NORTH AMERICAN
ORNITHOLOGICAL ATLAS COMMITTEE
HANDBOOK

A GUIDE FOR MANAGERS ON THE PLANNING AND IMPLEMENTION OF A BREEDING BIRD ATLAS PROJECT

Acknowledgments

This handbook is based on the input and experiences of members of the North American Ornithological Atlas Committee (NORAC) and other breeding bird atlas community members, and includes input obtained through meetings, teleconferences, email communications, and editorial review. The principal recommendations have been endorsed by NORAC. Special thanks to Michael Cadman and Matthew Shumar for peer review of the manuscript and associated improvements; Rebecca Stewart for review and editorial assistance; Maureen Garvie for copy editing and proofreading; Kevin Kavanagh for research on atlas publication history (Appendix A); John Lee for layout suggestions; Christine Lepage for reviewing and editing the French translation; and Christian Artuso, Gregor Beck, Carol Horner Ham, John Nishikawa, and Tim Stewart for donating use of photographs. The authors extend their thanks to everyone who contributed to the development and completion of this handbook.

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Canada

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North American Ornithological Atlas Committee Handbook

A Guide for Managers on the Planning and Implementation of a Breeding Bird Atlas Project

Purpose of Handbook

The purpose of this handbook is to facilitate undertaking breeding bird atlases in North America, to encourage the sharing of information and tools between jurisdictions, and to promote standardization of atlassing methods. The handbook contains information on a range of topics of interest to atlas organizers, including planning an atlas, fundraising, volunteer management, data collection and management, mapping, and publication considerations. It is likely to be of greatest use during the initial planning stages of an atlas project, with each chapter providing a relatively broad overview of the types of decisions and management that each stage of the process requires. Chapters are not exhaustive in detail; rather, they identify key issues and information and direct the reader to additional resources. Chapters begin with an executive summary of key points and a series of "principal recommendations" that were developed with the input of atlas experts and the North American Ornithological Atlas Committee (NORAC). These recommendations are intended to help organizers in the decision-making and planning processes. The handbook includes a list of literature cited and a glossary of terms. It also includes a summary of atlas projects to date (1975 to 2018) in Canada and the United States, including date(s) of atlas projects, websites, and available publications for each province and state. The authors encourage those planning a breeding bird atlas to coordinate with nearby jurisdictions and members of NORAC. Similarly, the authors encourage those jurisdictions that have already completed atlases to continue to share resources, information, and experience with others.

Black Scoter, P or D. Photo © Christian Artuso

Chapter 1 Introduction to Ornithological Atlases

Executive Summary. Ornithological (bird) atlases map the distribution, and in many cases, the relative abundance of bird species across a defined geographic region, such as a country, state, province, or smaller region, e.g., county. Many bird atlases have been undertaken in North America and elsewhere, usually with a focus on breeding birds. Most bird atlases are large, complex, multi-year, and multi-collaborator efforts, requiring not only professional staff but also large numbers of skilled volunteers. They are typically led by one or more host organizations, with input from several governmental and non-governmental partners. Atlases rely on hundreds, sometimes thousands, of skilled volunteer participants who gather the bulk of the atlas data, as well as professional staff who manage the project. Because of the large-scale nature of atlases, and the fact that birds occupy most habitats, atlases have tremendous potential to monitor changes in the environment and overall ecosystem health. Projects are thus invaluable from a wildlife management and conservation perspective, and results are used in diverse applications, including species at risk assessments, conservation efforts, land-use planning including environmental assessment, indicators of change in land use and habitat, and academic research. Since atlases are typically repeated at regular intervals (often 20 years apart), successive projects can document changes over time. Because atlases engage volunteers on a large scale, they also contribute significantly to the promotion of nature appreciation and the engagement of Citizen Scientists in bird monitoring, research, and conservation.

1.1 What is an ornithological atlas?

A biological atlas maps the distribution, and sometimes the abundance, of a group of species within a defined geographic area during a set time period. Biological atlases have been completed for various types of organisms from trees to invertebrates to mammals but have most commonly been completed for birds. Because many people can find and identify birds, they serve as excellent ecological indicators. Not surprisingly, then, ornithological atlases, notably breeding bird atlases, have become a mainstay of wildlife monitoring efforts.

Most ornithological atlases focus on *breeding* birds for a variety of reasons. Suitable breeding habitat is an obvious requirement for the completion of the life history of all bird species. Thus, understanding the extent and distribution of breeding habitat is important for conservation planning. During the breeding season, bird populations tend to be relatively stationary, making observations and mapping easier. Many birds are easiest to survey during this period because of the conspicuous behaviour (e.g., songs, territorial calls, and displays) they exhibit. As a result, many aspects of this manual focus on breeding bird atlases; however, most of the principles endorsed in this manual are also relevant to atlases that include data from other seasons, including year-round atlases.

Ornithological atlases typically provide a comprehensive and current geographic distribution on a relatively fine grid for each species surveyed, as well as measures of species diversity in various parts of the region. In addition, there is potential to document previously unrecorded species, species at risk, colonial species, and species not well covered by other standardized surveys. While distribution information may provide some clues to abundance and conservation status (e.g., more widespread species tend to be more common), most modern atlases now gather additional data on abundance or relative abundance, which can be used to determine how population densities vary through the region. These data will allow for more robust estimates of population change over time, including with subsequent atlases.

“First generation” atlases (i.e., the first atlas in a region) provide the baseline to which subsequent atlases can be compared. Subsequent atlases can document distribution changes (expansions and contractions), as well as changes in overall bird diversity and abundance. The intensive spatial coverage of an atlas provides the potential to examine how changes in diversity and abundance are related to factors such as changing land-use patterns (including habitat loss or restoration), changing environmental conditions, climate change, pollution levels, or other human-induced or environmental factors that may influence bird distributions. Some rapid changes may even be detectable within individual atlases from one year to the next. With sufficient sampling each year, the data from an individual atlas project can also be useful for assessing movements and redistributions of irruptive species.

The final results of an atlas project are numerous and diverse, but typically include:

- hundreds of thousands (sometimes millions) of individual bird records tied to particular locations at various geographic scales – an enormous geospatial dataset
- detailed and current breeding evidence maps documenting species' distributions
- relative abundance maps for each species
- detailed information, including location and habitat, for rare and at-risk breeding species

All of these aspects provide a means to assess future or past changes in bird distributions, i.e., a baseline for comparison with previous and future atlases, as applicable.

The geographic region or area to be surveyed for an atlas may be large or small, depending on the project's needs and goals. The area is typically defined by political boundaries, often the jurisdiction for which management decisions are made. In North America, atlases are most commonly completed at the state or province level, but some have been completed on larger scales (e.g., covering the three Canadian Maritime provinces: Erskine 1992, Stewart et al. 2015) or smaller scales (e.g., county level in some states). Elsewhere in the world, atlases sometimes encompass whole countries, several adjacent countries, or even continents (e.g., Spain: SEO/BirdLife 2012; Britain and Ireland: Balmer et al. 2013; Australia: Barrett et al. 2003).

Atlases typically divide the area to be surveyed into a grid, with some or all grid units sampled to document species present. Data recorded include information on species detected in the grid unit during each year of the atlas season, typically with information on breeding evidence. Many atlases now include some measures of relative or absolute abundance, and sometimes habitat information. Additional detail is often recorded for regionally rare species or species at risk. These data are then compiled and depicted on maps, providing a visual representation of each species' distribution and, if applicable, abundance. One of the most important products of an atlas is the detailed database with the maps, but most atlases usually produce a publication as well, including written accounts that further describe and interpret the data presented. Many first-generation atlases were published only in bound book format, but projects are increasingly making use of the Internet (or other electronic formats) for both project coordination and publication of results.

Atlases typically collect data over a five-year time frame, although there are exceptions. Five years is generally considered to provide a reasonable balance between maximizing coverage and detection and minimizing costs and time. Keeping the duration of atlas fieldwork to as few years as practicable reduces the possibility that changes in populations or geographic range *between* atlases will be confounded by changes *within* the atlas survey years. Smaller projects may finish in less time, while larger areas, particularly those that are remote or difficult to access, may require longer. Atlases are often repeated at 20-year intervals to monitor trends in distribution and abundance. Interestingly, the current Australian and South African atlases have evolved into continuous projects with no established end dates. Such approaches may be appealing, particularly in areas without alternative long-term monitoring or data collection programs; however, they can also present logistic challenges for fundraising, maintaining support, and encouraging comprehensive coverage within a finite time period, particularly in areas that are more challenging to access. The more drawn out the atlassing period, the less clearly it represents distributions at a finite point in time.

The majority of Canadian provinces and American states have completed at least one breeding bird atlas (see Appendix A), as have many European countries. Atlases mapping non-breeding birds are less common but have been completed in countries such as Britain and Ireland (Balmer et al. 2013) and Spain (SEO/Birdlife 2012) and in some North American regions (e.g., Louisiana, Ohio, and Oklahoma). Some year-round atlases have also been conducted, such as in Australia and South Africa, in part because many species are year-round residents. These atlases can be particularly valuable for understanding seasonal patterns of distribution and breeding behaviour if surveys are repeated throughout the year and full phenological information is collected.

Most atlases rely heavily on both volunteers and professional staff. Successful projects may involve the participation of hundreds, sometimes thousands, of skilled volunteers with the time, skills, and resources to participate. Typically, atlases engage the support of a host organization that serves as the organizational base for the project. The host group and partner organizations and agencies generally appoint a steering committee to oversee and guide the project as a whole. Project management is typically provided by a dedicated coordinator who works with the steering committee, host organization, partners, committees, staff, and volunteers on all aspects of the atlas. A network of Regional Coordinators (typically, volunteers) is often assigned to sub-regions within the atlas area to coordinate work of the volunteers and to ensure adequate field coverage at the more local level. Together, project organizers take on all atlas activities from project conception to completion, including project design; volunteer recruitment and training; preparation of information packages, grid maps, and data forms; fundraising; data gathering and review; website creation and maintenance; data management and analysis; Geographic Information System (GIS) analyses and mapping; and preparation of final publication materials.

1.2 What is the value of an atlas?

The data collected through atlas projects can be extremely valuable for informing decision-making on conservation issues, for long-term monitoring of populations, and for research. Few other sources of data provide such a complete picture of geographic distribution within a region or such detailed information on changes in distribution over time. Abundance data can offer insight into species' rarity and overall population sizes and trends that can be difficult to assess accurately at local or regional scales from other established, long-running programs. These and other analyses of atlas data have been used to assist with conservation planning at local and regional scales and have been applied to environmental impact assessments; they have supported evaluations of the necessity for legal protection of rare species, helped identify areas that would benefit from special protection, and helped evaluate potential causes of population changes. The data are also useful for academic investigations on species, ecological communities, and habitat associations.

In addition, atlas projects are an excellent opportunity to engage the local community in conservation and nature appreciation. Participants at all levels of experience may take part, provided that a balance of skill levels exists in all grid units. Participants can contribute to data collection as their abilities allow; even beginning enthusiasts can submit casual observations for their incidental encounters. Often, more experienced atlassers enjoy taking novice participants into the field to teach them field methodology and identification skills. Atlases also offer the chance to engage the general public through direct contact with landowners, encounters with outdoor enthusiasts, and directed interactions outside of the traditional nature community. Many birders trained through atlas projects later participate in other bird monitoring programs such as the North American Breeding Bird Survey.

Conservation planning

Atlas data can answer a broad range of questions in full or in part. What areas or habitats are most valuable for birds that might need conservation or stewardship efforts? How can conservation goals be met while accommodating development? What areas or habitat types are particularly important for the conservation of priority species or species assemblages? What areas represent biodiversity hotspots for birds? What is the jurisdictional or stewardship responsibility of a region for the conservation of certain species?

Repeated atlases also provide population comparisons that can help set conservation priorities and guide actions. Which species are declining in distribution or abundance, and which are increasing? Can these changes be linked to changes in habitat that might suggest management actions? Do these trends warrant additional legal protection for species? For example, data from atlases are being used in Canada by species at risk assessment committees to determine species' eligibility for listing under the national Species at Risk Act or equivalent provincial or territorial legislation. This listing may provide legal or policy protection or identify stewardship opportunities. Detailed geo-referenced data gathered on significant species may also be useful for identifying critical habitat areas for species at risk, which in turn may lead to legal protections for species at risk habitat (e.g., Whittam et al. 2015).

Environmental assessments and site inventories

While the resolution of most atlas data is typically not precise enough to evaluate individual project sites, atlases do provide a pool of species expected to occur in the area being inventoried or assessed, which can then be searched for. This pool can highlight potential species at risk that may occur in a site, and can prompt additional or specialized surveys for species not readily detected during basic standardized surveys such as point counts. An atlas also provides a baseline that can be useful for evaluating species data from project level surveys; for example, how does diversity or species abundance at the site compare to that in the surrounding landscape? Is the site more or less rich than other adjacent habitats? In addition, some atlas data may be specific enough to be of value for detailed environmental assessments and inventory purposes.

For example, point count data or significant species data (e.g., species at risk, colonial species) often have precise coordinates that may be relevant to particular sites.

Evaluating impacts of local, landscape, and environmental change

Declining populations or the disappearance of species from regions, both of which may be indicated by atlas data, may signal changes in habitat quality. Atlas data can also help to evaluate the effectiveness of habitat restoration or management actions, or help to assess large-scale environmental changes such as forest regeneration or climate change. Combining atlas data with habitat information gleaned from satellite images, soil and watershed databases, land-use statistics, and other externally collected data can be very helpful to land managers and for land-use planning exercises. For example, some conservation groups (e.g., Bird Studies Canada, Nature Conservancy of Canada, and local land trusts) are using fixed location point counts to monitor bird populations as part of their conservation efforts. These efforts include monitoring priority habitats to ensure that management techniques continue to support target species, as well as tracking the effectiveness of habitat restoration activities on lands formerly in agriculture or other land uses. In addition to implementing atlassing methodologies, these monitoring efforts often use point count locations established during atlas projects for ongoing monitoring with the benefit of atlas data as a baseline.

The large-scale nature of breeding bird atlases also provides an opportunity to gather vast amounts of data not only on birds but also on other species and changes in the broader landscape. While organizers may worry about potentially overloading volunteers with requests for additional data, many projects have found that volunteers gladly collect data on selected environmental variables such as particular habitat features, land use, levels of insect infestation, and other readily observed variables, especially when given a clear indication of how the information might be used. Supplementary data can support planning of conservation actions as well as research into causes of population change.

Building a body of conservation enthusiasts and volunteers

Atlassing is an extremely enjoyable and popular pursuit in its own right. Tens of thousands of volunteers have participated in atlas projects in North America, in part because of the potential to contribute to an important biological wildlife monitoring and conservation project. Many people, however, participate largely because they enjoy birdwatching, time spent in nature, or the outdoor recreation aspects of the activity.

Participating in a meaningful, nature-focused activity is an important and enjoyable enough reason for many to help with atlassing. It is also a great way to engage the public, landowners, and youth in Citizen Science and environmental monitoring projects; such engagement can lead to participation in other projects and provide meaningful training opportunities for young persons. Atlassing can engage people with a wide range of interests, from professional ornithologists focused on quantitative surveys, to dedicated birders trying to maximize their species lists, to casual naturalists with a general interest in birds or a focus on a particular species group such as owls. While organizers' primary concern may be ornithological, the importance of volunteerism should not be underestimated. As well, many funding opportunities focus in whole or part on the engagement of the volunteer sector.

1.3 Why use an ornithological atlas?

Strengths of atlas projects

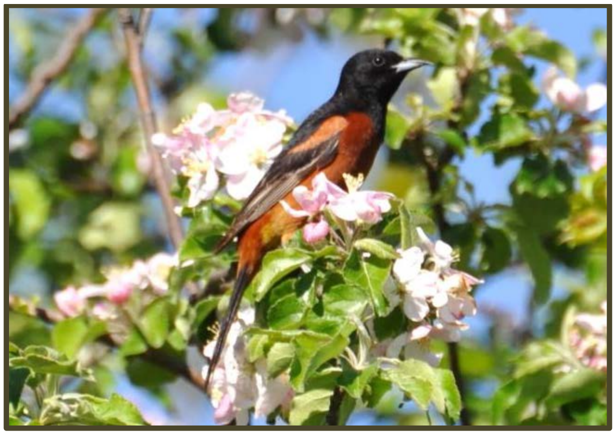
Atlases, like any survey method, have strengths and weaknesses. They can be used to provide comprehensive coverage of species at a relatively fine scale across a large geographic area, something not typically accomplished by other surveys. For instance, the North American Breeding Bird Survey (BBS) covers only certain randomly selected roadsides and provides only a single snapshot of species detected on a single morning each year at various points along the route. Over a large geographic region (e.g., a bird conservation region or a province/state), the BBS may cover most habitats, but in a local area many habitats will not be adequately sampled, and many less conspicuous species are likely to be overlooked. Checklist programs such as eBird have fewer restrictions on sample design, thus potentially covering additional habitats. However, without guidance through a sampling design such as an atlas, many birders tend to visit the same sites repeatedly, resulting in very uneven geographic coverage. Atlases encourage birders to go to many sites they might otherwise never visit, providing much more comprehensive coverage as well as large numbers of new locality records, including for many priority species such as species at risk. Nevertheless, there are many similarities between checklist programs and atlases, and atlases can often benefit from checklist data and vice versa; some atlases are now using a data entry platform built on the foundation of eBird.

Atlases have the objective of sampling all habitats within a grid unit (e.g., a 10 x 10 km grid), providing relatively comprehensive information on the local community. This comprehensive information can be used to estimate the number of species actually present in any given geographic area, thus providing more precise information on distribution and regional abundance, and more accurate range maps than those produced by other survey methods. Atlases also tend to provide more comprehensive and precise information on species at risk, many of which may be tied to rare habitats that are poorly sampled by other surveys. By capturing data on all species at once, they can be more efficient than specialized single-species surveys. They also collect much more detail on the breeding status of species through the use of breeding evidence codes; and breeding phenology data are typically collected as part of routine atlassing protocols. Atlases typically lead to new information on the distribution of species at risk by encouraging visits to areas that have not previously been visited by birders. Detailed data collected about species at risk (e.g., precise locations of breeding habitats) can help monitor populations as well as identify key habitats or areas where conservation efforts can be targeted. Finally, atlas projects can incorporate the effort of birders of all skill levels, since even novice birders can contribute data for the species with which they are familiar.

Limitations of atlas projects

Atlases are extremely large, multi-year undertakings that are time consuming and challenging to coordinate and execute. Dozens of people are required to help organize an atlas project, and typically hundreds (or even thousands) of people participate. As a result, atlases tend to be relatively expensive, even though much of the surveying and many other tasks are completed by volunteers. In some regions, it may be difficult to find enough volunteers of sufficient ability to achieve complete coverage goals, especially in more remote regions, thus requiring extra funds to hire staff to fill gaps. The large number of surveyors with variable birding skills participating in an atlas can lead to incomplete data and extra work on data quality control.

The intensity of geographic coverage also comes at the expense of frequency of coverage; for example, while most BBS routes are repeated every year, atlases are typically repeated only every 20 years.



Orchard Oriole, H. Photo © Gregor G. Beck

Chapter 2 Planning and Funding a Breeding Bird Atlas

Executive Summary. Breeding bird atlases may be led by a single organization or agency, but the use of effective collaborations can provide great advantages. Establishing clear roles and responsibilities and appropriate administrative and technical committee structure will help to ensure good collaboration and smooth progress in diverse areas. While atlases rely heavily on volunteer participation for data collection, successful and timely completion of most atlases also depends on the support of paid staff, most importantly a full-time project coordinator. As well, developing a detailed, multi-year budget is essential for project planning and fundraising. Comprehensive atlas projects for large jurisdictions may require millions of dollars of cash and in-kind support to achieve good coverage. All possible funding options, including support from partners, funding agencies, corporate sponsors, and donors, will need to be explored, and fundraising may require considerable time. Collaborating and coordinating with other atlas projects, especially on tasks such as data management, mapping and analysis, can lead to significant cost savings and other efficiencies and greater project success.

Principal recommendations

- Establish a clearly defined management and committee structure to oversee all aspects of the atlas project. Collaborations involving a mix of non-governmental organizations and governmental agencies can provide diverse and complementary strengths. Clearly establish each organization's roles and responsibilities, including project lead, and determine how decisions will be reached.

- Establish committees to oversee the administrative and technical aspects of the project.
- Hire one or more staff whose job and sole responsibility is the management and coordination of the project.
- Develop a detailed, multi-year budget, fundraising plan, and work plan from the outset.
- Communicate with other regions, provinces, or states to determine the most appropriate timetable for completing atlases in each jurisdiction so that competition for resources will be minimized.

2.1 Management structure

Atlases may be operated by a single organization or agency or as collaborations among several groups. Both arrangements have advantages and disadvantages.

Single organization

Decisions may be made more quickly and efficiently within a single organization since there are likely fewer steps and less complexity in the decision-making process (i.e., fewer groups to consult). However, few organizations have sufficient resources to plan, fund, and implement single-handedly a project as large and long running as most modern breeding bird atlases. Even if there is only one lead organization, there will almost certainly be involvement from collaborating partners through a committee structure. The active engagement of additional collaborators has the added benefits of ensuring that the project meets the needs and conservation objectives of multiple groups and increasing buy-in for use of the end product.

Collaboration

Although decisions may take longer and the potential for disagreement is increased, an atlas project can be run effectively through collaboration. Each participating organization/agency has strengths and weaknesses, and these generally balance each other over the duration of the project. When selecting collaborators, make sure that a range of strengths is included, rather than all having the same or similar strengths. Collaborating groups are usually a combination of governmental agencies and non-governmental organizations (NGOs). Museums, universities, or colleges may also participate. Involving local and regional birding organizations can be important for recruiting volunteers and building support. Having a management structure that includes both NGOs and governmental agencies is often beneficial; for example, governmental agencies and NGOs may have access to different resources (e.g., financial, cartographic, data management, or in-kind support). Some potential funding organizations will only make grants to registered charities, whereas some governmental agencies may be able to access internal funds or provide in-kind support for travel to remote regions, data management, or mapping support. Regardless of the management structure and composition, the development and signing of a memorandum of understanding is prudent and helps to clarify roles and responsibilities.

2.2 Lead organization

If the atlas project is a collaboration, one organization should take the lead in managing the project overall. Having a single lead organization or agency streamlines decision-making and makes execution of actions more efficient. However, all organizations involved should have input into decisions and clear roles. Decide early, and establish clearly, how decisions will be reached in the case of multiple opinions. In addition, identify the types of decisions that can be made by the host organization/agency versus the types of decisions that should be brought to the steering committee. Typically, each collaborating group would be represented on the project's steering committee, with roles and responsibilities set out in a terms of reference document.

2.3 Administration and staffing

Committees

The successful completion of an atlas project involves many components, but they can be broadly defined under two major categories, administrative and technical, both overseen by a steering committee that guides the project as a whole. Each atlas will likely have multiple committees or sub-committees operating under these major themes to oversee the management of each side of the project. Typically, committees and sub-committees report back to the steering committee. Committees serve not only to supervise project operations but also to communicate back to the lead organizations/agencies. It may also be worth considering including individuals from other organizations, outside the lead organizations, who have useful expertise and experience in managing large-scale, long-term, volunteer-based projects. Similarly, it could be very beneficial to include individuals who have been involved in the management of other atlas projects.

Steering committee: Responsible for overall project oversight, including staffing, budget oversight, finances, general project progress, administration.

Administrative committees: Handle such items as inter-collaborator cooperation, project structure, funding, staffing, budgeting, and project development. Specific committees/sub-committees may include a volunteer committee, fundraising committee, and publication committee.

Technical committees: Deal with project design, the collection of data and production of results, data handling, data interpretation, field and instruction materials design, fieldwork design, error checking, data analysis, and mapping. Specific committees/sub-committees may include a data management committee, significant/rare species review committee, abundance data committee, and data analysis committee.

Staffing

A project of the scale of an atlas cannot generally be run by volunteers alone, at least not without full-time support, paid or volunteer. Having individuals whose job and sole responsibility is the management and coordination of the atlas project helps to ensure that tasks are completed efficiently and on schedule. Depending on the scale of the atlas and the stage of the project, two to four full-time individuals may be required, along with some additional part-time support for tasks requiring particular expertise (e.g., GIS analyst, website development, database management). Individuals on the payroll of partnering agencies may lend their time and skills on a part-time or even full-time basis as well.

Tasks best undertaken by paid staff rather than volunteers include:

- overall project coordination
- data handling (including database management)
- GIS mapping and analysis
- fundraising
- inter-agency liaison
- resource mobilization (i.e., overseeing effort across the region to ensure adequate coverage)
- hiring and training of seasonal staff and paid field crews

- production of written materials (e.g., atlas manual, newsletters, website content)
- volunteer training and management (often in conjunction with volunteer regional coordinators)

During the period of fieldwork, it will be necessary at a minimum to have one person working full-time to manage the overall project. This is typically a paid staff person but could be a full-time volunteer. This coordinator is usually responsible for fundraising, coordinating volunteers, overseeing data collection, and developing budgets and annual operating plans. Depending on the size and scope of the atlas, a second individual may be needed to assist with these and other administrative tasks. Assistance will also be needed once fieldwork is complete and data are being reviewed and analyzed and the results prepared for publication. Further support may be required to assist with publication (e.g., copyediting, translation, graphic design and layout, map production, website design, etc.).

2.4 Project funding

Budgeting for an atlas project

Funding is necessary not only to support any paid staff but also for production and dissemination of project materials, travel expenses, database management and web support, data analysis, and publication of results, as well as general overhead expenses. An atlas project cannot be completed without some significant dedicated funding, with at least some of that confirmed on a multi-year basis.

The host organization, along with the steering committee and senior project staff, should carefully develop an anticipated budget for the expected expenses of their project over its duration. Consider both large expenses (e.g., salaries, travel, data management systems, publication) and small (e.g., office supplies, computers, printer inks, photocopying, postage). Some expenses could be considerably higher than anticipated – for example, contracting data management services. Try to develop an estimate of how much the project will cost to complete on both an annual basis and overall. Be realistic and thorough and include contingencies. Depending on the scale of the jurisdiction, do not be surprised if the *annual* operating budget is into the hundreds of thousands of dollars. While some budget items can be eliminated or scaled back if there is difficulty in obtaining funding, others cannot without compromising the whole project. If significant funds are not available to support the project throughout the defined period, consider postponing until such time as adequate funding can be assured. Be honest, and avoid the temptation to underestimate funding needs with the excitement and optimism generated by a new, exciting project.

Sources of funding

Funding can be obtained from two primary streams: contributions (cash and in-kind) from project partners, and fundraising from external sources. Funding opportunities change considerably over time, and hard economic times can make things particularly difficult. Raising sufficient funds for a project as large as a breeding bird atlas will always be challenging, but the positive conservation outcomes and large-scale volunteer engagement present promising opportunities.

Project collaborators are an obvious source of funding, although they may not necessarily be the primary source, depending on the size of the organizations involved and the amount of discretionary funds each has at its disposal. For example, while some government agencies may be able to redirect existing staff to support an atlas, most NGOs have relatively little discretionary funding and depend on fundraising. Not all collaborators will have the means to support the atlas project on a financial level. Even with those that do, their contributions can rarely support the project in its entirety.

Even if partners cannot provide cash support, they may be able to provide in-kind assistance. This may include part-time or full-time use of specially trained staff (e.g., GIS experts), participation of senior science staff, administrative support and bookkeeping, office space, website hosting, travel, printing/plotting services, maps, etc. Use the detailed budget developed prior to beginning the project to see if any items can be covered by in-kind contributions from partners. The less cash that must be raised, the easier it will be to meet funding goals. Being able to show significant matching support, both cash and in-kind, from project partners is an important – and often essential – aspect of successful fundraising.

External sources of funding are typically in the form of grants, contributions, and donations. This support is typically from charitable foundations, government (or other) granting agencies, corporations, businesses, and private citizens. Larger contributions generally come from traditional granting agencies and foundations, though non-partner NGOs and corporations may also contribute sizable amounts. Some agencies and donors may also offer in-kind support that offsets what would otherwise be cash expenses for the project. In many jurisdictions, summer student work grants (typically, governmental sources) may be available to support the hiring and training of student or youth positions. Much of this funding is targeted at undergraduate or graduate students as well as recent graduates. Students can often support fieldwork as well as many aspects of project management (e.g., preparing and distributing materials to volunteers; data entry and data management).

Fundraising

Raising the funds necessary to complete an atlas will be a major undertaking, likely involving a very significant portion of the atlas project staff time. Assistance from senior staff from the host as well as partner organizations will likely be required. Obviously, identifying and applying to prospective funders with a strong connection to birds, wildlife, environment, and the geographical area of your project is important. However, consider other less obvious funding sources – for example, those that have a strong interest in supporting the volunteer sector, the outdoors, and innovative approaches to outreach and education. Be aware that many funding agencies have firm deadlines for applications (many just once per year), specific formatting requirements, and strict guidelines about eligible expenses, eligible recipients, etc., so be sure to research opportunities carefully. Corporations operating in the atlas region may also become major atlas supporters. Many grants have stringent reporting guidelines, so be prepared for the time involved not only in seeking funds but also for reporting. Collaboration with university or government researchers can be a valuable way to strengthen funding proposals; atlas data can be used to address many specific academic or conservation oriented questions, while field research projects, especially in remote areas, can be a good opportunity to fill gaps in atlas coverage.

