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A CITIZEN SCIENCE APPROACH TO ORNITHOLOGICAL RESEARCH: TWENTY YEARS OF WATCHING BACKYARD BIRDS

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Abstract. Effective continent-wide monitoring of bird populations requires engagement of the public in order to gather data across large spatial and temporal scales. One long-term, continental-scale monitoring program, Project FeederWatch, has enlisted more than 40 000 people from all U.S. states and Canadian provinces since 1987. The project, operated by the Cornell Laboratory of Ornithology and Bird Studies Canada, has accumulated more than 1.5 million checklists allowing researchers to study changes in the distribution and abundance of species that regularly visit supplemental bird feeding stations in North America. Because of the efforts of FeederWatch participants, researchers have been able to identify species of concern, to track changes in the distribution and abundance of native and non-native species, and to understand how novel pathogens affect populations. Following two decades of successful public engagement, Project FeederWatch provides an ideal case study in the challenges and opportunities of public involvement in scientific research.

Key Words: citizen Science, monitoring, Project FeederWatch.

EL ENFOQUE DE LA CIENCIA CIUDADANA EN LA INVESTIGACIÓN ORNITOLÓGICA: VEINTE AÑOS OBSERVANDO AVES EN EL JARDÍN TRASERO

Resumen. El monitoreo efectivo de poblaciones de aves a nivel continental requiere el compromiso del público para poder adquirir datos a lo largo de grandes escalas espaciales y temporales. El Proyecto de Observación de Comederos, un programa de monitoreo de largo término y a escala continental, ha enlistado más de 40.000 personas de todos los estados de Estados Unidos y las provincias Canadienses desde 1987. El proyecto, operado por el Laboratorio de Ornitología de Cornell y por Estudios de Aves Canadá, ha acumulado más de 1.5 millones de listas permitiendo a investigadores el estudio de los cambios en la distribución y abundancia de especies que visitan regularmente las estaciones suplementarias de comida en Norte América. Gracias a los esfuerzos de los participantes del Proyecto de Observación de Comederos los investigadores han podido identificar a aquellas especies que requieren atención, seguir los cambios en la distribución y abundancia de especies nativas e introducidas, y entender cómo nuevos agentes patogénicos afectan a las poblaciones. Luego de dos décadas de compromiso público exitoso, el Proyecto de Observación de Comederos provee un caso de estudio ideal para los retos y oportunidades que ofrece la participación ciudadana en la investigación científica.

INTRODUCTION

Ornithology enjoys a long tradition of successful research and monitoring programs that rely upon observations submitted by the public, including projects such as the North American Breeding Bird Survey (Sauer et al. 2007), the Christmas Bird Count (Butcher et al. 1990), and various monitoring programs operated by the Cornell Laboratory of Ornithology (www.birds.cornell.edu/LabPrograms/CitSci/) and the British Trust for Ornithology (www.bto.org). Indeed, much of our knowledge of trends in the distribution and abundance of birds in North America has been generated from data gathered through public engagement in citizen science programs (e.g., Robbins et al. 1989, Link et al. 2006, Butcher and Niven 2007).

Because birds tend to be widely distributed and mobile organisms, data must be gathered at the proper, and often large, spatial extents and time periods in order to successfully monitor trends in populations. Heterogeneity in both regional environmental conditions and in the composition of biotic communities limits the usefulness of extrapolating population size or trend estimates from localized studies to larger areas. Likewise, monitoring needs to be carried out over many years, if not decades, because short-term studies often fail to capture the dynamic

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nature of populations or fail to identify cyclic patterns in distribution and abundance (Hochachka et al. 1999). With few exceptions, most notably with monitoring waterfowl in North America (e.g., Drever 2006), the financial resources are not available to fully pay for large-scale and long-term monitoring efforts. Instead, such monitoring typically relies on voluntary public participation. Reliance on public participation in data collection requires special attention to the design of such studies in order to facilitate acquisition of sufficient high-quality data to usefully provide knowledge of bird populations.

