial (absolute $r < 0.3$) and substantially fluctuating (SE of the slope $\geq 0.021$) trends, while Least Flycatcher and Warbling Vireo trends were not substantially fluctuating. Overall, only one of the nine species showed a negative trend, two showed positive trends, and six trends were flat. The 17-year trend of all species pooled represented an average annual substantial ($r = 0.368$), fluctuating increase in productivity of 0.022 ($SE = 0.016$) per year.

Estimates of annual adult survival rate ranged from a low of 0.320 for Baltimore Oriole to a high of 0.781 for Black-capped Chickadee, with a mean of 0.553. Estimated annual survival for Yellow Warbler (0.349) was below the mean, while estimates for Least Flycatcher (0.612) and American Robin (0.703) were above the mean. The estimates for survival probability for Least Flycatcher and Baltimore Oriole should be viewed with caution because they are based on fewer than five between-year recaptures or the estimate is very imprecise ($SE(\varphi) \geq 0.200$ or $CV(\varphi) \geq 50.0\%$).

The estimated mean survival rate for adults at INBS (0.553) appears to be similar compared with values for the Northwest MAPS region (1992-2003; see http://www.birdpop.org/nbii/surv/default.asp), but 8.6% higher than that of the North-central Region (0.467). Three species showed substantially higher (>10%) values for INBS than in the North-central Region (Least Flycatcher, Black-capped Chickadee and American Robin), while only the latter two showed substantially higher values for INBS than in the Northwest Region. Yellow Warbler and Baltimore Oriole showed substantially lower (<10%) survival at INBS than in the North-central Region, while Yellow Warbler and Least Flycatcher showed lower survival values for INBS than in the Northwest Region.

Recapture probability varied from a low of 0.033 for American Robin to a high of 0.415 for Yellow Warbler, with a mean of 0.167. Recapture probability for Least Flycatcher (0.073) and Baltimore Oriole (0.137) were below the mean, while the estimate for Black-capped Chickadee (0.175) was above the mean.

There were many fewer between-year recaptures at INBS than would be expected for a data set including this many years of operation. Because of the lack of between-year recaptures there were only seven species for which we could attempt survival analysis, and for two of these (House Wren and Gray Catbird) program MARK could not produce estimates. Once at the site, the birds are remaining for entire breeding season as demonstrated by large numbers of within-year recaptures. However, birds are not recaptured in subsequent seasons. We are not sure why this is the case, because the habitat appears to be of good quality. The use of MAPS net locations during spring migration probably has some effect on what is captured during the MAPS season, i.e. net avoidance. Further seasons of data or correlation of this data to weather or habitat variables may provide answers to this question.

Of three substantially decreasing species at INBS, two (Least Flycatcher and Warbling Vireo) had a slightly lower population trend, while one (Black-capped Chickadee) had a slightly higher trend than that for the two MAPS regions; productivity was variable but showing a stable or increasing trend; and survival rate was higher for two species (Least Flycatcher and Black-capped Chickadee) and unavailable for comparison for Warbling Vireo. The evidence suggests that for Least Flycatcher and Warbling Vireo low productivity may be the driving factor of the decline, but that this could improve over time if the positive trend continues, while for Black-capped Chickadee the evidence suggests that both productivity and survival are increasing.

Higher-than-expected productivity may also be driving the population trend for two (House Wren and American Robin) of the three significantly increasing species. Assessment is compromised by the unavailability of survival rates for three of the four species.

The 15 years of operation of the Inglewood Bird Sanctuary MAPS Station offers a unique opportunity to look at long-term trends. The two gaps in operation offered challenges for data analysis, though, as did the operation of migration monitoring nets in the same location. As a result we were only able to assess vital rates for eight target species. For some species, the general stability or increase in productivity would suggest that the habitat quality is improving because the adults that are present on the stations can produce more young per adult even as adult population levels are increasing. Looking at the age structure of the population may shed more light on this question. An adult population that is composed mostly of after-second year birds suggests that the habitat is of good quality because these birds “know” and can defend good territories. However, if the adult population is composed mostly of second year birds it suggests that after a single year of occupying a territory the birds are leaving Inglewood to find better habitat. After-second year birds are also assumed to be able to produce more young than inexperienced second year birds and a population high in after-second year birds would therefore have higher productivity.

**Acknowledgements**

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## 1.0 Introduction

The Calgary Bird Banding Society (CBBS) was incorporated in March 1995. Prior to incorporation, the founding members initiated a relationship with the Inglewood Bird Sanctuary (IBS), a federal Migratory Bird Sanctuary operated since 1929 right in the city of Calgary, Alberta. The main objective of CBBS remains conducting migration monitoring and other banding-based studies at IBS, which has long been known as an important migration site for neotropical migrants (Sherrington 1975, Elphinstone 1990).

IBS is also a member of the Monitoring Avian Productivity and Survivorship (MAPS) program. This report identifies and compares trends in populations, productivity and survival of target species during the breeding season at IBS based on constant effort MAPS mist-netting.

### 1.1 Monitoring Avian Productivity and Survivorship (MAPS)

The MAPS program was established in 1989 by The Institute for Bird Populations (IBP), Point Reyes, California (DeSante and Nott 2001). Its goal is to provide long-term demographic data on landbirds as an aid in identifying the causal factors driving population trends documented by other avian monitoring programs such as the North American Breeding Bird Survey and Christmas Bird Counts. It is a cooperative effort among public agencies, private organizations, and individual bird banders in North America to operate a continent-wide network of constant-effort mist-netting stations during the breeding season.

MAPS is a recommended survey in the Canadian Landbird Monitoring Strategy of the Canadian Wildlife Service (Anon. 1994).

### 1.2 Goals and Objectives of MAPS

The objective of MAPS is to provide long-term population and demographic information on target passerine species at various spatial scales by providing:

- annual indices and longer-term trends in adult population size and post-fledging productivity from analyses of numbers and proportions of adult and young birds captured during the breeding season; and
- annual estimates and longer-term trends of adult survivorship, adult population size, and recruitment into the adult population from analyses of mark-recapture data on adult birds gathered at these same stations.

These indices and estimates can be used to aid in:

- identifying the proximate causes of population changes in the target species;
- identifying conservation and management actions to reverse the population trends of declining species; and
- evaluating the effectiveness of conservation and management actions.

MAPS data has underpinned publications on survival rate estimates (DeSante et al. 1995), proximate demographic causes of population change (DeSante et al. 2001), and the influence of climate change on avian productivity in the Pacific Northwest (Nott et al. 2002).

The MAPS program divides the continent into eight major regions based on biogeographical and meteorological considerations. IBS falls on the boundary between the Northwest and North-central regions (Fig. 1A). During the early establishment of the MAPS program, the IBP designated which neotropical migrants, based on expert opinion, were expected to be the most common (i.e. providing enough data to allow statistically robust

inferences to be made) or of highest monitoring priority for these two regions (Table 1). Over time, with many additional stations and improved statistical techniques, the IBP has been able to calculate survivorship estimates for 81 species in the Northwest and 54 in the North-Central regions (DeSante and Kaschube 2007).

Table 1. Neotropical migrant target species in the Northwest and North-central MAPS regions and whether they have been captured at INBS (x) and whether they are included in this report (xx).

| **Northwest Region** | **North-Central Region** | **INBS** |
|---|---|---|
| | American Goldfinch | x |
| | American Redstart | x |
| American Robin | American Robin | xx |
| | Black-capped Chickadee | xx |
| | Brown-headed Cowbird | x |
| | Common Yellowthroat | x |
| | Downy Woodpecker | x |
| Dusky Flycatcher | | |
| | Gray Catbird | xx |
| | Least Flycatcher | xx |
| Lincoln‟s Sparrow | | x |
| MacGillivray‟s Warbler | | |
| Orange-crowned Warbler | | x |
| “Oregon” Dark-eyed Junco | | |
| | Red-eyed Vireo | x |
| | Rose-breasted Grosbeak | x |
| Song Sparrow | Song Sparrow | x |
| Swainson‟s Thrush | | x |
| Warbling Vireo | | xx |
| Western Flycatcher complex | | |
| Wilson‟s Warbler | | x |
| Yellow Warbler | | xx |

For a complete list of species captured at INBS, and their scientific names, see Appendix A.