Smaller-scale fundraising activities and donations from individuals may also help to support an atlas project, although typically at a much more modest level. Appealing to private citizens, usually those involved in the community for which the atlas is being completed (e.g., the birding community), may provide one-time or annual contributions to the project. Exposure and publicity are helpful in raising awareness of the project, which may in turn lead to greater financial support (particularly among individuals and corporations). Ornithological organizations, naturalists clubs, “Friends of” organizations, and others with an interest in nature are all possible supporters. With respect to individual donations, make it easy for people to donate. Provide an online payment option in addition to traditional mailed-in personal cheques. (This would generally be coordinated through a partner NGO, especially one able to issue donation receipts for income tax purposes.) Donations from individuals and companies can also be used to help underwrite the costs of publishing a print version of the atlas; for example, for a set fee, a company or individual or club could sponsor a certain species in the book (or web versions). This is a popular and potentially quite significant source of revenue – especially in the later, publication stages of an atlas. For example, the second Ohio Breeding Bird Atlas project raised $14,000 toward its book publication this way (Rodewald et al. 2016).

Track all grants, donations, and provision of in-kind support, etc., carefully in a master database so that supporters are fully recognized in publications, newsletters, and websites. Be sure to maintain detailed records about volunteer contributions, including time spent on various aspects of atlassing (i.e., hours of fieldwork, travel, and data entry), distances driven, etc. Keep track of obligations made to funders and supporters, both promises made by the atlas project itself as well as obligations made through contribution agreements for grants. Decide from the outset how funders, sponsors, and donors will be recognized and remain consistent throughout the project. Be sure to consider whether there will be different recognition for different levels of funding.

2.5 Timeframe for an atlas

It is important to develop a clear and realistic timeframe for the atlas, both for budgeting sufficient funds and staff and to ensure that all partners and funders have realistic expectations. Typically, the project will need to start at least one year before fieldwork begins, will involve about five years of fieldwork, and will require at least two years to complete data management, analysis, reporting, and publication.

A typical atlas will need to have a partnership agreement in place and funding for a coordinator and at least some support staff at least 1 to 1.5 full years prior to the planned start of fieldwork. Many tasks and decisions need to be completed during this period, including fundraising and engaging partners, building the database and maps (see Chapters 9 and 10), developing the sampling frame and sampling strategies (Chapters 4 and 5), developing a network of Regional Coordinators and recruiting volunteers (Chapter 8), and preparing atlas materials for surveyors (such as maps, data forms, and instructions). In some cases, if any novel data collection procedures are proposed (e.g., for quantitative sampling or for supplementary habitat data), it may be worthwhile to do some pilot work to ensure that those procedures will work well for volunteers. Changing procedures after an atlas is started can cause confusion to volunteers and compromise data quality.

Most provincial and state atlases have usually planned for fieldwork to run for about a five-year period (Chapters 3 to 5). This is generally considered a reasonable compromise between trying to collect as much data as possible with available volunteer and staff resources and maintaining interest, keeping costs under control, and minimizing the amount of change taking place during data collection. However, atlases in smaller regions, especially with large numbers of volunteers, could potentially be completed in a shorter time, while atlases in large, remote areas with limited numbers of volunteers may require longer periods.

Finally, it is important to allocate sufficient time (typically about two years) after the end of fieldwork for data management, including validating and correcting records, importing data from other sources (e.g., other surveys that took place during the atlas period from the same geographic region, such as the Breeding Bird Survey), analyzing data (Chapter 11), preparing maps (Chapter 10), writing species accounts, and finally publishing the atlas (Chapter 12), whether online or in hard copy. Checking and reviewing data on an ongoing basis and planning analyses and mapping techniques in advance are important to ensure that the atlas publication will be completed on schedule.

2.6 Coordinating among atlas projects

Sharing data

As more atlases are completed across a broader geographic range (e.g., in more states and provinces across the continent), sharing data between regions can help build an informative picture of the distribution and abundance of birds on a broader scale. To compare data between projects easily, or to use data from one project in another, methodology should be similar, if not identical. For example, such elements as the size of grid units, the breeding codes used, the survey method used to collect abundance data, and the way that effort is recorded should ideally be the same.

If starting a new project for a region, compare the methodologies used by surrounding atlas projects and decide if it would be possible to adopt their methods for your atlas to facilitate data sharing and combined data analysis (for broader-scale views). Even if it is not possible to match your methodology to that of neighbouring projects (for instance, if this is a second project for the region, and there is a need to match certain aspects of methodology to the first for change analyses), make your data available for the use of others.

Competition with other atlas projects for resources

Given the length of time required to complete an atlas project, and the number of states and provinces in North America, it is inevitable that multiple projects will be running concurrently. In some cases, this situation has the potential to create competition for limited resources, either financial or personnel. While some potential funding resources may only be available within a particular geographic region (e.g., state or provincial funding, and local naturalists groups), other support such as federal agencies, national non-government organizations, agencies, or corporations could potentially support atlases in many different regions. Timing atlases asynchronously may reduce competition for limited financial and human resources. For example, the Canadian Wildlife Service and Bird Studies Canada have both supported most provincial and regional atlases in Canada; they have developed a schedule to spread out the atlases in Canada, allowing resources to be shifted among atlases over time.

Volunteers are another resource that may potentially be shared by neighbouring atlas projects. If nearby atlases run asynchronously, volunteers from one region may be willing to travel to other regions to support those atlases.

Running atlases at the same time

In other cases, synergies may result from having multiple regions covered at the same time. For example, two or more adjacent states, provinces, or regions may choose to prepare a joint atlas under the coordination of a single group of partners, managed by a single set of staff. This arrangement can help avoid duplication in effort and materials and can reduce the amount of funding needed. It may create greater challenges for some of the coordinating staff, but where the time needed for tasks is independent of the number of items/records involved in the task (e.g., development of data management systems and analysis of data), the result may be a net saving of time. As an example, both the first and second breeding bird atlases in the Canadian Maritime provinces were done as joint efforts in New Brunswick, Nova Scotia, and Prince Edward Island (Erskine 1992; Stewart et al. 2015).

Sharing resources (regardless of atlas timing)

Sharing documents, forms, software, web applications, etc., with other projects can reduce expenses for future projects while also helping to enhance consistency. It is worth asking other projects if they are willing to share their materials. Adopting existing data management systems can be especially cost effective. Even if existing materials are not exactly what is needed, modifying them is often easier, faster, and less expensive than building something from scratch. When using other projects' materials, ask what they would change or improve if they were to create similar materials again, and make those improvements.

To help ensure more effective coordination amongst the breeding bird atlas community, many regions are collaborating and planning on a larger scale. In the United Kingdom, the British Trust for Ornithology is a central repository for all regional atlas projects, and Trust staff serve as advisors on new and ongoing projects, bringing experience and expertise to each. Canada has a national atlas committee with representatives from government and non-governmental agencies involved with past, present, and future atlases. And, across North America, NORAC shares information on various aspects of atlassing.

Pacific Loon, FY. Photo © Christian Artuso

Chapter 3 Recording Species Evidence and Effort Data

Executive Summary. The establishment of standardized approaches and standard codes for recording breeding evidence has made comparisons among atlas projects simpler and more meaningful, and may reduce confusion for participants. Collecting data through the use of separate checklists for each visit and site is strongly recommended to provide information for analyzing detectability, to facilitate more accurate recording of effort, to obtain more precise phenology information, and to enable sharing data with other programs such as eBird. Participants should be encouraged to submit data promptly to help in managing atlas progress and to allow for timely feedback on atlas progress. Atlas volunteers have the potential to collect many different types of data and so should be encouraged to collect additional data on abundance, species at risk, or other variables that would enhance the value of the atlas. Similarly, atlas participants should be made aware that all records are subject to scientific review, that additional information may be required to document certain records, and that not all records submitted may be included in the final project results. Volunteer atlassers represent a diverse community of various skills, particularly with respect to computer and Internet familiarity, so data forms and data submission options should reflect this diversity. Establishing clear coverage goals, based on reasonable effort, will be important for managing available volunteers effectively.

Principal recommendations

- Adopt a standardized set of breeding evidence codes that are compatible with the recommended codes, presented below for use across the North American breeding bird atlas community. If different codes must be used, ensure that they can be mapped readily to the standard code definitions.

- Record data in the form of checklists, using a separate checklist for each date, visit, and location (as is currently done for eBird).
- Encourage collection of complete checklists (all species detected during the survey) including documentation of effort, but allow for submission of partial checklists (e.g., casual observations) which only include selected species.
- Gather data on all bird species, including non-native species.
- Provide training and support to atlas participants to ensure that codes are used correctly, and to encourage greater participation in the gathering of abundance and other data beyond basic breeding evidence.
- Publish "safe dates" for the collection of breeding evidence, abundance, and other data.
- Provide multiple options for data submission to maximize participation by the birding community. Most birders can be expected to use online submission tools, but some users may only be comfortable with paper forms. Mobile apps allowing for direct data capture in the field can be expected to become increasingly popular.
- Develop appropriate targets for minimum coverage of each grid unit based on hours, habitats, and/or proportion of expected species detected.

3.1 Standardized breeding evidence codes

When it comes to deciding what and how to record data for your atlas project, a standardized approach has many advantages. Standardization allows for more reliable data analyses and comparison of results within a project, between successive atlas projects, and among atlases of different regions. Standardized codes also reduce the risk of errors by birders working on different projects and facilitate use of shared software for data entry and management.

Typically, for each observation or species detected, the breeding evidence associated with that observation falls under one of three broad categories: Possible, Probable, or Confirmed. Species observed without breeding evidence are classified as "Observed." Breeding evidence is further classified by a code denoting the specific evidence observed (e.g., NB = nest building). While the understanding of what types of breeding evidence/behaviour constitute possible, probable, or confirmed breeding may vary among species, standardized codes facilitate accurate documentation of that evidence.

The following is a list of recommended breeding evidence categories and standardized codes for atlases in North America.

OBSERVED

X (or O or blank): Species (either male or female) observed in a grid unit during an atlas visit but not in suitable breeding habitat, or outside “safe dates” (i.e., during a period when migrant individuals of the species or other non-breeders such as moult migrants are likely to be present). Such an observation does not constitute evidence of breeding. (An X or O is analogous to not entering a breeding evidence code in eBird.) This code could also be used for sub-adults of some raptors or other species that are not known to breed while still in sub-adult plumage. Allowing atlassers to use a blank code for “observed” can speed data entry, especially for early-season atlassing when many birds may be on migration, but if a blank code is allowed, atlassers should be reminded to verify that they did not forget to enter a breeding evidence code.

F: Individual seen **flying** over a site, of a species that is unlikely to be breeding near the location where it was observed. There is debate on the utility of this code, especially as the bird may be breeding elsewhere in the grid unit. This code, if adopted, may be most useful on point counts to indicate that the bird is not actually breeding near the point count location.

POSSIBLE

H: Individual of a species (either male or female) observed in suitable breeding **habitat** during its breeding season. This code should also be used for species such as raptors, herons, or swifts at foraging sites that are used during breeding season, if they are likely within daily commuting distance of a nesting site in that grid unit.

S: Singing males or other territorial behaviour (such as drumming) in suitable breeding habitat in nesting season.

PROBABLE

M: Multiple singing/calling/drumming individuals (at least three) displaying territorial behaviour in different locations during one season in a single grid unit and in suitable nesting habitat during the species' breeding season. This code should only be used within safe dates and should be accompanied by information on the number of individuals detected. Some atlases have not used this code, while others have required a higher threshold (e.g., seven in Quebec). However, if there are at least three different territorial males (as opposed to one or two lone males), it is probable at least one of them will have a mate and breed.

P: Pair observed in suitable nesting habitat during breeding season.

T (S7 or T in eBird)**:** Individual defending a **territory**, presumed through territorial song, the occurrence of an adult bird, or other territorial behaviour at the same location in breeding habitat, on at least two occasions seven days or more apart in the same season.

D (C in eBird)**: Displays** or courtship involving a male and female (e.g., courtship feeding, copulation) or antagonistic behaviour between two or more individuals (e.g., territorial disputes or chases), in suitable nesting habitat during the species' breeding season.

V: Visiting probable nest site.

A: Agitated behaviour or anxiety calls of an adult.

B (PE in eBird)**: Brood** patch on adult female or cloacal protuberance on adult male.

N (B in eBird)**: Nest** building by wrens or excavation of holes by woodpeckers.

CONFIRMED

NB: Nest building at the actual nest site, or adults carrying nest material.

DD: Distraction display or injury feigning.

NU (UN in eBird)**: Used nests** that were occupied or eggshells from eggs laid in the same year they were found.

FY (FL in eBird)**:** Recently **fledged young** (nidicolous species) or downy young (nidifugous species), including those incapable of sustained flight.

AE (ON in eBird)**: Adults entering**, occupying, or leaving nest sites in circumstances indicating an occupied nest (e.g., sitting on nest).

FS: Adult carrying a **fecal sac**.

CF: Adult **carrying food** for the young.

NE: Nest containing **egg(s)**.

NY: Nest with **young** seen or heard.

Notes

1. Most breeding evidence codes for Possible or Probable (especially H, S, M, P, T) should only be used within the pre-determined and disseminated "safe dates" for that species, when most individuals detected are likely to be on their breeding territories (see below).
2. Possible and Probable categories are represented by single letters, confirmed by double letters. In most instances, the letters selected represent a mnemonic aid.
3. For codes NE and NY, presence of cowbird eggs or young is confirmation of both cowbird and host species.
4. Codes are presented in order of lowest to highest confidence of breeding evidence; e.g., P (pair) is considered higher evidence of probable breeding than M (multiple).

Modifications to these codes may be made as required to meet the needs of individual projects, but should not change the definitions (e.g., if a project chooses to use a code other than "NB" for nest building, the definition of what constitutes nest building should be the same as other atlases). For example, the most recent Quebec atlas chose to use codes that represent mnemonics for French translations of the codes, but the codes relate to the same definitions. However, the fewer changes made, the easier it will be to do comparative analyses between atlases and regions and to use a shared database structure.

Invalid code combinations

In addition to the established breeding codes, a list of invalid code combinations by species should be determined for each project. These are primarily combinations of species and breeding codes that do not make sense biologically; for instance, the code

CF (carrying food) cannot be used for Mourning Doves as the species regurgitates food for chicks and would not be seen carrying food. By having such a list established, it can be incorporated into the data entry process as an automatic check completed by the software. Note that some codes are simply unusual and can be used with caution. In these cases, it is best to ask atlassers to provide additional documentation, describing the behaviour observed and why that particular code was used. A number of atlases have already developed these tables and would likely be willing to share them.

Non-native species

The atlas should record data on all bird species detected, including non-native species and species that may potentially be escapes; some of these may later establish themselves in the wild. A breeding bird atlas can be a valuable tool for documenting the spread of invasive species, which may also affect trends of native species. Also, changes in the distribution and abundance of some of the more established and widespread non-native species, such as European Starling or House Sparrow, can be informative of larger-scale environmental changes. The only exception would be to exclude observations of species that are clearly not wild, such as exotic waterfowl in city parks (many of which may have their wings clipped or pinioned).

Hybrids

Suspected hybrids or mixed pairs should be documented carefully, as they can provide important information both for understanding ecology and for planning conservation of certain species. This documentation is particularly important for species known to hybridize regularly, such as Golden-winged and Blue-winged Warblers or Mallards and Black Ducks, but can also be very interesting for novel and unusual hybrids. Technically, a mixed pair would constitute breeding evidence for both species, but atlassers should include additional information on both species' records describing the situation and evidence for a mixed pair. Atlassers who discover a mixed pair should be encouraged to determine if additional individuals of each species are breeding with their own species in the area.

Confirmation of breeding

Many of the earliest atlases placed a strong emphasis on achieving the highest possible level of breeding evidence for each species, as much less was known about the breeding distribution of many species. Increasingly, the emphasis has shifted to maximizing the number of species detected in a grid unit and use of standardized approaches for estimating relative abundance and distribution. For many analyses, especially of common species, all records, whether Possible, Probable, or Confirmed, are likely to be treated equally.

However, in some situations confirmation of breeding can be important. For rare species, and edge of range species, it is particularly important to know whether they are breeding, or simply non-breeding individuals (including single, unpaired males) visiting an area. Confirmed and Probable breeding codes also provide useful information on the phenology of species, which can be useful for management planning (e.g., avoiding disturbance to nests) as well as research (e.g., understanding how climate change may be affecting the breeding ecology of species).

3.2 How to record data

Recording data as checklists

All breeding evidence data should be recorded in the form of checklists that include all observations from a particular date, visit, and location, similar to the format used by eBird but with the addition of a breeding evidence code for all records. As a minimum, a separate checklist should be submitted for each daily visit to a grid unit. However, atlassers may optionally record separate checklists for different visits on the same day to the same or different parts of the grid unit (as they currently do for eBird). Ideally, the data entry system should allow atlassers to record which parts of the unit they visited.

Checklists may be either complete (all species detected during a particular atlas visit are recorded) or partial (only selected species are recorded). Complete checklists are recommended whenever possible, because they provide the greatest value for atlas analyses. These checklists should include all species, even those seen outside safe dates that may be on migration (Observed). These data make the lists compatible with eBird and are also valuable for many purposes, including determining whether breeding seasons are changing over time (e.g., analysts have the potential to review these checklists if safe dates are later adjusted). Partial checklists are appropriate for casual observations, and they may be used in other situations, such as when an atlasser is only targeting a particular species.

This checklist approach represents a change in recommendations from many older atlases that only recorded data cumulatively over the season, with only the highest breeding evidence and little or no date information. The early approach was necessitated by limitations in data entry, data management, and storage capacity, but a great deal of information was lost in the process. Given that atlassers are increasingly expected to enter their own data online, that data entry systems are increasingly user-friendly (including those that capture data in the field), and that many atlassers are already accustomed to entering checklists into eBird for every visit, these limitations should no longer be considered as significant.

Recording checklists separately for every visit has several advantages. One of the most important is that all observations are clearly tied to effort. Linking effort with observations greatly facilitates analyses to estimate detectability of species, which is important for determining the likelihood that a species that is actually present in a square is not recorded after a certain amount of effort. Checklists also provide information on phenology – the breeding status of species throughout the season. As well, they can be used to verify observations in relation to safe dates, especially if all species are recorded, including potential migrants (Observed). Further, checklist data can be transferred to other programs such as eBird, so that users who are also eBirders do not need to enter their data twice. Finally, counts on checklists provide useful information on abundance.

On each visit, observers should record the highest breeding evidence for each species detected on that visit, although this may sometimes take into account evidence from previous visits. For example, the code T (for territorial male) would only be used on a visit if the species had been found singing or displaying at the same site on a previous visit in the same season. Similarly, the code M (multiple males) could potentially be used once the cumulative number of different singing males exceeded a threshold across multiple visits. Once breeding has been confirmed in a grid unit, observers do not need to spend extra effort trying to confirm the species again, although they should record whatever evidence they do detect. Such data can be valuable for understanding the breeding phenology of a species in the region, which can be useful for understanding impacts of climate change or trying to time activities to avoid jeopardizing actively nesting birds.

Ideally, atlassers should provide additional information on the precise locations surveyed as part of each checklist. The minimum location information is simply the name of the square, but additional information increases the value to the atlas and also to other programs such as eBird. For example, if part of a grid unit falls within a park, precise location information could allow tracking which species actually occur in the park. The simplest method to store this information is a coordinate in the centre of the area surveyed and an estimate of the distance travelled (as currently recorded by eBird). However, new technologies have made it increasingly easy to delineate the precise area surveyed, either by creating a track-log with a GPS or a mobile device, or by drawing a polygon or a line on a Google map; both methods can be expected to become easier in the future as new tools are developed. The value of the data will increase as more precise information is recorded.

Atlassers should also be encouraged to estimate the number of distinct individuals of each species detected during the survey. These data would allow the checklist to be readily transferred to eBird and may provide useful information for estimating relative abundance. Some atlassers may choose to keep a precise tally, but it is equally acceptable to make an estimate of numbers at the end of the survey. However, the estimate should only consider birds actually detected (heard or seen) by the atlasser – not the number believed to be present but not detected. Atlassers should be encouraged to estimate numbers for all species detected, because this increases the value of the checklist. For example, estimating only numbers for rare species and not for common species creates bias in analyses. As a result, some current eBird models exclude all checklists for which one or more species has not been counted.

Approaches for surveying within a grid unit

Typically, most breeding evidence data are collected in an unstructured manner, with atlassers free to survey the grid unit in any way that they like. However, atlassers should be encouraged to spend at least some time in every habitat in the grid unit, because one of the key objectives is to maximize the number of species documented in the grid unit. Some atlases have encouraged covering the habitats roughly in proportion to their abundance in the square, but spending extra time in some of the rarer habitats should also be encouraged as it can be important for revealing rare or unusual species that may be of particular interest. If the habitats are discrete, atlassers could consider creating separate checklists for each one, although this practice is most useful if the locations surveyed are precisely documented.

The value of the atlas data for quantitative comparisons of trends and distribution can be increased if unstructured sampling is supplemented with standardized sampling. Many standardized sampling approaches, such as point counts, also provide data on relative abundance. (See further discussion in Chapter 5.)

Supplemental data

All atlassers should be asked to provide supplemental data on rare or unusual species. Many atlases have found that these data are some of the most valuable recorded during the atlas because they provide precise location information for species of particular conservation or management interest, as well as a means to validate unusual records. (For more detail, see Chapter 6.)

Other types of supplemental information could also be considered, but care should be taken to balance the extra demands placed on the volunteers with the potential value of the data. For example, the second Pennsylvania breeding bird atlas project (Wilson et al. 2012) requested precise location data for 50 species of interest and for 25 state rarities, as well as documentation of records related to Eastern Hemlock (which suffers from the Hemlock Woolly Adelgid forest pest). By and large, these requests were successful. However, not all additional data requests met with the same success. The project also asked for additional marsh/nocturnal surveys in a subset of grid units (one of every six), but here less extra effort was made by volunteers than had been hoped – perhaps due to the reluctance to survey at night or to access difficult habitats. If such data are felt to be important for an atlas, dedicated surveyors (volunteer or paid) could be deployed to undertake these specialized atlassing surveys.

Importance of timely data submission by participants

Atlassers should be encouraged to record data in the field to enhance accuracy and reduce the risk of errors. If recording is left until returning home, or even to the vehicle, observations may be confused with those on other dates or forgotten altogether. Field records may be made either on the observer's own notepad/device, or the atlas may provide daily field card/notes. Development of apps for mobile devices (see Chapter 9) would be one approach to encourage data entry. As well, if data are being submitted via scannable data cards, providing cards suitable for use in the field saves the volunteer from later having to copy out all the data again.

Observers should be encouraged to submit data online as soon as possible after data collection. This practice avoids a daunting pile of paperwork at the end of the season and lessens the risk that data are lost prior to entry or that the observer never gets around to submitting the data. Also, most data entry systems automatically check the records to identify unusual records or breeding codes or rare species and prompt the user to provide additional information. If records are submitted promptly, the likelihood is greater that the observer will be able to provide that additional information. In some cases, observers may be motivated to do additional fieldwork to obtain more information on particular species. Prompt data submission also allows for timely feedback to all atlassers on progress on the atlas. If real-time maps are available, participants can be rewarded by watching the growth of coverage in their region – or, conversely, they may be motivated to collect more data if the maps highlight gaps in their assigned regions.

At the end of the main breeding season, all observers should be reminded to enter remaining data as soon as possible. A firm deadline and regular reminders as the deadline approaches are important motivators. A deadline date in early or mid-autumn is recommended to facilitate planning for the following season. After the deadline, Regional Coordinators may wish to contact volunteers in their region who have not yet submitted data to determine whether they actually did collect data, or whether they still plan to do so the next year.

Recording effort

To maximize analytical potential of the data, it is necessary to assign an effort value to all observations. Doing so is relatively easy for dedicated atlassing visits, as the amount of effort spent in the field can be recorded along with the list of species observed. For compatibility with eBird, the following measures should be considered as a minimum on each checklist.

***Start time*:** Knowing the start time of the survey is important, as bird activity and detectability change over the course of the day.

***Party-hours*:** This measure is the number of hours spent in the field by a single person (i.e., a party of one) or group of people atlassing together (i.e., a single party, but with multiple observers). For example, one person in the field atlassing for one hour is one party-hour, and two or more people in the field atlassing together for one hour is also one party-hour. Because of the amount of overlap in observations when in a group, an hour of fieldwork by a group does not lead to as many observations as when those people are split up and surveying different areas. However, the number of individuals birding together should also be recorded, so that other measures such as total volunteer effort can be calculated. Surveys such as the Christmas Bird Count and eBird also use party-hours to help track effort.

Distance travelled: During the breeding season, birds typically do not move far from their nesting territories, so keeping track of the number of miles or kilometres covered by an atlasser or group of atlassers can provide a measure of the number of birds encountered and potentially a sense of the area covered. It may be worth differentiating distance travelled on foot, in a vehicle, or by other modes of transport, as is currently done for Christmas Bird Counts, although this information is not currently captured by eBird.

If possible, it would also be desirable to record the actual route travelled and/or the area searched using a GPS tracklog or a shape file drawn on a web-mapping interface, although such information is not (yet) captured by eBird.

Casual observations

It is more challenging to come up with an effort value for casual sightings (i.e., observations made outside of a dedicated atlassing visit), but casual records should not be excluded from the dataset as they may be important data for the species. Casual sightings should still be reported in the form of a checklist with a date and time of observation, but they should be distinguished either by being marked as an incomplete checklist or else with a specific code indicating “casual.” In some cases, amount of time and distance travelled may still be recorded. As long as casual observations are clearly differentiated, analysts can decide how to analyze incomplete/casual checklists (see Chapter 11).

Special surveys for nocturnal birds or marsh birds

Specialized surveys of birds of particular habitats (such as marsh birds), or of nocturnal birds (such as owls and nightjars), would benefit from using standardized approaches. Such species are often not well captured in general atlassing; thus, it can be hard to tell whether the absence of reports of these species is due to insufficient specialized effort or whether the species really are rare or absent from the grid unit.

At a minimum, atlassers should report separate checklists for nocturnal surveys (as is also requested by eBird) or other specialized surveys, along with the associated effort data. This way, analysts can determine how much effort was devoted to specialized surveys versus regular surveys. These types of observations can be even more valuable if atlassers use standardized marsh bird or nocturnal owl survey approaches. Protocols can often be adapted from existing surveys targeting these species, such as those organized by Bird Studies Canada in many provinces of Canada. The main change required from the standard surveys would be adopting suitable site selection protocols to fit within the grid structure of an atlas (see Chapter 5), and ensuring that a suitable data entry form is available.

Effects of visit timing

There are great differences in what may be observed at the start of the summer versus the middle or end of summer. If atlassing only takes place in the peak of the breeding season, late nesters like goldfinches may not be confirmed, and earlier nesters like waterfowl and shorebirds may be missed. Knowing the phenology of species breeding in the atlas region can help to avoid missing breeding windows, as can understanding species' breeding behaviour. For example, males of many species become much less vocal as soon as they have secured a mate but may start singing again later in the season if the species has a second nesting attempt.

Most species are much more active and vocal in the early morning than during the afternoon. Atlassers who only visit sites in the afternoon will require much more effort to detect species and breeding evidence. Some species do not vocalize at all outside of the dawn chorus. Also, nocturnal species such as owls, nightjars, and woodcocks will be difficult to detect without at least one or two night-time visits to the area. Volunteers should be encouraged to adopt atlassing strategies and habits that maximize the potential to encounter all species that may be nesting in the area.

Designing forms for the field

Field data forms should be designed to facilitate entering data into a computer, whether by the volunteers (hopefully, most participants) or by atlas staff. A number of recent atlases in Canada have used forms that can be scanned and read by software. However, these scannable forms can be time-consuming to prepare, and a fair amount of time is usually still needed for data verification, as the scanning software can have trouble reading handwriting. The cost-effectiveness of scannable forms depends on the volume. If only a small percentage of forms are submitted on paper, it may be easier for atlas staff to enter them manually through the web interface rather than learning to use the scanning software.

All field data forms should be designed to be easy to complete, should include all required fields to be completed on each visit, and should match the layout, order, and design of the web data entry portal. Volunteers will be much more likely to enter their data online if the process is easy, which implies a close match between the forms and the software. A breeding evidence form should have fields for observer, location, date, start time, and other effort fields, as well as a list of expected species for recording numbers and breeding evidence. Additional space should be available to add species, notably migrants, not expected as breeders in the grid unit. If any supplementary information is being requested (e.g., habitat information), it should also be on the form. It is also worth considering how much species communities change across the atlas region. If species composition is sufficiently different across the atlas jurisdiction, consider developing multiple lists/forms for use in each region (e.g., northern Quebec vs. southern Quebec).

Materials need to be easily portable. Full-sized 8.5” x 11” sheets can be awkward to carry and fill out in the field compared to smaller cards. However, larger sheets can be pre-folded in ways that make them easy to carry. Field forms should usually be printed on relatively stiff paper, such as card stock, to make them easier to slip into a pocket or notebook without being damaged. Some atlassers may prefer to write observations in a notebook, using the data form as a guide. While data forms usually have a list of expected species, birders may prefer to write species in their notebooks in the order they encounter them, using four-letter codes. Data entry systems should be flexible enough to have a different interface for these types of data. (For example, the North American Breeding Bird Survey data entry system now has two different interfaces, one with a list of species in taxonomic order to match the field form, and another that allows entry of four-letter species codes in any order.)

