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CITIZEN-SCIENCE MONITORING OF LANDBIRDS IN THE MISSISSIPPI RIVER TWIN CITIES IMPORTANT BIRD AREA

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Abstract. As urbanization alters undeveloped landscapes, conservation of remnant native habitats is increasingly important. Citizen science has emerged as a powerful tool in monitoring these developed areas. The Mississippi River Twin Cities Important Bird Area (IBA) covers nearly 14 751 ha of bird habitat along the Mississippi River between Minneapolis and Hastings. While we know this area's value to waterbirds, we know less about how landbirds, especially migrating songbirds, use this habitat. To address this issue, Audubon Minnesota supported the development of a landbird monitoring program using volunteer birders to perform point count surveys during both migration and breeding seasons. During the 2007 field season, 13 citizen scientists working on 7 sites within the IBA recorded 126 landbird species. This program has great potential to provide data on bird assemblages that may aid in management, as well as provide volunteers with the opportunity for stewardship and engagement with nature.

Key Words: citizen science, Important Bird Area, monitoring, passerines.

UN PROGRAMME DE SURVEILLANCE DES OISEAUX TERRESTRES EN UTILISANT DES BENEVOLES ORNITHOLOGUES EN LE MISSISSIPPI RIVER TWIN CITIES IMPORTANT BIRD AREA

Résumé. Parce que l'urbanisation modifie le paysage naturel, la conservation des habitats non-développés est de plus en plus importante. Des bénévoles ornithologues sont devenue un outil puissant de gérance surtout dans les zones urbaines. Le Mississippi River Twin Cities Important Bird Area (IBA) couvre près de 14 751 hectares d'habitat pour oiseaux le long du fleuve du Mississippi entre Minneapolis et Hastings. Bien qu'on sache beaucoup a propos des oiseaux aquatiques, moins d'informations est connue sur les oiseaux terrestres, surtout les oiseaux chanteurs migrateurs qui utilisent cet habitat. Pour traiter cette question, Audubon Minnesota prenantes ont choisi d'élaborer un programme de surveillance des oiseaux terrestres en utilisant des bénévoles ornithologues pour effectuer des enquêtes a différent points d'observation au cours de deux saisons de reproduction et de migration. Durant le printemps et l'été 2007, 13 bénévoles ornithologues ont travaillé sur 7 sites de l'IBA. Ils ont enregistré 126 espèces d'oiseaux terrestres. Ce programme a le potentiel de fournir des données sur des assemblages d'oiseaux qui est susceptible d'aider à la gestion de l'IBA, ainsi que de permettre aux bénévoles et à la communauté de participer dans la protection de ce terrain et d'engager avec la nature.

INTRODUCTION

The increase in anthropogenic land use across the world is driving profound changes to native ecosystems. Between 40 and 50% of the planet's surface has in some way been altered by human activities (Vitousek et al. 1997). Urbanization in particular can effect drastic changes in bird community composition and populations. As the intensity of urban land use increases, non-native bird species replace native ones, resulting in a pattern of bird community homogenization that is repeated across the globe (Blair 2004, Chace and Walsh 2006, Clergeau et al. 2006).

Over the past several decades, migrant songbirds have emerged as one of the most threatened bird groups in the Americas. Many species with sharp population declines winter in Mexico, South and Central America, and the Caribbean and migrate to breed in North American forests, shrublands, and grasslands

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(Askins 1995, Rich et al. 2004). Much of this decline is attributed directly to anthropogenic land changes; new developments fragment forests, critical breeding habitat is lost, and that which remains becomes subject to increased edge effects. In some areas, nest parasitism and predation in fragmented forests is extensive enough that these areas may be acting as sinks for some songbird species; populations in the fragments may only be viable as long as they are repopulated by overflow from larger, intact forests (Robinson et al. 1995). However, even fragmented urban habitat patches incapable of sustaining resident breeding populations may offer important resources to Neotropical migrants (Mehlman et al. 2005).

Understanding the potential value of urban habitat patches to songbirds during migration is an important aspect of a comprehensive conservation strategy. Monitoring data may suggest better land management practices that can make the urban matrix more hospitable to native bird species (Savard et al. 2000, Marzluff and Ewing 2001).