**2.0 Methods**

2.1 Establishment and Operation of Station

The Inglewood Bird Sanctuary MAPS station (INBS) has operated for 16 years, 1992-2008 (1994 was missed due to lack of personnel and 2005 was limited due to flooding), in accordance with the standardized banding protocols developed for the MAPS Program throughout North America (DeSante et al. 2005). INBS is located within the city of Calgary, Alberta (Fig. 1B; Lat 51º 01‟ 27”N, Lon 114º 00‟ 36‟‟W) at approximately 1030 m elevation. It is situated in a riparian woodland reserve area adjacent to the Bow River within the 35-ha federally-protected Inglewood Bird Sanctuary.

Ten nets were operated in the same locations in each year of the study with the exception of nets 9 and 15. Net 9 operated only in 1992 and 1993, and was replaced with net 15 in 1995 and has been run as net 15 up until the present (MAPS nets in pink and white on Fig. 1C). One 12-m-long, 30-mm-mesh, nylon mist net was erected at each of the net sites on each day of operation (Figs. 2 and 3). The station was operated for six morning hours per

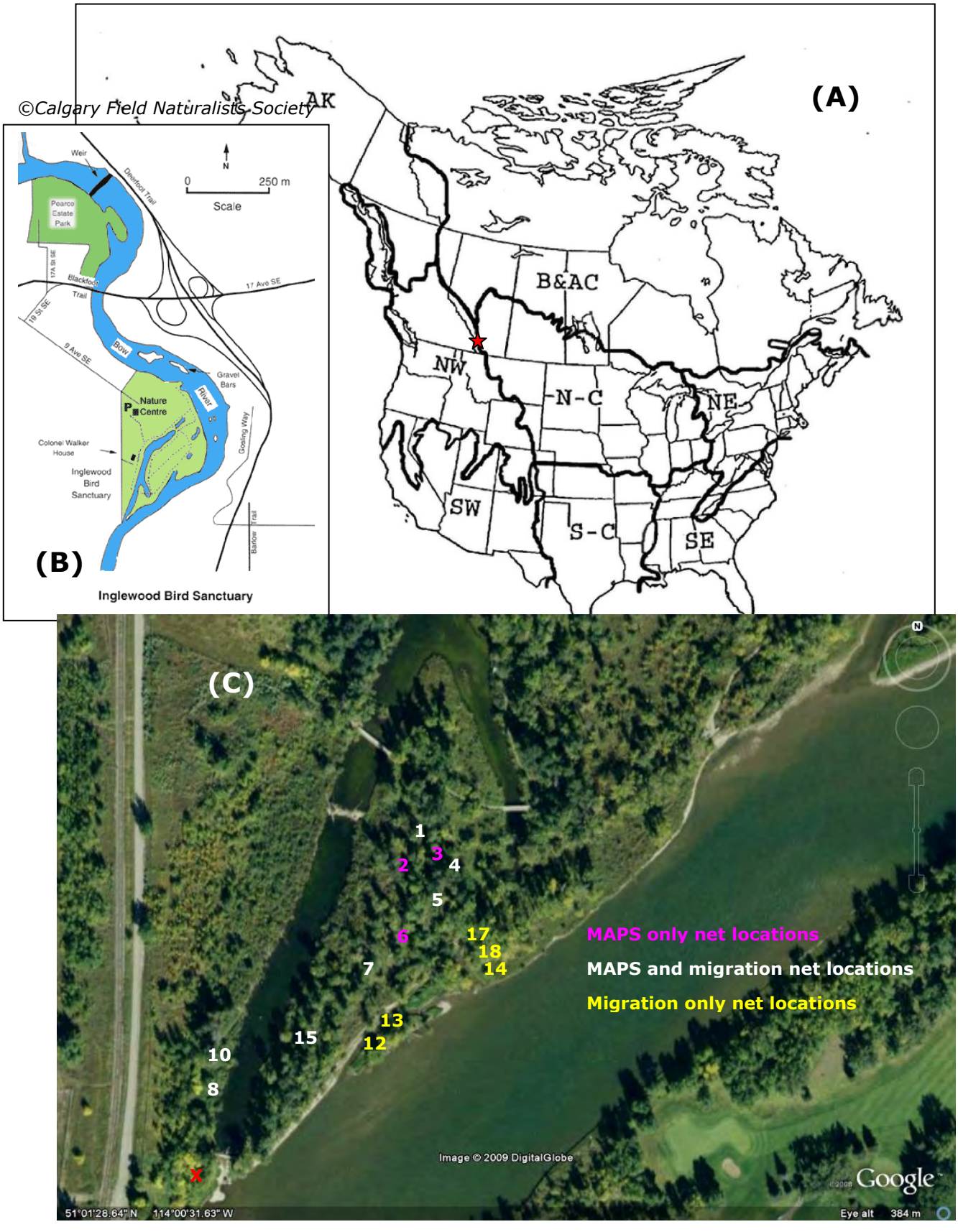


Figure 1. Location of (A) Inglewood Bird Sanctuary (INBS), in the context of the eight MAPS regions in North America, (B) INBS in the City of Calgary, and (C) net locations (see legend) and banding area (**X**).

Figure 2. Net lane #1 in the riparian cottonwood forest. Photo courtesy of Beverley Kissinger.

Figure 3. Maryanne Kissinger checks net lane #13. Photo courtesy of Beverley Kissinger.

day (beginning at approximately 5:30 a.m.) during one day in each of seven consecutive 10-day periods between May 31 and August 8. During 2005, the station was only operated for the first two periods because heavy flooding along the Bow River caused the station to have to be abandoned for the remainder of the season. With few exceptions, the operation of the station occurred on schedule during each of the ten-day periods during each year of operation. To facilitate constant-effort comparison of data, nets are opened, checked, and closed in a similar manner on all days of operation. This protocol was adjusted as required to minimize stress to captured birds.

INBS is also a spring and fall migration monitoring site; seven of the MAPS nets (numbers in white on Fig. 1C) are also used for migration monitoring, and five additional nets are used just during migration monitoring (numbers in yellow on Fig. 1C).

2.2 Data Collection

With few exceptions, all birds captured at INBS station were identified to species, age, and sex. New captures were banded with USGS/BRD numbered aluminum bands. Birds were released immediately upon capture and before being banded or processed if situations arose where bird safety was compromised. Such situations could involve exceptionally large numbers of birds being captured at once, or the sudden onset of adverse weather conditions such as high winds or rainfall. As applicable to species/sex/age and condition on the captured birds, the following data were collected from all birds, including recaptures, according to MAPS guidelines, using standardized codes and forms (DeSante et al. 2005):

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

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

A simple habitat map was prepared in 2001(indicating extent and location of major habitats, as well as structures, roads, trails, and streams). The pattern and extent of cover of each of four major vertical layers of vegetation (upperstory, midstory, understory, and ground cover), in each major habitat type, were classified into one of twelve pattern types and eleven cover categories according to guidelines in the MAPS Habitat Structure Assessment Protocol (Nott et al. 2003). The dominant habitat at INBS is seasonally flooded cold-deciduous

woodland (balsam poplar *Populus* balsamifera), and the sub-dominant habitat is temperate cold-deciduous shrubland (e.g., saskatoon *Amelanchier alnifolia*). A second habitat structure assessment was carried out in 2007.

2.3 Data Entry and Verification

The computer entry of all banding data was completed by CBBS using the computer program MAPSPROG (Froehlich et al. 2006). The critical data for each banding record (capture code, band number, species, age, sex, date, capture time, station, and net number) were proofed by hand against the raw data and any computer entry errors were corrected. Computer entry of effort, breeding status, and vegetation data was completed by the operator using MAPSPROG (Froehlich et al. 2006). All banding data were then run through a series of verification programs as follows:

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

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

2.4 Data Analysis

All landbird species encountered at the station were classified into six groups based upon their breeding or summer residency status. Each species was classified as one of the following:

- a regular breeder (B) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station during all years that the station was operated.
- a usual breeder (U) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station during more than half but not all of the years that the station was operated.
- an occasional breeder (O) if we had positive or probable evidence of breeding or summer residency within the boundaries of the MAPS station during half or fewer of the years that the station was operated.
- a transient (T) if the species was never a breeder or summer resident at the station, but the station was within the overall breeding range of the species.
- an altitudinal disperser (A) if the species breeds only at lower elevation than that of the station but disperses to higher elevations after breeding.
- a migrant (M) if the station was not located within the overall breeding range of the species. This category includes extralimital breeders, i.e., the species bred at the station but the station was outside the normal breeding range for the species.