With the proliferations of smartphones, many atlassers would find an app allowing them to track their observations to be very useful. Data could be uploaded from the field directly to the web database using cellular networks, or else stored on the device until the atlasser is next connected to the Internet. Recently eBird has developed apps that work on both Android and IOS devices; it may be possible to adapt these or other apps for atlas purposes. A well-designed app could include many of the same features that are available during web data entry, such as prompting for additional information on significant species and verifying that breeding evidence codes are valid.

3.3 Quality control of data

Given that most participants in an atlas are volunteers whose skill levels will vary, there is the potential for misidentifications among submitted records as well as for inevitable errors in data entry. Data entry systems should be designed to flag unusual records and prompt participants to review and correct mistakes or confirm records that they believe are valid, providing additional information as required. Unusual records can be identified by comparing species lists to those of neighbouring grid units, as well as to past atlas results. Likewise, records that are made at an unusual date for the species, those with unusual breeding evidence codes, those with unusually high numbers of individuals recorded, and those with breeding evidence for a species whose primary habitat is not known to occur in the grid unit could also be flagged. Observers should be encouraged to enter their data as soon as possible after fieldwork, so that they are more likely to remember additional details on unusual species when prompted, especially if they had not realized they were unusual species.

Organizers should not hesitate to follow up with participants on unusual records, ideally as soon as possible after the data are entered, while the observer's memory of the encounter is still fresh. Photographs, digital recordings, or other documentation may be requested for such species. Atlas organizers should indicate to project participants in advance that all records submitted to the project are subject to peer review, that additional documentation may be required for some records, and that the atlas organizers retain the prerogative to include or exclude submitted data. Such consent could be incorporated into the data submission process.

Inevitably, some inaccuracy will remain in checklists; even experts make occasional identification errors, especially for birds that are not heard or seen clearly. Some of these errors will be difficult if not impossible to detect. For example, they may be related to species that do occur in the grid unit but were not actually detected on that particular visit, or species that occur in the surrounding grid units but not in the grid unit in question. Fortunately, the consequences of these types of errors, as long as they are relatively rare, are usually negligible.

Another challenge relates to gaps in the submitted records. Of course, there will always be some species that are overlooked in any given grid unit. For example, typically atlassers may detect 70–90 percent of species that actually occur in a 10 x 10 km grid unit after 20 hours of effort. This gap in detection can be taken into account in the analyses, provided that effort is accurately recorded for each checklist and there are no systematic biases. Some potential sources of bias include: older participants tend to have some high-frequency hearing loss, leading to missing species with high-pitched calls; less-skilled individuals may not recognize certain songs or calls; rare or restricted habitats may be overlooked or not visited; some atlassers may only do surveys during daylight hours, or only later in the season, missing nocturnal or early breeders. Several approaches can be used to address these types of deficiencies. Atlassers can be provided with lists of species that might be expected in a grid unit – including information on the number of adjacent grid units that have already detected each species. Multiple atlassers can be encouraged to visit grid units, helping to reduce variation among observers. Also, especially for observers working in many grid units, atlas organizers may consider reviewing species lists for each observer in relation to effort to see if there are any patterns that may flag a need to review records or suggest a need for additional training or coverage by other observers. Atlas organizers can also review the amount of effort undertaken at different times of year and times of day and, if necessary, encourage atlassers to fill gaps.

3.4 Adequate coverage

How to define adequate coverage

Defining a minimum recommended level of coverage is important for addressing the compromise between obtaining as complete data as possible for a grid unit and maximizing the number of grid units that can be covered (e.g., Smith 1990). This compromise allows for using limited available resources (e.g., volunteer-hours) as efficiently as possible. It also reflects the objectives of the atlas in addition to mapping breeding bird distribution. For example, how important is documenting significant species? Is abundance also being mapped? How important is confirmation of breeding?

How will the atlas results be analyzed and used? Is this a first, second, or third generation atlas?

Minimum recommended coverage is typically defined based on either survey effort or numbers of species detected. For example, most ongoing and recently completed Canadian atlases consider a 10 x 10 km atlas grid unit adequately covered once it has received 20 survey hours and the recommended number of point counts has been completed (although the Saskatchewan atlas is encouraging atlassers to move to a new square after 12–20 hours of coverage). However, skill levels of atlas participants vary, which can affect the number of species that might be expected after a given level of effort. Also, grid units of more uniform habitat may not only have fewer species but also take less time to cover adequately.

As a result, some atlases have suggested targets based on the percentage of expected species that have been recorded, where the "expected" list varies by grid unit, usually based on species that have been recorded in the local region. It is important to recognize that the definition of what constitutes "adequate" coverage is subjective and depends on a number of factors. Varied terrain and habitats across a region mean that more species will be present in some grid units than others.

For change analyses, it is important that most grid units have at least a certain amount of coverage; those with insufficient coverage could in some cases be excluded from comparison (depending on the approach to change analysis). With more advanced statistical analyses, it is possible to examine change between atlases despite differences in effort at the unit level. For example, Taylor et al. (2015) used statistical models controlling for the effects of effort, geographic location, and elevation to predict the probability of observing a species in any given grid unit after 20 hours of effort, and then used these predictions to examine how the probability of observing a species had changed between the first and second Maritimes atlases. These types of analyses are greatly facilitated by recording data as separate complete checklists for each visit. Nevertheless, extrapolation from grid units with only a few hours of effort is much less reliable than from those with extensive effort.

Methods of establishing minimum coverage

Past research has shown that in 400 hours of field time a skilled observer could obtain atlas data for 63 percent of species in 80 10 x 10 km grid units, 75 percent in 40 units, 87 percent in 25, 92 percent in 4, or 94 percent in 2 (Sharrock 1973). Clearly, after a point there will be diminishing returns for hours invested, and these hours may be more usefully spent surveying a new area. Also, a minimum level that is too high may discourage volunteer participation and may reduce not only the number of grid units visited but also the number that can be included in analysis. However, a very low minimum coverage goal tends to result in the most visible and/or widespread species being recorded and many less common or more secretive species being overlooked.

In many atlases, detecting at least 75 percent of the number of expected species has been the accepted target, with the note that if the expected total is later shown to have been underestimated, the target (the absolute value) must also be adjusted to match the new total. This method usually results in most widespread and common species being detected, as well as a certain proportion of rarer species. Cumulatively, within a local region, the result should be that most rarer species are detected in a least some of the areas where they occur.

Second generation atlases can rely on first generation atlases to provide expected species lists. For first generation atlases, there are two approaches to developing expected species lists: fieldwork (scouting) or map work (extrapolation). In the former, experienced observers spend time in the field in the area to be atlassed, collecting preliminary data during the year prior to the first official year of atlas fieldwork. Alternatively, experienced ornithologists can often make reliable estimates using topographic maps and their knowledge of the region's avian biodiversity. Preliminary estimates can be made from such maps prior to the start of atlassing and then revised after the first year of fieldwork if necessary.

Species accumulation curves

Some situations may allow or require a combination of approaches to establish minimum coverage for the region, with minimum coverage for some grid units being hour based, and other grid units species based. Using a real-time species-accumulation curve (updated as participants enter data) instead of an absolute numerical target may help indicate when a grid unit has adequate coverage (through diminishing returns). This approach potentially allows for variation in volunteer skills and grid unit accessibility. For it to work, the data need to be entered as fieldwork is completed, ideally at the end of each field day, so as to provide an opportunity to recognize under-covered squares while there is still time to collect data for them. Prompt data entry is particularly important at the peak of the breeding season, when most breeding evidence is collected.

3.5 Safe dates

Safe dates are the dates within which atlassers can be reasonably confident that encounters are with a local resident and potentially breeding bird, not a migrant. Males of many species will sing during migration, and even though the species may breed within the observer's region, the individual observed singing may not necessarily be breeding in that grid unit.

Safe dates for each species will vary by location, especially by latitude, but also with factors such as altitude and habitat. A new atlas may be able to obtain a starting list from atlases in neighbouring jurisdictions, from nest records schemes, or from provincial/state records committees. The atlasser guide should provide information on safe dates for each species and should remind atlassers of the necessity of stronger breeding evidence outside those dates.

Nevertheless, atlassers should be encouraged to record all species detected during each atlas visit, even those that are likely migrants, to allow analysts to review these dates in the future. Species detected outside the safe dates should be recorded as "Observed," unless breeding has been confirmed. The data entry system should validate the breeding evidence codes against the safe dates and prompt the atlasser for further information or corrections if an unusual combination is used.

Another approach is to use "recommended coverage dates" (i.e., the range of dates within which atlassers should aim to make most of their visits) instead of safe dates. These would be dates within which nearly all species detected are probably breeding. While atlassers should be encouraged to do some atlassing outside of these periods to record early and irruptive breeders, that effort should be additional to atlassing in peak periods.

3.6 Nest records

Atlases also provide an opportunity to gather a great deal of new information on the nesting behaviour of many species. Nest record data can provide important information on nesting phenology, nesting habitat, and, if the nests are visited repeatedly, nesting success. National nest records schemes exist in both Canada (Project NestWatch: http://www.birdscanada.org/volunteer/pnw/) and the United States (NestWatch: http://nestwatch.org/). Atlassers can make significant contributions to these projects or to local or regional nest records schemes. Atlas coordinators should decide whether to develop their own nest records forms, ideally compatible with existing systems, or else to link atlassers directly to existing systems. For example, online data entry systems could prompt volunteers to create a nest record form whenever they enter a code indicating they have found an active nest (e.g., NB, NE, or NY). Volunteers should be reminded in advance of the information desired for each nest, so that they collect the relevant data while in the field. This information may include the precise coordinates and height of the nest, the vegetation around the nest and its position, the materials used to build the nest, the contents of the nest (e.g., numbers of eggs or young, including whether there are any cowbirds), and the behaviour of the adults. It should be noted, however, that collection of nest record data is secondary and that completing atlassing goals is the primary objective.

Boreal Owl, X (not FY).
Photo © Christian Artuso

Eastern Screech-Owl, FY. Photo © Christian Artuso

Chapter 4 Sampling Strategies for the Atlas Region as a Whole

Executive Summary. Data for breeding bird atlases are collected within "grid units." The terminology for these units varies by jurisdiction, with Canadian atlases typically calling grid units "squares" and US atlases referencing them as "blocks." Units are typically established based on lines of latitude/longitude or the Universal Transverse Mercator (UTM) coordinate system, typically square and around 5 x 5 miles or 10 x 10 km (although some are smaller). Hexagons have been used in some jurisdictions. Basic units may be grouped into larger units for administrative and organizational purposes, as well as for data analyses. In settled areas with a large population base and extensive road networks, it may be possible to achieve "complete coverage" for an atlas project, in which all grid units receive a certain minimum coverage. However, in more sparsely populated areas, or areas with fewer atlassers, it may be necessary to use a randomized or stratified procedure to select a subset of grid units as priorities for surveying.

Principal recommendations

- Encourage atlassing in as many grid units as possible, ensuring minimum coverage is achieved in priority areas. Be aware of the trade-off between "over-covering" some grid units versus not getting enough volunteer effort deployed to under-atlassed areas.
- Set annual milestones for coverage within each region of the atlas jurisdiction, including remote regions, for example, with targets for number of grid units achieving their minimum coverage, and number of point counts completed. Special efforts should be made to cover remote regions early in the atlas to

ensure at least some coverage in all regions every year and reduce the risk of major gaps at the end.

- When determining the grid base and unit size to sample, atlas organizers should choose what best suits their project needs, bearing in mind what was used in previous atlases (if applicable) and in neighbouring regions, as well as what basic map products are available to assist atlassers.
- Choose a sampling strategy that best suits project needs and capacity. Where possible, strive for complete coverage of grid units. If this is not feasible due to the project's size or capacity, undertake a two-level sampling approach with more complete coverage in areas with more people (where more precise data may be important) and sub-sampling grid units in more remote areas.
- To cover remote or less populated areas, consider a variety of options including organizing special atlassing trips for volunteers, hiring paid crews, and drawing on other data sources. How the atlas approaches remote or less populated areas will in some part depend on the chosen sampling strategy.

4.1 Sampling units

When making plans for a first atlas, several factors should be considered in selecting a sampling grid. The grid should be appropriate for the long term, including future atlases. It should also be useful and relevant to other land management agencies, research, and conservation organizations. It is important to check with potential users of the data if there is an existing grid system in the region that would be particularly relevant for planning or research (e.g., that may have already been used for other surveys). All else being equal, it is desirable to select a system that is compatible with that used in adjacent jurisdictions that have already or are about to run an atlas.

Setting up the structure of the atlas grid

The basic unit for atlassing is the grid unit, often called a square or block, depending on whether the atlas region is in Canada or the United States, respectively. The grid base for an atlas is usually derived from the Universal Transverse Mercator (UTM) coordinate system or latitude/longitude measurements, either of which can be read from maps or portable global positioning system (GPS) units. Both UTM and latitude/longitude systems present challenges for creating a grid; UTM grids have irregular shaped units at zone boundaries, while longitude lines converge toward the poles, resulting in smaller units farther north. These aspects will need to be considered during analyses. (Note: In a few instance, hexagonal grid units have been used, e.g., in Oregon, Puerto Rico.)

Size of grid units

The size of the grid units should be selected according to the purpose of the atlas rather than on an estimate of the number of volunteers available or the size of jurisdiction. For instance, if the purpose is primarily to determine distribution, especially for areas for which this information is not well known, a larger grid may be sufficient. However, with a finer grid resolution, there is potential for a more precise analysis of distribution from the data collected, provided that grid units are adequately covered. Comparison of results between successive atlases (and between atlases of different jurisdictions) may be more detailed and meaningful if data are collected on a smaller grid.

The most commonly used grid is approximately 5 x 5 km for smaller jurisdictions or 10 x 10 km for larger or more sparsely inhabited areas. In some instances, grid units as small as 1 x 1 km or as large as 100 x 100 km have been used. Some atlases have based the square on a fraction of a degree of latitude/longitude. Road networks and/or municipal boundaries may be a consideration, since roads in a flatter landscape are often laid at regular intervals, which can allow for convenient and clear divisions of area. Using the same grid base as neighbouring projects may have the advantage of facilitating the sharing of information, both for breeding evidence in grid units occurring at the borders of the atlas area and for data analysis and comparison of trends and relative abundance.

Organization of grid units into larger regions or blocks

For atlas projects spanning larger areas, it is often convenient to group grid units into larger organizational or administrative regions. These regions can then be assigned to a volunteer Regional Coordinator (see Chapter 8 for more information on the role of the Regional Coordinator and volunteer coordination). Grid units may also be grouped into larger areas that provide a coarser map view (e.g., 100 x 100 km “blocks” have been used in most Canadian atlases, comprising 100, 10 x 10 km “squares”). The main value of these larger units is to provide a sampling framework for setting minimum coverage in more remote areas (e.g., selecting a minimum number of smaller grid units for coverage within each block).

Providing maps for grid units

Free online public mapping software, such as Google Earth, provides relatively up-to-date information on roads and landscapes (including via satellite imagery or aerial photography). One relatively low-cost option for creating maps is to develop downloadable Keyhole Markup Language (KML) files using Google Earth for the atlas grid that provides an overlay of all the grid boundaries. As well, detailed digital topographic maps are often available from government bodies, such as the United States Geological Survey (USGS) or Natural Resources in Canada (NRC). Municipal offices may have maps showing property lines and can provide information on ownership, which may be helpful in situations where there is no resident on site. Many of these governmental agencies or departments are often atlas partners, so seeking permission to use established base maps can save major potential expense. It may be worthwhile to provide maps of grid units in portable document format (PDF) so that atlassers can print them out to bring into the field. However, other atlassers may be able to use the KML files on their GPS units or smartphones.

4.2 Approaches to sampling/coverage

How the atlas chooses to sample an area will depend on the size of the area, its accessibility, available human resources, and the project's goals.

Complete coverage: for areas with a relatively extensive road network and/or a large population and potential atlas participant base; most often for atlases of small and settled areas.

- All grid units are sampled (atlassed) to the recommended minimum coverage.

Systematic or random sampling: for remote or sparsely populated areas with few atlassers.

- A grid unit within a larger grouping of grid units is selected as a priority for atlas sampling (e.g., one of every four units). These may be picked randomly, systematically (e.g., always pick the northwestern-most unit), or with variations such as random sampling but rejecting adjacent units to increase dispersion.
- Additional grid units can be surveyed, but atlassers are encouraged to ensure that all priority units are sampled first.
- The Maritimes Breeding Atlas used this approach, although in practice most units

were sampled in the more accessible areas.

Representative sampling**:** for remote regions, where only a small portion of grid units can be sampled; it may be appropriate to select grid units that are representative of the habitats found in the region rather than totally randomly.

Two-level sampling**:** for areas that contain a relatively extensive road network and/or a large population/atlas participant base in part, but which also have areas that are remote with few participants.

- In this case, atlases are likely to aim for complete coverage in the former while choosing a sampling strategy for the latter.
- The Ontario Breeding Bird Atlas is one example of an atlas that used a two-level sampling strategy with nearly all grid units sampled in southern Ontario, and only a sample of grid units visited in the north.

Stratified sampling**:** similar to two-level sampling, but area may be divided into multiple regions with different coverage goals.

- For example, all coastal squares might be covered but only half of inland squares.
- Coverage regions may be ecologically or politically defined or based on practical considerations such as accessibility.

4.3 Stratified random sampling according to habitat

Sampling according to habitat requires a preliminary assessment of the major habitat types contained within the region to be atlassed. Such an assessment needs to take into consideration not only habitat types but also their extent, their relative importance to the organisms to be atlassed, and their vulnerability to development or intensive commercial activities.

Once habitat has been mapped, each grid unit would be assigned a primary habitat type and grouped accordingly. The coverage area would then consist of multiple strata, each representing a primary habitat type. Since certain strata may be of greater importance or interest than others, the amount of coverage assigned to each could vary accordingly. Once the sampling percentages, based on coverage desired, are chosen for each stratum, a random sample for each stratum can be selected relative to each of their desired coverage percentages (e.g., 100 percent sampling may be desired for rare or critical habitats).

4.4 Sampling remote areas

Remote areas present a particular challenge to achieving adequate coverage. Visiting all grid units in remote areas is generally not possible. While it may be tempting to try to get partial coverage in as many grid units as possible, it is generally better to sample a smaller number of grid units with the same coverage goals as in more accessible areas. This method allows comparison of species richness and abundance with those in more accessible regions and facilitates mapping. The most appropriate sampling strategy depends on the number of units that can be covered. If more than 10 percent of units can be covered, then a systematic or random sample may be appropriate. If the anticipated coverage is much lower (e.g., less than 5 percent of units), it may be worth selecting grid units that have “representative” habitat distributions of the larger unit. Grid units with exceptionally diverse or atypical habitats for the area may also be sampled, as they may be of particular conservation importance. However, they are not suitable for mapping probability of occurrence or relative abundance across the region, and hence should not replace sampling of more representative units. Similarly, supplemental sampling of rare/declining habitats may be worthwhile, especially if the habitats themselves are threatened or may support rare species.

An additional sampling challenge in remote areas is accessibility, especially if there are few or no roads. Other modes of transport could include canoe, kayak, or even helicopter. If the atlas emphasis is on distribution, then rivers provide a means to access and add map data for many grid units in remote areas. Atlassers can potentially be flown to one end of a river and then travel down the river, atlassing along the way. While atlassers should record data all along the trip, a careful advance selection should be made of grid units for intensive coverage, trying to make them as representative as possible of the broader landscape. If possible, at least some grid units should be selected away from the main travel route, as the habitats away from the river may be quite different. Topographic maps or remote sensing data (satellite imagery) can be used to evaluate potential habitats in advance. Special care should be taken around health and safety considerations; atlassers should travel in teams and be provided with satellite phones and other communication equipment to ensure regular contact, and insurance should be adequate to cover any emergencies. Paid crews may be necessary to cover these areas, although some adventurous volunteers may be keen to participate, especially if all or part of their expenses are covered.

To help fill gaps in remote areas, it may also be possible to incorporate data from other sources, such as surveys from academic or government researchers, although the field methods may be different from atlas protocols, necessitating adjustments to analyses.

Efforts to cover remote areas should be spread throughout the duration of the atlas, ideally starting in the first year. This is important for several reasons, including ensuring all regions are covered over the same span of years, spreading out the funding requirements for remote areas across years, and reducing the risk that logistical challenges (e.g., shortage of funds, adverse weather, forest fires) later in the atlas result in large gaps in coverage.

4.5 Strategies for covering areas with few participants

Handling situations where volunteer participation is low is a similar challenge to atlassing in remote areas, although these areas are more likely to be accessible. The best approaches involve prioritizing squares and balancing the distribution of effort; good and even coverage is preferable, even at the expense of the number of grid units covered. As in remote areas, paid crews and/or special trips can help cover the area, as can “mining” data from other sources. Promoting the atlas effectively can help raise awareness and increase participation; special efforts can be made to recruit volunteers in areas with low participation.

Atlantic Puffin, AE. Photo © Carol Horner Ham

Chapter 5 Quantitative Sampling to Estimate Abundance

Executive Summary. Abundance data provide important additional information on breeding bird populations, complementing the distribution mapping made possible with breeding evidence data. Early abundance data were sometimes collected using order of magnitude estimates within a grid unit. Modern atlases, however, increasingly use quantitative approaches such as point counts, area searches, transects, or timed checklists, allowing more rigorous statistical analyses. The point count method is relatively simple to undertake and is recommended as the most efficient approach for estimating abundance for many species. Specialized surveys may be needed to get adequate data for some species, such as marsh birds or owls. Ensuring that the abundance data collected are representative of the entire grid unit is of paramount importance. The best way to do this is to pre-determine locations for quantitative sampling. In practice, this is easiest using existing road networks. If atlassers are allowed to select sampling sites themselves, they should do so in advance of arriving at a site to reduce bias.

Principal recommendations

- All breeding bird atlas projects should gather and analyze abundance data, with point counts being the recommended method.
- Establish pre-determined sampling locations for road-based abundance surveying to increase likelihood that sample points will be representative of habitats in the grid unit.

- Where the establishment of pre-determined sampling locations is not possible due to lack of roads or other access points, encourage atlassers to sample within a representative selection of habitat types within the grid unit.
- Wherever possible, incorporate additional quantitative protocols to gather information on under-surveyed species, such as marsh birds and owls.
- Consider the use of digital acoustic recorders to supplement traditional quantitative sampling methods.

5.1 Why estimate abundance?

Abundance estimates, whether absolute or relative, are important not only for understanding species distributions but also for measuring change over time. Most species are unevenly concentrated within their breeding range. Since distribution maps are based on presence or absence, only a single individual need be present to "occupy" that grid unit. Simple distribution maps cannot distinguish between grid units with a single pair and units with hundreds of pairs. Understanding where species are concentrated is important for establishing and directing conservation efforts. Similarly, a common species may decline dramatically but still occupy the same number of grid units – without abundance data, the decline may go undetected. Abundance information is also important for understanding species-habitat relationships and for other research questions.

5.2 Survey techniques for collecting abundance data

Order of magnitude estimates

Some atlas projects, especially early ones (e.g., Cadman et al. 1987; Erskine 1992), used a tiered system of orders of magnitude to estimate abundance within a grid unit. These estimates rely on the expert judgment of the principal atlasser within the grid unit. However, they are very difficult to standardize, and many atlassers are uncomfortable making these guesstimates. They are also very hard to analyze statistically. As a result, they have rarely been mapped or used in analyses.

Point counts

Point counts are the most widely used quantitative sampling method for breeding songbirds in North America. For an atlas, typically a set number of randomly selected point counts are identified within each grid unit to be surveyed. Atlassers should visit these points in the early morning during the peak breeding season and record the number of each species observed or heard during a prescribed period using standard protocols (e.g., Ralph et al. 1995). The duration of point counts, the number of counts per grid unit, and whether or not they are on-road or off-road have varied among atlases. Some atlases have divided counts into multiple time and distance intervals, while others have simply used unlimited distance point counts. Time and distance interval sampling allows estimation of detectability, which could potentially be used to calculate actual densities rather than simply an index of relative abundance (e.g., Matsuoka et al. 2014). However, the accuracy of those estimates depends on how accurately atlassers estimate distances – which can be very unreliable for birds that are heard and not seen. Sufficient data are also needed to measure differences in detectability among habitats or observers. The importance of more complex sampling methods is still being debated. Either approach can be used to get data for mapping relative abundance.

Some atlas projects have relied strictly on paid crews to undertake point counts, whereas others have used volunteers or a combination of paid staff and volunteers. It is important to ensure that all atlassers undertaking point counts are able to identify all the species they hear by song or calls. Hired staff should be screened for identification skill using recordings of point counts; volunteers should be encouraged to self-screen using web-based training materials (e.g., www.natureinstruct.org).

Pros*:* Point counts are generally easy and relatively quick to complete. Many atlassers are familiar with the protocol, and those who are not can learn quickly. There is relatively little opportunity for confusion in methods. A well-defined survey window with a fixed survey area makes the data easy to analyze.

Cons: All survey methods that rely heavily on auditory cues are prone to biases when completed by atlassers with hearing deficiencies or by those who are not sufficiently skilled in bird song identification. Not all atlassers have sufficient skill, confidence, or inclination to complete point counts, which may necessitate additional recruiting effort and/or hiring special survey crews. Even skilled atlassers can sometimes mix up certain similar calls. Surveys are most often completed along roadsides (especially in settled landscapes), creating a bias toward roadside habitats. Rarer species may not be detected on enough point counts to provide reliable estimates. Similarly, certain species that either do not sing (e.g., most non-passerines), or sing outside of the point count window (e.g., nocturnal or early spring species), may be under-represented on the surveys.

Digital audio recorders

Digital audio recorders can be used in various ways to enhance or supplement traditional point counts. A basic approach is to encourage atlassers to use small portable recorders to record simultaneously while conducting traditional point counts. Some models of small low-cost digital recorders designed for home music recording can work quite well for this (Rempel et al. 2014). It is important to select a model with stereo microphones and a fairly omnidirectional pickup pattern so that birds calling from any direction can be detected. Atlassers should be encouraged to carry a lightweight tripod to support the recorder; otherwise, the handling noise will be a problem. They also should be careful not to move around too much during recording; rustling of leaves or crunching on gravel can make a recording difficult to interpret. These types of recordings can be useful for verification of rare species, identification of sounds that the atlasser did not recognize in the field, or addressing observer effects (e.g., by asking independent observers to interpret the recordings and comparing the results). Data management systems can be designed to allow participants to upload recordings (or other media files). Avichorus (www.natureinstruct.org/avichorus) is a web-based application that can be used by volunteers to interpret recordings.

Autonomous recording units (ARU) that can be programmed to turn on and off automatically can also be used for more innovative sampling, particularly in off-road areas. These units are generally more expensive but could potentially be purchased by atlas partners and distributed to volunteers to cover priority areas. For example, volunteers could be asked to set them up in particular habitats and program them to record at several different times during the day to sample both the dawn chorus and nocturnal birds. Several research groups are currently evaluating the most appropriate sampling strategies for using these types of units, and more guidance can be anticipated in the near future.

Transects

Transects are similar to point counts, except the survey travels a path of determined length (often, but not necessarily, a straight line) over a fixed duration. The technique can be used on foot, but it is also still widely used for aerial surveys of some species (e.g., waterfowl surveys). Pros and cons are similar to those for point counts, with these exceptions:

Pros**:** The survey length is longer, so there is greater opportunity to detect infrequent singers. Because the survey travels more ground, there is a better chance of surveying multiple habitats and/or detecting hidden species. If species are recorded in distance bands, density can be estimated.

Cons**:** The surveys take longer to complete, so fewer can be done in a single morning. The methods are more open to interpretation (e.g., whether to walk at a steady pace or to pause frequently to listen along the transect), and some tracks may be hard to follow. Transects should follow random directions with respect to habitat, to provide valid results on density. However, access to random routes could be limited in many areas because of private lands or difficult terrain.

We are not aware of any atlases that have used transects for general abundance estimation, though they are widely used for specialized surveys (e.g., aerial surveys, ship-based surveys of seabirds, and occasionally surveys of grassland or forest birds).

Area search

The area search survey method has the potential to provide a more thorough sampling of species within a defined area that is generally much smaller than the grid unit. For example, the second and third atlases for Britain and Ireland used area searches in 2 x 2 km "tetrads" to estimate relative abundance (Gibbons et al. 1993; Balmer et al. 2013). The survey is usually of fixed duration, or it is open but the number of hours is carefully recorded.

Pros: Surveys are relatively exhaustive compared to point counts or transects, so biodiversity is typically well sampled. Methodology is very simple and easy for new participants to understand – essentially general atlassing at a smaller scale.

Cons: It is very difficult to standardize effort and survey coverage due to variation in observers and variation in habitat and terrain. It can be difficult to keep track of the number of different individuals of each species. Also, private lands can limit access to only portions of a sample unit. Typically only one or two survey units can be sampled in a day, providing less statistical power for estimating trends compared to point counts. If the area is not completely covered, it can be difficult to estimate how much area was actually covered.

Timed checklist

Timed checklists are similar to area searches, but area is not defined. The observer keeps track of numbers of each species detected, distance travelled, and time elapsed. This is the format of data submitted to eBird and is the recommended approach for breeding evidence.