Citizen science consists of using non-scientist volunteers to collect scientific data to be used by scientists to answer research questions (Trumbull et al. 2000). Citizen science is being recognized as an increasingly powerful tool in environmental monitoring. Volunteers have assisted in data collection across a diversity of programs monitoring everything from water quality (Savan et al. 2003) to reef fishes (Pattengill-Semmens and Semmens 2003), butterflies (Prysby and Oberhauser 2004), and birds (Breeding Bird Survey, Christmas Bird Count).

There are numerous advantages to using a citizen science approach to monitoring. The use of volunteers can allow researchers to collect large amounts of data affordably (Danielsen et al. 2005). Natural resource monitoring programs can provide an opportunity for community education/outreach (Brossard et al. 2005) and encourage a sense of stewardship for natural areas/resources (Ryan et al. 2001). Volunteer programs also are a good bet to outlive their counterparts in government agencies. The Christmas Bird Count, for example, has been running since 1900. Volunteers and citizen scientists tend to "own" their part in the program, taking the responsibility seriously for the long term.

However, the robustness of the data collected by volunteers is frequently questioned, and the limited skill of volunteers compared to professionally trained researchers may impose constraints on certain types of data collection and analysis (Penrose and Call 1995, Engel and Voshell 2002). On the other hand, many of the most expert birders in the world do not work as professional biologists.

Started in the early 1980s by BirdLife International, the Important Bird Area (IBA) program (CEC 1999) has become a globally recognized initiative that identifies habitats of high conservation value to avifauna and pursues conservation initiatives to permanently protect these areas. An IBA is a site that contains habitat critical to birds during any phase of their lives (Chipley 1999). Beyond identifying high-value sites, the IBA program involves developing, with local partners and stakeholders, conservation and monitoring plans for each site. Data collected during monitoring can be used to complete a bird inventory of the IBA, track trends in bird populations, and provide guidance for land planning and management.

In this paper we discuss the Mississippi River Twin Cities IBA Landbird Monitoring Program, an initiative that engages volunteer citizen scientist birders in counting landbirds in this highly urbanized IBA. This case study highlights the process of developing a bird monitoring strategy tailored to volunteers and an urban landscape, assesses the outcomes of the first monitoring season, and suggests potential improvements to the protocol and key considerations for similar initiatives.

METHODS

Mississippi River Twin Cities Important Bird Area

The Mississippi River Twin Cities IBA stretches along the Mississippi River from the Washington St. Bridge in downtown Minneapolis, MN to Lock and Dam #2 near Hastings, MN, covering approximately 14 751 ha of open space, residential, and industrial land uses. The IBA boundaries roughly follow those of the Mississippi National River and Recreation Area (MNRRA), which is administered by the National Park Service. Most of the undeveloped land in the IBA lies within a network of city and regional parks along the river. Additionally, two major habitat areas (Fort Snelling State Park and the Minnesota Valley National Wildlife Refuge) are adjacent to the IBA. This area, situated at the confluence of the Minnesota, Mississippi, and St. Croix Rivers, lies on the Mississippi River Flyway migration route through central North America. In spite of the predominantly urban land use in the metropolitan area, the remaining open spaces have the potential to act as valuable migration stopover habitat.

The Mississippi River Twin Cities site was designated a recognized IBA under three Minnesota criteria: habitat hosting large assemblages of

waterfowl during migration and waterbirds during breeding (MN-1); habitat for endangered, threatened, or species of conservation concern [Black-crowned Night Heron (*Nycticorax nycticorax*), Bald Eagle (*Haliaeetus leucocephalus*), Peregrine Falcon (*Falco peregrinus*)] (MN-2); and site with long-term research value and high species diversity in an urban area (MN-4).

The nomination cited substantial data from waterbird and waterfowl surveys (Lidell and Cooper 1998, Bardon 2001), but less is known about the landbirds that migrate through the IBA. Observations from 1965–2004 on Grey Cloud Island and 1988–2004 in the Mississippi River Gorge (Galli 2005) list 155 landbird species that use the IBA either during migration, breeding, or winter, but exact numbers for this group of birds were unknown.