Since banding allowed unique identification of individuals, the total number of individual birds captured of each species could be calculated on a yearly basis. Data for a given species were included in analyses of mean birds

per 600 net-hours if the station was within the breeding range of the species; that is, data were included if the species was a breeder (B, U, or O), or transient (T), but not if the species was an altitudinal disperser (A) or a migrant (M). Data for a given species was included in trend and survivorship analyses only if the species was classified as a regular (B) or usual (U) breeder at the station. Throughout this report we define "target species" for trend and survivorship analyses as those for which an average of 2.5 individual adult birds were captured per year. A total of 11 species met this requirement for population and reproductive trends. For survivorship analyses, an additional requirement for including a target species in the analysis was that at least two returns were recorded.

2.4.1 *Adult population indices and productivity analyses*

The proofed, verified, and corrected banding data from all 16 years were run through a series of analysis programs that calculated for each species:

- mean numbers and capture rates (per 600 net-hours) of first captures (in a given year) of individual adult and young birds. Following the procedures pioneered by the British Trust for Ornithology (BTO) in their CES Scheme (Peach et al. 1996), we used the number of adult birds captured as an index of adult population size.
- mean reproductive index (RI). For each species each year, we calculated a yearly reproductive index as the number of young divided by the number of adults. Years for which the reproductive index was undefined for a species, i.e., no adults of that species were captured in that year, are not included in the mean reproductive index for that species.

If the station was operated for multiple days within a single period (usually because weather precluded finishing a period on the scheduled day) only data from the first day were included in the means and in trend analyses.

2.4.2 *Analyses of trends in adult population size and productivity*

We estimated trends in adult capture rates of adult and young birds and productivity (RI) with linear regression. Fifteen years of data were included in the analysis (1992, 1993, 1995-2004, and 2006-2008). Because only two days were operated during the 2005 season, it did not meet the minimum data requirements for inclusion in survivorship or trend analysis. We report the slope of the regression (β – for capture rates this is an estimate of the change in numbers of birds per 600 net-hours per year), standard error of β (*SE*), correlation coefficient (*r*), and significance of the correlation (*P*-value). Throughout this report, we use an alpha level of 0.05 for statistical significance and we use the term “near-significant” or “nearly significant” for $0.05 \leq P < 0.10$ and “highly significant” for $P<0.01$. For trends, species for which $r \geq 0.30$ are considered to have a substantially increasing trend, those for which $r \leq -0.30$ areconsidered to have a substantially decreasing trend, those for which absolute $r < 0.3$ and $SE \leq 0.018$ are considered to have a non-substantial and non-fluctuating trend, and those for which absolute $r \leq 0.3$ and $SE > 0.018$ are considered to have non-substantial, widely fluctuating trends. Trends using constant effort “chain” indices, which are the typical method of analyzing trends in MAPS/constant effort data, could not be calculated because of the two missed years of sampling (1994 and 2005). However, because of the consistency of sampling effort in all other years it was reasonable to use the change in annual numbers of birds per 600 net-hours to determine trends in adult population size. Trends in productivity are presented for those species for which a trend in adults was calculated.

2.4.3 *Survivorship analyses*

We used the computer program MARK (White and Burnham 1999) to calculate, for selected target species, maximum-likelihood estimates and standard errors (*SE*s) of annual apparent survival rates ($\varphi$) and recapture probabilities ($p$). Apparent survival rate is defined as the probability of a bird banded at a given station in a given

year surviving to the next year and remaining at the same station. Recapture probability is defined as the conditional probability of recapturing a bird at a station in a subsequent year that was banded at the station in a previous year, given that it survived and remained at the station at which it was originally banded. The presence of transient individuals (dispersing, „floating", and late or early migrating individuals) in the sample of newly captured birds tends to bias apparent survival rates and/or recapture probabilities low, because they are only captured once and never recaptured. We used a version of the CJS model (ad hoc robust design model) that reduces bias and increases precision of adult apparent survival-rate estimates by effectively eliminating these birds from the sample (Nott and DeSante 2002, Hines et al. 2003).

We considered five target species for which an average of 2.5 adult birds were captured over the 15 years of sampling (1992, 1993, 1995-2004, and 2006-2008 – 37.5 year-unique captures) and for which we recorded at least two between-year recaptures. Although 15 years of data would allow us to consider all possible combinations of both time constant and time dependent models for each of the two parameters estimated from the transient model, we limited our consideration to time-constant models that produced estimates for both survival and recapture probability that were neither 0 nor 1.

**3.0 Results**

A total of 1642 captures of 52 species were recorded at INBS between 1992 and 2008 (Table 2). There were 1048 new bandings of adult birds. Newly banded birds comprised 64% of the total captures.

3.1 Mean Indices of Adult Population Size and Post-fledging Productivity

Mean annual numbers (per 600 net-hours) of individual adult and young birds and the reproductive index for each species and for all species pooled, are presented in Table 3 for all years in which the station operated.

The most abundant species at the INBS station, with overall capture rates greater than 4.0 adults/600 net-hours were, in descending order: American Robin, Yellow Warbler, Cedar Waxwing, House Wren, Gray Catbird, Warbling Vireo, Baltimore Oriole and Least Flycatcher. Total species richness was 48 species, while the mean number of adults captured was 113.6 per 600 net-hours, and the mean reproductive index was 0.55 young per adult over the entire period.

3.2 Multi-year Trends in Adult Population Size

Seventeen-year (1992-2008; data for 1994 and 2005 are not included) population trends for nine species and all species pooled are shown in Figure 4. Number of adult individuals captured per 600 net hours was used as the measure of population size for species which were regular or usual breeders and summer residents at the station. The slope of the linear regression line was used as the measure of the population trend, and it and the standard error of the slope (in parentheses) are presented on each graph. The correlation coefficient ($r$), and the significance of the correlation ($P$), are included for each target species and for all species pooled on each graph.

Warbling Vireo and Black-capped Chickadee were the only substantially declining species ($r \leq -0.3$) with significant ($P < 0.05$) trends. Least Flycatcher was substantially declining but the trend was not significant ($P > 0.10$). Substantially increasing trends ($r \geq 0.3$) were highly significant ($P < 0.01$) for House Wren, American Robin and Gray Catbird. Populations of Cedar Waxwing, Yellow Warbler and Baltimore Oriole showed non-substantial (absolute $r < 0.3$) trends. Overall, three of the nine species showed negative trends, three showed positive trends and three showed no change. All nine species showed substantially fluctuating trends (SE of the slope $\geq 0.021$). The 17-year trend of all species pooled represented a nearly-substantial ($r = 0.313$), highly fluctuating but not significant ($P = 0.267$) increasing population trend.

Population trends for Inglewood Bird Sanctuary are compared with long-term (1966-2007) and short-term (1993-2005) trends for the Breeding Bird Survey routes for Alberta (Table 4).

### 3.3 Multi-year Trends in Productivity

Seventeen-year (1992-2008; data for 1994 and 2005 are not included) productivity trends for nine species and all species pooled are shown in Figure 5. The productivity index was defined as the number of young per adult in each year for species which were regular or usual breeders and summer residents at the station. The slope of the regression line was used as the measure of the productivity trend. The slope, the standard error of the slope (in parentheses), the correlation coefficient ($r$) and significance of the correlation coefficient ($P$) are shown on each graph.

Only American Robin showed a substantially declining trend ($r \leq -0.3$), but it was not significant ($P > 0.05$). Both Black-capped Chickadee and House Wren showed substantially increasing trends ($r \geq 0.3$), but former was significant and the latter was not significant. Populations of Gray Catbird, Cedar Waxwing, Yellow Warbler and Baltimore Oriole showed non-substantial (absolute $r < 0.3$) and substantially fluctuating (SE of the slope $\geq$ 0.021) trends, while Least Flycatcher and Warbling Vireo trends were not substantially fluctuating. Overall, only one of the nine species showed a negative trend, two showed positive trends, and six trends were flat. The 17-year trend of all species pooled represented an average annual substantial ($r = 0.368$), fluctuating increase in productivity of 0.022 ($SE = 0.016$) per year.