Pros: There are no restrictions on the areas visited, so there is the opportunity for all habitats and species to be represented. It is very easy for participants to collect data, and many will already be familiar with the process. Potentially, data can be incorporated from eBird. This method also has the potential to get data on more species, as it essentially captures information from general atlassing.

Cons: Limited standardization of methods necessitates reliance on a large sampling effort to smooth out potential biases. Sites are not randomly selected, so they may not be representative of the broader region. Estimates of numbers of individuals detected may be less reliable if the time interval is long.

5.3 Achieving adequate habitat representation

The greatest challenge in producing accurate and meaningful relative abundance analyses is ensuring that all (or at least the major) habitats are appropriately and sufficiently represented within the data. This goal is most easily assured by using a survey method with random selection of survey sites in advance. For example, with point counts, locations can be selected at random by computer within dictated parameters (e.g., only along roads). Using a GIS program containing habitat layers allows for the specification of a certain number of survey points per habitat type, proportional to representation in the grid unit. If the survey type is not conducive to pre-selecting sites and/or the means are not available to do so, participants should record the precise coordinates of the locations surveyed. Optionally, they could record habitat, although it is usually more reliable to determine habitat from remote sensing data based on coordinates. Also, atlassers should be encouraged to select a representative diversity of habitats from the grid unit. This is best achieved by giving them a target number of sample units per habitat type. Review the submitted data to assess the surveyed habitat types and encourage participants to make an effort to survey under-represented habitats in the subsequent field season(s). If volunteers are chronically under-surveying certain habitat types and/or some grid units do not have the necessary number of surveys to be used in analysis, consider using paid staff to complete the necessary surveys in these areas.

5.4 On-road and off-road sampling designs

While some regions and areas may have a relatively dense road network, many less-populated areas do not, and in some grid units roads do not access all habitats. Even within grid units with good road coverage, roadside point counts may tend to under-represent some species or habitats that are not as frequently found near roadways.

Off-road surveys are necessary when there are obvious deficiencies in the habitats covered by the road network. Using a GIS analysis to assess the habitat types within a set distance of the road edge (e.g., 100 m), it is possible to determine how well the roads sample habitats within the grid unit. If any significant habitats (e.g., covering >5 percent of the land area) are under-represented, atlassers should be encouraged to sample those habitats off-road in sufficient numbers to proportionally represent the additional habitat. If the road network adequately covers all represented habitats within the grid unit, off-road surveys may not be necessary. However, it may be worth encouraging some off-road surveys to assess any potential bias associated with roadsides.

While most roads are typically accessible to the public, off-road counts need to consider land ownership and access. Unless the atlas project has access to this information, it may be necessary to ask atlassers to select the locations of off-road surveys themselves. Strict criteria should be established for selecting appropriate survey sites (e.g., distance from roads, habitat edges, other counts, etc.) for participants. Additionally, be sure to emphasize that the selection of survey locations should be as random as possible and not made based on the known location of an unusual or uncommon species, to minimize the risk of bias. Ideally, locations should be selected before arriving at the site.

5.5 Incorporating other surveys into an atlas

In most jurisdictions, other quantitative surveys are likely to be running concurrently with the atlas, such as nocturnal owl surveys, marsh monitoring surveys, breeding bird surveys, or other surveys. Such surveys can be incorporated into the atlas planning from the outset, or data from these surveys can be incorporated into the atlas after the fact, either as distribution data or potentially as abundance data (depending on their quantity and how they were gathered). For example, many different atlases have incorporated point level information from the Breeding Bird Survey (BBS) into the breeding evidence information, after assigning each point location to a specific grid unit. The Missouri atlas (Jacobs and Wilson 1997) used data from BBS routes in the state to map abundance. The Saskatchewan atlas is planning to use five-minute point counts but will record data separately for the first three minutes and last two minutes, to develop corrections so that BBS data can also be integrated into the relative abundance analyses.

Even if one or more specialized surveys occur in the atlas area, it is worth considering incorporating specialized protocols into the atlas to improve geographic precision and match the atlas grid units. For example, marsh bird survey protocols can be used to survey wetlands within atlas squares, potentially providing enough data for quantitative mapping. Ideally, the protocols would match those in the specialized survey (e.g., similar timing and use of playback), although site selection protocols would need changing to match the atlas grid units. Similarly, standardized owl survey protocols (which may or may not include playback) could be used at the appropriate time of year. Potentially, randomly selected roadside points could be used, if they are restricted to those near suitable habitat. Given the large number of volunteers involved and the large area covered, by incorporating additional protocols from the outset, atlases have the opportunity to gather valuable information for some of the most poorly understood groups of species. Such opportunities, however, must be balanced with considerations of overload for volunteers.

Bobolink, D. Photo © Christian Artuso

Chapter 6 Significant Species Data

Executive Summary. Information about rare, uncommon, or colonial species or species identified as being at risk is of particular interest for wildlife management and conservation planning purposes, so establishing protocols on how to gather and review such data is vital. Given the importance and general interest to birders of these "significant species," many atlassers will be willing to gather additional information. By making the collection of all relevant data simple and clear, atlas organizers can help to ensure that significant species are documented adequately. Certain species, including colonial nesters and some species at risk, are particularly sensitive to disturbance, and thus care must be taken during fieldwork. Similarly, the disclosure of nesting locations could be sensitive in many cases, so developing a protocol in advance regarding the sharing and mapping of sensitive data is recommended.

Principal recommendations

- Encourage atlassers to collect additional data about birds deemed to be significant species in each atlas jurisdiction. The amount of additional data to be collected may vary by species and region. Precise geographic coordinates, number, sex of individuals observed, and standard breeding evidence should be recorded as a minimum. Additional details may include identification details, habitat description, further details of breeding evidence, and means of accessing the site. The use of online "smart forms" could facilitate the recording of supplemental data for each species.
- Establish a list of significant species for each atlas region and sub-regions if necessary, so atlassers will know ahead of time that additional information will

be required. These species (which may include species at risk as well as regionally rare species) can be flagged in atlas handbooks and data forms to ensure that the additional information is collected. (If atlas data may later be imported into eBird, make an effort to include any species that may require additional documentation in eBird.)

- Encourage atlassers to submit significant species forms promptly, so that records have the potential to be field-checked if necessary.
- Establish protocols for the review, publication, and sharing of data on significant species, some of which may be deemed sensitive and/or confidential.
- Establish multiple means to keep atlassers apprised of changes to the list of significant species for which additional documentation is required (notably, species at risk lists, which change periodically). Potential means to update atlassers in this or other matters include a dedicated page on the project website, newsletters, e-news, etc. (Adding candidate species at risk to the list of "significant species" that require extra documentation could be a precautionary approach.)

6.1 The value of collecting significant species data

Rare and legally protected species, as well as those of high "jurisdictional responsibility" (i.e., species with a large or particularly important population within a defined region), are among those species of the greatest conservation concern and interest. A breeding bird atlas is an important tool for assessing the status of species, both for determining the potential need for legal protection and for monitoring populations. Even surveys designed to specifically target a protected species rarely have the breadth or depth of coverage of an atlas. Given that atlas participants are already in the field and observing these species, it is not only useful but relatively easy for them to collect additional data on significant species.

Atlas data can support conservation in many ways. Many conservation groups rely on detailed records of species at risk for their stewardship work. Identifying and mapping critical habitat depend on having good location information for each species. Information on numbers detected can help support assessment. Careful documentation of breeding sites for colonial nesters is important because the sites may support significant proportions of a species' population.

Sensitive species forms also provide a mechanism for gathering additional supporting documentation (e.g., written descriptions, photographs, or recordings). This documentation may not be required for all species but is especially important for range extensions or regionally unexpected species to verify that they were correctly identified.

6.2 Which species to include

Legally protected species/species at risk/species of conservation concern: These species are perhaps the most obvious candidates for inclusion, since they are often species of very high conservation concern. Further, they are often those that receive the most attention in conservation programs, recovery efforts, environmental impact assessments, and potentially even legal actions.

Colonial: Many waterbirds (e.g., seabirds, herons) and a handful of passerines (e.g., some swallows) are colonial breeders. Detailed knowledge of breeding colonies is particularly important, since disruptions or other harmful actions near a colony can have a large negative impact on the colonial population. Details on colonies can also help with mapping abundance and measuring change over time, as these species are often not well monitored with point counts. (Note: Directions for atlas participants should clearly explain if there are exceptions regarding when additional data are to be collected for colonial species, such as when certain species are nesting singly or in low numbers – or when collecting information, such as number of nests, will disrupt the colony.)

Rare: The criteria defining what is considered “rare” and what is better described as uncommon may be considered on a case-by-case basis looking at certain population thresholds. Different regions may choose to move that threshold or emphasize different groups. Rare species often have the potential to become legally protected species, and having a strong body of information on the species’ population status can aid in this decision. Rare species also include those species undergoing range expansions, in which case other variables such as breeding evidence, particularly breeding confirmation, as well as habitat, may be important to document.

Locally significant species: These species are those whose population status in the atlas region is different from that of the rest of the species’ range. This category could include species with significantly higher or lower population densities, or disjunct populations. Species with lower local populations have the potential to become regionally rare, which may invite further attention for local conservation efforts. Species with locally high populations may also be deemed “significant,” because these local populations may be a source population for surrounding areas, and/or the area may have a high stewardship responsibility for the species. It may also be worth considering the inclusion of disjunct populations, which may merit special conservation attention or research interest.

Hybrids or mixed pairs: Suspected hybrids or mixed pairs should be documented. This is important both for novel hybrids and for relatively common hybrids (e.g., Golden-winged and Blue-winged Warblers; Mallards and American Black Ducks; some of the chickadee species that regularly hybridize), to document the extent of hybrid zones.

6.3 How and what information to collect from the observer

The particular data collected from participants may be selected according to the needs and purposes of the specific atlas or region. However, recommended information for all significant species includes, at a minimum, date, precise geographic coordinates of the individual or colony, numbers, and breeding evidence. Ideally, the atlasser should estimate the coordinates of the bird (not the observer), estimating the bird’s location based on the observer’s position as necessary. It may also be important to record the age, sex, and any additional behavioural and habitat observations. For rare or unexpected species, where the species identification and breeding status need to be verified, the inclusion of the following is particularly important: identification description (e.g., appearance, voice – ideally supplemented with photos or recordings); description of habitat; and description of behaviour (including location within habitat, and substrate if perched). Particularly for significant range extensions, it may be worth encouraging atlassers to visit the site again to increase the level of breeding evidence. For colonial species, atlassers should also describe the habitat using standardized classification, the colony’s location within the habitat, and the approximate number of active nests.

The data required may also vary with the level of breeding evidence reported. For example, documentation will not generally be required for species that were simply “Observed” or for colonial species for which the colony was not found.

6.4 Data forms

While some volunteers may be reluctant to fill out additional forms beyond those for basic breeding evidence, providing clear, simple-to-use forms (paper and online) will help encourage atlassers. For example, the effective use of online data submission prompts (e.g., pop-up dialogue boxes for critical data depending on the species and breeding evidence code) will make it easier for atlassers to submit these data and substantially increase compliance. Setting a minimum amount of data required (e.g., geographic coordinates) and making the rest optional might encourage more atlassers to submit supplementary data. Determining which data are essential and which are optional will vary by species, geographic location, breeding evidence, and the anticipated needs of the atlas. Interactive online data forms can be used to prompt for the particular data needed for each species, including differences in the data needed for species at risk, unexpected species, and colonial nesting species.

As with breeding evidence forms, data entry is now done largely through web-based interfaces. However, there is still value in providing standard forms that can be brought into the field for collecting relevant data (or at least prompting volunteers on which data to collect in their notebooks). Well-designed field forms can be submitted to the atlas office if the volunteer has trouble with the online system. Be sure that volunteers know which species require additional data, as well as which data to collect.

Most atlas projects include in their instruction manuals a summary of “significant species,” broken down further by region if there is variation within the jurisdiction. Such a summary would indicate for each significant species the conservation status, appropriate survey type, and required instructions. This information can also be marked on the breeding evidence form that volunteers carry into the field.

Note that since species at risk status changes periodically, project organizers will need to find ways to notify atlassers of changes in the list of significant species (e.g., newsletters, websites, etc.).

6.5 Quality control

As with breeding evidence, some method of data verification will need to be established for all aspects of the record (including verification of location and species identification). This is especially true for rare and uncommon species at risk, where there can be important implications for both species and site conservation. Typically, a technical committee will review significant species records to determine whether or not to include records, or whether there is a need for further review or verification. The review process may involve several steps (see Figure 6.1).

It is extremely important that incomplete or missing information be obtained from participants as soon as possible, ideally within the same season that the observation was made. As noted above, interactive online data forms can greatly assist with this task. Regional Coordinators can play a particularly important role in reviewing significant species data and be the first point of contact. The timely submission and review of significant species data also provides an opportunity for follow-up in subsequent atlassing years, in all but the last field season of the project. Clarification may be required for incomplete, questionable, or confusing submissions. If a significant species form is not submitted for a particular record, the record will need to undergo the data review process with whatever information is available.

6.6 Making data available

The data collected on significant species can be of great value and interest to many organizations and agencies. Local governments and conservation agencies or groups may use the information for conservation planning, management, or even legal proceedings. Many jurisdictions have conservation data centres (often affiliated with NatureServe or NatureServe Canada) that store records on significant species. Academic institutions may also have an interest in using the data for scientific research. Because of the broad potential interest in significant species records, it is wise for each atlas to establish a data-use policy early in the project to help guide decisions on how data may be used and shared.

Due to the sensitivity and sometimes legal implications of some information, consideration must be given to limiting its dissemination. Significant species may be sensitive to disturbance; they may also be highly sought after, and publicizing locations may result in unintentional disturbance by well-meaning public who wish to view the individual(s). Additionally, many are found on private lands, and respecting the privacy of landowners must be considered. On the other hand, it may not be possible to protect critical habitat for species at risk if the location of that habitat is not released. Similarly, habitat may inadvertently be developed if the presence of rare species is not known by planners or developers. Furthermore, some locations may already be known to birders, in which case there is little point in restricting access to data that may are already be known.

If not already formally associated, atlas organizers should work with government agencies and their conservation data centres to develop a policy for release of sensitive data. As a general principle, data should usually be released to maximize their conservation value, unless the risk to the species or habitat of releasing the data substantially outweighs the benefits.

6.7 Considerations in surveying sensitive species

Surveys of breeding birds could result in unintended disruption of birds' activities. Care should be taken when atlassing around significant or sensitive species to ensure that individuals are not unduly disturbed. In addition to adhering to general birders' codes of ethics, the following should be considered:

- Limit time spent in the individual's territory, and avoid damaging habitat or disturbing individuals.
- Limit or avoid the use of playbacks or otherwise calling in the individuals to reduce potential disturbance, unless this is necessary to confirm the presence or identity of the species or it is part of an established protocol for a special survey.
- Avoid approaching nests unless absolutely necessary. If imperative (e.g., to determine if the nest is active), do so carefully and indirectly, leaving by a different route to avoid providing predators with a dead-end scent trail. Use a stick or other non-human item to lift vegetation away from the nest for checking contents. Try not to linger longer than necessary to assess nest contents.
- Whenever possible, confirm breeding by using less intrusive codes, such as carrying food (CF) or adults entering (AE) or fledged young (FY), rather than observing the nest with young or eggs (NY and NE). While it can be valuable to follow a nest over time to track breeding success, this should only be done for a species at risk if it is part of a special study.
- Particular care should be taken not to disturb colonies. Volunteers should not land boats near or walk through waterbird colonies.
- Ensure that atlassers are aware of and respectful of legislation to protect species at risk and other significant species in the region.

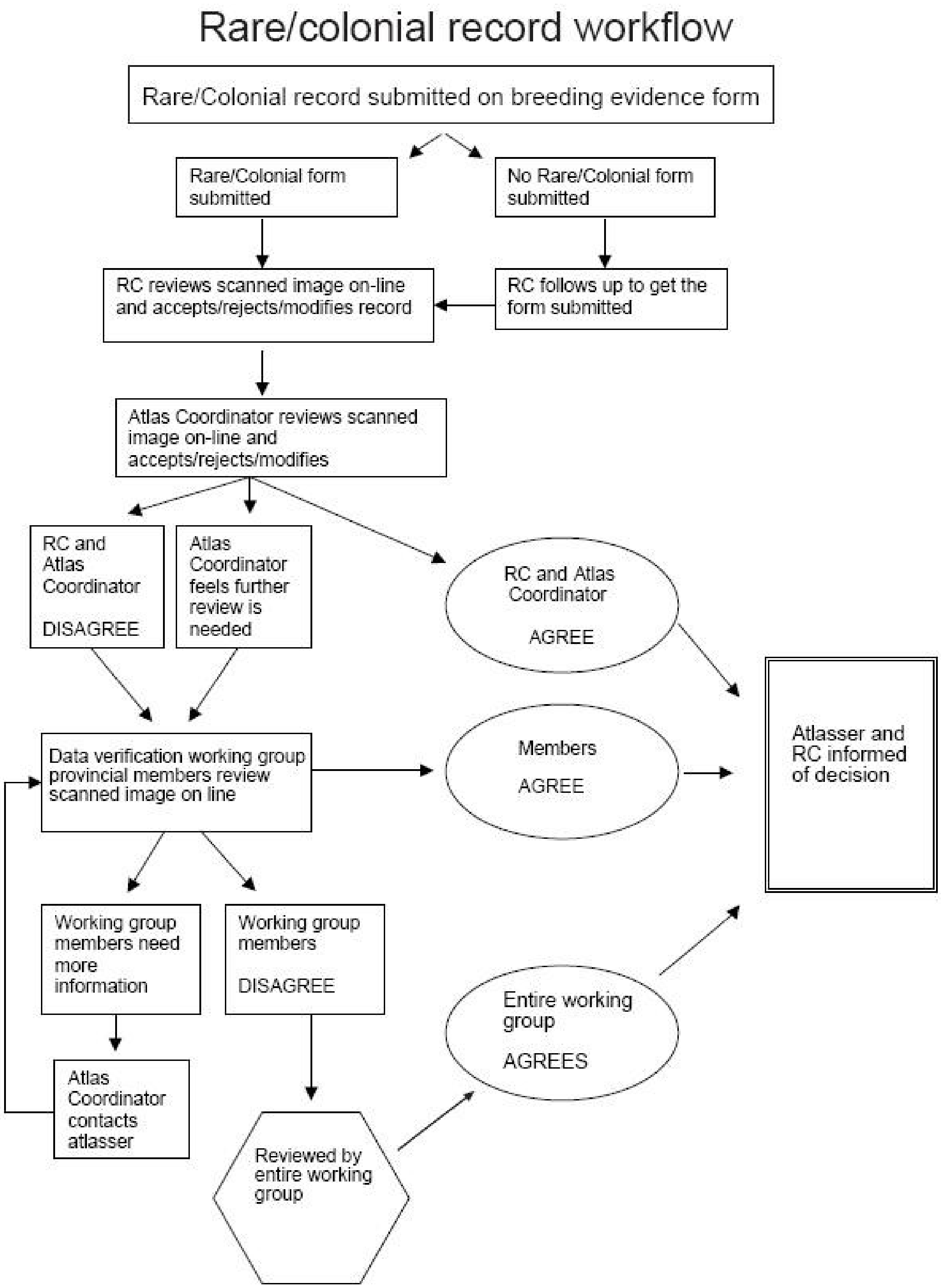


Figure 6.1 Example of a data verification and review process for rare/colonial records from the second Maritimes breeding bird atlas (Stewart et al. 2015).

Yellow Warbler, NB. Photo © Christian Artuso

Chapter 7 Recording Habitat Data

Executive Summary. Since habitat and land use influence bird distribution and abundance, bird atlas organizers have often encouraged participants to collect such information as part of atlassing protocols. While this information could be valuable, the collection of standardized data can be challenging, and atlas managers (and subsequent potential data users) may not be confident that volunteer-collected data are reliable. Further, many birders are uncomfortable collecting such extra data and may resist being asked to do so. In a great many cases, remote sensing and land-use data from provincial or state agencies may be more reliable and more accurate than field-collected data, and therefore preferable as the standard approach to analyzing habitat data for breeding birds. In general, habitat information should only be requested if there is a known need and use for it. Some potential uses include documenting specific habitat being used by certain species (e.g., species at risk, colonial waterbirds, and species breeding beyond their typical range); providing details on nest records; and validating remote sensing data, especially in areas where land use changes relatively quickly (e.g., agricultural lands). For the habitat information gathered by atlassers to be useful, it must be standardized to appropriate habitat classification systems (e.g., provincial forest inventories, ecological land classifications). A number of pre-existing land classification systems have been established in North America, so it is not necessary for atlas projects to develop their own unique codes. An alternative may be to ask atlassers to take and upload photographs of the habitat.

Principal recommendations

- Atlas organizers should rely principally on remote sensing or available land-use data for analyses relating to habitat, rather than on field-gathered data from volunteer atlassers. It is thus particularly important to ensure that atlassers provide accurate geographic coordinates for point count and significant species locations.

- Consider collection of habitat data or general habitat descriptions for special situations (e.g., records relating to documenting significant species, understanding use of agricultural lands by grassland birds, or verifying habitat at off-road point counts), especially in situations where existing remotely sensed habitat data are not available or need verification. This may be particularly important if habitats change frequently, such as crop types or early successional habitats.
- Consult with potential data analysts to ensure that the data will actually be useful and used before asking volunteers to collect them.
- Adopt a standardized approach to habitat and land-use classifications, if possible employing existing categories within the jurisdiction.
- Try to adopt a habitat classification system that is as simple as possible (yet meaningful) to ensure reliable use by volunteers; consider asking volunteers to collect photographs rather than coding habitat in the field.

7.1 The value and use of habitat data

Understanding the diversity of habitats across a landscape is essential to understanding the range and relative abundance of bird species. It is not surprising, then, that some breeding bird atlas projects have asked atlassers to collect habitat data as a routine part of surveys. Despite this potential value, such data have not typically been analyzed, and many managers and researchers have opted to use remote sensing data to provide details on bird habitat. Regardless of *how* data are obtained, knowledge of habitat associations is obviously important for conservation, especially for species where active management may be required (e.g., species at risk recovery, habitat restoration efforts, grassland bird recovery efforts where precise crop/land use data are essential).

The use of habitat data can provide improved population estimates through correlation of abundance surveys (e.g., point counts) to habitat at each survey stop, with subsequent extrapolation of these data across an entire grid unit based on habitat proportions. Habitat data can also be used in the comparison of first and subsequent atlases. As an example, determining where habitat is undergoing large-scale change (e.g., urban/suburban development, agricultural intensification) can help to inform or interpret results. Knowledge of habitats present in a grid unit or region may also be helpful for atlas organizers in predicting expected species, which in turn may assist in determining coverage goals or determining if a particular species should be considered a "significant species" for the region.

7.2 Approaches to data collection

Field data: Conceptually, it seems appropriate to ask fieldworkers to collect data on the habitats where they actually observe the birds. However, there are many challenges with requesting and using habitat data collected on the ground, especially by volunteers. Most birders are not botanists and may not be able to provide accurate information on plant/tree species present. This is less of a problem if only major habitat characteristics are recorded, but these can be hard to quantify. Most habitats are heterogeneous, and it is difficult to estimate – or measure – parameters like the average height of the trees, the percent cover of deciduous and coniferous trees, or even the percentage of the area that is forest or field. An additional challenge is that sightlines are often limited, so descriptions may be biased by the habitat type in the observer's immediate field of view. However, there are situations where habitat descriptions can be very useful. Descriptions of the location of a nest and the habitat immediately around the nest provide valuable natural history information. Similarly, even basic habitat descriptions for species at risk can be useful for understanding exactly which habitats the species is using in that region. Data on agricultural land use (e.g., crop types) can also be of value for understanding how species use these lands, especially as cover type may change annually and remote sensing data may not be up to date.

Remote sensing and/or other land-use data: The widespread availability of remote sensing data, including satellite imagery and high-resolution digital aerial imagery, means that most researchers and managers now rely primarily on these data. As a minimum, much of this imagery can now be viewed online (e.g., through Google maps), but in addition many regions now have these data interpreted into GIS land cover layers, although the quality of the interpretation may vary among regions. In some areas, LiDAR data that can provide details of habitat structure (e.g., canopy height) are also available. As well, many provinces / states have land-use data from a variety of sources, which could be made available for use in analyses. Two key benefits of using available datasets are that they can provide standardized habitat data for all (or at least a large portion) of the atlas area and the data are already in categories understood and used by resource users (e.g., government and industry). Potential disadvantages of using these existing datasets are that the data may not be updated during the atlas period (and thus the information in the dataset will not reflect what is happening on the ground), and/or they may not contain sufficient habitat detail to adequately inform bird-habitat relationships, particularly for species of conservation concern.

7.3 Level of detail

When the collection of field habitat data is deemed appropriate, the amount of detail to be collected depends on the intended use. When selecting what to include in data collection, consider not only your specific atlas project but potential subsequent atlases that may benefit from habitat data for comparisons. Some atlas projects have only collected data for certain species and/or purposes. For instance, recent Canadian atlases asked volunteers to record habitat at off-road point counts (although most analyses ended up using remote sensing data instead). Pennsylvania did a special project on Eastern Hemlock associations. Habitat data are often requested for significant species or species of interest. If field-collected habitat data are thought to be useful, more data are better for analyses, generally speaking, but this benefit must be balanced with the potential of trying volunteers' patience by asking them to fill out more forms (especially when those forms are about habitat rather than birds). This concern can potentially be reduced if volunteers understand exactly how the data will be used and why they are important. If the data are complex to collect, it may be worthwhile to make habitat data optional for volunteers but required for paid fieldworkers. Additionally, the collection of habitat data, like the collection of abundance data, can be emphasized increasingly in each successive year of fieldwork, giving volunteer atlassers new challenges as their confidence and skills advance.

7.4 Codes

To simplify documentation, it is advisable to use a pre-existing habitat classification system, as long as it includes the main categories of interest for analyses. For example, there are already environmental land classification systems and national vegetation classification systems. Most Canadian projects use the Ecological Land Classification, while American projects use the National Vegetation Classification System. The Monitoring Avian Productivity and Survivorship (MAPS) program uses the latter for obtaining habitat data from bird banders. Banders are given a categorized list of possible codes and asked to select one for each habitat type within their station. A similar approach could be taken with obtaining habitat data from atlassers. The advantage of using a pre-existing system is that data can more easily be compared across projects.

7.5 Recording data in the field

Methods

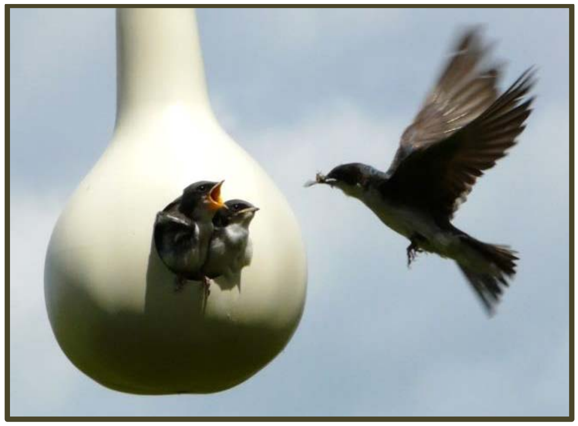
Once codes have been selected, consider creating a custom list to provide each atlasser with the codes known to be present within the atlas region. With irrelevant or unneeded codes removed, the list will be less overwhelming. Ideally, the habitat code should be recorded from this list while atlassers are at the site, since they might note a particular characteristic necessary for selecting the proper code. Participants thus need to bring a printed list, though providing a website link to the same might be appealing for atlassers with smartphones. Habitat data should be recorded separately for each observation point determined relevant for your atlas project, e.g., each individual off-road point count or each significant species occurrence. Where the landscape is heterogeneous, it may be necessary to record the dominant habitat type as well as additional habitat types.

For special projects, such as understanding the use of particular crop types in agricultural land areas or particular tree species in forests, ensure that adequate training material is available so that atlassers can accurately identify the species. Although atlassers may be good at identifying birds, they may not be familiar with local agricultural crops or trees.

While some atlassers may be uncomfortable collecting even basic habitat data, there will be others who are happy to collect habitat descriptions, especially if the approach is straightforward, the data are relatively simple to collect, and the value of the data is clear.

Recording geographic coordinates

If the atlas project has decided not to have atlassers collect habitat data, it becomes particularly important for them to record accurate geographic coordinates for locations of rare species, point counts, etc. Some atlassers may not have access to a portable GPS unit and may be unfamiliar with other means of determining coordinates (e.g., maps, Google Earth, etc.). Despite the proliferation of handheld GPS units and other devices with mapping software (e.g., smartphones, in-vehicle positioning systems), there is likely still a need to provide training opportunities for atlassers on the correct use of mapping tools. If there appears to be need for incentives to acquire portable GPS units, atlas organizers may wish to approach local outdoor stores to see whether a discount could be offered to volunteer atlassers in exchange for appropriate recognition by the project.



