

National Audubon Society's Technology Initiatives for Bird Conservation: A Summary of Application Development for the Christmas Bird Count¹

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Abstract

Since 1998, Audubon's Christmas Bird Count (CBC) has been supported by an Internet-based data entry application that was initially designed to accommodate the traditional paper-based methods of this long-running bird monitoring program. The first efforts to computerize the data and the entry procedures have informed a planned strategy to revise the current technology tools supporting the needs of the CBC. A tightly integrated life-cycle development path, outlined within, has now been employed to revise the CBC application. This document will give a brief overview of this process.

available online through this portal. Efforts to get this valuable dataset into a centralized database were an important first step to setting the stage for future Internet-based data collecting initiatives. The CBC data had been partially computerized, having benefited from work done by the USGS Patuxent Wildlife Research Center's efforts at computerizing data subsets for efficient analysis and earlier work done at the Cornell Laboratory of Ornithology and at the University of Colorado in Boulder. Audubon then contracted to have the remaining data put into the database. Currently there are 104 years of data in a centralized database available for efficient regional or sub-continental analysis of early winter North American bird population trends (<http://www.audubon.org/bird/cbc>).

Introduction

Bird conservation efforts have gone through several shifts in strategy over the past 30 years – from a purely regulatory approach to conservation to a grassroots one. In the late 1990's the National Audubon Society and the Cornell Laboratory of Ornithology decided to make use of developing technical opportunities to gather data to better inform bird conservation efforts locally, regionally and nationally, to leverage public interest and participation in birding, and make the results of bird monitoring efforts more available to the public (Fitzpatrick and Gill, 2002).

The National Audubon Society and the Cornell Laboratory of Ornithology implemented one of the first publicly available citizen science websites dedicated to bird conservation information and Internet-based monitoring tools in 1997 through the creation of Bird-Source (<http://www.birdsource.org>). The development of a data entry application for compilers and regional editors of the Christmas Bird Count (CBC), the longest running bird monitoring project in existence, was an early, and the largest, interactive data entry project

Discussion: The First Generation CBC Application

The first generation of the CBC online data entry application was coded in JavaScript and presented data entry screens for CBC compilers that were based on the original paper forms developed by compilers and used for recording field data before the CBC data was computerized. The intention was that the traditional paper forms be mimicked on the screen so that minimal adjustment had to be made to the data entry procedures. The user interface screen design led compilers, via a central forms selection page, through the required entry on each screen form: compiler information, participant list, weather information, effort information, checklist of birds, and rare bird information. The checklist of species presented for each CBC count circle was customized to that circle, displaying a list of species based on the previous 25 years of species seen in that location (a CBC count circle is 15 miles in diameter and is fixed around a latitude and longitude). Initially these customized checklists were dynamically generated, but there was a delay in processing behind the scenes before sending the resulting species list back to the user's browser, which presented too much waiting time as most users had the limited bandwidth of a dial-up internet connection. The decision was made to pre-generate the checklists prior to user access and then store the checklists in a library of files, from which it

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could be accessed on demand at the time of data entry. The required flow of data entry was not obvious to users, and mandatory elements were not indicated on the screen until after an attempt to submit information. Once compilers were finished with circle data entry, the checklist for each circle was then made available to the corresponding regional editors so that they could perform their authorization process to the numbers entered by tagging rare or unusual species with editorial codes.

The project administrator used a central administrative tool that allowed circle setup in the database, circle login and password administration, follow-up on data entry status of all circles, and centralized reporting. This administration tool was envisioned to be a virtual complete database management tool for the project administrator, with little support required from technical personnel. But after several years of use, the project manager found the tool did not allow the flexibility needed to query the database beyond the predefined reports provided for the most frequently asked questions. This tool also required several manual processes to create new circles, permit access to the circle data entry, and to check the status of data entry.

In this first generation of the CBC application, some tabular output reports for access by the general public were created, including the ability to view checklists within each circle, the number of circles submitted for each year in each state, list of circles where each species was seen sorted highest to lowest, and a report indicating which years specific count circles were active. These first reports (e.g. with highest counts listed first) addressed some of the "competitive birders" traditions of the CBC. Data could be requested and obtained from the central database, but much analysis was still being done through use of paper-based data, such as data published in *American Birds*. Users could not, at that time, download data at will for offline analysis. Compilers, editors and researchers requested more access to the data, one of the original intents of the project; and at the end of the first generation, additional data output capability, including graphs and maps, and interactive download capability, were implemented.