### 3.4 Estimates of Adult Survivorship

We were able to obtain estimates of adult survival and recapture probabilities (Table 5) using transient models for five species. We present time-constant estimates of annual adult survival and recapture probability. Table 5 also includes survival rates for the same species in the Northwest and North-central Regions of MAPS as a whole.

Estimates of annual adult survival rate ranged from a low of 0.320 for Baltimore Oriole to a high of 0.781 for Black-capped Chickadee, with a mean of 0.553. Estimated annual survival for Yellow Warbler (0.349) was below the mean, while estimates for Least Flycatcher (0.612) and American Robin (0.703) were above the mean. The estimates for survival probability for Least Flycatcher and Baltimore Oriole should be viewed with caution because they are based on fewer than five between-year recaptures or the estimate is very imprecise (SE($\varphi$)$\geq$0.200 or CV($\varphi$)$\geq$50.0%).

Recapture probability varied from a low of 0.033 for American Robin to a high of 0.415 for Yellow Warbler, with a mean of 0.167. Recapture probability for Least Flycatcher (0.073) and Baltimore Oriole (0.137) were below the mean, while the estimate for Black-capped Chickadee (0.175) was above the mean.

## 4.0 Discussion and Conclusions

### 4.1 Population and Productivity Trends

Populations of adult birds of nine species pooled indicated a nearly-substantial, highly fluctuating but not significant increasing population trend. All nine species showed substantially fluctuating trends (SE of the slope $\geq$ 0.021). Adult populations of four of nine target species showed substantially declining trends, which was offset by substantially increasing trends in four other species. Declines were shown by: Warbling Vireo, Black-capped Chickadee and Least Flycatcher. Increases were shown by: House Wren, American Robin and Gray Catbird.

Short-term (same period as INBS operation) population trends of the same nine target species, taken from Breeding Bird Survey (BBS) routes in Alberta (see Table 4; data from http://www.mbr-pwrc.usgs.gov/bbs/bbs.html), reflects some similarities and some differences with the trends from INBS. Two (Least Flycatcher and Warbling Vireo) of the three species showing declining populations at INBS also showed declines on the BBS routes, while the trend for Black-capped Chickadee was opposite, with the BBS showing an increasing trend. Two (House Wren and Gray Catbird) of the three species showing increasing populations at the MAPS stations also showed an increase on the BBS routes, while one species (American Robin) had an opposite trend, although the BBS decline was insignificant. Cedar Waxwing, Yellow Warbler and Baltimore Oriole all showed no trends at INBS, but significant or nearly significant declining trends (-11.03, -1.79 and -6.27, respectively) on BBS routes. These disconnects may be explained because of differences in how the MAPS and BBS programs choose sample sites; they appear to sample different types of habitats, and thus could be expected to show different results. If several MAPS sites, located over a broad area, were pooled these differences would likely be smaller.

Similar to the population trends, trends of productivity of nine target species showed a nearly substantial but not significant increase of +0.022 over the 15 years. More species (eight) showed positive or stable trends than showed negative (one) trends.

### 4.2 Survival Rates

The estimated mean survival rate for adults at INBS (0.553) appears to be similar compared with values for the Northwest MAPS region (1992-2003; see http://www.birdpop.org/nbii/surv/default.asp), but 8.6% higher than that of the North-central Region (0.467). Three species showed substantially higher (>10%) values for INBS than in the North-central Region (Least Flycatcher, Black-capped Chickadee and American Robin), while only the latter two showed substantially higher values for INBS than in the Northwest Region. Yellow Warbler and Baltimore Oriole showed substantially lower (<10%) survival at INBS than in the North-central Region, while Yellow Warbler and Least Flycatcher showed lower survival values for INBS than in the Northwest Region.

There were many fewer between-year recaptures at INBS than would be expected for a data set including this many years of operation. Because of the lack of between-year recaptures there were only seven species for which we could attempt survival analysis, and for two of these (House Wren and Gray Catbird) program MARK could not produce estimates. Once at the site, the birds are remaining for the entire breeding season as demonstrated by large numbers of within-year recaptures. However, birds are not recaptured in subsequent seasons. We are not sure why this is the case, because the habitat appears to be of good quality. The use of MAPS net locations during spring migration probably has some effect on what is captured during the MAPS season, i.e. net avoidance. Further seasons of data or correlation of this data to weather or habitat variables may provide answers to this question.

### 4.3 Causes of Population Changes

Based on all demographic data available, we made assessments as to whether population declines or increases were driven by productivity on the breeding grounds, adult survival presumably during migration and/or on the winter grounds, both or neither (Table 6). Assessments were based on a synthesis of population trends and significance, productivity trends and indices, and survival probability, relative to those in the Northwest and North-central regions of MAPS as a whole (http://www.birdpop.org/nbii/prod/default.asp).

Of three substantially decreasing species at INBS, two (Least Flycatcher and Warbling Vireo) had a slightly lower population trend, while one (Black-capped Chickadee) had a slightly higher trend than that for the two MAPS regions; productivity was variable but showing a stable or increasing trend; and survival rate was higher for two species (Least Flycatcher and Black-capped Chickadee) and unavailable for comparison for Warbling Vireo. The evidence suggests that for Least Flycatcher and Warbling Vireo low productivity may be the driving

factor of the decline, but that this could improve over time if the positive trend continues, while for Black-capped Chickadee the evidence suggests that both productivity and survival are increasing.

Higher-than-expected productivity may also be driving the population trend for two (House Wren and American Robin) of the three significantly increasing species. Assessment is compromised by the unavailability of survival rates for three of the four species.

4.4 Conclusions

The 15 years of operation of the Inglewood Bird Sanctuary MAPS Station offers a unique opportunity to look at long-term trends. The two gaps in operation offered challenges for data analysis, though, as did the operation of migration monitoring nets in the same location. As a result we were only able to assess vital rates for eight target species. For some species, the general stability or increase in productivity would suggest that the habitat quality is improving because the adults that are present on the stations can produce more young per adult even as adult population levels are increasing. Looking at the age structure of the population may shed more light on this question. An adult population that is composed mostly of after-second year birds suggests that the habitat is of good quality because these birds "know" and can defend good territories. However, if the adult population is composed mostly of second year birds it suggests that after a single year of occupying a territory the birds are leaving Inglewood to find better habitat. After-second year birds are also assumed to be able to produce more young than inexperienced second year birds and a population high in after-second year birds would therefore have higher productivity.

**5.0 Literature Cited**


Anon. 1994. Canadian Landbird Monitoring Strategy. Unpublished technical report. National Wildlife Research Centre, Canadian Wildlife Service, Ottawa, ON.

Banfield, A. W. F. 1953. Additions to the list of Banff National Park birds. Canadian Field Naturalist 67: 179-180.

Banfield, A. W. F. 1954. Notes on the birds of Jasper National Park, Alberta. Canadian Field Naturalist 68: 182.

Chruszcz, B. and H. Breniser. 2003. Effects of prescribed burning and forest thinning on bird abundance and diversity in Banff National Park. Report prepared for Parks Canada, Banff National Park, Banff, AB. 60 pp.

DeSante, D. F. and D. R. Kaschube. 2006. The Monitoring Avian Productivity and Survivorship (MAPS) program 1999, 2000, and 2001 report. Bird Populations 7: 23-89.

DeSante, D. F. and D. R. Kaschube. 2007. The Monitoring Avian Productivity and Survivorship (MAPS) program 2002 and 2003 report. Bird Populations 8: 46-115.

DeSante, D. F., K. M. Burton, J. F. Saracco and B. L. Walker. 1995. Productivity indices and survival-rate estimates from MAPS, a continent-wide programme of constant-effort mist-netting in North America. Journal of Applied Statistics 22: 935-947.