Tree Swallow, NY. Photo © Gregor G. Beck

Chapter 8 Approaches for Managing Volunteers

Executive Summary. Breeding bird atlas projects depend by their nature on the participation of large numbers of volunteers. To effectively engage and retain atlassers over the duration of the project, it will be necessary to continually nurture their participation through training sessions and the provision of resources, support, and feedback. Such assistance includes providing instructional manuals and ongoing training and support during data gathering and data entry stages using multiple approaches (e.g., newsletters, website updates, updated maps, and data summaries). The task of engaging volunteer atlassers is made simpler and more efficient if a team of volunteer Regional Coordinators (RCs) is established across the atlas jurisdiction. Regional Coordinators are the backbone of the atlas volunteer network and are often the first point of contact for atlassers locally, helping to deploy volunteers effectively across the region and ensuring that all grid units are covered. Regional Coordinators can also assist in reviewing local data and encouraging atlassers to submit their data promptly at the conclusion of each field season. The assigning of a "principal atlasser" to a specific grid unit can help to ensure that all areas are atlassed and increase likelihood that coverage goals are met. Providing detailed instructional materials, maps, data forms, and other resources in multiple formats (e.g., print, electronic) to volunteers will make their job easier, which in turn should make things easier from a project management perspective. Since many atlas projects have already been undertaken in North America, many of these resources should be available and online for potential sharing and adaptation.

Principal recommendations

- Develop and disseminate atlas resource materials (e.g., manuals, maps) and implement training sessions well in advance of the first field season to help volunteer atlassers prepare for fieldwork.
- When planning a new atlas project, seek input and support from other atlas projects and share resources and materials wherever possible.
- Establish and support a team of volunteer Regional Coordinators whose roles in recruiting, training, and supporting atlassers will be invaluable.
- Assign "principal atlassers" to specific grid units to help in meeting coverage goals, but encourage atlassers to submit observations from any grid unit.
- Devise and implement a capacity-building strategy – for example, a graduated series of workshops over the duration of the atlas period (with topics ranging from atlassing basics to birding by ear and points counts). This approach may also include smaller regional coaching networks to continually build and support the volunteer network. Consider the use of online training materials to increase outreach.
- Engage volunteers early in the project and continue to recruit new atlassers throughout, providing diverse and meaningful opportunities for engagement in as many aspects of the project as possible. Provide tools for feedback from volunteers to help keep a pulse on needs and opportunities.

8.1 Regional Coordinators

Breeding bird atlas projects require large numbers of volunteers to ensure adequate coverage of the project area, presenting challenges in coordination and organization. Most atlases should anticipate the participation of hundreds, possibly thousands, of volunteer participants. Some of these will be field assistants (e.g., spouses, friends, or children) helping a more actively involved atlasser who completes the data records, but many volunteers will be actively engaged in the planning, fieldwork, and personal record keeping and data entry associated with the project. The successful engagement and support of a large volunteer contingent is central to a successful atlas project. The job of recruiting, training, and supporting this throng of volunteers relies not only on atlas staff but also on a set of Regional Coordinators (RCs) who will be the first point of contact for most atlassers around the region. Without doubt, RCs are the backbone of the volunteer network, and their role is invaluable for day-to-day management and one-on-one support of volunteers.

RCs are responsible for an atlas sub-region, corresponding to a group of grid units, e.g., an ecoregion, county, or another defined region within the atlas focal area. RCs handle most volunteer management matters regionally, including playing a major role in recruitment, the dissemination of resources, and the vetting of data. RCs should be selected to manage regions with which they are very familiar. This usually, although not always, means the region in which they live. Certain regions, such as remote areas, by necessity may require non-resident RCs or project staff. Ideally, the RC chosen for such regions should have some experience with it. The familiarity is necessary for assigning volunteers to grid units, providing support in response to localized issues that arise, recognizing what species are likely to occur in the region, identifying regionally rare species requiring additional documentation, or knowing safe reporting dates. The RCs can often provide a preliminary assessment of breeding evidence and significant species data due to their knowledge of what to expect for their region.

A top priority of the atlas coordinator and the project's steering committee should be ensuring that the network of RCs is as well trained and supported as possible. Training sessions in early stages of the atlas, as well as annual RC meetings throughout the project, will help to ensure that issues relating to volunteer management are addressed in a timely fashion. These occasions also provide opportunities for atlas organizers to share project updates and to supply additional training. Good relationships and regular communications (e.g., monthly during the off-season and at least bi-weekly leading up to and during the atlas season) are key to the project running smoothly.

It is also essential to monitor performance of RCs to ensure they are doing an adequate job, particularly in communicating with and supporting volunteers. If an RC is unable to keep up with the requirements (which could be simply due to insufficient time to devote to the project), a replacement should be found as early as possible. In some regions it may be worthwhile to set up teams of RCs, to divide up the workload and allow them each to spend more time atlassing.

Some of the typical roles held by Regional Coordinators (adapted from the Atlas of Breeding Birds of the Maritime Provinces, Stewart et al. 2015) include:

- recruiting atlas volunteers
- distributing materials to volunteers
- assigning grid units
- tracking coverage within their region
- organizing local events (e.g., workshops, presentations)
- assisting in training volunteers (e.g., reviewing field methods and data submission)
- investigating and verifying rare sightings if necessary
- updating list of grid units requiring outside help to cover
- attending Regional Coordinator meetings
- providing feedback to the Atlas office
- keeping an up-to-date list of atlassers in their region
- reviewing all hard-copy data, and compiling and forwarding to Atlas office
- reviewing all bird records, including Rare/Colonial species forms (online)
- updating/modifying regional bird lists (online)
- answering questions (phone and email) from volunteers in their region

8.2 Assigning grid units

Assigning volunteers to individual grid units may help with coordination, ensuring that all target grid units receive coverage and/or that coverage is relatively even across the project area. Having one or more assigned grid units can be very motivating to volunteers as they develop a personal connection to the areas they are atlassing and are more likely to put in greater effort. For example, they may be more likely to make visits throughout the season to look for early or late-nesting species, and more likely to find and visit rare habitats. However, there is also the risk that if volunteers are assigned only one unit, disproportionate effort may be invested in that unit at the expense of others, resulting in uneven coverage and less efficient use of volunteers. This bias can be avoided to some extent by clarifying project coverage goals to volunteers at the outset as well as encouraging them to move on to a new grid unit once their first one has been adequately covered. When volunteers are few, consider asking them to register for multiple grid units to encourage more even coverage. If some regions have fewer volunteers than others, atlassers in well-surveyed regions could be encouraged to sign up for one or more grid units in other regions.

Regional Coordinators should review progress towards coverage at the end of each season, as measured by species/effort accumulation, and encourage new assignments if appropriate. However, Regional Coordinators should first be sure to communicate with volunteers, since not all will have entered data as they are collected.

While it is very helpful for atlas organizers to have assigned atlassers for particular grid units, project volunteers should be welcome to submit casual observations for grid units regardless of who may already be assigned. In this sense, individuals assigned to particular grid units could be considered “principal atlassers” or “responsible atlassers” rather than the only person who can contribute observations for that location. Their role should be to ensure that the grid unit is adequately covered but not necessarily to provide all the coverage themselves. Since atlassers have differing skill sets, organizers may also suggest that volunteers adopt the “share your square” concept wherein volunteers focus on different aspects of atlassing, according to their skills. For example, one person may focus on collecting breeding evidence data, while another focuses on point counts.

8.3 Instructional materials

All atlas projects will require a manual (or comparable instructional materials) detailing for participants the project goals and methods. Some atlases may also create supplementary materials, such as instructions on how to atlas for specific groups of species (e.g., species at risk). When preparing instructional materials, consider what will be important to volunteers and what questions they may have. Often a good approach for planning materials is addressing the fundamentals: who, what, when, where, how, and why. Volunteers may be much more likely to follow a particular methodology if they understand its importance. Consider including a small flash card with important information such as breeding codes that can be carried by volunteers in the field. Keep training materials as brief as possible, but ensure that key resources are complete and include all protocols that might be used by volunteers over the course of the project.

It will likely be necessary to offer materials in both print and digital format. Many volunteers may prefer to receive materials via email or to access them via the website, allowing them to choose which to print. This option saves on printing and mailing expenses for the atlas project. However, some volunteers may still prefer hard copies of materials. If necessary or appropriate for your jurisdiction, make available translations of instructional materials and data forms.

8.4 Training sessions

Consider offering training sessions for volunteers who would like practical experience in atlassing techniques. Possible topics include atlassing basics and introduction to field surveying; introduction to breeding evidence data collection; practical sessions on point counts; introduction to collecting habitat data; introduction to tools (e.g., GPS and map reading) and data sheets (if applicable); and bird identification workshops. These sessions and tutorials can be done at club meetings, conferences, online, or through weekend workshops and field sessions. Online webinars can involve live, interactive participation and can also be recorded so that people can view them again in the future. Training videos or videos of workshops could be made available on the Internet using YouTube or other streaming services. Field sessions can be undertaken in areas requiring additional coverage, thereby serving both as a training session and filling an atlas coverage gap. Depending on the topic, some sessions could be undertaken prior to the breeding season, whereas other, practical sessions may need to be done during the atlassing season.

A mentoring system can also be a good way to train new atlassers. Many experienced birders enjoy helping to train new birders. Beginning atlassers who are paired with experienced birders in the early years of the atlas may be able to take on their own grid units in later years.

8.5 Maps and data forms

In addition to instructional resources, some volunteers will also require printed data forms, and all volunteers will require maps for their intended grid unit. These materials can be made available to volunteers through the Internet to save on printing and mailing expenses; volunteers should also able to choose whether the resources would be more useful in print or digital format. If there is concern about making these materials available to the general public, require atlassers to log in using their participant number to access them. Atlassers without access to the Internet or a printer can be mailed a full resource package or provided with this information through their RC.

8.6 Motivating volunteers

One of the best ways to keep atlas volunteers (as well as RCs and staff) engaged and enthused over the full atlas duration is through regular updates on the project's progress. This can be done through the project website and through regular communication by email, social media, or electronic newsletters, and/or in-person get-togethers. For example, updates to breeding evidence maps or relative abundance maps are a great way to keep people up to date on progress – and help reveal data omissions or coverage gaps. Similarly, effort maps, which change colour as effort increases and coverage is complete, are a great incentive. For the second Maritimes atlas, volunteers responded very positively to seeing squares that had attained 20 hours of effort (the target coverage threshold) change to dark green online. For some volunteers, awareness of a pending cut-off for data submission for the next update of the maps is a helpful incentive to submit that year's observations. Similarly, updated data summaries on the project's website help to keep volunteers engaged since they can see their data become integrated within the larger atlas project. Updates are also often helpful for reporting back to project funders on annual progress.

8.7 External and existing resources

Many resources (both instructional and for data recording) already exist from other atlas projects. Some projects have made them available on their websites; others may need to be obtained from project coordinators. Borrowing and adapting materials rather than creating new ones can save time and effort and, potentially, expense.

Provide links on the atlas website to other online documents with relevance to your atlas project. Non-atlas resources can also be helpful to volunteers. Existing online resources used for practising bird identification and atlassing skills include Dendroica (www.natureinstruct.org/dendroica) for bird song and visual identification; Avichorus (www.natureinstruct.org/avichorus) for doing point counts by ear; and WhatBird (www.whatbird.com) and AllAboutBirds (www.allaboutbirds.org) for introductory information about birds, including songs. Note that Dendroica was first developed to support the Ontario Breeding Bird Atlas.

The atlas website could also provide recommendations on field guides or other materials helpful for a particular region. Increasing numbers of digital field guides provide both illustrations and recordings of songs, but some may be better for one region than others. In addition to online resources, a number of apps developed for mobile devices help birders learn songs through quizzes.

8.8 Recruiting volunteers

Breeding bird atlas projects are a great example of Citizen Science at its best, and many birders are seasoned atlas veterans. In fact, many birders anxiously await the next atlas in their region, and others are said to experience withdrawal at the completion of fieldwork! To help promote atlas projects in your region, consider a diversity of approaches. Recruit Regional Coordinators who are familiar with their local birding community. Contact local birding networks and listservs as well as nature and conservation groups and have them help promote atlassing. Social media can be a valuable way to engage birders, especially in younger generations. Existing Citizen Science projects, such as Christmas Bird Counts and the Great Backyard Bird Count, are fertile ground for promoting upcoming and current atlas projects with broader audiences. As well, innumerable media opportunities can be developed around breeding bird atlas projects, which can help promote projects and recruit new atlassers. The large scale of atlas projects and the public's general love of birds are great fodder for the media. Do not assume that every birder in your jurisdiction is already aware of your atlas project – and do not underestimate the value of community and regional media outlets for "good news" stories about nature, birds, and volunteerism!

Black-legged Kittiwake, NY. Photo © Carol Horner Ham

Chapter 9 Data Management Systems

Executive Summary. Given the volume and complexity of data collected during a breeding bird atlas project, it is essential to have sophisticated and powerful database and software systems in place for data management and processing and sharing results. A number of data management systems developed for existing atlases can potentially be shared with new projects. While a few atlassers may still prefer to submit data in hard copy, participants are increasingly comfortable with online options. Entering data directly online provides project managers (and participants) with up-to-date observations and statistics on coverage and effort, reduces cost, and facilitates the review of significant species records. Data management systems can also flag potential errors at the time of data entry (e.g., typos or incorrect code use) and flag records where additional information is required from the atlasser (e.g., location and details for significant species). Atlas organizers should budget for significant expenses related to data management.

Principal recommendations

- Adopt web-based data management systems for as many aspects of the project as possible, including data entry, data screening, submission of additional documentation (e.g., for significant species), dissemination of project materials, data compilation, generation of project results, and volunteer and publication management.

- Encourage atlas participants to submit their records online to speed data entry, screening, analysis, and mapping, as well as facilitating overall project management.
- Consider adopting or adapting, as required, existing atlas data management software for new projects to save on expense and effort and to facilitate comparisons between jurisdictions.

9.1 Functions of a data management system

More than simply a database of information, a well-designed data management system can be a tool with which the entire atlas project can be managed. The central core of the system is the database containing all of the information collected during the project. This will include not only results of fieldwork (breeding evidence, abundance data, significant species details) but also maps of atlas results, contact information for atlassers, coverage statistics, volunteer effort, and more.

Early atlas projects managed data through paper forms and submissions by postal mail. Discontinuing the use of paper forms has many advantages, not least of which is the overall project efficiency and the saving of paper. Paper forms also need to be retained and filed, which requires considerable physical space. They also require many person-hours to digitize, whether through scanning or typing and subsequent verification of data. There can be significant delays between collection of field data and their availability online. Lastly, paper forms can be quite costly, depending on the paper used (e.g., waterproof), printing required, and method of distribution to atlassers (e.g., postage).

Modern atlas projects primarily use online user interfaces. What makes each specially designed system unique is the particular interface for adding and managing the data. Although paper forms are usually still available and often used by participants in the field, future atlases will likely move exclusively (or almost exclusively) to online interfaces for data entry, as more and more atlassers are comfortable with online data entry, including direct entry on smartphones or other devices in the field. In some recent projects in Canada for instance, more than 95 percent of data were entered online by participants. However, care should be taken not to exclude important segments of the birding and conservation community who may not be online (including for cultural reasons). In these cases, it may be necessary to budget for atlas staff to enter data on behalf of participants, or to recruit volunteers to help with data entry.

Online systems should, at a minimum, allow users to enter data into the database. The data entry process may be simple or multi-stepped, depending on the complexity of data. Potential data-submission interfaces may include not only breeding evidence and effort but also significant species forms, habitat forms, nest records, point count or other abundance data, plus other specialized survey forms (such as those used for marsh monitoring programs or nocturnal owl surveys).

Systems may also include automated queries that allow users to view data summaries, with more detailed summaries potentially available to administrators or coordinators. At a basic level, summaries might report hours of effort, numbers of checklists, or the number of species reported for each grid unit. They could provide the highest level of evidence for each species, the number and/or identity of the point counts completed, the names of atlassers providing data for the grid unit (where consent is provided), etc. More complex data queries could be established to create species accumulation curves or maps based on raw data showing preliminary distribution results.

Online data entry should also allow for immediate data screening and feedback to participants. Certain combinations of data that are erroneous can be automatically prevented or flagged upon submission, prompting the user to correct or verify data. This function saves time and effort for the Regional Coordinator and other persons involved in verification during later review. Data management systems can also provide mechanisms, such as pop-up windows, to prompt atlassers to enter additional data (e.g., map coordinates or descriptions) for significant species records. That way, additional details can be entered at the same time as the main record, saving time and effort in data entry for atlassers and helping to ensure that the additional information needed for record verification is entered.

Another significant component of online systems is the ability to manage data review and atlas progress. For example, the online data management system can provide tools for atlas staff and/or Regional Coordinators to track coverage, review data forms, contact atlassers, create regional summaries, and modify the region's rare bird list. Multiple reviewers in different locations thus can review data online at their convenience as well as coordinate the flow of that review from one stage to the next.

Further, at the publication stage, online tools can be used to coordinate text editing and photo selection.

9.2 Choosing the right data management system

The selection of a data management system should be considered up front during atlas planning. Decide on the project's goals and management needs and what specific data will be collected, and then determine what features a system requires to meet these needs. Adopting standard data collection methods and sampling design will maximize the compatibility of your data with other projects.

There are many advantages to adopting pre-existing technology and software and modifying the system as required, rather than creating a new data management system. While there may be significant upfront costs to adapting or adopting some of these systems (e.g., $50,000 – $100,000), the costs of developing a new system are likely to be much higher (and result in fewer features).

Features that should be considered in an online system:

- efficient data entry
- automated data verification and checking
- linking of breeding evidence checklists, significant species, and nest record forms
- management of the data review process
- management of volunteer information
- real-time data summaries and progress reports
- mapping of species and effort information
- tracking of coverage progress
- submission of photos (birds and/or habitat) and sound recordings as documentation
- data and information security (including data backups and protection of confidential information)
- publication and manuscript management

North American system options

Several data management systems have been used in North America in recent years. Some states and provinces have developed their own systems, in some cases linked to a broader data management system within the organizing host. Several institutions have developed systems for use by multiple atlases: the Patuxent Wildlife Research Center (USGS Breeding Bird Atlas Manager); the Cornell Lab of Ornithology; and Bird Studies Canada. The Patuxent system was used by several atlases but is no longer accepting new atlases. The Cornell Lab of Ornithology recently developed a revised atlas data management system based on eBird and is currently accepting new projects. This system allows atlassers to take advantage of the many summary and reporting features available in eBird. The Bird Studies Canada system has been used for all but one of the Canadian atlases since 1999, and is currently being updated to improve integration among atlases and links with eBird. Atlas organizers are encouraged to contact these organizations and agencies, and seek the advice of colleagues leading other atlases, to determine best options.

9.3 Quality control checks

A well-designed data management system will be able to perform basic quality-control checks on submitted data. These checks could include identifying typographical errors, incorrectly entered data, invalid data (or code) combinations, and/or other data or notation errors. The system could also flag records that are potentially inaccurate or wrong (e.g., unexpected species that may be incorrectly identified; unusual breeding evidence codes for a species that may be incorrectly used; unusually high numbers of individuals reported on point counts that may be typos, etc.).

Typos and incorrectly entered data: Inevitably, especially with large scale volunteer data entry, errors will be made in data entry. For many data sets, the computer system can be provided with a list of valid codes or number ranges for comparison with submitted data. Any submitted data that do not match the list in the system raise a flag and prompt the user to either correct the entered data or, if it is an unusual but not impossible code, to confirm that the entry is indeed correct, perhaps providing additional documentation. For example, if the atlasser meant to enter NE (nest with eggs) but accidentally typed ME, this would be flagged, as there is no valid atlas status with the code ME.

Invalid data combinations: Erroneous data combinations can be due to typos, misidentifications, or misinterpreted observations in the field. The data entry system can flag invalid combinations of data as well as provide information that explains why the species–code combination is considered invalid or questionable, providing atlassers with an opportunity to identify and correct errors during data entry.

For data combinations that cannot be automatically classified as valid or invalid, such as a probable nesting outside of safe dates, records can be flagged for additional verification, first by the atlasser who entered the data and then by additional reviewers. Further, the data management system can be designed to prompt the atlasser to enter additional information to justify the use of the data combination at the time of entry.

Note that not all errors will be caught by the data management system. If the user enters data for the wrong species, or an incorrect count on a point count, this can only be detected by careful proofreading. The system should remind users to proofread their forms when they are complete. To facilitate checking, a well-designed system will provide users with a formatted summary of the data they just entered, and could potentially require users to confirm that they have verified their data.

9.4 Importing data from other projects

Many jurisdictions have a variety of other bird-monitoring or bird-survey projects taking place at the same time as the atlas, which could potentially contribute useful observations. At a minimum, these projects will include the North American Breeding Bird Survey and eBird, but various other surveys may also be available, including state or provincial projects or museum records. Many environmental consulting firms make use of atlas data, so it may be possible to request that they reciprocate by adding their own data to the atlas.

Ideally, all such data would be provided as digital files to allow for import directly into the atlas database. Depending on the size of the database, the atlas data manager may create a customized script for importing data or may ask providers to manipulate their data into a standard format. All such data records should be flagged with their source in the database, along with their associated effort data (if any), so that analysts can decide how to use them. All such records should be useful for mapping breeding evidence, but only those with good effort data can be used for more quantitative analyses (e.g., probability of detection). In most cases, these data will not have specific breeding evidence records; however, provided they are within safe dates, they can be considered as Possible (“H” or “S”) as a minimum. Unless they have already been rigorously reviewed, such records need to be subject to the same quality controls and review as other atlas records.

Importing data from the Breeding Bird Survey may require extra effort to digitize coordinates of the stop locations where data are collected. Individual routes typically span multiple grid units; thus, it is necessary to determine which individual points are in which grid unit. The offices of the Breeding Bird Survey (BBS) in the US and Canada are currently still in the process of building a database of stop level locations; the proportion of routes for which volunteers have used a GPS to record locations of their stops varies considerably among provinces and states. Atlas organizers may need to work with the local BBS coordinator (who is hopefully also participating in the atlas!) to encourage volunteers to GPS any remaining routes.

While eBird checklists are associated with a coordinate, depending on the distance travelled, the birder may not have remained within an atlas grid unit. Ideally, birders should be encouraged to enter their data into the atlas first, with a subsequent export into eBird, rather than the other way around, to ensure that data are fully compatible with the atlas. Fairly regular exports of data from the atlas to eBird may be required so that birders can see their data in eBird as soon as possible.

Semipalmated Plover, DD. Photo © Christian Artuso

Chapter 10 Mapping Features and Considerations

Executive Summary. Maps are the cornerstone of breeding bird atlases and can be used to illustrate concisely and attractively major project findings on breeding distribution and relative abundance, as well as measures of effort and coverage. Draft maps created during the project's field years can also be valuable to project managers and Regional Coordinators for planning fieldwork in upcoming seasons and can provide motivation and feedback to project volunteers and funders. Second and successive generation atlases will want maps to show changes in distribution and relative abundance over time. Maps can also be developed to synthesize and summarize overall atlas results, such as range shifts, species richness, atlasser effort, etc. Print publications (and perhaps some formats of electronic publications, such as e-books) may have limited room for multiple maps per species, so finding efficient ways to illustrate detailed (yet readable) information in as little space as possible is of paramount importance. Design considerations for mapping may include some space constraints as well as factors such as sensitivity to variation in people's colour perception or potential for printing in black and white.

Principal recommendations

- At a minimum, publish draft breeding evidence and effort maps online at the conclusion of each year's field season to illustrate progress, highlight results, and encourage prompt submission of results by atlassers. If possible, make maps available in real time or at regular intervals throughout the field season.

- Consider showing change in breeding evidence between atlases (e.g., range expansion or contraction or shifts) using overlaid dots rather than printing side-by-side breeding evidence maps from different atlas time periods.
- Mapping considerations should include sensitivity to colour selections and combinations to ensure they can be perceived by everybody; and suitability of map design for publication in multiple formats, including Internet, print, and electronic formats, such as smartphones, tablets, dynamic mapping portals, etc.

10.1 Uses of atlas maps

Visual representations and graphical summaries of data are much easier for most people to understand than numeric summaries. Not surprisingly, then, most atlases opt to present most of the project results through charts, graphs, and maps. With successive generations of atlas projects, atlas maps become more interesting and informative, since they can illustrate changes over time relative to earlier atlases. Many current and recent atlas projects also map relative abundance, providing even more information – and adding to the complexity of the maps. More recently, some atlases, such as the second Maritimes atlas, have mapped the probability of observation and changes in the probability of observation over time, as an index of changes in abundance.

Mapping data as they are collected during years of active fieldwork allows organizers and volunteers to see at a glance which areas have been well covered and which require additional effort. Thus, maps can play an essential role in coordinating assigned grid units or determining areas to target specialized surveys. If interim maps are made available during the course of fieldwork, organizers and volunteers are better able to distribute effort to areas with lower coverage. For volunteer participants, seeing draft maps online can also provide meaningful incentive to continue participating, and perhaps foster added enthusiasm to gather new types of data, such as point counts.

Project funders and supporters like to be able to see the results of their funding contributions, and maps provide tangible evidence of the work being completed. Also, in some instances, maps may provide some help in deciding where to target fundraising efforts, such as seeking funds to better understand areas of high species richness, special habitats, or remote regions.

10.2 Mapping atlas results

Breeding evidence and changes in distribution

The breeding distribution for each species is mapped based on the level of breeding evidence found for that species within the grid unit. The breeding evidence category (i.e., Possible, Probable, or Confirmed) can be represented by the use of different sizes of dots (Figures 10.1, 10.2) or different colours for each grid unit (Figures 10.3, 10.4). It is important to clarify to readers that these codes do not necessarily reflect abundance; whether or not a species is confirmed often depends more on atlasser behaviour.

When two or more atlas projects have been completed for a jurisdiction, the change from one atlas to another can be mapped. Changes between successive atlases can be shown by displaying breeding evidence maps from each project side by side (e.g., Federation of Alberta Naturalists 2007). Alternatively, maps can be created that show change data on the same map (Figure 10.4). Many atlases overlay the grid unit with a coloured dot to indicate that the species was documented in the current atlas project but not the first. Conversely, a dot of a different colour overlaying the grid unit can be used to illustrate that the species was documented during an earlier but not the current atlas project. This approach not only saves space but also makes comparison of ranges (and changes in which species were detected within specific grid units) simpler. A third approach is to map the current breeding evidence distribution on a single map, and to complement this with a “change” map to illustrate whether a species was found in a particular grid unit during the first or second atlas, both, or neither (Figure 10.5).

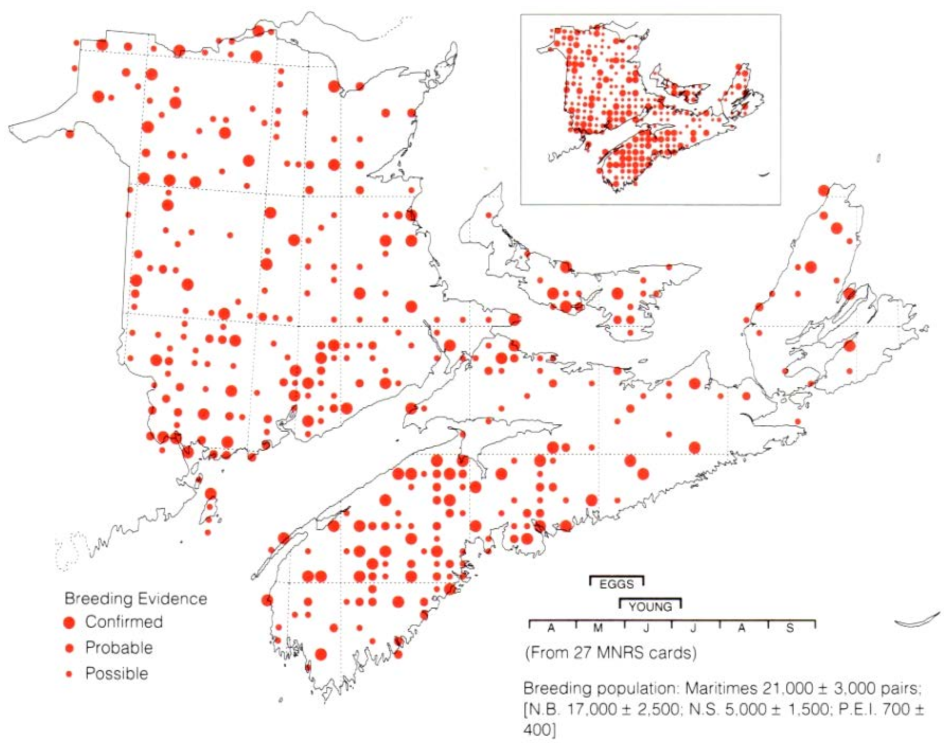


Figure 10.1. Breeding evidence map from the first Maritime Provinces breeding bird atlas (Erskine 1992) for Brown Creeper, with size of dot representing breeding evidence category for each grid unit.