Monitoring Program Development

In September 2005, Audubon Minnesota and other partners with an interest in the IBA (City of Saint Paul Parks Department, Ramsey County Parks, the Minnesota Department of Natural Resources, the National Park Service, and non-profit groups Friends of the Mississippi River and Great River Greening) met to discuss goals and assess needs for the management of this area. The main goal that emerged from this meeting was to institute a monitoring plan in order to collect baseline data on the status of landbirds within the IBA.

In early 2006, we began collaborating with Audubon Minnesota on designing a landbird monitoring protocol for the IBA. The program's objectives were to, 1) catalogue landbird species present in the IBA, 2) determine species' use of the IBA habitats during migration, breeding, and winter, 3) monitor long-term trends in land bird species in the IBA, and 4) develop a citizen science program to engage the public in monitoring, build support for the IBA program in the Twin Cities, and grow the program into a sustainable long-term initiative.

Sampling Design

One of the main goals in defining a sampling design for the IBA was to maintain some continuity with National Park Service Passerine Monitoring Protocol (Knutson et al. 2007) so that data could be readily meshed with the Great Lakes Inventory and Monitoring Network database. We defined the sampling design according to two levels of access: 1) publicly accessible park/reserve land, and 2) trails within the parks. In order to simplify site access, we only considered publicly owned lands for site selection. Because of safety concerns, habitat protection, ease of navigation, and permanence of points, we placed sampling points based on trail access. The number of sampling points per site varied with site area, from 11 points on the smallest sites (50 to 90 ha) to 14 points—the maximum number of points that could reasonably be completed in a 4-hour morning of surveying—on sites larger than 170 ha. We generated sampling points in ArcGIS v.9.0 (ESRI 2004) by laying a 250-m grid over the study area, randomly selecting squares in which to place sampling points, and snapping these points to the nearest trail, maintaining approximately 250 m separation between each.

Point Count Protocol

Due to the mostly forested habitat on the sites, we chose to conduct surveys using a fixed 50-m radius point count (Bibby et al. 1992) with two bands: 0 to 50 m and greater than 50 m. Volunteers conducted weekly spring migration surveys from 15 April 2007 through 31 May 2007 and two breeding season surveys between 1 June and 1 July 2007. Each volunteer or team worked the same site for the whole season to facilitate navigation through the site and distance estimation at each point. Volunteers recorded all landbirds seen or heard in a 5-min period, placing them in the appropriate distance band. Aerial foragers observed using the habitat around the sampling point and birds flushed from the point upon the observer's approach were counted while flyovers were not. Only one person made observations; other team members could silently observe or act as recorders of data dictated by the observer. Observers also noted as "supplemental observations" any landbird species seen between points or outside of the count periods that were not recorded during the point counts.

Volunteer Recruitment and Training

For the pilot season, we recruited experienced birders using an e-mail announcement sent to various list-serves, nature centers, and individuals. We conducted a 2-hr training session to introduce the volunteers to the project background and goals, protocol, and materials. Volunteers practiced 50 m distance estimation, navigation using a GPS unit, and conducting point counts. We provided them with a packet that included color maps of their site, data sheets, an instruction booklet summarizing the survey protocols, and a handheld GPS unit. Upon completion of each week's site visit, volunteers sent their hardcopy datasheets to us for entry into a database.

Pilot Season Assessment

Observer Variability

To evaluate observer variability across the volunteer observers at different sites, we performed modified independent observer point counts on each site during breeding season surveys using the researcher as a common standard. Most sites had two person teams of volunteers where the observer dictated observations to a recorder. To accommodate this situation, we performed point counts on the same days as the volunteers but followed them through the sites one point behind (a delay of approximately 10 min). While the delay may have resulted in some differences in number and species of birds recorded, conducting the validation during the breeding season, when most birds are on territories, should minimize this variation. In order to assess whether the volunteer teams and the researcher were counting similar numbers of birds per species, we used a Chi Square analysis to test for differences in the frequency distribution of birds per species counted by the volunteer and researcher on each site. We also calculated the percentage of species recorded by both observers on each site to determine whether the volunteers and the researcher were identifying the same species on the site. Using information from variable circular plot point count data collected in Minnesota and Ohio (see Blair and Johnson 2008), we determined mean detection distance cut-offs and percent detection by sight and vocalization for the most commonly missed species and used these measures and foraging behavior to look for broad similarities between these birds.