None of the project administrative tasks, such as receipt of fees and forms, creation of mailings, and tracking of data entry status, were implemented into the first CBC application, and collection and management of participant names by compilers continued to be a manual process.

Due to time constraints and the experimental nature of moving the CBC data entry application onto the Internet, a centralized development methodology for the applications was followed, allowing little opportunity

for user input during this first effort. The lack of a feedback mechanism created obstacles to adoption of this first CBC application by compilers and regional editors. In addition, the strategy of intentionally developing input screens to mimic paper forms revealed some shortcomings that produced a cumbersome user experience.

The efforts of BirdSource staff to develop and implement this Internet-based initiative for the CBC were intensive, valuable, and informative. Virtually all of the other Internet-based projects that have been developed under the BirdSource partnership and Cornell and Audubon individually have been informed by the lessons learned through this process. Audubon now is in the process of applying a new generation of programming languages to the Christmas Bird Count Internet-based experience as well as addressing CBC workflow processes in a comprehensive manner and has determined the following guidelines to be important as we work on this important task.

Discussion: The Second Generation CBC Application

In 1997 home computers and Internet access were not as widely used, web-based application development was expensive, and web-based computing not widely adopted by the public. Now that we have better tools and more widespread Internet access, a more integrated CBC system can become part of the compiler, editor and participant's routine computing experience.

Taking a manual process and moving it to an automated environment requires the evaluation of the business processes around the project itself. There are many reasons for this. With the movement to automated methods of conducting business, processes should be assessed as to their true value; how many paper forms should be mailed and returned by mail versus just accessing online? Processes should be optimized for adoption within a technical platform; the checklist that compilers fill out must be displayed in smaller amounts on the computer screen because it is hard to see small print on a computer screen, whereas on paper, all species can fit on one page. In addition, because there are over 1600 users of the data entry system annually, the communication dynamic and workflow among the stakeholders changes along with adoption of the automated environment. These must be considered when designing the system so that interaction amongst users and those supporting them is kept efficient. While no CBC processes were determined to be expendable, in fact it was determined that not all processes should be automated. One example of a process best left as a manual one was the submission of

rare bird reports. A rare bird report, containing detailed notes, is submitted to the count compiler by the participant who views the bird first-hand. It is important that the regional editor reviewing this sighting see the original paper form with notes, rather than see a transcribed computer form submitted by a third party (the compiler or designated data entry person).

Audubon plans to follow a model of application development that will consider the needs of all of the CBC "roles" – the compilers, editors, participants, support personnel, and project administrator – to create a CBC community. To achieve this, the CBC application will provide an online interface to the database customized for each role; compilers, participants, regional editors, project administrator, associate project administrators, and support personnel. Participants will be able to register for a CBC online, search for, find and contact their compiler online, find resources about their count (dates, checklists, regional editor contact information), and receive updates on the upcoming CBC season. Previously, record keeping on participants was kept offline and decentralized, so beyond the boundaries of one circle we had little knowledge of the true numbers of participants. When the ability for participants to register online is completed the CBC community will finally better understand the number of total participants, repeat participants, those who count on more than one CBC, and those receiving American Birds (a publication of the summary results of each CBC, American Birds, is now distributed to all registered, paying, U.S. participants of the CBC).

Access to the new CBC application will be similar to any accounting or financial database. Each person using this system will be assigned a virtual "role" that will determine what they see on the screen; a compiler will have be able to enter, edit and see data corresponding to their circle(s), regional editors will be able to see and edit data corresponding to their regions (one or more states), a participant sees information about circles in which they have been involved or circles in which they want to become involved in the future (as well as compiler contact information and dates of counts). The project administrator has the flexibility to flag each person in one or more roles, at will, without having to separately maintain individual login or password information. The project administrator will also have the flexibility to assign "associate administrator" roles so that as more CBCs are conducted, project support can be distributed across many people (*fig. 1*)

Back office (support) tasks will be accessed through this application so that compiler contact information, forms and money submission, and entry progress can be monitored using the same centralized dataset.