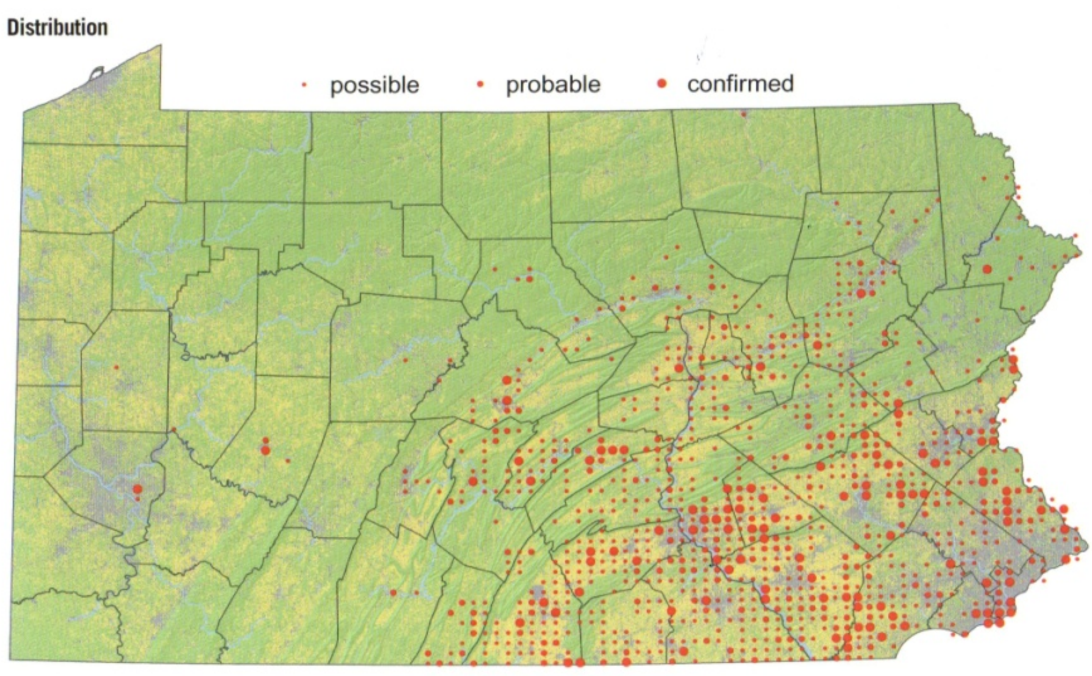


Figure 10.2. Breeding evidence map from second Pennsylvania atlas (Wilson et al. 2012) for Fish Crow, with size of dot representing breeding evidence category. The accompanying Distribution Change map (Figure 10.5) depicts changes in breeding evidence by grid unit between first and second atlases.

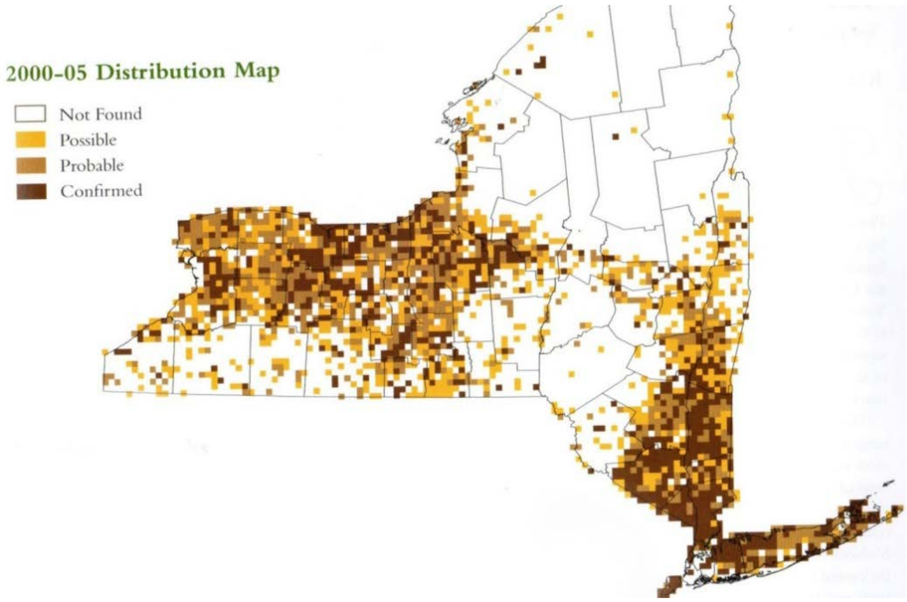


Figure 10.3. Breeding evidence map from second New York State atlas (McGowan and Corwin 2008) for Red-bellied Woodpecker, with different colours representing different breeding evidence categories for each grid unit.

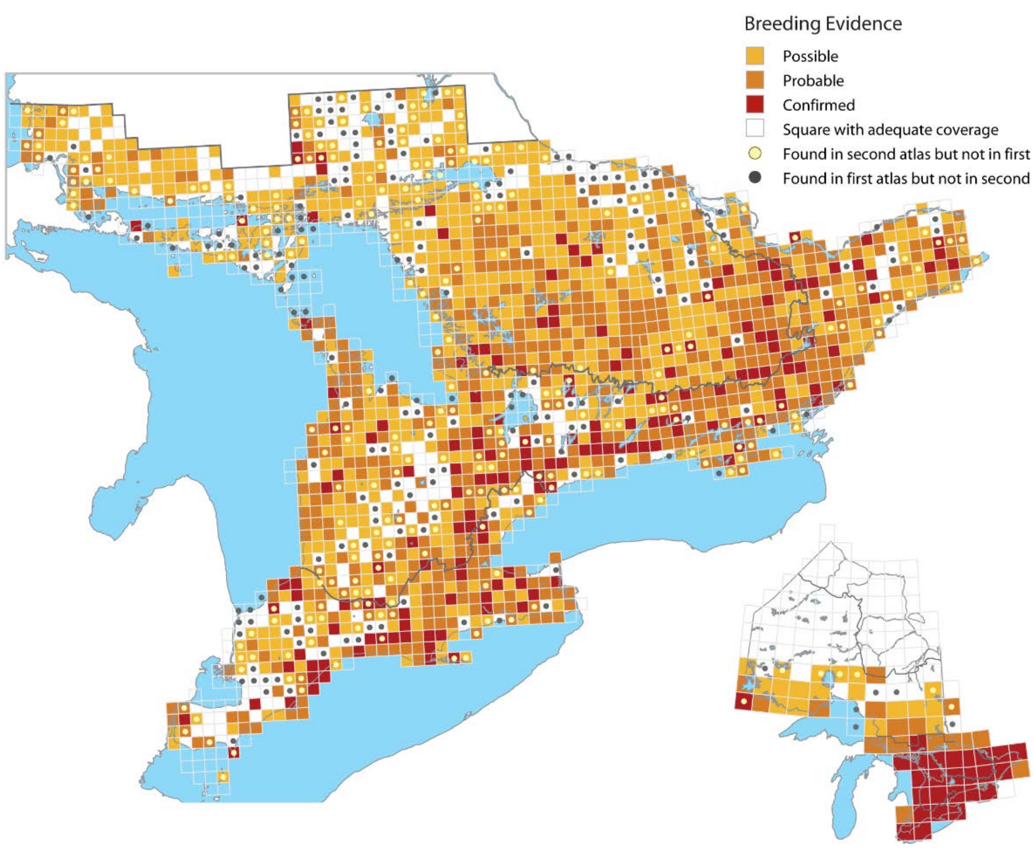


Figure 10.4. Breeding evidence map from the second Ontario breeding bird atlas (Cadman et al. 2007) for Scarlet Tanager, with different colours representing different breeding evidence categories for each grid unit. Yellow and black dots highlight breeding distribution changes between the first and second atlases.

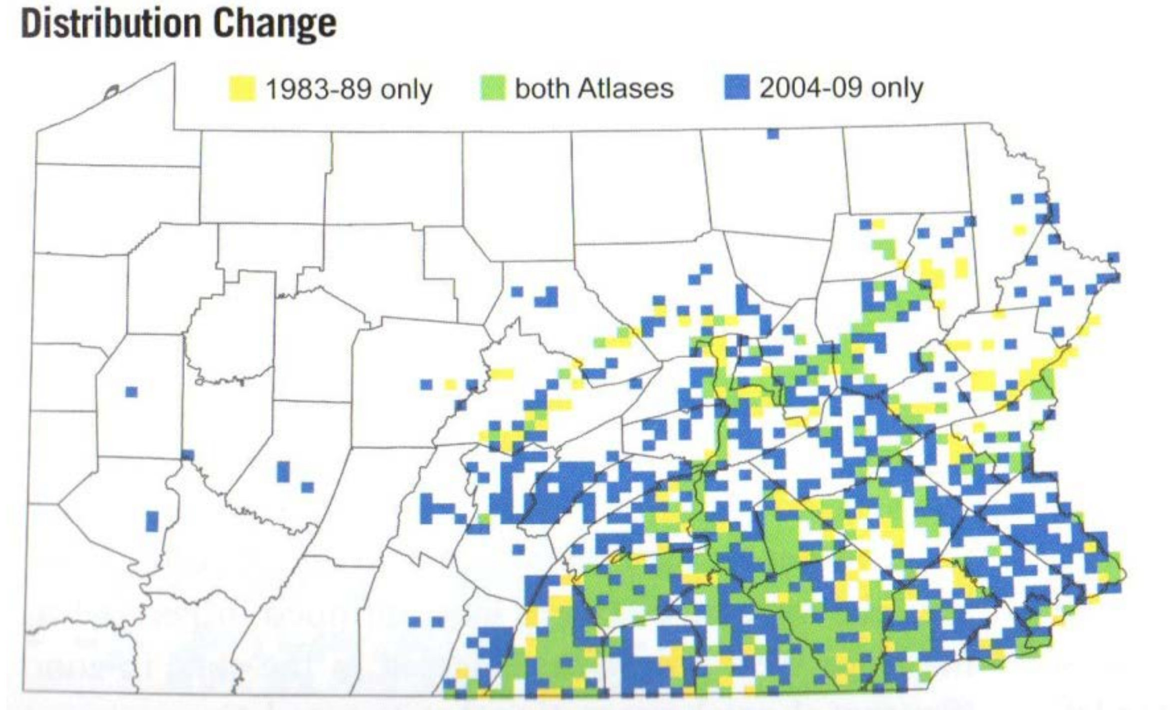


Figure 10.5. Distribution change map from second Pennsylvania atlas (Wilson et al. 2012), depicting changes in breeding evidence by grid unit between first and second atlases for Fish Crow.

Abundance

There are different approaches to mapping abundance as well as probability of observation (an indicator of abundance). The mapping approach taken may depend in part on the type of abundance data collected and the type of map desired. Data may be averaged within each grid unit with a single colour representing a level of abundance, similar in depiction to a typical breeding evidence map. Alternatively, a "smoother" abundance map can be produced by applying computer modelling to "contour" the data, with different levels of shading used to represent relative abundance levels. The resulting contoured map is intuitive and simple to understand, since it is similar to weather radar maps that illustrate the relative intensity of precipitation with different colours or intensities (Figure 10.6). An additional way to measure and depict abundance is through an analysis of the probability of observation, which is derived from the amount of time it takes to detect a species' breeding evidence in a grid unit. This can be done for an individual atlas – as well as for successive generations of atlases, in which case comparisons can be made (Figure 10.7). Further details regarding mapping and analyses of abundance and probability of observation are described in the second Maritimes Breeding Bird Atlas (Taylor et al. 2015).

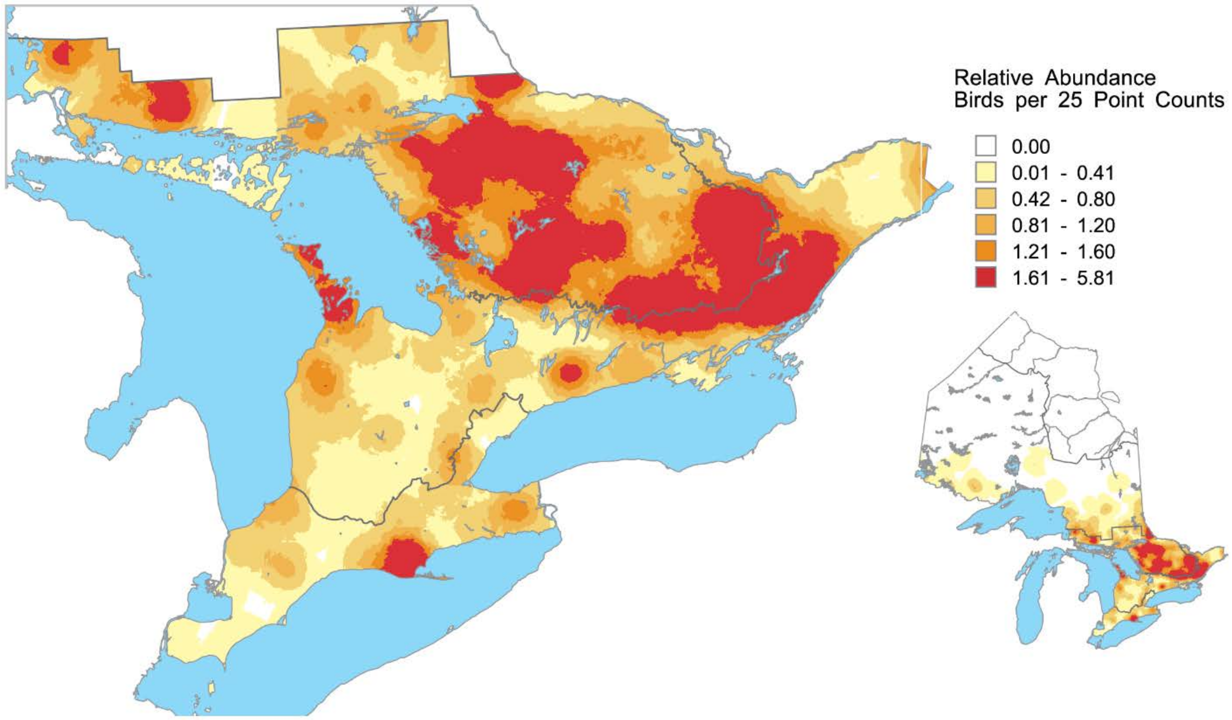


Figure 10.6. Relative abundance map from the second Ontario breeding bird atlas (Cadman et al. 2007) for Scarlet Tanager, wherein the more intense colour is associated with greater abundance.

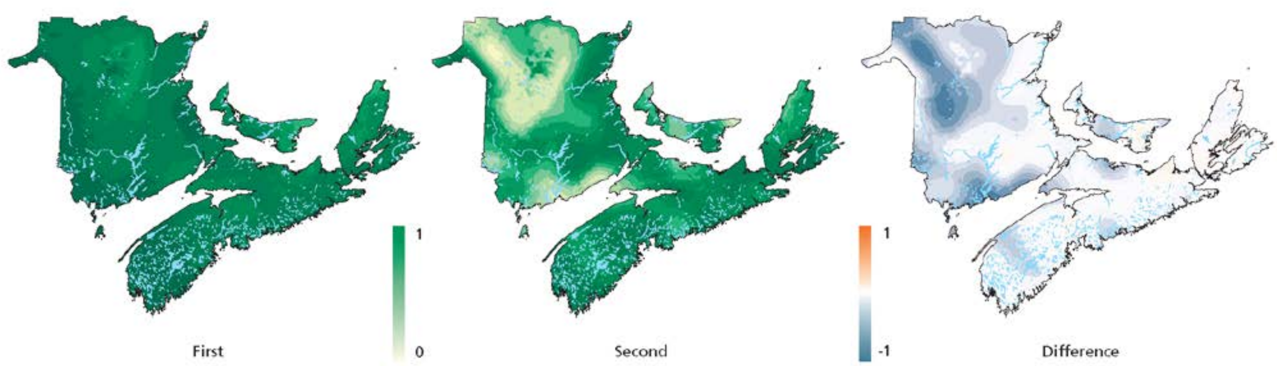


Figure 10.7. Probability of observation map from the second Maritime Provinces breeding bird atlas (Stewart et al. 2015) for Tree Swallow, illustrating change since the first atlas. Blue indicates a decrease in the probability of observation between first and second atlas whereas red indicates an increase; darker shades indicate a greater degree of change between atlases.

Additional maps

Many additional mapping products can be developed to assist with both the undertaking of the atlas project itself and the interpreting of results at the completion of fieldwork. The following illustrate just a few examples of additional mapping products.

Species richness: At the completion of the atlas project, each grid unit will have a final tally of species detected. This tally can be mapped for quick visualization of the areas within the region containing high or low species richness. This is often done using a stepped scale for species count with a different hue or shade for each step. This approach could also be used to map estimated species richness, based on the probability of observation, which corrects for variation in effort among grid units.

Species groupings: Certain species assemblages are often characteristic of particular geographic regions or habitat types. Composite maps showing species with similar habitat or other needs can be developed at the completion of atlas projects. For example, The Land Between initiative (www.thelandbetween.ca) highlights conservation needs and unique faunal assemblages in an ecotone in southern Ontario between the pre-Cambrian Shield and the Great Lakes–St. Lawrence Lowlands. This initiative has highlighted the jurisdictional importance of the region to particular species, such as the Golden-winged Warbler.

Atlasser effort: Atlasser effort (e.g., measured in hours, numbers of checklists, or numbers of point counts) can be mapped both during and at the completion of the atlas project. This can be a useful tool during the atlas fieldwork years to direct effort, as well as a useful summary at its completion (Figure 10.8). Changes in effort between subsequent atlases can also be mapped (Figure 10.9).

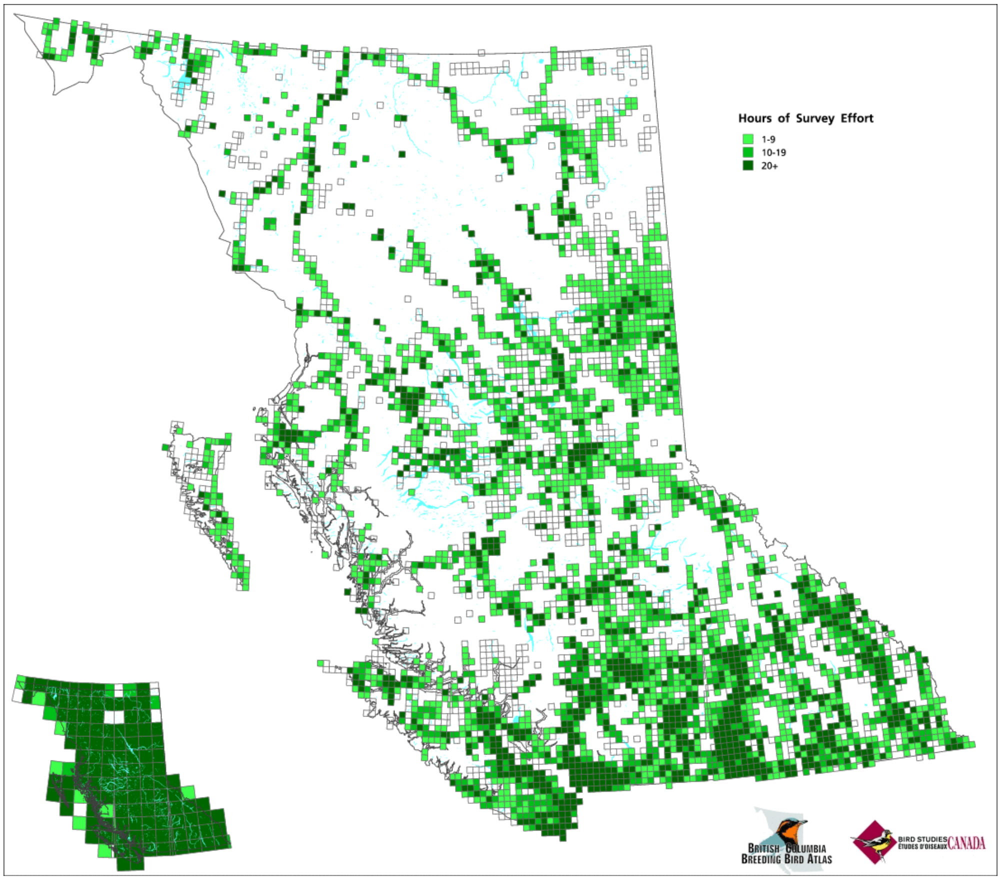


Figure 10.8. The number of hours of survey effort reported for each 10 km grid unit (“square,” in Canadian atlassing lexicon) and 100 km larger unit (“block,” in Canadian atlassing lexicon; see inset) for the completed British Columbia breeding bird atlas (Davidson et al. 2015).

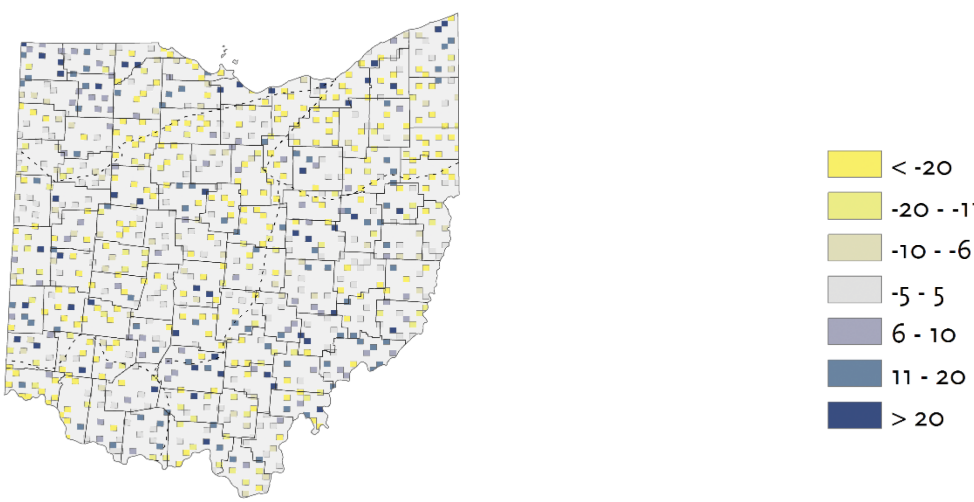


Figure 10.9. Change in field effort hours between atlas periods for the completed second Ohio breeding bird atlas (Rodewald et al. 2015). Negative values (toward yellow) indicate priority grid units with higher effort during the first atlas, and positive values (toward blue) indicate higher effort during second atlas.

10.3 Map formats

Atlas results can be published in multiple ways; common formats include the Internet, bound books, e-books, summary publications, etc. Each method of publication comes with its own considerations and requirements for map presentation.

Book publishing

Results from the earliest atlases were shared using traditional hard-copy books, and many recent atlases continue to publish results in book form, either as the primary means of presentation or in accompaniment to additional formats. (For further discussion of publication options, see also Chapter 12.)

Sizes: *S*pace is limited in printed publications, so balancing readability with space usage is a necessary consideration. For most atlas projects, the most important information to be conveyed by the publication is maps of distribution and relative abundance, as well as change in successive atlases. Maps should therefore be given preference on the page over accompanying text and/or photos, to ensure legibility.

Reference features: Be sure to include one or more maps in the introduction of the book with key reference features (e.g., landmarks, place names, major habitats, etc.) that include all features referenced in the species account descriptions. On breeding evidence and abundance maps, reduce clutter and improve readability by showing only the major features (typically without labels).

Internet

Nearly all recent and current atlases maintain an active website where some or all results are shared during and on completion of the project. Some atlases use the website to augment a printed publication, but for many the website is the sole means of presentation.

Given that maps published on the Internet are not bound by the same constraints as printed maps, there is much opportunity to expand their features and functions. Maps can be made interactive in many ways, augmenting the experience and information conveyed for the reader. One example is to make grid units “clickable,” taking the reader to various other linked data summaries such as lists of species detected in the grid unit, completed point counts, and/or effort information for that unit. Hovering the cursor over a grid unit might provide the name of the unit and/or identifying land feature, to help with orientation. An alternative is to have reference layers such as place names hidden or displayed with a mouse click.

Dynamic mapping portals

Both books and websites typically present static images prepared in advance using a fixed set of data. However, web-based software applications can be used to produce a dynamic map of results using the most up-to-date version of the database, thus presenting the data in "real time" (i.e., each time a map image is requested by the user, the data are called anew and the map is drawn fresh). These types of interactive maps potentially allow multiple overlays, enabling users to explore different combinations of results (e.g., to view which species are co-occurring). While there is considerable interest and value with dynamic mapping portals and applications of this sort, it should be noted that they are susceptible to breakdowns and require ongoing maintenance as technologies change over time.

10.4 Design considerations

As long as maps are intuitive and easy to read, there is no right or wrong way to present them. However, to make maps easy to read for as many people as possible, a few additional items may be considered.

Colour choices for mapping: Certain hues can be very difficult or impossible for some persons to tell apart (i.e., those with decreased ability to see colour or differences in colour), even when they may look substantially different to a person with full colour vision. A number of websites and software packages exist that can simulate what your maps would look like to persons with decreased ability to see colours or differences in colour (e.g., https://www.betterevaluation.org/en/resources/tool/vischeck, http://colororacle.org). If possible, ask persons with colour vision deficiency to review the selected colours and/or sample maps.

Monochromatic printing: In some cases, users may want to print maps on a monochrome printer. To facilitate this, maps should be single hue or black and white. For example, the levels of breeding evidence or relative abundance can be indicated by the shade of the square, not the colour. Shades of some colours are more easily distinguished than others. Select a colour that will allow quick and easy identification of the results; produce several samples using the selected colour(s) and ask for feedback from others before finalizing the decision.

Black-and-white reproductions: Even if the atlas results are published in print in full colour, reproductions of the materials (e.g., photocopying or home printing) may often be in black and white. Pay attention to the hues and shades chosen, to make sure they can be easily differentiated when converted to black and white.

Publication format: Maps printed in bound books will appear the same in each copy of the book, but those shared online will be viewed using many different monitors and interfaces, each with different settings. Select colours and shades that are easily distinguishable across a range of display brightness, contrasts, and colour balances. Produce several samples and check them on a variety of displays. With the increased use of mobile devices and smartphones, it is worth including mapping options that work well on smaller screens.

Eastern Bluebird, NY. Photo © Tim Stewart

Chapter 11 Analyzing Atlas Data within and between Atlases

Executive Summary. The comparison of data between successive atlas projects is not only of interest to birdwatchers and volunteer atlassers – it is also of utmost importance for wildlife management and conservation. Changes in the distribution and abundance of species provide information for setting conservation priorities. Understanding how changes in the landscape are affecting birds can inform management options. New atlases should be designed to facilitate comparison with both past and future atlases. Standardizing methods, to the extent possible, with previous atlases helps with detecting change; however, managers should not hesitate to adopt new, improved data collection approaches that will allow more robust comparisons in the future. For example, most second-generation atlases have adopted some aspect of quantitative sampling (such as point counts; see Chapter 5) that cannot be compared directly with the first atlas but will provide for robust comparisons in the future. Statistical approaches for estimating current distribution and abundance, as well as changes over time, need to take into account incomplete detectability (i.e., the fact that many species that are actually present in a grid unit may not be detected). A number of analytical approaches have been developed recently to estimate changes in distribution from species lists, controlling for variation in effort; further statistical developments can be anticipated in the future. Recording information on effort and a complete list of species detected on each visit provides for much more flexibility in using these approaches. The most robust change analyses will be based on standardized quantitative data such as point counts, but integration of these data with general atlassing data will increase power and flexibility.

Principal recommendations

- Encourage participants to record effort for all observations, and to record complete checklists as much as possible (see Chapter 3), to provide a basis for modelling and adjusting for the effect of effort on species detectability.
- Be aware that many incidental (casual) observations or data imported from other projects may not be suitable for inclusion in change analyses.
- Adopt quantitative sampling methods to allow for more robust change analyses in the future, and encourage atlassers to count (or estimate) numbers of individuals detected for all species during "regular" atlassing.
- In estimating species distribution, take into account incomplete detectability – the fact that species may be present in a grid unit and not detected.
- When analyzing change, review recent literature to determine the most appropriate statistical methods available; much recent progress has been made in methods development, and further improvements can be anticipated.

11.1 Planning for change analyses

When planning a first atlas project, it is important to adopt data collection methods that will allow for robust statistical analyses, both for present distribution and future changes. The primary purpose of completing a second or subsequent atlas is to measure changes in distribution and abundance and to get an up-to-date assessment of the status of breeding birds. For analyses to be robust, data need to be as strong as possible. Several features that can help with change analyses include using standardized data collection approaches as much as possible; recording accurate information on effort and a complete list of species detected on each visit; and adopting quantitative sampling methods to estimate abundance, such as point counts, to estimate changes in abundance over time. Note, however, that it is not essential that all data collected through atlassing be relevant for change analysis. For example, casual observations can still provide valuable distributional information, even if they are not suitable for inclusion in change analyses due to the lack of effort data.

Repeat atlases should attempt to use similar methods to previous atlases as much as possible, but should not feel constrained to avoid adding new or improved approaches such as quantitative sampling. Provided that factors such as effort are accurately recorded, methodology changes can often be addressed through use of appropriate statistical analysis methods.

11.2 Why measure change?

Atlas projects can be invaluable for assessing distribution changes of breeding species. Distribution changes measured by atlases are often more informative than would be possible from other types of surveys, because they provide much more comprehensive data at a finer landscape scale. For example, BBS routes cover only a limited part of the landscape and are restricted to roadsides. Data in eBird tend to be concentrated in popular birding areas, leaving many gaps across the landscape, and also lack standardized protocols or sampling intervals.

The ability to correlate atlas data with other variables, such as land use, road networks, population growth, etc., can help to provide insight into the reasons for detected changes. Bird atlas data can also be valuable for measuring distributional responses of birds to climate change, changes in land use or habitats such as regeneration or clearing of forests or changing agricultural practices, inter-specific competition, or other factors. Change (trend) data are often used in conjunction with range and population size estimates (which can also be obtained from atlases) to assess the legal status of breeding or resident species or to develop conservation plans.