As a result of more than 20 years of successful public engagement, Project FeederWatch (www.feederwatch.org) provides an example of how bird populations may be monitored across large spatial and temporal scales. FeederWatch engages the public in bird monitoring through a simple research protocol focused on birds that frequent supplemental feeding stations in winter. Created in 1976 in Canada as the Ontario Bird Feeder Survey, FeederWatch expanded in 1987 to cover all of the United States and Canada as a joint research and education project operated by the Cornell Laboratory of Ornithology and Bird Studies Canada. The FeederWatch dataset is now proving to be a valuable resource for monitoring changes in the distribution and abundance of birds that regularly visit feeding stations during the winter (Wells et al. 1996, 1997, Lepage and Francis 2002, Bonter and Harvey 2008).

Our objective in this paper is to demonstrate the utility of data from Project FeederWatch, and by extension the utility of other large-scale citizen science projects, with three case studies. Specifically, we demonstrate how FeederWatch data have been used to 1) document changes in bird distribution and abundance by examining recent range-wide declines in Evening Grosbeak (*Coccothraustes vespertinus*) populations, 2) track the spread of an invasive species (the Eurasian Collared-Dove, *Streptopelia decaocto*) across North America, and 3) assess the impact of an unexpected event (emergence of a novel form of the pathogen *Mycoplasma gallisepticum*) on House Finch (*Carpodacus mexicanus*) populations. All three examples clearly exhibit how protocol-driven monitoring programs can gather data valuable for objectives beyond those originally specified.

METHODS

FeederWatch Protocol

FeederWatch participants periodically count the maximum number of each species seen in the proximity of a bird feeding station during a series of two-day count periods. Counts are conducted between mid-November and the beginning of April each year, with count periods separated by a minimum of five days. On average, FeederWatch participants submit 10 checklists per site from approximately 10 000 total locations each winter. Reports are submitted from all U.S. states and Canadian provinces. More than 40 000 locations have been monitored since 1987.

State- and province-specific filters screen all data for questionable bird observations. Checklists reporting species located out of their expected range, or counts that are greater than expected based on the location and behavior of the species, are flagged for review. Flagged reports are marked as invalid in the database until the participant submits evidence that confirms the report (e.g., photographs). Flagged records that remain unconfirmed are not used in data analyses.

In addition to the bird counts, participants also record data on observational effort and weather conditions that can be used as covariates in analyses. Effort is quantified by recording 1) the number of half-days spent observing the count area during a two-day count period (range: 1–4 half days), and 2) the approximate number of hours spent watching and counting birds during the count period. Weather conditions recorded include daytime temperature extremes, precipitation type and duration, and depth of snow cover, if present. Information describing the habitat surrounding the count site is also recorded. All data are submitted either via the Internet through a customized data entry system (~75% of data in 2007), or on computer-readable paper data forms.

CASE STUDIES

Quantifying Population Changes

Analyzing FeederWatch data collected between November 1988 and April 2006 (n = 1 169 935 checklists), Bonter and Harvey (2008) documented a range-wide contraction of the winter distribution of Evening Grosbeaks along with a decrease in abundance of the species at sites still hosting grosbeaks. Survey-wide, mean flock size when the species was present at a site declined 27% over 18 years. During the same period, the proportion of sites reporting Evening Grosbeaks declined by 50% (Fig. 1). Further, at 391 sites that historically hosted Evening Grosbeaks and where counts were submitted in at least 10 years (long-term sites), significant declines were detected at 76 sites.