Volunteer Feedback and Profile

After the summer field season, we asked the citizen scientist participants to answer a 30-question anonymous online survey to assess the profile of the volunteer corps and their perceived effectiveness of the monitoring protocol. Respondents were asked to evaluate the materials and processes associated with the point counts and training session and provide some basic demographic information, including their reasons for participating in the monitoring program.

RESULTS

Pilot Season Overview

During the 2007 pilot season, volunteers surveyed 7 sites during spring migration and breeding season. A total of 13 individuals participated in the survey as observers, recorders, or other team members. Across both seasons and all 7 sites, volunteers recorded 126 landbird species, including supplemental observations and unknowns. Of that total, 26 species were migrants passing through, 2 were winter residents, 7 were partial identifications (i.e., unknown sparrow), and the remaining 91 were species known to breed in the Twin Cities area. Of these 126 species, 30 are listed as birds in greatest conservation need in Minnesota (Table 1).

Assessment Results

Observer Variation

Analysis of the results from the observer validation counts suggested significant variation in the distribution of the number of birds per species counted by the volunteers compared to the researcher during the summer 2007 season (Table 2). For 4 of the 6 volunteer observers evaluated, over 62% of species recorded during the validation visits were recorded by both the volunteer and researcher. The percent of species detected by both observers ranged from 37% to 79% of species. Since one of our goals is to use the volunteers' data to run site-based analyses of bird community composition, this variation between observers should be addressed.

The species most likely to be missed by one of the observers were Chimney Swift (*Chaetura pelagica*), Tree Swallow (*Tachycineta bicolor*), Blue Jay (*Cyanocitta cristata*), and House Finch (*Carpodacus mexicanus*), which were "unshared" on 4 of 6 sites. Cooper's Hawk (*Accipiter cooperii*), Gray Catbird (*Dumetella carolinensis*), Brown-headed Cowbird (*Molothrus ater*), and Northern Flicker (*Colaptes auratus*) were unshared on 3 of 6 sites. On 2 of the 6 sites one observer failed to record Blue-gray Gnatcatcher (*Polioptila caerulea*), Yellow-throated Vireo (*Vireo flavifrons*), American Robin (*Turdus migratorius*), Eastern Phoebe (*Sayornis phoebe*), and Common Grackle (*Quiscalus quiscula*). The volunteers and the researcher were equally likely to miss these species during the validation counts. These missed species fall into four groupings based on mean detection distance cut-off, detection by sight or vocalization, and foraging behavior (Table 3).

Volunteer Feedback

Overall, 75% of survey participants said that they were "very satisfied" with their experience in the IBA monitoring program; the remainder rated their experience as "somewhat satisfactory." Likewise, 75% of respondents indicated

TABLE 1. Minnesota landbird species in greatest conservation need recorded on the Mississippi River Twin Cities IBA in 2007. Adapted from Minnesota Department of Natural Resources (2006).