11.3 What types of change can be measured?

Repeat atlases can be used to assess changes in distribution and abundance. Distributional changes may include changes in range density (i.e., the proportion of grid units occupied within the broader distribution) as well as changes in range boundaries that indicate potential expansions or contractions or geographic shifts in breeding distribution. Understanding changes in abundance can help with understanding changes in range. For example, reductions or expansions in range may be driven by decreases or increases in the overall population of a species. Alternatively, they could represent changes in the concentration of a population (e.g., the same number of individuals concentrated into a smaller area), perhaps associated with habitat change. Abundance data can also help detect changes in populations that are not associated with changes in distribution; for example, a common species may undergo quite large increases or decreases in numbers leading to changes in density, but with minimal change in distribution.

11.4 Collecting data to facilitate change analyses

Several aspects of data collection can help with reliably estimating distribution and abundance and how these are changing over time. Key factors include standardizing as many factors as possible (such as grid units); ensuring that sufficient data are collected in each sample unit to allow for robust analyses; and recording information on other factors such as effort that cannot be fully standardized.

Grid Units

Ideally, the grid units used in an atlas would not change over time, but sometimes change may make sense for other reasons, such as compatibility with other sources of data. Small changes will not have much influence in change analyses. For example, in Ontario, the grid system for the second atlas was changed to the more modern NAD83 UTM system, instead of the older NAD27 UTM used in the first atlas. (This change was necessary since many maps available to atlassers used the new system.) Because the units had about a 98 percent overlap, this shift could be largely ignored in the trend analysis. Changes in the size of grid units would preclude comparisons of trends in the proportion of grid units occupied by a particular species, unless the units were nested in such a way that data could be combined to create comparable data. For example, if a first atlas used 10 x 10 km grid units, data from a second atlas that sampled 5 x 5 km grid units that each represented one-quarter of the original unit could be combined for a trend comparison.

Effort

Effort can never be fully standardized across time and space and hence will need to be taken into account in analyses. However, reducing variation in effort as much as possible has advantages. Establishing a minimum level of effort for each unit not only reduces variation but also ensures that sufficient data are available from each unit for analyses. For example, it is not possible to estimate species richness reliably in units where only a few species were reported. There are also benefits to encouraging participants to limit their effort in any given grid unit and instead focus additional field hours in other grid units that have been less well covered. As discussed in Chapter 3, basic targets for effort for each grid unit can be based on party-hours or approaches such as detecting a certain percentage of the species expected to be in the unit.

The most important factor for analysis is to record the amount of effort expended on each visit, as well as the complete list of all species detected on that visit. Recording these two elements allows for the most robust and reliable statistical analyses. There are also statistical approaches for estimating species-effort relationships based only on total species recorded each year with associated effort; these approaches may be important for analyzing older atlas data, but they are generally less accurate. Data collected without effort information may need to be excluded from most quantitative analyses.

Participant numbers and skill levels

While atlas organizers cannot control participant skill level directly, they can encourage active participation by skilled observers, as well as provide training and encourage mentorship amongst participants. As the number of people engaged in birdwatching grows, so too should the pool of potential atlassers in many regions; this is especially true in more populous jurisdictions but may be less so in areas of lower population density. With support, training, and effective use of technology, these birders are often "twitching" at the chance to participate in the next local atlas. The Internet has made it easier for the public to learn about atlas projects and to build their skill level. Online programs (e.g., www.natureinstruct.org/dendroica) provide excellent opportunities for birdwatchers to practise their skills prior to the field season. With increased interest and training, it is likely that second and third generation atlases will have not only more participants but also more skilled participants. Changes in the average skill level of participants could potentially result in bias in trend analyses; however, that risk is outweighed by improvements in data quantity and quality. Various analytical approaches can also be used to address variation in detection probabilities among observers. For example, the number of species detected per unit effort can be compared among observers to distinguish experienced birders from beginners. Such analyses depend upon high quality data. All participants, of all skill levels, should be encouraged to submit only observations for which they are confident of the species identification and breeding evidence observed.

11.5 Accounting for effort

Analysts need to consider that not all effort is equal during an atlas. Effort can be broadly categorized into three different categories.

Casual effort: observations made usually while the observer is engaged in something else, such as travelling through a grid unit or undertaking activities other than birding in the unit, and only records a few noteworthy observations. This effort is difficult to quantify, especially as only selected observations are typically recorded, and these observations are difficult to include in statistical analyses.

"Regular" atlassing effort: observations made while the observer is actively in the field for the purpose of collecting atlas breeding evidence data. This effort can usually be quantified as a number of hours, as it generally has a concrete start and stop time upon entering and leaving the field, although observers may sometimes take a break in the middle (e.g., for lunch), which should be excluded from the number of hours if there was little active birding during that time. If the atlasser takes an extended break, it may be worth encouraging developing a second complete list after the break, especially if a new area of the grid unit is being explored.

Standardized effort surveys: surveys undertaken using standardized count methods. These would include point counts or transects or an intensive standardized survey in a small grid unit such as the tetrads used in the British and Irish Atlas. They would also include surveys designed to collect data from habitats or for species that are traditionally harder to atlas (e.g., wetlands, nocturnal species). While the effort for these data can be quantified in hours, the way the data are collected is often quite different from "regular" atlassing effort.

Standardized effort surveys can often provide data that are particularly suitable for change analyses, but they should generally be analyzed separately from data collected during "regular" atlassing. Similarly, data imported into the atlas from other projects (such as Breeding Bird Survey routes) may often need to be analyzed separately.

11.6 Statistical analysis methods for atlas data

Many of the same issues arise whether analyzing distribution from a single atlas data set or comparing multiple atlases. In both cases, it is important to take into account incomplete detectability – the fact that failing to detect a species does not mean it is not present in the grid unit. For example, in many areas, 20 hours of survey effort (a typical recommended minimum coverage) might be expected to detect 75–80 percent of species present in the grid unit. This assumption implies that 20–25 percent of species were not recorded, even though they were present. In general, common species in a particular area are likely to be recorded with a minimal effort, but considerably more effort is needed to have a high chance of recording rare species. Of course, the same species may be rare in some grid units and common in others, depending on the distribution of suitable habitat.

Determining proportion of grid units where each species is present

It is relatively simple to report the total number of grid units where a species was reported, divided by the total number of grid units surveyed. However, this calculation will almost always underestimate the proportion of grid units where the species actually occurs. A somewhat more useful number can be obtained by calculating the proportion of grid units with the minimum recommended coverage where the species was reported, though this will still be an underestimate of distribution because the species will have been missed in some areas where it actually occurs.

A more robust approach is to use occupancy models (Mackenzie et al. 2006) to estimate the probability that a species will be detected, given that it is present, and adjust the estimates accordingly. For example, if a species was detected in 40 percent of squares with 20 or more hours of survey effort, but the estimated detection probability after 20 hours of effort is only 80 percent, then the estimated occupancy of the species would be in 50 percent of squares. These types of models rely on having multiple observations from each survey unit, such as data from several different daily checklists, or from multiple years. The most reliable estimates are available from complete checklists. Methods also exist for estimating detectability from incremental checklists (where only new species are recorded on each visit), but they are less precise and do not allow testing assumptions. The South Dakota Breeding Bird Atlas (2009) undertook a standardized approach to estimate detectability by asking paid atlassers to complete repeated, structured visits to certain sites, following the exact same route over a fixed window of time (in their case, three visits, each four hours long). Similar approaches can be used for data with variable amounts of effort to estimate detectability by general atlassers, provided that daily checklists are reported.

Estimated occupancy can be used to compare the proportion of grid units where a species occurs in different regions of the atlas area or between successive atlases, even if the average effort varies across space or time.

Estimating probability of observation

A related approach that measures an index of both abundance and occurrence is to estimate the *probability of observation* for a given amount of effort. The rationale is that the probability a species is detected in a grid unit after a limited amount of effort depends on the occurrence of the species in the unit, the ease with which it is detected, and its abundance. This measure is not good for comparison among species because some species are easier to detect than others, but the approach can provide useful comparisons within a species across space or time. The reliability of these approaches depends on having accurate information on effort in relation to the species detected.

Blancher et al. (2007) used cumulative species detection curves in the first and second Ontario breeding bird atlases to estimate the probability that each species would be detected after 20 hours of effort. This approach can be extended to consider the effects of covariates such as habitat or altitude on the probability of observation, as was done for comparing the first and second Maritimes breeding bird atlases (Taylor et al. 2015) or developing maps that correct for variation in effort among grid units in the British Columbia Breeding Bird Atlas (Davidson et al. 2015).

Estimating abundance

The first atlas to undertake "abundance" sampling was the second British and Irish atlas (Gibbons et al. 1993), which asked atlassers to survey multiple 2 x 2 km "tetrads" within each 10 x 10 km grid unit. They used the proportion of tetrads within each grid unit where a species was detected as an index of abundance for that grid unit. This measure is technically more similar to the probability of observation in that it is influenced not only by abundance but also by detectability and occupancy. Furthermore, this index, like that of probability of observation, is most sensitive for measuring changes in abundance of less common species. For widespread and common species, a large change in abundance (e.g., a doubling of the population) may result in only a small change in the proportion of tetrads where the species was detected (because it was already detected in most tetrads).

Point counts are the most widely used approach for estimating variation in relative abundance. A large body of literature exists on analysis techniques for working with point count data; these resources should be consulted before choosing the best approach. Some of the most sophisticated trend analysis approaches have been developed for the BBS, many of which would also be relevant for atlases. The simplest approaches use average number of birds per point count in each grid unit as a metric of relative abundance. Various smoothing algorithms can be used to create maps that estimate abundance in grid units that had relatively few point counts (see mapping Chapter 10).

More sophisticated approaches can be used to estimate actual population size of each species, using estimates of the average detection radius around a point count and the probability that a bird within that radius is detected. The second Pennsylvania atlas collected both distance and time to detection data on point counts to help obtain these estimates (Wilson et al. 2012). Further work would be useful to determine how much this data actually changed the resultant maps, to evaluate whether similar efforts are needed in other atlases. One factor that may be important is consideration of observer effects. As a minimum, it is important to ensure that all observers conducting point counts are experienced at identifying all relevant species by sound. However, even experienced observers are known to vary in the likelihood that they detect different species. This variation could lead to some bias if, for example, all of the point counts in a particular region are conducted by the same observer. Having a mix of observers conducting point counts in each region can reduce the effect of observer variation on the outcome.

Another potential source of information on abundance is the estimated number of birds detected during general atlassing on each checklist, as is currently collected by eBird. New methods are currently being developed to make best use of these data for eBird, which may increase the value of these data in the future, especially for species that are detected less frequently on point counts. It is important to ensure that atlassers record estimates of numbers of individuals detected for all species, not just the rare ones; otherwise the data will be biased by lacking data on areas where species are common.

Mixed approaches

Ideally, analyses of change and abundance should incorporate all available data, in part because different data provide different types of information. For example, while point counts are ideal for the more widespread species, they are unlikely to provide sufficient information for rare species. In contrast, probability of detection models can work for many different species, although they are less sensitive for detecting change in the most common species and only provide an indirect measure of changes in abundance.

Osprey, AE. Photo © Gregor G. Beck

Chapter 12 Publication and Dissemination of Atlas Results

Executive Summary. A major goal of a breeding bird atlas should be to make project results as widely available as possible so that this information can be readily accessible for conservation, research, and educational purposes. Historically, atlas results were shared through the publication of a hard-copy book, but the Internet and other electronic technologies have diversified publication options significantly. Most modern atlas projects now share results (and other project materials) through multiple formats. While printed books involve additional costs for production, many expenses are common to electronic versions also, and printing costs can be offset by sales, grants, or other opportunities (including publication by a commercial, third-party publisher). Regardless of the final format(s), breeding evidence and other maps and species accounts are the mainstays of the atlas publication. The maps and species accounts summarize concisely each species' breeding distribution and abundance, as well as information on changes over time, in the case of repeat atlases. The value of an atlas for conservation can be further increased by making the raw data available to researchers and managers.

Principal recommendations

- Disseminate atlas results as broadly and quickly as possible, using electronic and, where appropriate, print formats.
- Provide as much information freely through the Internet as possible.
- Look for innovative opportunities to collaborate with other bird publications and projects in the atlas region.

- For print publications, consider reducing costs by focusing text on new results obtained from the atlas and providing additional material online.
- For any publication format, engage communications experts and users in the design and review stage, to ensure that the material is easy to understand and use.
- Develop a strategy for making the original field data available to researchers and managers to encourage new and innovative analysis approaches and to maximize the value of the atlas for conservation.

12.1 Publication formats

For the results of an atlas project to be widely disseminated and useful, they must be made easily available to the public, researchers, and the birding and conservation community through publication. In the past, this usually meant book format, but now atlases also have the option of sharing their results via the Internet or other electronic format (e.g., e-books, apps, DVDs). Each method comes with pros and cons. The ultimate decision on whether to publish traditionally in print, electronically, or some combination thereof should be made after weighing the needs and considerations of the particular atlas project, as well as the expectations of project participants, partners, and funders.

While the publication of a hard-copy book entails additional major steps, much of the cost and effort remains the same, regardless of whether the atlas is web based or print. For example, data validation and cleanup, data analysis, mapping, writing chapters and species accounts, reviewing content, copy editing, proofreading, some design/layout and even translation (if required for one's region) are all required regardless of ultimate format. With books, the biggest additional costs relate to printing, design/layout for print-specific materials, storage, inventory insurance, postage, shipping containers (i.e., cardboard mailers), plus the logistics and cost relating to promotion, distribution, and handling of sales. These additional costs, notably printing, are significant, so the development of a detailed publication-specific budget is essential. Such a budget should include various book sale scenarios to ensure that the project does not end up in deficit. If the book must be published in more than one language, the budget must account for the costs of translation, additional layout expense, and some additional printing costs (although split print runs in multiple languages can be done at time of press for relatively little additional cost).

Some atlas projects have followed alternative approaches to the traditional or standard atlas print publication. For example, Massachusetts published its second atlas with a 48-page hard-copy “highlights” document, which serves as a companion to web-based species accounts and an e-book version (Walsh and Petersen 2013). The full atlas is also available as a “print on demand” publication. Additional innovative approaches are possible, such as combining breeding bird atlases with related publications to economize on costs and seek common markets.

12.2 Printed book publication

Advantages

- Printed texts are easy to read, peruse, and scan; the book format also facilitates easy comparison and contrast between species within a particular atlas, as well as between atlases for different regions.
- Print versions do not require special equipment to read or access, making them useful to people without computers and those away from computers.
- They require no additional attention or maintenance once they have been published and distributed.
- They are tangible and can be very attractive, which may be more satisfying from the perspective of both the producer and some end-users; some funders and atlas volunteers may also prefer the tangible and permanent nature of a printed book.

Disadvantages

- The largest disadvantage for an atlas project is production cost (most notably, printing and distribution logistics, although some third-party publishers may cover some or most of these costs), with longer publications increasing costs.
- Cost is also a major factor for prospective atlas purchasers, which can limit distribution, especially if the publication is large and expensive.
- Only a finite number are printed, and once these are sold out, no one else can own a copy unless used copies can be found (increasingly possible online).
- Space is limited to what will fit on the allocated number of pages for each species (usually one or two pages), as well as what can reasonably be covered in preliminary and end chapters.
- Content is static once printed.

- Content is not easily searchable (beyond standard indexing), if specific information is sought.

Things to consider

If the hard-copy book option is selected, securing a commercial publisher may help reduce logistical considerations and financial risk to the atlas project. Indeed, many atlases have collaborated with university presses to publish. While there can be advantages to having the support of a publishing partner (e.g., publisher paying the printing bill or assisting with distribution), it should be anticipated that there may be some loss of editorial direction and control (and of potential "net profit" after costs are recovered). The publisher may also demand concessions regarding how much book content can be made available through the Internet. In addition, it is not uncommon for publishers to require a grant in aid of publication (i.e., a subsidy from the project toward book production); this amount can be significant, especially if the goal is to help reduce the retail cost of the publication. An additional concern is that some publishers (notably, academic presses) lack resources to assist in marketing and promoting the books they publish. As a result, some projects have self-published their atlases, thereby maintaining greater autonomy and overall publication and marketing control. This is a significant undertaking, and the decision whether to self-publish or collaborate with an established publisher really depends on the comfort level and experience of each project team. If the atlas organizers lack experience in the book publication process, they might be better advised to collaborate with a traditional publisher.

Regardless of whether an atlas is self-published or done in collaboration with a traditional publisher, determining the print run and extent of the book itself remain the hardest decisions in the process. A larger print run reduces the cost per unit but increases the overall printing bill. A larger print run also includes the inherent risk that there could be a significant number of unsold books down the road and that revenue generated will not cover the publication costs. Decisions regarding print run, final retail pricing, and related considerations can be greatly informed by an active pre-sale promotion. The pre-sale can generate both interest and revenue – the latter being particularly helpful to offset publication costs. (As an example, about 45 percent of sales for the second Ontario Atlas were generated through the pre-sale.) A potential way around the dilemma of deciding on a print run is to "print on demand." In this case, the printer produces each copy at the time of ordering by the consumer. While there is no risk of too many copies being printed, the unit cost is typically very high. An additional –

and attractive – option is to undertake an extensive pre-sale and undertake a limited print run, informed closely by the number of actual sales.

Funding the additional costs of a print version can be significant, but it is generally hoped that the majority of the cost is recovered through revenue from purchases. Securing additional donations or grants can help offset costs; similarly, donated services (e.g., volunteer writers, editors) or materials (e.g., photographs, artwork) can also offset production costs. Some atlases have also sought donations from individuals or corporate sponsorships. Securing donations for specific species account pages can generate significant revenue toward the publication, given the number of breeding birds in any state or province. As an example, the Ohio breeding bird atlas raised an additional $14,000 toward publication costs through species sponsorships (Rodewald et al. 2015).

For any publication method, atlas regions that are officially bilingual or with a significant percentage of the population speaking a second language will need to consider translating the results into the second language. Translation adds both time and cost to the production of the atlas publication. Alternatively, a combined translated version may be produced as one publication, although this obviously adds to the book's length. Check with project funders, partners, and participants to determine whether the atlas should or must be translated.

12.3 Web publication

Advantages

- Web-based publications are less expensive than producing a printed text, with major savings realized for printing, some graphic design, and storage/handling/distribution. (Major costs and effort remain for cartography, data analysis, writing, editing, copy editing, proofreading, as well as Internet-specific costs, such as web server space and domain registration).
- Results are typically, but not necessarily, free to the public (charges can be levied for e-books and web access, but this may reduce the use of the results for conservation).
- Results are accessible by anyone with Internet access.
- Space is flexible; if some species are more complex and/or require more space to display results, this is easily done.

- Content can be made interactive, including pop-up bubbles on hover and links to additional/deeper information.
- Material can be modified, revised, and changed over time if desired (although this likely would not happen on a major scale once species accounts are prepared).
- The full database can be made searchable. The public can run queries according to their interests or requirements to examine the data in greater depth.

Disadvantages

- Access requires an Internet-connected device, typically with a high speed connection.
- The database and web servers must be maintained in perpetuity; there is some annual cost to this, though if the space and web address have been provided by a local organization, that cost is minimized.
- Some users may find it harder to browse, scan, and compare results between species or between atlas regions – for instance, if wishing to take a quick glance at distribution patterns to compare a particular subset of species.
- For mobile users and some Internet customers, there can be data download costs.
- There is greater risk of content being used without consent or recognition.

Things to consider

The most important and enduring aspect for any atlas, regardless of format, is sound content and easy use. A strong web publication (and web pages in general) should be simple to navigate. It can be tempting, with all the tools now available to web developers and designers, to try to add fancy designs and gadgets, but these have the potential to confuse some users and may require very high speed connections or necessitate large data use.

Make things easy to find by keeping navigation straightforward. Include a site map that lists all the main pages of the site (the individual species accounts/maps can be indexed separately). Place a navigation menu prominently at the top of the page. Try to avoid burying links to primary pages within other pages. Group materials together the same way they would be found in a printed book. Place the introduction, methods, overview of results, etc., within their own area, and group species accounts and maps together in another.

Ideally, each species should have a page that includes text, photo(s) or artwork (if applicable), map(s), charts/graphs, and any additional data such as change data or population estimates. Make fonts and images easy to read. Maps should be large enough to display legibly on a high-resolution (e.g., 1680 x 1050) monitor, but increasingly should also be designed to be usable on a mobile device. Select colours with high contrast that can easily be differentiated from each other; keep in mind sensitivities regarding colour vision deficiency.

Consider incorporating a database query interface where users can request summary information on things such as species lists for particular grid units, lists for particular species, summary statistics (e.g., species count, effort) for grid units or regions, etc. Include detailed data use policies and a means to contact someone regarding requests in this area.

12.4 e-Books

E-publication provides an intermediate format between book publication and online publication. While it incurs many of the same costs as print publication including preparation of materials and layout and design, it avoids the major costs associated with actual printing and distribution. An e-book can be distributed commercially, through various online retail outlets, as a potential way to cover some of the publication costs. However, the number of people purchasing copies may be limited, especially if some of the data are also freely available online. An alternative possibility would be to underwrite the costs of the e-book through grants, and then make it freely available from the atlas website, perhaps as a complement to an online portal. The main advantage of the e-book would be to allow users to download a copy that they can access even when they are not connected to the Internet. There are several different formats that can be used for distributing e-books; these may be more or less suitable for different mobile platforms.

12.5 What to publish?

Data maps

Without maps, there is no atlas. The most important atlas results are the maps showing the distribution and breeding evidence and, if applicable, abundance and/or probability of observation. Maps displaying the amount of effort or species per grid unit can provide a valuable overview of atlas effort and species diversity. For a repeat atlas, change maps are often also informative, comparing results from the first and second atlas. Web publication opens up the possibility of more complex, interactive maps, which could, for example, allow users to click on a portion of a map and see the details behind the map, such as the number of observations, or a list of other species found in the grid unit. For considerations regarding the production of the maps, please see Chapter 10.

Species accounts

A mainstay of most atlas publications is the species accounts that accompany maps and other resources. Species accounts typically include notable aspects of the results for the species; patterns of distribution; areas of high concentration or abundance; discernible patterns of habitat/landscape association; changes in abundance or distribution over time; and unusual records. The text may also discuss the breeding biology of the species, habitats of the species, or historical records. Species accounts are particularly important for providing expert interpretation of the maps, especially for distinguishing results that appear to be biologically important from those that may simply be due to chance or variation in atlasser effort. For example, authors may link the atlas results to data from other sources such as the Breeding Bird Survey to interpret what has changed.

Careful planning and instructions are needed to keep the species accounts to a reasonable length, particularly if a hard-copy book is being produced or if the work will need to be translated. Authors may be tempted to include as much information as possible, but if there are already good reference works available on the species in the atlas region (including previous atlases), it may not be necessary to repeat information on basic breeding biology, etc. The emphasis of the text should be on the new information gained through the atlas. Especially for an online publication, it may be worth including links to existing sources of more detailed natural history information on each species.

The actual writing of species accounts is a large task that can either be undertaken by one or a few skilled authors (generally paid) or shared among many authors. Each approach has advantages and disadvantages. A single author (or very limited number of authors) can result in greater consistency in interpretation of results and writing style. However, this can be a very large job, especially if a lot of literature needs to be read on each species, and may increase the time needed for completion. Recruiting a team of authors, especially volunteers, could reduce the costs and time requirements and bring together a broader range of expertise. However, managing a team of volunteer authors and copy-editing a wide range of writing styles can also be time consuming. If a team approach is chosen, knowledgeable birders or ornithologists with a particular area of expertise may be helpful in filling gaps. However, it is probably more important to find authors who write well and are capable of interpreting the available results than it is to find authors who are experts on each species. The historical data and breeding biology can always be researched, but editing or rewriting a poorly written manuscript can require a lot of work. If it is not possible to recruit experts on each species for writing, consider asking them to be reviewers instead.

Provide authors (volunteer or otherwise) with good sample species accounts, detailed instructions (including a firm maximum word count and style guide), and specific deadlines to help ensure a smooth and efficient writing and review process. Make sure that authors have access to all relevant data for the species they have been assigned, including breeding evidence and abundance maps, data on change of distribution, range shifts, significant species records, and anything else that may be relevant. Ideally, all analyses should be completed before the authors begin writing.

A single editor may be assigned to review accounts within a single family or species group to ensure conformity of submitted material to the desired style/structure. Additionally, all species accounts should be reviewed and fact-checked for accuracy. Since fact-checking can be time consuming, volunteers may be employed for this stage as well. This should be done prior to submission to the species group editor who is responsible for incorporating the reviewers’ comments and working with the author on revisions. Once this step is completed, the overall atlas editor(s) typically reviews and edits the manuscript, as required, for completeness, consistency, and accuracy.

Charts/graphs

Other information can be derived from the atlas database and presented in the form of charts or graphs: for example, the proportion of grid units occupied (or probability of observation, depending on how this analysis is run), percent change between first and second atlases, statistics on the relative frequency of each level of breeding evidence for a species, etc.

Information presented visually is more quickly assimilated than that shown in text. Consider using graphs or charts to display the information that is most relevant to the purposes of your atlas project. (Some atlases have also included Breeding Bird Survey trends to complement atlas results.) If the results will be published in print form, remember that space will be a limiting factor when deciding what to show visually and what to convey in text. Web-based publication allows more flexibility in what may be presented visually. For print publications, there is also the option of putting supporting information in appendices or online, although this approach may be less desirable if it makes the work harder to read; in many cases, readers will not seek it out.

Species illustration/photos

To increase visual interest and appeal, accounts may be accompanied by a photo or illustration of the species. Additionally, images may be used on the cover, frontispiece, title page, and other parts of the publication. Not infrequently, especially with the ready availability of high-quality digital cameras and large numbers of photographers, it is possible to obtain rights to use high-quality photographs for free for conservation, educational, or other non-profit uses. It may be more difficult to obtain artwork for no payment due to the amount of time required to produce original illustrations, although artwork can be very appealing.

If the project plans to request that photos be contributed for possible inclusion in the publication, be prepared for a large number of potential submissions. The second Ontario Breeding Bird Atlas project received over 6,000 photo submissions, with room for only 400 photos in the book. An online photo review process may help facilitate selection. As well, requests for photos (birds, habitat, atlassers) should be undertaken early in the project, so that participants can take photos during the current atlas period. Many atlases appoint a photo or image editor (paid or volunteer) who works with other volunteers or committee members to select images. The prevailing approach is to select high-quality images that feature the species displaying breeding behaviour or in its breeding habitat – as opposed to a field guide identification image. If space permits, additional images may be included that illustrate breeding habitat or other special features.

To allay possible disappointment for those contributing photos or images, it may be useful to indicate that many more submissions are anticipated than can be accommodated in the publication. That is, make it clear that images are being "submitted for consideration" only. Once photos have been selected (or at the time of submission), be sure to obtain written permission to publish the images, preferably in both print and electronic formats, thereby providing the most options for future uses.

Introductory and end material, including appendices

These elements could include (but are not limited to) title pages; funder and partner recognition; table of contents; foreword; acknowledgments; list of participants; background; methods; general introduction, description of regional conditions, such as climate, geology, habitats, land uses, etc.; overview of results including details on effort, species communities, population estimates, change data (if applicable); instructions on how to read and interpret maps and accounts; appendices summarizing prior atlases' results, population size estimates (if applicable), information on conservation initiatives and species of conservation concern; glossary; list of scientific names and translations, if appropriate; gazetteer; literature cited; index; and reference maps of the atlas project region.

The introductory and appendix materials can be extensive and likely do not lend themselves to volunteer writers as much as the species account sections. Many of these pieces will need to be written by persons intimately familiar with ornithology and the project's methodology and results. Organization and sharing of these materials can be done using the same portal system as for species accounts.

12.6 Other considerations relating to publication

Manuscript coordination

The greatest challenge in having multiple people work on a single manuscript is managing the multiple versions and files that are produced. The Internet now allows exchange of materials nearly instantaneously, and can also act as a central hub for storage and exchange (upload/download) of files and versions. A portal system can allow species account or chapter authors to log in and access materials they have been given permission to see. This system can also allow administrators to track which files are being downloaded and by whom. A check-out/check-in system prevents more than one version of the manuscript being worked on at a time. However, provisions may be needed at a review or fact-checking stage to allow multiple fact-checkers/reviewers to conduct their reviews simultaneously, with the account editor later consolidating all reviews into a single document. As each new version is uploaded, a new file should be created so as to leave all previous versions intact and available, in case they are needed. Typically, each review stage includes embedded editorial changes or comments, as well as a covering synopsis regarding the draft. This form of manuscript management system can be adapted for each atlas, regardless of how many reviewers or editors are involved in the editing and review process. Manuscript management systems can be developed for a specific atlas project, but many existing Internet-based systems can also be suitable. For example, the Ohio atlas used Google Drive to manage documents, which allows for concurrent revisions; this proved to be a successful and efficient approach.

Use of volunteers in the publication process

Most atlas projects employ a combination of volunteers and paid staff in the publication process. Volunteers can be of tremendous help in taking on tasks including writing (e.g., drafting species accounts), manuscript review, and photo review and selection (e.g., populating a photo management database, etc.). As is often the case, having well-defined tasks, clear instructions, and careful supervision is central to success.