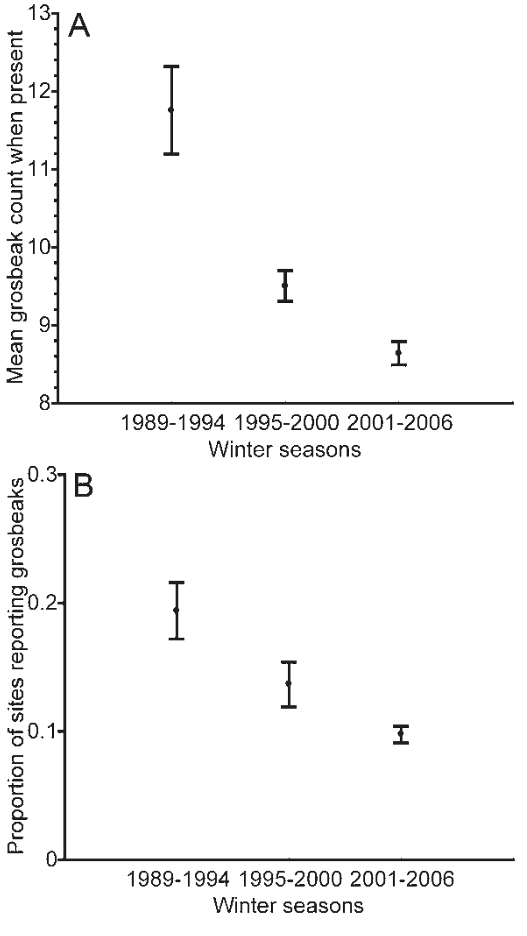

Figure 1. (A) Mean Evening Grosbeak flock size when present and (B) average proportion of Project FeederWatch sites in the United States and Canada reporting Evening Grosbeaks at least once during a winter season. Values for individual winters were averaged across six seasons (mean and 95% CI). Source: Bonter and Harvey (2008), reprinted with permission by the Cooper Ornithological Society. © Cooper Ornithological Society 2008.

No significant increases in Evening Grosbeak counts were detected at these long-term sites (Bonter and Harvey 2008). Other research using data from Project FeederWatch to quantify population changes in various species include Wells et al. (1996), Wells et al. (1997), and Lepage and Francis (2002).

Tracking Invasive Species

The Eurasian Collared-Dove was introduced in the Bahamas in the 1970s and likely dispersed from the Bahamas to south Florida by the early 1980s (Smith 1987). Populations have rapidly expanded across North America in recent years (Whitman and Harvey 2005, Beckett et al. 2007). According to FeederWatch data, the range of the Eurasian Collared-Dove has undergone a pronounced anisotropic expansion extending out of Florida along a predominantly southeast-to-northwest axis (Whitman and Harvey 2005). FeederWatch reports show a rapid change in the number of states with populations of collared-doves, increasing from five states in 2000 to 32 states in 2006. Within Florida, where the species has been established for more than 20 years, the proportion of sites reporting collared-doves continued to increase between 2000 and 2006 (linear regression, $F = 15$, df = 1 and 5, $P = 0.012$). The mean flock size where the species was recorded has ranged between 2.8 and 3.9 birds and has marginally increased over the same time period (linear regression, $F = 6$, df = 1 and 5, $P = 0.054$).

Assessing Impacts of Unexpected Events

In the winter of 1993–1994, House Finches with severe cases of conjunctivitis were observed in the vicinity of Washington, DC. Investigation revealed that the ailment was caused by a novel strain of the bacteria *Mycoplasma gallisepticum* (MG, Fischer et al. 1997). Because the symptoms in infected birds were readily recognizable, FeederWatch participants were enlisted to report the maximum number of apparently sick and healthy House Finches during their standard FeederWatch counts and as part of a new project, the House Finch Disease Survey. Using FeederWatch data collected from 1994–1997, Dhondt et al. (1998) were able to track the rapid spread of this disease through the eastern House Finch population. The epidemic first spread north, probably carried by House Finches migrating north in spring. The disease then spread south and west, and was reported in most of the eastern range of the House Finch by March 1997. Observational data revealed that the frequency of apparent infection peaked each fall (Altizer et al. 2004), and the disease has had a significant and lasting impact on finch populations, with over half of the House Finches in eastern North America disappearing in the first three years of the disease outbreak (Hochachka and Dhondt 2000). Data collected through Project FeederWatch and the House Finch Disease Survey have proven useful for investigation of the dynamics of MG in House Finch populations (Fischer et al. 1997, Hartup et al. 1998, Hochachka and Dhondt 2000, Hartup et al. 2001). In addition to investigating the effects of MG on populations of wild birds, FeederWatch data have also been used to examine population changes that may be associated with West Nile virus (Bonter and Hochachka 2002).