This new application will maximize effective support strategies through improved online help, implement an intuitive design, make use of bulk email distribution capability for year-round consistent communication, and encourage an online CBC community of shared information by providing many ways to be involved.

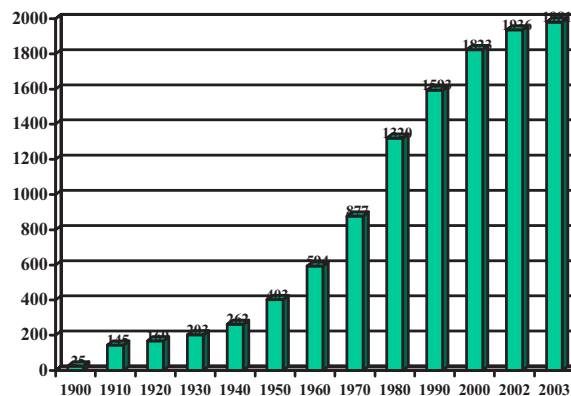


Figure 1— Number of Christmas Bird Counts 1900-2003. The number of circles conducting counts has dramatically increased in the first 103 years of the CBC. Implementing an efficient technology strategy for Compilers, Editors and support personnel to maintain the CBC is critical due to the sheer growth in numbers of circles. Since December 1998 all circle data has been entered online during the count season.

Methods: Development and Planning

Audubon will proceed to develop this CBC application using current technology planning methods based in professional software development practices. A successful Internet application can benefit from full life-cycle development processes listed below as well as project management methods designed to contain and monitor the timeline toward achievement of the project goals. Because the CBC program happens consistently during a specific "Count Period" each year, we have a well-defined timeline within which we must achieve the completed project.

The software development life cycle being employed for this application consists of the following stages:

- 1) Project planning, determining staff allocation and general timeframe, as well as defining project goals,
- 2) Definition of the application requirements, details on the features and functionality of the application and translating the CBC "business procedures" into the application, e.g. defining what types of data to record, reporting requirements, and formulas such as what constitutes a "species" in the world of the CBC,

- 3) Creation of the application design, such as how the screens will look and the navigation of how a users move through the application to reach the various parts,
- 4) Development of the application, the actual programming of the computer instructions,
- 5) Integration of application pieces and testing phases (two rounds, which are iterative), the second testing phase involving a group of the users,
- 6) Implementation and unveiling of application to the user community or the general public. A timeline is assigned to each stage based on the system specifications and complexity of features.

During all phases a careful project management focus will be used to achieve goals in an orderly and integrated process and to minimize the addition of additional, but unnecessary, functions that would delay the project timeline and waste precious staff time. Integrated into these steps is a frequently used strategy, known as Rapid Application Development (RAD), that is iterative and incorporates user feedback (in this case the various testers of the system; compilers and others) from tests of a live application prototype during the development phase. This will result in a rapid regeneration of the application and changes to user interface based on this feedback, for immediate tester rechecking and ultimately for an improved user experience. This RAD process will be tightly managed so that changes implemented adhere to the project goals.

Most importantly, a common goal among professional programmers, code will be written in a manner flexible enough so that it may be reused in other Audubon Science projects in the future. The code developed for the CBC application can apply to other similar monitoring programs within Audubon, such as bird monitoring projects on Important Bird Areas and at Audubon Centers and Sanctuaries. Examples of data these projects would have in common are names and

addresses of people associated with the project, along with their assigned roles (editor, administrator, participant project manager), species lists and associated attributes such as sort order, political and geographic region, numbers of birds seen with associated date, time and location values, and weather information. In addition, the common processes that applications for these projects would use include the security system (login and access to data), data entry (ability to create, edit or delete data), reporting, data verification and scientific editing by bird specialists, and project administration tools for the person responsible for assigning roles and handling full access into all tables in the database. It is easy to see how project similarities mean that code can be efficiently re-purposed.

The history of the CBC is rich with the collective experience of tens of thousands of participants, compilers, regional editors and others, who have created a valuable resource for informing bird conservation. The ultimate goal of those involved in the CBC application development process will be to preserve this important value while adding flexible capability to store, track and query a bird population dataset valuable for conservation.

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