Species	Scientific Name	Rationale
Bald Eagle	*Haliaeetus leucocephalus*	Federally Threatened, MN Special Concern
Red-shouldered Hawk	*Buteo lineatus*	MN Special Concern
Peregrine Falcon	*Falco peregrinus*	MN Threatened
Virginia Rail	*Rallus limicola*	Moderate Concern in Prairie Pothole Waterbird Plan
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Highest Partners in Flight Priority (PIF 1)
Yellow-bellied Sapsucker	*Sphyrapicus varius*	High Partners in Flight Priority (PIF 2A)
Olive-sided Flycatcher	*Contopus cooperi*	Partners in Flight Continental Watchlist
Eastern Wood-Pewee	*Contopus virens*	High Partners in Flight Priority (PIF 2A)
Willow Flycatcher	*Empidonax traillii*	Partners in Flight Continental Watchlist
Least Flycatcher	*Empidonax minimus*	High Partners in Flight Priority (PIF 2A)
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	High Partners in Flight Priority (PIF 2)
Marsh Wren	*Cistothorus palustris*	High Partners in Flight Priority (PIF 2)
Sedge Wren	*Cistothorus platensis*	Highest Partners in Flight Priority (PIF 1)
Wood Thrush	*Hylocichla mustelina*	Partners in Flight Continental Watchlist
Veery	*Catharus fuscescens*	Highest Partners in Flight Priority (PIF 1)
Brown Thrasher	*Toxostoma rufrum*	High Partners in Flight Priority (PIF 2A)
Prothonotary Warbler	*Protonotaria citrea*	Partners in Flight Continental Watchlist
Blue-winged Warbler	*Vermivora pinus*	Partners in Flight Continental Watchlist
Golden-winged Warbler	*Vermivora chrysoptera*	Partners in Flight Continental Watchlist
Cape May Warbler	*Dendroica tigrina*	Highest Partners in Flight Priority (PIF 1)
Canada Warbler	*Wilsonia canadensis*	Partners in Flight Continental Watchlist
Ovenbird	*Seiurus aurocapilla*	Natural Resources Research Institute Forest Bird Monitoring shows significant regional declines
Field Sparrow	*Spizella pusilla*	Highest Partners in Flight Priority (PIF 1)
Grasshopper Sparrow	*Ammodramus savannarum*	High Partners in Flight Priority (PIF 2)
Henslow's Sparrow	*Ammodramus henslowii*	MN Endangered
Swamp Sparrow	*Melospiza georgiana*	High Partners in Flight Priority (PIF 2A)
White-throated Sparrow	*Zonotrichia albicollis*	Natural Resources Research Institute Forest Bird Monitoring shows significant regional declines
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	High Partners in Flight Priority (PIF 2A)
Dickcissel	*Spiza americana*	Partners in Flight Continental Watchlist
Eastern Meadowlark	*Sturnella magna*	USFWS Region 3 Concern List

TABLE 2. Pearson Chi Square results for difference in frequency distribution of birds per species counted by volunteer compared to researcher during the summer 2007 observer validation of bird count data for Mississippi River Twin Cities IBA. Each volunteer team monitored a different site.

Volunteer observer	Pearson X^2 statistic	DF	*P*-value
1	480.21	11	<0.001
2	152.35	16	<0.001
3	25.16	21	0.240
4	66.18	28	<0.001
5	85.11	31	<0.001
6	78.92	32	<0.001

that they were "very likely" to participate in this monitoring program in the future. The majority of respondents favorably rated various aspects of the monitoring program and training session (Table 4). The most challenging aspect of the point count protocol appeared to be the total time required to complete the counts each survey morning (only 25% of respondents rated this as "easy"). While only half of the respondents felt that bird identification during migration was "easy," most respondents felt that the 50 m distance estimation was "easy." Volunteers made several suggestions for potential improvements to the program materials.

Volunteer Profile

Monitoring program volunteers ranged from 30 to 75 years old, with at least one under-18 youth participating with their parent. Gender distribution in the pilot season participants was fairly even and all survey respondents identified as Caucasian/White. All survey respondents had at least some college education, with most having completed a bachelor's degree or an advanced/professional degree. Most were retired or working part-time. Most of the respondents appear to be regular bird watchers concerned about bird conservation. All

TABLE 3. Common characteristics of species missed ("unshared") by either the volunteer observer or the researcher during the summer 2007 observer validation of bird count data for 6 Mississippi River Twin Cities IBA sites. Each volunteer team monitored a different site.

Species	Scientific Name	Shared Characteristics
Blue Jay	*Cyanocitta cristata*	Mean detection distance cut-off >44m
Eastern Phoebe	*Sayornis phoebe*	51–75% detections by sight
Chimney Swift	*Chaetura pelagica*	
Cooper's Hawk	*Accipiter cooperii*	
Northern Flicker	*Colaptes auratus*	Mean detection distance cut-off <35m
Common Grackle	*Quiscalus quiscula*	>75% detection by sight
		Primarily ground gleaners
House Finch	*Carpodacus mexicanus*	
American Robin	*Turdus migratorius*	Primarily ground/low foliage gleaners
Brown-headed Cowbird	*Molothrus ater*	
Gray Catbird	*Dumetella carolinensis*	
Tree Swallow	*Tachycineta bicolor*	
Blue-gray Gnatcatcher	*Polioptila caerulea*	>75% detections by vocalization
Yellow-throated Vireo	*Vireo flavifrons*	

TABLE 4. Volunteer responses to survey regarding utility of Mississippi River Twin Cities IBA Landbird Monitoring Program protocol. Total of 8 volunteers who completed the online survey.