DISCUSSION

A common theme across these three case studies is the occurrence of unanticipated events and how monitoring data, when collected at the proper scales, can inform research about the dynamics and effects of such events. This research often requires data collected prior to the event—before the questions even existed. When FeederWatch began, for example, Evening Grosbeaks were among the most common birds visiting supplemental feeding stations in much of the northern United States and southern Canada in winter. A precipitous population decline could not have been anticipated, and would not have been quantified in the absence of data collected following a consistent protocol over large spatial and temporal scales.

The example of another super-abundant species, the House Sparrow (*Passer domesticus*), provides a cautionary tale that reinforces the importance of monitoring even the most common birds. House Sparrow populations in Europe have experienced recent declines of upwards of 95% in some areas (Robinson et al. 2005). European House Sparrows were previously so abundant that observers were asked to *not* count them on the Common Birds Census in the United Kingdom between 1962 and 1974. As a result, the opportunity to gather important data during the start of the sparrows' decline was missed.

Another category of unanticipated changes that can be informed by large-scale monitoring programs involves the introduction of animal and plant species to novel areas. The potential ecological impacts of introduced species on native communities are vast and remain largely undocumented (Duncan et al. 2003, Gurevitch and Padilla 2004, Didham et al. 2005). Effects of introduced species can be dramatic; biological introductions and invasions are considered among the top five drivers affecting global biodiversity (Sala et al. 2000). FeederWatch data will be useful for assessing the possible impact on native dove populations of the colonization of Eurasian Collared-Doves. Further, FeederWatch data will inform future investigation of the colonization dynamics and effects of other species currently becoming established in North America such as the Nutmeg Mannikin (*Lonchura punctulata*), Monk Parakeet (*Myiopsitta monachus*), and other psittacines.

Similar to introduced animals and plants, novel pathogens and other sources of disease emergence can contribute to profound changes in bird communities. As with *Mycolasma gallisepticum* in House Finches, the only means of quantifying the impacts of West Nile disease on birds was through examination of long-term monitoring data (e.g., Bonter and Hochachka 2002, LaDeau et al. 2007). A small number of local studies cannot provide a clear picture of the impacts of disease because of the potentially patchy and local distribution of disease outbreaks (Durand et al. 2002, Hochachka et al. 2004).

Data from bird-monitoring projects such as FeederWatch are not perfect: inherent biases exist and must be addressed (Shaffer and Johnson 2008). For this reason, carefully designed and focused studies are rightly advocated. However, such designed studies are only possible when researchers have sufficient prior knowledge to expect certain patterns to occur. In this paper, we have described cases in which this sort of anticipation was effectively impossible. Thus, we suggest that the collection of monitoring data has been, and will continue to be, important. However, the analysis and interpretation of these data need to be tempered with an understanding of the strengths and weaknesses of the protocols used to collect the data.

Patterns discovered through analysis of monitoring data can generate a rich source of questions for further investigation. In this regard, *Mycoplasma gallisepticum* in House Finches provides a useful illustration of how monitoring and focused studies can complement each other, for two reasons. First, Project FeederWatch not only provided data needed to document the finches' decline, but also established a network of observers who could be recruited to collect data on the distribution of the disease itself (Dhondt et al. 1998). Second, the patterns discovered from analysis of monitoring data generated hypotheses that continue to be experimentally examined, with the monitoring and experimental studies complementing each other in order to provide a more complete picture of pattern and process in studies of disease ecology (Dhondt et al. 2005).

Keeping common birds common, a primary goal of the Partners in Flight initiative, requires monitoring programs that can detect significant population changes (Rich et al. 2004). Programs like Project FeederWatch can help fill some of the gaps in our ornithological knowledge while simultaneously helping to educate and mobilize the participants. Involvement in citizen science programs can lead to a more knowledgeable and engaged public with regard to conservation issues (Trumbull et al. 2000). By involving the public, scientists are not only gathering vast amounts of data, but are also building a constituency for conservation—a constituency that is often required to bring about action in the political arena.

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