DeSante, D. F., K. M. Burton, P. Velez, and D. Froehlich. 2005. MAPS manual 2005 protocol: instructions for the establishment and operation of constant-effort bird-banding stations as part of the Monitoring Avian Productivity and Survivorship (MAPS) program. The Institute for Bird Populations, Point Reyes Station, CA.

DeSante, D. F. and M. P. Nott. 2001. An overview of the North American Monitoring Avian Productivity and Survivorship (MAPS) program. *In* EURING Newsletter (Volume 3), F. Spina (Ed.). Istituto Nazionale per la Fauna Selvetica "Alessandro Ghigi", Italy. EURING Newsletter 3.

DeSante, D. F., M. P. Nott and D. R. O'Grady. 2001. Identifying the proximate demographic cause(s) of population change by modeling spatial variation in productivity, survivorship, and population trends**.** ARDEA 89: 185-208.

Elphinstone, D. 1990. Inglewood Bird Sanctuary – a place for all seasons. Rocky Mountain Books, Calgary, AB. 128 pp.

Froehlich, D., N. Michel, D. F. DeSante, and P. Velez. 2006. MAPSPROG Version 4.1: user's guide and manual. The Institute for Bird Populations, Point Reyes Station, CA. 172 p.

Hines, J. E., W. L. Kendall, and J. D. Nichols. 2003. On the use of the robust design with transient capture-recapture models. Auk 120: 1151-1158.
Lebreton, J-D., K. P. Burnham, J. Clobert, and D. R. Anderson. 1992. Modeling survival and testing biological hypotheses using marked animals: a unified approach with case studies. Ecological Monographs 62: 67–118.
Morrison [eds.]. Predicting species occurrences: issues of accuracy and scale. Island Press, Washington, D.C.
Moses, R. A., C. C. Shank, and D. R. Farr. 2001. Monitoring terrestrial vertebrates in the Alberta forest biodiversity monitoring program: selection of target species and suggested protocols. Chapter 16, Alberta Biodiversity Monitoring Program. 79 pp. Online: http://www.abmp.arc.ab.ca/. [Accessed: March 30, 2007].
Nott, M. P. and D. F. DeSante. 2002. Demographic monitoring and the identification of transients in mark-recapture models. Pp. 727-736 *in*: J. M. Scott and P. Heglund (eds.), Predicting species occurrences: issues of scale and accuracy. Island Press, New York, NY.
Nott, M. P., D. F. DeSante, and N. Michel. 2003. Monitoring Avian Productivity and Survivorship (MAPS) habitat structure assessment protocol. The Institute for Bird Populations, Point Reyes Station, CA.
Nott, M. P., D. F. DeSante, R. B. Siegel, and P. Pyle. 2002. Influences of the El Niño/Southern Oscillation and the North Atlantic Oscillation on avian productivity in forests of the Pacific Northwest of North America. Global Ecology and Biogeography 11: 333-342.
Peach, W. J., S. T. Buckland, and S. R. Baillie. 1996. The use of constant effort mist-netting to measure between-year changes in the abundance and productivity of common passerines. Bird Study 43: 142-156.
Pollock, K. H., J. D. Nichols, C. Brownie, and J. E. Hines. 1990. Statistical inference for capture-recapture experiments. Wildlife Monographs No. 107. The Wildlife Society, Bethesda, MD.
Pradel, R. J. Hines, J.-D. Lebreton, and J. D. Nichols. 1997. Estimating survival probabilities and proportions of transients‟ using capture-recapture data. Biometrics 53: 60-72.
Sherrington, P. (editor). 1975. Calgary‟s natural areas: a popular guide. Calgary Field Naturalists‟ Society. 184 pp.
Soper, J. 1968. Birds observed in Waterton Lakes National Park, Alberta. Unpublished manuscript, Waterton Lakes National Park, Waterton Park, AB.
White, G. C. 1983. Numerical estimation of survival rates from band recovery and biotelemetry data. Journal of Wildlife Management 47: 716-728.
White, G.C., and K.P. Burnham. 1999. Program Mark: survival estimation from populations of marked animals. Bird Study 46(suppl.): 120-138.

Table 2. Capture summary of newly banded, total banded (including recaptures and released unbanded) adult birds at Inglewood Bird Sanctuary MAPS station, 1992-1993 and 1995-2008.

| Species | 1992 | 1993 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alder Flycatcher | | | | | | | | | | | | 1 | 2 | | | 2 |
| American Goldfinch | 2 | 2 | | 1 | | | | | | 1 | | | | 1 | | 1 |
| American Kestrel | | | 1 | | | | | | | | | | | | | |
| American Redstart | | 1 | | | | | | | | | 1 | | | | | 1 |
| American Robin | 6 | 2 | 13 | 6 | 14 | 5 | 6 | 6 | 11 | 7 | 8 | 13 | 1 | 23 | 8 | 12 |
| Bank Swallow | 1 | | | | | | | | | | | | | | | |
| Baltimore Oriole | 4 | 6 | 2 | 5 | 5 | 1 | 3 | 1 | 5 | 7 | | 1 | | | 2 | |
| Black-billed Magpie | | | | | 2 | | | | | | | 1 | | 1 | | |
| Black-capped Chickadee | 5 | 6 | 5 | 2 | | 2 | 3 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | |
| Brown-headed Cowbird | 6 | | | | 3 | | | 1 | 1 | 2 | | 2 | 1 | 1 | | 2 |
| Cedar Waxwing | 27 | 8 | | 6 | 1 | 8 | 6 | 6 | 4 | 13 | 3 | 17 | 3 | 8 | 16 | 9 |
| Chipping Sparrow | | 4 | | | | | 2 | | | | | | | 1 | 1 | |
| Clay-colored Sparrow | | 1 | | | | 5 | 14 | 1 | 2 | | | | | | 1 | |
| Common Grackle | | | 1 | | 1 | | | | | 1 | | | | | | |
| Common Yellowthroat | | | | | | | | | | | | 1 | 1 | | | 1 |
| Downy Woodpecker | 1 | 2 | | 3 | 1 | 1 | | | 1 | | | | | | | 2 |
| Eastern Kingbird | 1 | 1 | | | 3 | 1 | 4 | | 2 | 1 | | 3 | 1 | 1 | | 1 |
| European Starling | | | 1 | | | | | | | | | | | | | |
| Gray Catbird | 3 | | | 1 | 1 | 2 | 9 | 1 | 6 | 16 | 8 | 12 | 1 | 4 | 4 | 6 |
| Hairy Woodpecker | 1 | 1 | 1 | | | 1 | | | | | | | | | | |
| Hermit Thrush | | | | | | | | 1 | | | | | | | | |
| House Finch | | | | | | | | | | | | | | 1 | 1 | 1 |
| House Sparrow | 1 | | | | | 2 | | | | | | | | | | |
| House Wren | 4 | 5 | 9 | 3 | 3 | 4 | 5 | 5 | 6 | 2 | 3 | 4 | 1 | 6 | 5 | 4 |
| Least Flycatcher | 12 | 6 | 3 | 1 | 2 | 3 | 2 | | 2 | 1 | | | 1 | 4 | 5 | 2 |
| Lincoln's Sparrow | | 3 | 1 | 1 | 4 | 1 | | 1 | | | | 1 | | | | 3 |
| Mourning Warbler | 1 | | | | | | | | | | | | | | | |
| Myrtle's Warbler | 2 | | | | | 2 | | | | | | 1 | | | | 2 |
| Northern Flicker (Int) | | | 1 | | | | 2 | | | | | | | | | 1 |
| Northern Waterthrush | | | | | | 1 | | | 1 | | | | | | | 1 |
| Northern Rough-winged Swallow | | | | | | | | | | | | | | | | 1 |
| Orange-crowned Warbler | | | | | | | | | | | | | | | | 1 |
| Ovenbird | 3 | | | | | 1 | | | | | | | | | | 1 |
| Purple Finch | | 1 | | | | | | | | | | | | | | |
| Red-eyed Vireo | 1 | | | | | | | | | | | | | | | |
| Rose-breasted Grosbeak | | | | 1 | | | | | | | | | | | | |
| Rufous Hummingbird | | | | | | | | | | | | | | | | |
| Song Sparrow | | 1 | | 1 | | | 3 | | | | | | 1 | | 1 | 1 |
| Swainson's Thrush | 10 | 8 | 6 | 4 | 3 | 1 | 5 | | 3 | 1 | 1 | 4 | 1 | 4 | | 7 |
| Tennesse Warbler | 1 | 6 | | 6 | 1 | 3 | 4 | 2 | | 1 | | | | 4 | 5 | 10 |
| Tree Swallow | 3 | | | | | | 2 | | | 3 | | 4 | | 8 | | 2 |
| Traill's Flycatcher | | | | 3 | 3 | | 2 | 1 | 4 | 1 | 1 | | | 2 | | |
| Veery | 2 | | | | | 1 | | | | | | | | | | |
| Warbling Vireo | 7 | 7 | 1 | 3 | 2 | | 4 | 1 | 1 | 4 | 2 | 1 | 1 | 2 | 1 | 2 |
| Western Tanager | | 1 | 3 | 1 | 2 | | 5 | | | | | 1 | | | | |
| Western Wood-peewee | 4 | 1 | 1 | 1 | 1 | 1 | 5 | | 3 | | | 2 | | 1 | 1 | 1 |
| White-breasted Nuthatch | 3 | 1 | | 1 | | | | | | | | 2 | | 2 | 1 | 1 |
| White-throated Sparrow | | | | 2 | | | | | | 1 | | 2 | | | | 2 |
| Willow Flycatcher | | | | | | | | | | | | | 1 | | | |
| Wilson's Warbler | | | | 2 | | 1 | 1 | | | | | 1 | | | | |
| Yellow-shafted Flicker | 1 | 1 | 1 | 2 | | | | | 1 | | | | | | | |
| Yellow Warbler | 16 | 10 | 7 | 2 | 6 | 6 | 13 | 3 | 4 | 5 | 4 | 2 | 2 | 7 | 6 | 4 |
| ALL SPECIES POOLED | 128 | 85 | 57 | 58 | 58 | 53 | 100 | 31 | 58 | 67 | 32 | 77 | 19 | 82 | 59 | 84 |
| Total number of captures | 173 | 120 | 90 | 88 | 84 | 84 | 139 | 48 | 98 | 100 | 53 | 114 | 46 | 137 | 130 | 138 |
| Number of species | 27 | 24 | 17 | 23 | 19 | 22 | 21 | 14 | 18 | 17 | 10 | 22 | 15 | 20 | 16 | 29 |