Program Aspect	Percent Respondents	
General	Somewhat Satisfactory	Very Satisfactory
Overall experience in the program	25	75
Survey Materials	Somewhat Helpful	Very Helpful
Main instruction Booklet	57	29
Protocol reminder one-sheet	14	71
4-letter bird codes sheet	43	29
Hand-held GPS unit	25	75
Orange flagging	25	75
Color site maps	38	63
Written description of sampling points	25	25
Site Conditions Form	Somewhat Satisfactory	Very Satisfactory
Clarity and layout	29	57
Ease of use	29	57
Sufficient space for data	29	57
Sufficient detail recorded	29	57
Bird Point Count Datasheet	Somewhat Satisfactory	Very Satisfactory
Clarity and layout	29	57
Ease of use	57	29
Sufficient space for data	43	29
Sufficient detail recorded	57	14
Point Count Protocol	Somewhat Easy	Very Easy
Time required to complete bird counts	0	25
Number of surveys per season	50	13
Navigation between survey points	38	25
Estimation of 50m distance band	88	0
Identification of birds during migration	38	13
Identification of birds during breeding	29	29
5 minute duration of point count	13	50
Using the data sheets	25	63
Operating the GPS	75	13
Pre-Survey Training	Somewhat Helpful	Very Helpful
Introduction to the monitoring project	17	67
Introduction to use of GPS unit	17	67
Practice navigation with GPS	0	67
Practice distance estimations	0	83
Practice point count	17	33

respondents reported bird watching recreationally at least 15 days out of the past year ($\bar{x}$ = 86 ± 23 days), and 7 out of 8 reported bird watching year-round.

Respondents reported participating in a variety of conservation organizations and 63% reported participation in both local and national bird monitoring initiatives during the past year. Respondents listed contributing to scientific research and landbird conservation as the most important reasons for participating in the IBA monitoring program.

DISCUSSION

The spring and summer 2007 pilot of the Mississippi River Twin Cities IBA Landbird Monitoring Program was a successful first step in establishing this program in the Minneapolis-Saint Paul metro. In comparison to the 155 landbird species listed in the IBA nomination, volunteers recorded the presence of 126 landbird species on 7 sites within the IBA during the pilot season. Considering the short duration of the pilot season (15 April to 30 June 2007) it is likely that more species will be accumulated in future years. Moreover, the initial volunteer interest and participation in this program suggests that, with the appropriate resources and support, this landbird monitoring initiative can be self-sustaining and serve as a model for other citizen science-based bird surveys in urban areas.

Managing Observer Variation

The results of the observer validation suggest that inter-observer variation should be considered in future revisions of the protocol. The current protocol dictates a single observer on each site and a single team working each site for the whole season. As the sites are parks and reserves with points located along trails, having the same team remain on one site for the whole season can make navigation easier and allow volunteers to build a rapport with the site. Rather than rotating teams between sites, asking teams to perform double-observer point counts rather than single observer/recorder counts may be the most viable solution when there are multiple volunteers on a site.

In the long term, a reasonable approach may be to assign multiple teams per site, providing the dual benefit of multiple observers and reducing the number of visits required of each volunteer. It is unclear whether the significant differences in the number of birds recorded during the modified double-observer validation are the result of the 10-min delay between observers or actual variation in observation skill. This issue will be addressed by performing a targeted comparison of the 10-min delay method with a both independent and double-observer methods.

Future training should also evaluate volunteers' bird identification skills, hearing acuity, and ability to accurately estimate distances during the point counts. The variation in the number of species recorded by volunteers compared to the researcher during the validation counts suggests that including some bird identification in the training, especially of migrant species, could improve accuracy. Neither the volunteer nor the researcher was more likely to overlook any of the "missed" species, suggesting that the detectability of the birds may be an issue. In this study, some of the unshared species were likely to be identified primarily by sight and others primarily by song. Many of the species missed by either the volunteer or researcher are very common (Blue Jay, House Finch) and may have been unconsciously filtered out while the observer looked and listened for less common species. Some observer variation may be due to differences in hearing acuity. Assessing participants' hearing can enable coordinators to appropriately place volunteers with compromised hearing on teams as recorders.