12.7 Providing access to raw and analyzed atlas data for research and management

Biologists, wildlife managers, and researchers may wish to use the atlas maps, text, or raw data to carry out analyses that go beyond those prepared for the atlas publication, either for their own research or for other purposes. The value of the atlas can be greatly enhanced by encouraging these types of uses. University or other researchers may use the atlas data, maps, and products to answer important biological or conservation-related questions that atlas staff have neither time nor expertise to address. They may also be able to develop new and improved analysis methods and bring atlas data together with data from many other sources, such as other types of bird surveys, land-use data, etc. Regional or local managers and environmental consultants may be able to use the raw data, including species at risk data, to help with land-use planning or environmental assessment in their region.

Ideally, data and atlas products should be made freely available to anybody who requests them, provided that appropriate safeguards are in place to protect sensitive information on species at risk or to address private landowner concerns. It may also be necessary to protect the identity of individual atlassers unless they have given explicit consent to allow their names to be released with the data. Individual atlassers can instead be identified by a number, allowing analysts to take into account observer effects without identifying the names of the observers.

The most flexible option for users is to make the data (or at least non-sensitive data) available on the Internet for anybody to download. While there may be some concerns about loss of control of the data, this can be offset by reduced staff time required to evaluate individual data requests and may encourage greater use. The North American Breeding Bird Survey, one of the largest systematic bird surveys in the world, makes its complete historical data set available freely for download, with the result that hundreds of scientific papers have incorporated the data for analyses on many topics ranging from population trends to habitat associations to effects of climate change. Atlas materials can be published online using a “creative commons” license. Provided credit is given, users are free to borrow and use the work in personal, research/scientific, and not-for-profit applications. The atlas project may decide whether or not to require for-profit applications to pay for use of materials.

An alternative approach is to request that users submit proposals and then agree to and sign a data-use agreement before data are released. This arrangement allows for greater control of the data set but may discourage some scientific users, and means extra work for atlas staff to review and process requests. While it may be possible to charge for the data, even a nominal fee to cover extraction costs may discourage some users and thus reduce the value of the data set for science and conservation. Further, it is worth considering that much of the funding for an atlas often comes from public sources (e.g., government), and much of the information was contributed for free by volunteers, so it may not be appropriate to charge users to receive the data. Of course, this would not preclude charging a fee to cover the costs of additional analyses or specialized data requests that require significant amounts of time to gather and assemble.

Data release policies for consulting firms or for-profit companies are often more controversial. Some atlas projects feel that commercial users should pay a more substantial fee, as use of atlas data may reduce commercial users' expenses and help them achieve greater profits. On the other hand, making the data freely available may encourage consulting firms to make use of the best data possible and thus have a positive influence on environmental assessment decisions and conservation. Furthermore, collaboration may encourage consulting firms to reciprocate by contributing any new data they gather during their own surveys. An alternative strategy for organizations running an atlas is to make data freely available but offer analysis or interpretation services to the consulting firm for an appropriate fee. Many consulting firms would be willing to pay to take advantage of mapping and analysis expertise.

Some data on significant species, such as precise locations for species at risk, may not be appropriate for release except in special circumstances (e.g., preparation of species at risk reports) due to the sensitive nature of the data. Information regarding precise locations of endangered species and other species at risk is sometimes held confidential to protect the individuals from undue disturbance or to respect privacy concerns for landowners. But withholding too much data can have detrimental side effects if, for example, a development proceeds in sensitive habitat because the developer and planning authorities were unaware that the site contained species of concern. The value of some research, such as studying habitat selection or species richness, may also be compromised if data are withheld. It is worth considering carefully which data really are sensitive and need to be restricted, and balancing the risks of releasing versus holding back information. For example, if large numbers of birders already know the locations of particular species, there may be little value in holding back the information. In any case, make sure to decide how much significant species data to release and to whom. Have a firm and clear data-use policy in place before releasing your data to the public (and be sure that atlassers are also aware of this policy in advance of submitting data). This way data requests can be easily handled and misuses of atlas data quickly identified and addressed.


Blackpoll Warbler, CF. Photo © Christian Artuso


Cerulean Warbler, H. Photo © Carol Horner Ham

Appendix A North American Breeding Bird Atlas Projects (1975–2018): Dates, Websites and Publications

Canada				
Province/state	**First atlas**	**Second atlas**	**Project website**	**Publications and notes**
Alberta	1987–1992	2000–2005		First atlas: Sememchuk, G.P. 1992. The Atlas of Breeding Birds of Alberta. Federation of Alberta Naturalists, Edmonton, vi + 391pp. Second atlas: Federation of Alberta Naturalists. 2007. The Atlas of Breeding Birds of Alberta: A Second Look. Canada. Federation of Alberta Naturalists, Edmonton, viii + 626pp.
British Columbia	2008–2012		www.birdatlas.bc.ca/	Davidson, P.J.A., R.J. Cannings, A.R. Couturier, D. Lepage, and C.M. Di Corrado (eds.). 2015. The Atlas of the Breeding Birds of British Columbia, 2008–2012. Bird Studies Canada, Delta, B.C. Accessed 1 December 2016. www.birdatlas.bc.ca
Manitoba	2010–2014		www.birdatlas.mb.ca/	Artuso, C., A.R. Couturier, K.D. De Smet, R.F. Koes, D. Lepage, J. McCracken, R.D. Mooi, and P. Taylor (eds.). 2018. The Atlas of the Breeding Birds of Manitoba, 2010-2014. Bird Studies Canada, Winnipeg. Accessed 16 November 2018. www.birdatlas.mb.ca
New Brunswick	1986–1990	2006–2010	www.mba-aom.ca/	New Brunswick is part of a regional atlas encompassing the three Canadian Maritime provinces. First atlas: Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, x + 270 pp. Second atlas: Stewart, R.L.M., K.A. Bredin, A.R. Couturier, A.G. Horn, D. Lepage, S.

				Makepeace, P.D. Taylor, M.-A. Villard, and R.M. Whittam (eds.). 2015. Second Atlas of Breeding Birds of the Maritime Provinces. Bird Studies Canada, Environment Canada, Natural History Society of Prince Edward Island, Nature New Brunswick, New Brunswick Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry, Sackville, 528 pp.
Newfoundland and Labrador				No standard atlas undertaken to date.
Nova Scotia	1986–1990	2006–2010	www.mba-aom.ca/	Nova Scotia is part of a regional atlas encompassing the three Canadian Maritime provinces. First atlas: Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, x + 270 pp. Second atlas: Stewart, R.L.M., K.A. Bredin, A.R. Couturier, A.G. Horn, D. Lepage, S. Makepeace, P.D. Taylor, M.-A. Villard, and R.M. Whittam (eds). 2015. Second Atlas of Breeding Birds of the Maritime Provinces. Bird Studies Canada, Environment Canada, Natural History Society of Prince Edward Island, Nature New Brunswick, New Brunswick Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry, Sackville, 528 pp.
Northwest Territories				No standard atlas undertaken to date.
Nunavut				No standard atlas undertaken to date.
Ontario	1981–1985	2001–2005	www.birdsontario.org	First atlas: Cadman, M.D., P.F.J. Eagles, and F.M. Helleiner. 1987. Atlas of the Breeding Birds of Ontario. University of Waterloo Press, Waterloo, xx + 617 pp.

				Second atlas: Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier (eds.). 2007. Atlas of the Breeding Birds of Ontario, 2001–2005. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto, xxii + 706pp.
Prince Edward Island	1986–1990	2006–2010	www.mba-aom.ca/	Prince Edward Island is part of a regional atlas project encompassing the three Canadian Maritime provinces. First atlas: Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing and the Nova Scotia Museum, Halifax, x + 270 pp. Second atlas: Stewart, R.L.M., K.A. Bredin, A.R. Couturier, A.G. Horn, D. Lepage, S. Makepeace, P.D. Taylor, M.-A. Villard, and R.M. Whittam (eds). 2015. Second Atlas of Breeding Birds of the Maritime Provinces. Bird Studies Canada, Environment Canada, Natural History Society of Prince Edward Island, Nature New Brunswick, New Brunswick Department of Natural Resources, and Prince Edward Island Department of Agriculture and Forestry, Sackville, 528 pp.
Quebec	1984–1989	2010–2014	www.atlas-oiseaux.qc.ca/index_en.jsp	First atlas (French edition): Gauthier, J. et Y. Aubry (dir.). 1995. Les Oiseaux Nicheurs du Québec: Atlas des Oiseaux Nicheurs du Québec Méridional. Association québécoise des groupes d'ornithologues, Société Québécoise de Protection des Oiseaux, Service canadien de la faune, Environnement Canada, Région du Québec, Montréal, xvii + 1302 pp. First atlas (English edition): Gauthier, J., and Y. Aubry (eds.). 1996. The Breeding Birds of Québec: Atlas of the Breeding Birds of Southern Québec. Montréal: Association québecoise des groupes d'ornithologues, Province of Québec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Québec Region, Montréal, xvii + 1302 pp. Second Atlas: Under preparation.
Saskatchewan	2017–2021		http://sk.birdatlas.ca/	First year of fieldwork in 2017 for the first Saskatchewan breeding bird atlas. Breeding bird information is available in: Smith, A.R. 1996. Atlas of Saskatchewan

				birds. Regina. Sask. Nat. Hist. Soc. Spec. Publ., no. 22.
Yukon				No standard atlas project undertaken to date. Breeding bird information is available in Sinclair, P.H., W.A. Nixon, C.D. Eckert, and N.L. Hughes. 2003. Birds of the Yukon Territory. UBC Press, Vancouver.
United States				
Alabama	2000–2006		www.buildingthepride.com/faculty/tmhaggerty/BBA%20Homepage.htm	Haggerty, T.M. (ed.). 2009. Alabama Breeding Bird Atlas 2000–2006. Alabama Ornithological Society, n.p.
Alaska				No statewide standard atlas. One regional atlas for 1994–1999: Andres, B.A. 2005. Breeding Bird Atlas of Fort Richardson, Alaska. Unpublished report, U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK, 95 pp.
Arizona	1993–2000			Corman, T., and C. Wise-Gervais. 2005. Arizona Breeding Bird Atlas. University of New Mexico Press, Albuquerque, 636 pp.
Arkansas				First atlas project was initiated in 1994 but appears not to have been completed.
California				No state-level atlas compiled. Numerous county-level atlases completed or underway.
Colorado	1987–1994	2007–2012	www.cobreedingbirdatlasii.org/	First atlas: Kingery, H. 1998. Colorado Breeding Bird Atlas. Colorado Bird Atlas Partnership, Denver. Second atlas: Colorado Bird Atlas Partnership. 2016. The Second Colorado Breeding Bird Atlas online database. Colorado Bird Atlas Partnership, Denver, CO. Accessed 1 February 2018. http://www.cobreedingbirdatlasii.org. (Also available

				in print.)
Connecticut	1982–1986			L.R. Bevier (ed.). 1994. The Atlas of Breeding Birds of Connecticut. State Geol. Nat. Hist. Surv. Connecticut Bull., no. 113.
Delaware	1983–1987	2008–2012	www.dnrec.delaware.gov/fw/BBA/Pages/BreedingBirdAtlas.aspx Also: www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=DE2008	First atlas: Hess, G.K., R.L. West, M.V. Barnhill III, and L.M. Fleming. 2000. Birds of Delaware. University of Pittsburgh Press, Pittsburgh. Second atlas: Publication in progress. Some results can be seen online.
Florida	1986–1991	2011–2016	www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=FL2011	First atlas: Kale, H.W., II, B.S. Pranty, B.S. Stith, and W.S. Biggs. 1992. An Atlas of Florida's Breeding Birds. Final report. Florida Game and Fresh Water Fish Commission, Tallahassee. Second atlas: See website for updated information.
Georgia	1994–2001			Schneider, T.M., G. Beaton, T.S. Keyes, and N.A. Klaus (eds). 2010. The Breeding Bird Atlas of Georgia. University of Georgia Press, Athens, 497 pp.
Idaho				No standard breeding bird atlas has been undertaken.
Illinois	1986–1991			Kleen, V.M., L. Cordle, and R.A. Montgomery. 2004. The Illinois Breeding Bird Atlas. Illinois Natural History Survey, Special Publication no. 26, xvii + 459 pp.
Indiana	1985–1990	2005–2011	www.in.gov/dnr/fishwild/3312.htm	First atlas: Castrale, J.S., E.M. Hopkins, and C.E. Keller (eds.). 1998. Atlas of Breeding Birds of Indiana. Indiana Dep. of Nat. Res., Indianapolis.

			http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=IN2005	Second atlas: Publication in preparation.
Iowa	1986–1990	2008–2012	http://bba.iowabirds.org/	First atlas: Jackson, L.S., C.A. Thompson, J.J. Dinsmore, B.L. Ehresman, J. Fleckenstein, R. Cecil, L. Hemesath, and S.J. Dinsmore. 1997. Iowa Breeding Bird Atlas. University of Iowa Press, Iowa City. Second atlas: See website: http://bba.iowabirds.org/ .
Kansas	1992–1997		http://www.ksbirds.org/kos/kos_kbbat.html	Busby, W.H., and J.L. Zimmerman. 2001. Kansas Breeding Bird Atlas. University Press of Kansas, Lawrence. A second atlas is under consideration.
Kentucky	1985–1991			Palmer-Ball, B., Jr. 1996. The Kentucky Breeding Bird Atlas. University Press of Kentucky, Lexington.
Louisiana	1994–1996		http://www.manybirds.com/atlas/atlas.htm	Wiedenfeld , D.A., and M.M. Swan 2000. Louisiana Breeding Bird Atlas. Louisiana Sea Grant College Program, Louisiana State Univ., Baton Rouge, 78 pp.
Maine	1978–1983		http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=ME1978	Adamus, P.R. 1987. Atlas of Breeding Birds in Maine, 1978–1983. Maine Dept. Inland Fisheries and Wildlife, Augusta.
Maryland and Washington, D.C.	1983–1987	2002–2006	http://www.mdbirds.org/atlas.html	First atlas: Robbins, C.S., and E.A.T. Blom (eds.). 1996. Atlas of Breeding Birds of Maryland and the District of Columbia. Univ. of Pittsburgh Press, Pittsburgh. Second atlas: Ellison, W.G. 2010. Second Atlas of the Breeding Birds of Maryland

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Massachusetts	1974–1979	2007–2011	http://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/breeding-bird-atlases/bba2	First atlas: Petersen, W.R., and W.R. Meservey (eds.). 2003. Massachusetts Audubon Society, Lincoln, 441 pp. Second atlas: Kamm, M., J. Walsh, J. Galluzzo, and W. Petersen. 2013. Massachusetts Breeding Bird Atlas 2. Scott and Nix, New York. 892 pp. Digital version, https://itunes.apple.com/us/book/massachusetts-breeding-bird/id766503987?mt=11
Michigan	1983–1988	2002–2007	http://www.mibirdatlas.org/MichiganBreedingBirdAtlasII.aspx	First atlas: Brewer, R., G.A. McPeek, and R.J. Adams, Jr. 1991. The Atlas of Breeding Birds of Michigan. Michigan State University Press, East Lansing. Second atlas: Chartier, A.T., J.J. Baldy, and J.M. Brenneman. 2011. The Second Michigan Breeding Bird Atlas, 2002–2008. Kalamazoo Nature Center, Kalamazoo. Accessed 26 October 2016 at http://www.mibirdatlas.org.
Minnesota	2009–2013		https://mnbirdatlas.org/	Pfannmuller, L., G. Niemi, J. Green, B. Sample, N. Walton, E. Zlonis, T. Brown, A. Bracey, G. Host, J. Reed, K. Rewinkel, and N. Will. 2017. The First Minnesota Breeding Bird Atlas (2009-2013). Online publication accessed 1 February 2017. https://mnbirdatlas.org/
Mississippi	1997–2004		http://130.18.140.19/atlas	Publication not undertaken.
Missouri	1986–1992			Jacobs, B., and J. D. Wilson. 1997. Missouri Breeding Bird Atlas, 1986-1992. Missouri Dep. Cons., Nat. Hist. Ser. no. 6.
Montana				No standard breeding bird atlas undertaken.
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				Second atlas: Molhoff, W.J. 2016. The Second Nebraska Breeding Bird Atlas. Bulletin of the University of Nebraska State Museum, Vol. 29: 320 pp.
Nevada	1997-2000			First Atlas: Floyd, T., C.S. Elphick, G. Chisholm, K. Mack, R. Elston, E.M. Ammon, and J.D. Boone. 2007. Atlas of the Breeding Birds of Nevada. University of Nevada Press. 581 pp.
New Hampshire	1981-1986			Foss, C.R. (ed). 1994. Atlas of the Breeding Birds of New Hampshire. Dover: Audubon Society of New Hampshire.
New Jersey	1994-1997			Walsh, J., V. Elia, R. Kane and T. Halliwell. 1999. The Birds of New Jersey. New Jersey Audubon Society. 704 pp.
New Mexico	2000-2011		http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=NM2001	Publication information not available.
New York	1980-1985	2000-2005	http://www.dec.ny.gov/animals/7312.html	First atlas: Andrle, R.F. and J.R. Carroll (eds.). 1988. The Atlas of Breeding Birds in New York State. Ithaca: Cornell Univ. Press. Second atlas: McGowan, K.J. and K. Corwin, eds. 2008. The Second Atlas of Breeding Birds in New York State. Cornell University Press, Ithaca, NY.
North Carolina				
North Dakota				

Ohio	1982-1987	2006-2011		First atlas: Peterjohn, B. G. and D. L. Rice. 1991. The Ohio Breeding Bird Atlas. Columbus: Ohio Dept. of Nat. Res. Second atlas: Rodewald, P.G., M.B. Shumar, A.T. Boone, D.L. Slager, and J. McCormac. 2015. The Second Atlas of Breeding Breeding Birds in Ohio. Penn State University Press, University Park, 600 pp.
Oklahoma	1997-2001			Reinking, D.L. (Ed.). 2004. Oklahoma Breeding Bird Atlas. Norman: Univ. of Oklahoma Press. Reinking, D.L. 2017. Oklahoma Winter Bird Atlas. Norman: Univ. of Oklahoma Press.
Oregon	1995-1999			Adamus, P. R., K. Larsen, G. Gillson, C. R. Miller. 2001. Oregon Breeding Bird Atlas. Eugene: Oregon Field Ornithologists.
Pennsylvania	1983-1989	2004-2008		First atlas: Brauning, D.W. (Ed.). 1992. Atlas of Breeding Birds in Pennsylvania. Pittsburgh: Univ. of Pittsburgh Press. Second atlas: Wilson, A.M., D.W. Brauning, and R.S. Mulvihill, eds. 2012. Second Atlas of Breeding Birds in Pennsylvania. Penn State Press, University Park, xxiv + 586pp.
Rhode Island	1982-1987	See note		First atlas: Enser, R.W. 1992. The Atlas of Breeding Birds in Rhode Island. R. I. Dept of Environmental Management, Providence. Second atlas: Fieldwork launched in 2016.
South Carolina	1988–1995		http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=sc1988	Cely, J.E. 2003. The South Carolina Breeding Bird Atlas, 1988–1995. South Carolina Department of Natural Resources, Columbia.
South Dakota	1988–	2008–	www.rmbo.org/sdbba2/	First atlas: Peterson, R.A. 1995. South Dakota Breeding Bird Atlas. South Dakota

	1993	2012		Ornithologists' Union, Aberdeen. Second atlas: See website for online results and publication, https://gfp.sd.gov/breeding-bird-atlas/
Tennessee	1986–1991			Nicholson, C.P. 1997. Atlas of the Breeding Birds of Tennessee. Univ. of Tennessee Press, Knoxville.
Texas	1987–1992		http://txtbba.tamu.edu/	Benson, K.L.P., and K.A. Arnold. 2001. The Texas Breeding Bird Atlas. Texas A&M University System, College Station and Corpus Christi, TX. Accessed 15 July 2016 at http://txtbba.tamu.edu/.
Utah				An attempt was made to launch a breeding bird atlas circa 2004–05, but no further information was found online. The project was struggling to find volunteers in November 2005.
Vermont	1976–1981	2003–2007	http://val.vtecostudies.org/projects/vermont-breeding-bird-atlas/	First atlas: Laughlin, S.B., and D.P. Kibbe. 1985. The Atlas of Breeding Birds of Vermont. Vermont Inst. of Nat. Science, Woodstock. Second atlas: Renfrew, R.B. 2013. The Second Atlas of the Breeding Birds of Vermont. University Press of New England, Lebanon, xx + 548 pp.
Virginia	1984–1989	2016–2020	http://www.virginiabirds.net/Virginia-Breeding-Bird-Atlas.html	First atlas: Trollinger, J.B., and K.K. Reay. 2001. Breeding Bird Atlas of Virginia. Richmond: Department of Game and Inland Fisheries and the Virginia Society of Ornithology. Second atlas: Launched in 2016
Washington	1987–1996		http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=WA1987	Smith, M.R., P.W. Mattocks, Jr., and K.M. Cassidy. 1997. Breeding Birds of Washington State. Volume 4 in Washington State Gap Analysis Final Report (K.M. Cassidy, C.E. Grue, M.R. Smith, and K.M. Dvornich (eds.). Seattle Audubon Society Publications in Zoology, no. 1.

West Virginia	1984–1989	2009–2014	http://martes.dnr.state.wv.us/BreedingBirdsAtlas/default.aspx	First atlas: Buckelew, A.R. Jr., and G.A. Hall. 1994. The West Virginia Breeding Bird Atlas. Univ. of Pittsburgh Press, Pittsburgh. Second atlas: publication status not available.
Wisconsin	1995–2000	2015–2019	http://wsobirds.org/atlas	First atlas: Cutright, N.J., B.R. Harriman, and R.W. Howe. 2006. Atlas of the Breeding Birds of Wisconsin. Wisconsin Society for Ornithology, Waukesha, xxii + 602 pp. Online version: http://www.uwgb.edu/birds/wbba/index.htm Second atlas: Launched in 2015.
Wyoming				No standard breeding bird atlas has been undertaken.

Hooded Merganser, P. Photo © Christian Artuso

Hooded Merganser, FY. Photo © Christian Artuso

White-throated Sparrow, S. Photo © Tim Stewart

Appendix B Glossary

Administrative region	Regions delineated within an atlas area for the purpose of managing data collection and volunteer resources.
Area search	A bird survey technique that involves searching throughout a defined area for a set period of time and recording all birds seen and heard.
Atlas square/block	The basic sampling unit for atlassing; the term "square" is typically used in Canada, "block" in the United States. Note that in Canada "block" refers to 100 x 100 km unit.
Atlasser	Volunteer or other person collecting data for the atlas.
Breeding bird atlas	Project to determine the distribution, status, and abundance of breeding bird species. Data are typically collected on a grid basis, with extensive volunteer involvement.
Breeding evidence	Standardized categories and codes into which atlassers classify the breeding behaviour associated with each atlas observation. Breeding evidence codes fall into one of three categories: Possible, Probable, and Confirmed. As an example, a bird heard singing in suitable breeding habitat during the breeding season is coded as "S" for singing and is considered evidence of "Possible" breeding.
Breeding evidence map	Occurrence or distribution map showing the grid units in which breeding evidence for the species was detected during the atlas. Breeding evidence maps are not typically corrected for survey effort but do indicate the level of breeding confirmation.

Breeding phenology	The timing of breeding or reproductive events, often studied in relation to climate (precipitation, sunlight, etc.).
Casual observation	Atlas observation made outside of a dedicated atlas visit to an atlas grid unit.
Change in the probability of observation	The change in the probability of observation between two atlas periods.
Christmas Bird Count	Annual one-day volunteer bird census program, initiated in North America in 1900. Approximately 2,500 Christmas Bird Counts are undertaken regionally between December 14 and January 5 in the western hemisphere.
Citizen Science	Research undertaken in large part by volunteers, often non-professional scientists.
Critical habitat	Defined under Canada's Species at Risk Act as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in a recovery strategy or in an action plan for the species.”
Database	An organized collection of data, usually with various tables, views, and queries.
Database management system	A computer software application that interacts with the user, other applications, and the database itself to capture and analyze data.
Detectability	A species' probability of detection (i.e., observation or detection rate).
Distribution	Species pattern of occurrence within a geographic area.
First generation atlas	The first breeding bird atlas to be completed for a region; provides baseline data for comparison with subsequent atlases.
Geographical Information System (GIS)	A system designed to collect, store, analyze, and manage spatial or geographical data.
Geographical Positioning System (GPS)	Navigation system that provides location and time data across the earth; position is determined by connection with GPS satellites
Great Backyard Bird Count	An annual four-day event that engages birdwatchers across North America in counting birds, often at (but not limited to) backyard feeders. The duration of individual surveys depends on the volunteer, spanning from 15 minutes to all day.

Grid unit (or sampling unit)	The individual unit to be sampled as part of the breeding bird atlas, often referred to as an atlas "square" in Canada or a "block" in the United States. The size of grid units typically ranges from 1 x 1 km to 10 x 10 km, depending on the project.
Land-use inventory	An inventory that categorizes land uses or types (e.g., grasslands, coniferous forest) across a geographic area. Classification systems used vary greatly depending on the inventory's purpose. Many jurisdictions have standardized land-use inventories that are maintained and updated on a regular basis (e.g., the Canada Land Inventory).
Marsh Monitoring Program	Monitoring efforts to gather distribution, abundance, and status information on wetland dependent species, most often birds and anurans. Several marsh monitoring programs are run throughout Canada and the United States. Protocols typically involve point counts and playback.
Matching funds	Funds that are set to be paid in support of a project relative to funds from other sources. For example, some granting agencies require a 1:1 match, meaning that for every dollar they put towards the project, the same amount must be supplied by another funding source.
Minimum (adequate) coverage	The minimum amount of survey effort and minimum number of species detected for the surveys for a grid unit to be considered complete (e.g., 20 hours of survey effort with 75 percent of expected species detected). The minimum coverage goals are set by each atlas.
Monitoring Avian Productivity and Survivorship (MAPS)	Constant mist-netting effort and census program to determine the vital rates of breeding birds throughout North America. Approximately 1,200 stations are run each year.
Nocturnal Owl Survey	Annual roadside survey for owls. Protocol includes point counts and playback.
Non-native species	A species occurring outside of its natural range (past or present), often a result of intentional or unintentional dispersal by human activities; term used interchangeably with “alien species” or “exotic species.”
North American Breeding Bird Survey (BBS)	Volunteer survey to collect long-term data on the population status and trends of breeding birds throughout North America. Approximately 2,800 routes are run each year. Routes consist of 50 point counts (“stops”) spaced 800 metres apart.
Point count	Timed surveys in which the observer records all birds seen and heard at geo-referenced (often pre-determined) points.

Predicted species distributions	Species distributions estimated, using statistical models, independent of survey effort in individual grid units.
Priority squares (or priority grid units)	Units designated a "priority" for sampling, i.e., to be sampled ahead of other non-priority atlas squares. The prioritization will depend on the individual atlas and its survey goals.
Probability of observation	The probability of recording a bird species in any given square, given a standardized rate of effort (e.g., 20 hours). Also referred to by some as the “probability of detection.”
Rare bird form	Additional documentation requested from atlasser for observations of rare species; the same form may also be used for rare species, colonial species, and species at risk.
Regional Coordinator (RC)	Individual, usually a volunteer, who coordinates and leads volunteer atlassing efforts in an atlas administrative region.
Regionally rare species	Species that are very uncommon throughout the entire atlassing area or in some administrative regions but are not considered "at risk." Atlassers are typically asked to provide additional documentation (a rare bird form) when regionally rare species are encountered.
Relative abundance	Measure or index of the number of individuals found in a geographic area; typically determined using point counts, "relative" because the number of individuals counted is an index of the total population.
Remote sensing	Aerial sensing technologies used to detect and classify objects on earth via propagated signals (often vegetation communities or other land classifications).
Safe dates	Dates within which atlassers can be reasonably confident that encounters are with a local resident and potentially breeding bird, not a migrant.
Second generation atlas	The second breeding bird atlas to be completed for a region.
Species at risk	Under the Canadian Species at Risk Act, those species in danger of becoming extinct or extirpated (i.e., listed as extirpated, endangered, threatened, or of special concern). For the purposes of data collection, many Canadian atlases consider species at risk to be any species assessed as "at risk" by the Committee on the Status of Endangered Wildlife in Canada, regardless of whether it has been listed under federal legislation. In the United States, imperilled species (those in danger of extinction) can be listed as Endangered or Threatened under the Endangered Species Act. May also include species listed as at risk under provincial or state legislation.

Species-accumulation curve	Graph recording the cumulative number of species detected in a particular area (in the case of atlases, usually the grid unit) as a function of the cumulative effort expended to detect them.
Steering committee	Management group, made up of representatives from partner organizations, which guides the atlas project overall.
Timed checklist	Survey technique in which all birds recorded are detected within a finite time period.
Transect survey	Survey technique in which all birds detected are continuously recorded while walking along a line, i.e., a transect.
Universal Transverse Mercator (UTM) coordinate system	A mapping projection that uses a two-dimensional coordinate system (easting and northing). It divides the earth into 60 zones, each 6 degrees wide and running north-south. Canadian atlases have used the UTM grid system to delineate sampling units.

Razorbill, H. Photo © Gregor G. Beck

Greater Yellowlegs, S. Photo © Christian Artuso

Appendix C   Literature Cited

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