Table 3. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the Inglewood Bird Sanctuary MAPS station averaged over the 15 years, 1992-2008[1]. Data for each species is only included if the breeding range of the species includes the station.

| Species | Adults | Young | Reproductive Index[2] |
|---|---|---|---|
| American Kestrel | 0.1 | 0.0 | 0.00 |
| Downy Woodpecker | 1.5 | 1.7 | 0.63 |
| Hairy Woodpecker | 0.3 | 0.0 | 0.00 |
| Northern Flicker | 0.9 | 0.3 | 0.07 |
| Western Wood-Pewee | 2.0 | 0.7 | 0.45 |
| Traill's Flycatcher | 2.5 | 0.1 | 0.10 |
| Least Flycatcher | 4.3 | 1.1 | 0.24 |
| Eastern Kingbird | 2.0 | 0.1 | 0.08 |
| Warbling Vireo | 4.6 | 0.3 | 0.11 |
| Red-eyed Vireo | 0.1 | 0.0 | 0.00 |
| Black-billed Magpie | 0.4 | 0.2 | 0.33 |
| Tree Swallow | 3.5 | 0.1 | 0.04 |
| Northern Rough-winged Swallow | 0.2 | 0.0 | 0.00 |
| Bank Swallow | 0.1 | 0.0 | 0.00 |
| Black-capped Chickadee | 3.5 | 5.5 | 2.47 |
| White-breasted Nuthatch | 1.0 | 0.5 | 0.75 |
| House Wren | 11.2 | 11.2 | 1.14 |
| Veery | 0.2 | 0.0 | 0.00 |
| Swainson‟s Thrush | 5.1 | 0.0 | 0.00 |
| Hermit Thrush | 0.1 | 0.0 | 0.00 |
| American Robin | 13.9 | 14.6 | 1.58 |
| Gray Catbird | 7.9 | 0.6 | 0.13 |
| European Starling | 0.1 | 0.1 | 0.00 |
| Cedar Waxwing | 12.3 | 0.6 | 0.05 |
| Tennessee Warbler | 3.9 | 3.8 | 2.22 |
| Orange-crowned Warbler | 0.1 | 0.1 | 0.00 |
| Yellow Warbler | 13.1 | 5.9 | 0.54 |
| Yellow-rumped Warbler | 0.9 | 1.8 | 1.58 |
| American Redstart | 0.3 | 0.0 | 0.00 |
| Ovenbird | 0.5 | 0.0 | 0.00 |
| Common Yellowthroat | 0.5 | 0.0 | 0.00 |
| Wilson's Warbler | 0.4 | 0.0 | 0.00 |
| Western Tanager | 1.0 | 0.0 | 0.00 |
| Chipping Sparrow | 0.5 | 0.6 | 0.58 |
| Clay-colored Sparrow | 2.1 | 1.0 | 0.12 |
| Song Sparrow | 1.1 | 0.3 | 0.05 |
| Lincoln's Sparrow | 1.5 | 0.4 | 0.34 |
| White-throated Sparrow | 0.7 | 0.1 | 0.08 |
| White-crowned Sparrow | 0.1 | 0.0 | 0.00 |

Table 3 (con't). Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the Inglewood Bird Sanctuary MAPS station averaged over the 15 years, 1992-2008[1]. Data for each species is only included from a station that lies within the breeding range of the species.

| Species | Adults | Young | Reproductive Index[2] |
|---|---|---|---|
| Rose-breasted Grosbeak | 0.1 | 0.1 | 0.00 |
| Red-winged Blackbird | 0.0 | 0.1 | und.[3] |
| Common Grackle | 0.3 | 0.1 | 0.33 |
| Brown-headed Cowbird | 2.6 | 0.2 | 0.08 |
| Baltimore Oriole | 4.5 | 1.2 | 0.20 |
| Purple Finch | 0.1 | 0.1 | 0.00 |
| House Finch | 0.3 | 1.2 | 4.33 |
| American Goldfinch | 1.2 | 0.0 | 0.00 |
| House Sparrow | 0.3 | 0.1 | 0.50 |
| ALL SPECIES POOLED | 113.6 | 54.9 | 0.55 |
| Number of Species | 47 | 33 | |
| Total Number of Species | | 48 | |

[1] The station operated during the 15 years 1992, 1993, and 1995-2008 between 1992-2008.

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

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

Table 4. Population trend for target species at Inglewood Bird Sanctuary MAPS Station over the 17 years 1992-2008 (data for 1994 and 2005 are not included – see text), compared to long-term and short-term population trends from Breeding Bird Survey routes for Alberta. *P*-value in parentheses.

| Species | INBS | | Alberta Population Trend | |
|---|---|---|---|---|
| | Trend | Significance | Long (1966-2007) | Short (1992-2007) |
| Least Flycatcher | declining | 0.273 | -1.7 (0.00) | -6.53 (0.00000) |
| Warbling Vireo | declining | 0.047 | 1.3 (0.21) | -1.75 (0.05211) |
| Black-capped Chickadee | declining | 0.016 | 0.9 (0.46) | 1.47 (0.67603) |
| House Wren | increasing | 0.003 | 1.1 (0.12) | 1.44 (0.22394) |
| American Robin | increasing | 0.028 | 1.1 (0.01) | -0.34 (0.54789) |
| Gray Catbird | increasing | 0.037 | 2.9 (0.03) | 7.07 (0.00266) |
| Cedar Waxwing | flat | 0.595 | 2.6 (0.19) | -11.03 (0.07171) |
| Yellow Warbler | flat | 0.701 | 0.4 (0.47) | -1.79 (0.04600) |
| Baltimore Oriole | flat | 0.417 | -2.8 (0.00) | -6.27 (0.04600) |

Table 5. Estimates of adult annual survival and recapture probabilities among newly captured adults using a time-constant transient survival model for select species[1] breeding at the Inglewood Bird Sanctuary MAPS station obtained from 15 of 17 years (1992-2008)[2] of mark-recapture data, compared to trends for the same species in the Northwest and North-central MAPS regions.