Certain behavioral traits may also confound observers. During breeding season, some species such as Blue Jays, behave cryptically while they are nesting and may be less easily detected than at other times of the year. Around half of the species unshared during the summer validation forage primarily on or near the ground, a behavior that may make them less conspicuous, especially if an observer is too focused on scanning tree trunks and canopies. Assessing the characteristics of frequently missed species may enable organizers and volunteers to target groups of birds that merit extra attention during training and counts or might be best recorded as merely present/absent.

Other volunteer monitoring programs, such as the Tucson Bird Count (Turner 2003) use online visual and auditory tests to assess participant skill and provide resources for species identification (McCaffrey 2005). While this is an efficient way to offer training to participants, it can be challenging to deliver high quality sound clips at a reasonable cost to the program. In programs where training and evaluation resources are limited, a mentoring system where novices are paired with more experienced volunteers may prove the most effective and efficient way to train new volunteers. Providing first-time program volunteers with a species list for their site may also help them focus their identification practice on an appropriate subset of birds.

Protocol Improvements

Overall, volunteer feedback regarding the pilot season of the monitoring program was positive. Based on the survey and informal communications, some materials, such as description of sampling points, may not be necessary. The intensive time commitment appeared to be an issue for some volunteers; each survey required 3- 4 hrs to complete and the protocol required a training session, six weekly visits during migration, and two during breeding season. Many interested potential volunteers could not meet this time commitment and declined to participate. It will be important to manage the time required for participation such that volunteers receive adequate training and participate in point counts without feeling so overburdened that they stop participating in the program. Increased participation may offer a solution; with sufficient volunteers, teams can split the total survey season between them, cutting the time commitment in half and lessening observer bias on each site.

Building the Program and Engaging Volunteers

An ideal balance for citizen science bird monitoring programs such as this one would be to build a core of skilled birder participants but extend participation into other demographics to bring a dimension of community education and stewardship to the program. The location of this IBA suggests that participants may be drawn from both urban and suburban locales. The Twin Cities metro has a diverse array of groups, including local Audubon chapters, the Minnesota Master Naturalist Program, and nature centers, which may provide future participants and opportunities to engage urban residents with the local parks and birdlife.

One of the more important improvements that we can make to the program as a whole is to establish a permanent online presence. A website that provides a central location for program information and materials and allows volunteers to both enter their own data and view all data from the project will provide multiple benefits. A well-designed online data entry system will improve overall efficiency and quality control and lay the basis for communicating the project's results back to the community. Our objective is to design an online interface that facilitates public outreach, houses project materials, streamlines coordination of volunteers, provides user-friendly data entry to volunteers, and efficiently shares data with multiple databases and entities, such as the eBird online database (Audubon and CLO 2008), National Audubon Society's IBA Database, the National Park Service (a key stakeholder for this IBA), and Audubon Minnesota. Integrating data from this small-scale monitoring program into larger-scale datasets can not only provide context to local observations, but also contribute to Coordinated Bird Monitoring (Bart and Ralph 2005).

Currently, we are tabulating the data in a spreadsheet and sending the volunteers a summary of the results for the entire IBA and results specific to their own sites. The site-specific summaries include both raw counts per species and a colorized chart tracking the seasonal progression of the bird community (numbers of birds of each species over time) during the monitoring period. Volunteers indicated they were especially interested in the latter information. Both the Tucson Bird Count (TBC 2008) and the Monarch Larva Monitoring Project (MLMP 2001) websites allow users to search and view data by location and time, a feature that is invaluable to engaging volunteers and providing timely feedback (K. Oberhauser, pers. comm.). Employing a similar system, eBird's Google Earth mapping application, for this monitoring program will enable the volunteers to access results themselves without waiting for data to be summarized by a third party.

In the long term, we hope that this monitoring program will produce data useful to land managers, planners, and researchers working in urban green spaces. More importantly, we hope that this program and others like it will empower communities to explore and connect with urban nature, participate in the scientific process, and speak out as advocates for their natural resources.

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