| Species | Num. ind.[3] | Num. ret.[4] | Survival probability[5] | Surv. C.V.[6] | Recapture probability[7] | Survival probability[8] | Surv. C.V.[9] | Recapture probability[10] | Survival probability[11] | Surv. C.V.[12] | Recapture probability[13] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Least Flycatcher* | 125 | 4 | 0.612 (0.189) | 30.9 | 0.073 (0.113) | 0.587 (0.168) | 28.6 | 0.716 (0.234) | 0.397 (0.035) | 8.8 | 0.448 (0.056) |
| Black-capped Chickadee | 54 | 6 | 0.781 (0.120) | 15.4 | 0.175 (0.108) | 0.480 (0.030) | 6.3 | 0.402 (0.041) | 0.413 (0.400) | 9.6 | 0.461 (0.063) |
| American Robin | 383 | 6 | 0.703 (0.156) | 22.2 | 0.033 (0.047) | 0.544 (0.015) | 2.8 | 0.258 (0.016) | 0.420 (0.490) | 11.5 | 0.395 (0.071) |
| Yellow Warbler | 279 | 18 | 0.349 (0.113) | 32.4 | 0.415 (0.366) | 0.561 (0.011) | 2.0 | 0.496 (0.016) | 0.549 (0.021) | 3.9 | 0.402 (0.028) |
| Baltimore Oriole* | 93 | 3 | 0.320 (0.250) | 78.1 | 0.137 (0.263) | ** | ** | | 0.554 (0.065) | 11.7 | 0.175 (0.057) |

[1] Species included were those for which an average of 2.5 individual adult birds were captured per year and least two returns were recorded during the regular MAPS season (May 31 – Aug 8). Only the 15 years considered usable for survivorship analysis were included in the averages. However, all capture records for the dates May 1 – August 8 were included in the creation of the capture history. Estimates are presented only for species for which neither survival nor recapture probability were 0 or 1.

[2] Estimates for survival were calculated using data from 15 of the 17 years (1992- 2008). Data were not included for 1994 because the station did not operate, nor 2005 because the station was not operated in enough periods during the MAPS season for the data to be considered usable for survivorship analysis (see text).

[3] Number of adult individuals captured at stations where the species was a regular or usual breeder (i.e., number of capture histories).

[4] Total number of returns. A return is the first recapture in a given year of a bird originally banded at the same station in a previous year.

[5] Survival probability (φ) presented as the maximum likelihood estimate (standard error of the estimate).

[6] The coefficient of variation for survival probability, CV(φ).

[7] Recapture probability (p) presented as the maximum likelihood estimate (standard error of the estimate).

[8] Survival probability for the Northwest Region of MAPS (standard error of the estimate).

[9] The coefficient of variation for survival probability CV(φ) in the Northwest Region of MAPS.

[10] Recapture probability (p) for the Northwest Region of MAPS presented as the maximum likelihood estimate (standard error of the estimate).

[11] Survival probability for the North-central Region of MAPS (standard error of the estimate).

[12] The coefficient of variation for survival probability CV(φ) in the North-central Region of MAPS.

[13] Recapture probability (p) for the North-central Region of MAPS presented as the maximum likelihood estimate (standard error of the estimate).

* The estimate for survival probability should be viewed with caution because it is based on fewer than five between-year recaptures or the estimate is very imprecise (SE($\varphi$)≥0.200 or CV($\varphi$)≥50.0%).

** Data not available.

Table 6. Assessment of vital rates for target species showing substantially decreasing or substantially increasing population trends at the Inglewood Bird Sanctuary MAPS station.

| Species | Population trend and its significance[1] | Population trend[2] | Productivity[3] | Survival Probability[4] |
|---|---|---|---|---|
| **A. Decreasing Species** | | | | |
| Least Flycatcher | -0.248 | much higher | stable, low | slightly higher; lower |
| Warbling Vireo | -0.243* | slightly higher | stable, low | unavailable |
| Black-capped Chickadee | -0.317* | lower | increasing, high | high |
| **B. Increasing Species** | | | | |
| House Wren | +0.638** | slightly lower | increasing, high | unavailable |
| American Robin | +1.019* | higher | decreasing, high | high |
| Gray Catbird | +0.848* | much lower | increasing, low | unavailable |

[1] Significance of the trends in adult population levels: ** $P < 0.01$; * $0.01 \leq P < 0.05$.
[2] Population trend from previous column is compared to the population trend from Breeding Bird Survey routes (Table 4).
[3] Productivity assessment is based on the productivity trend (from Figure 5), and on the reproductive index (R.I. value from Table 3 and the Northwest Region of MAPS), respectively.
[4] Survival assessment is based on comparison with survival in the Northwest Region of MAPS.

http://www.birdpop.org/nbii/prod/default.asp

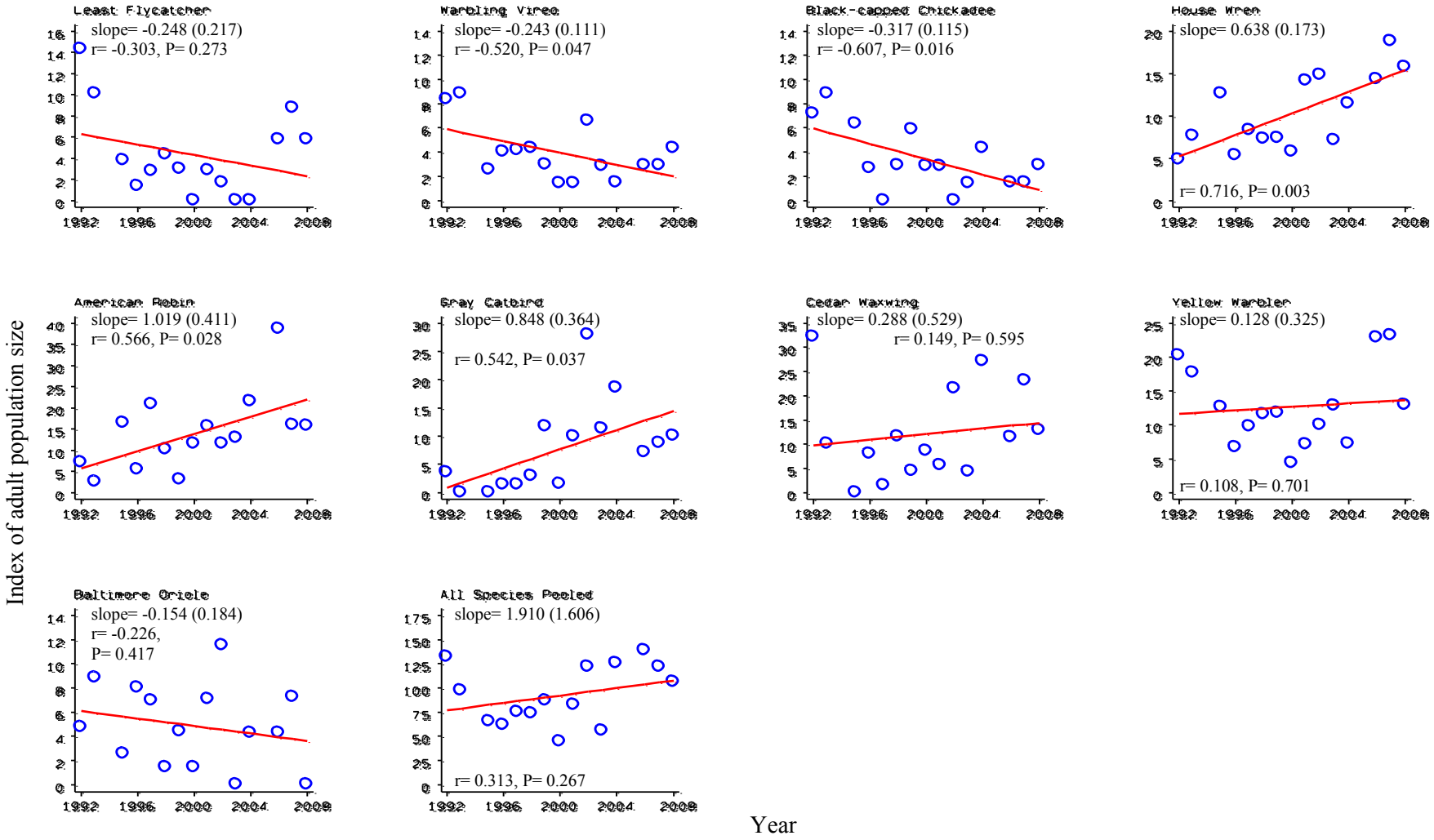


Figure 4. Population trends for nine species and all species pooled at the Inglewood Bird Sanctuary over the 17 years 1992-2008 (data for 1994 and 2005 are not included – see text). Number of adult individuals captured per 600 net-hours was used as the measure of population size for species which were regular or usual breeders and summer residents at the station. The slope of the linear regression line was used as the measure of the population trend and is presented on each graph with the standard error of the slope in parentheses. The correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are also shown on each graph.

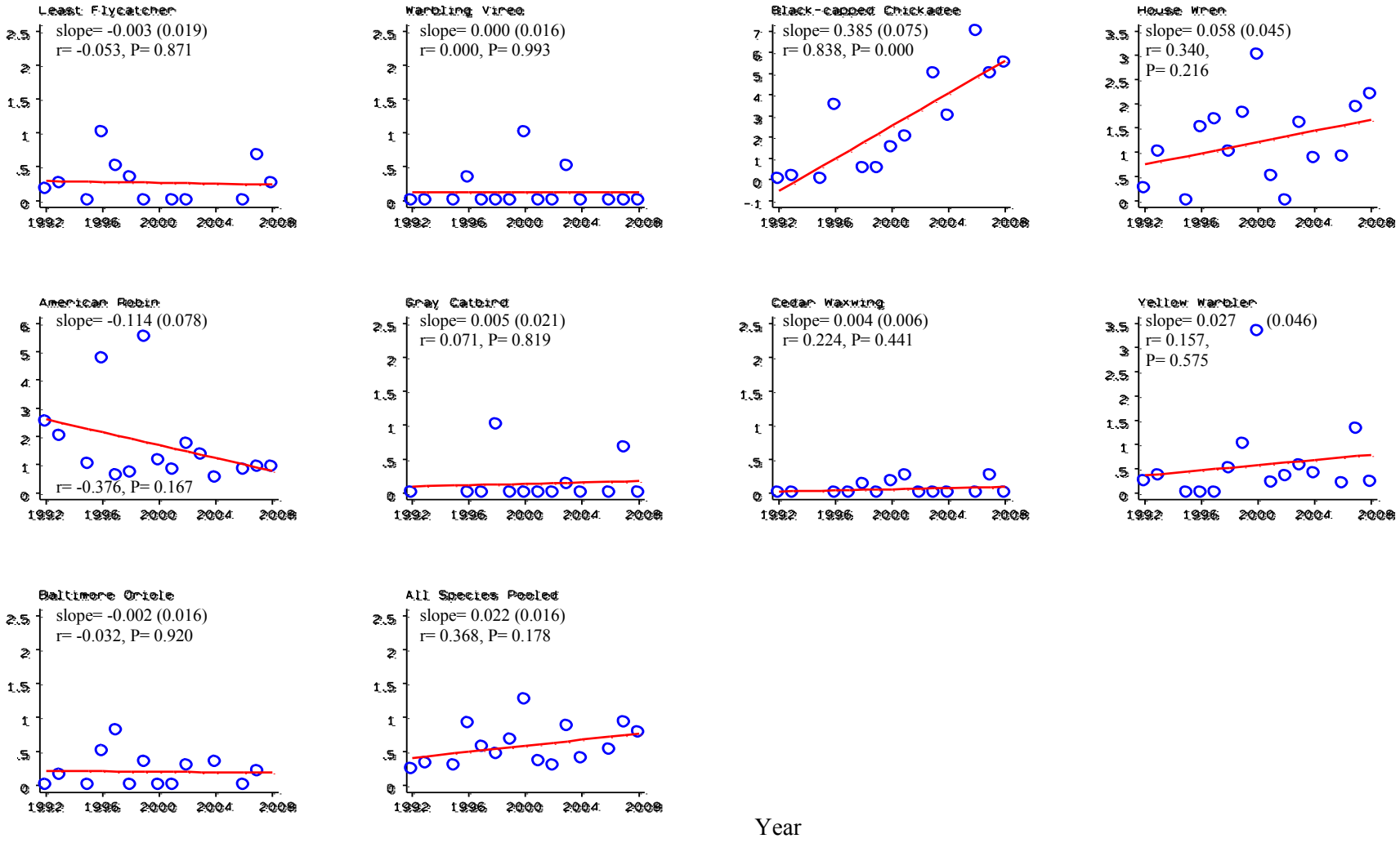


Figure 5. Trend in productivity for nine species and all species pooled at Inglewood Bird Sanctuary over the 17 years 1992-2008 (data for 1994 and 2005 are not included – see text). The productivity index was defined as the number of young per adult in each year for species which were regular or usual breeders and summer residents at the station. The slope of the regression line was used as the measure of the productivity trend. The slope, the standard error of the slope (in parentheses), the correlation coefficient (*r*) and significance of the correlation coefficient (*P*) are shown on each graph.

## APPENDIX A:

### Alphabetical list of common and scientific names of birds captured at Inglewood MAPS station

Alder Flycatcher (*Empidonax alnorum*)
American Goldfinch (*Carduelis tristis*)
American Kestrel (*Falco sparverius*)
American Redstart (*Setophaga ruticilla*)
American Robin (*Turdus migratorius*)
Baltimore Oriole (*Icterus galbula*)
Bank Swallow (*Riparia riparia*)
Bay-breasted Warbler (*Dendroica castanea*)
Black-billed Magpie (*Pica hudsonia*)
Black-capped Chickadee (*Poecile atricapilla*)
Brown-headed Cowbird (*Molothrus ater*)
Cedar Waxwing (*Bornbycilla cedrorum*)
Chipping Sparrow (*Spizella passerina*)
Clay-colored Sparrow (*Spizella pallida*)
Common Grackle (*Quiscalus quiscula*)
Common Yellowthroat (*Geothylpis trichas*)
Downy Woodpecker (*Picoides pubescens*)
Eastern Kingbird (*Tyrannus tyrannus*)
European Starling (*Sturnus vulgaris*)
Fox Sparrow (*Passerella iliaca*)
Gray Catbird (*Durmetella carolinensis*)
Hairy Woodpecker (*Picoides villosus*)
Hermit Thrush (*Catharus guttatus*)
House Finch (*Carpodacus mexicanus*)
House Sparrow (*Passer domesticus*)
House Wren (*Troglodytes aedon*)
Least Flycatcher (*Empidonax minimus*)
Lincoln's Sparrow (*Melospiza lincolnii*)
Mourning Warbler (*Oporornis philadelphia*)
"Myrtle" Warbler (*Dendroica coronata coronata*)
Northern Waterthrush (*Seiurus noveboracensis*)
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)
Orange-crowned Warbler (*Vermivora celata*)
Ovenbird (*Seiurus aurocapillus*)
Purple Finch (*Carpodacus purpureus*)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)
Red-eyed Vireo (*Vireo olivaceus*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Ring-necked Pheasant (*Phasianus colchicus*)
Rufous Hummingbird (*Selasphorus rufus*)
Song Sparrow (*Melospiza melodia*)
Swainson's Thrush (*Catharus ustulatus*)
Tennessee Warbler (*Vermivora peregrina*)
Tree Swallow (*Tachycineta bicolor*)
"Traill's" Flycatcher: includes Alder (*Empidonax alnorum*) and Willow (*E. traillii*) flycatchers
Veery (*Catharus fuscescens*)
Warbling Vireo (V*ireo gilvus)*

Western Tanager (*Piranga ludoviciana*)
Western Wood Peewee (*Contopus sordidulus*)
White-throated Sparrow (*Zonotrichia albicollis*)
Willow Flycatcher (*Empidonax traillii*)
Wilson's Warbler (*Wilsonia pusilla*)
Yellow Warbler (*Dendroica petechia*)
Yellow-shafted Flicker (*Colaptes chrysoides*)