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A COLLABORATIVE WEB-BASED RECORDING PROGRAM FOR HOUSING RECORDS OF MIGRATORY BIRDS DURING NON-BREEDING PERIODS IN CENTRAL AND SOUTH AMERICA

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Resumen. – Un programa cooperativo basado en el internet para albergar los registros de aves migratorias durante los periodos de no reproduccion en Centro y Sud America. – Está comprobado que rastrear las rutas migratorias y la distribución de las áreas no reproductivas de las aves migratorias Neotropicales es logísticamente difícil, consume tiempo y es costoso. El objetivo del programa AverAves Migratorias Prioritarias es colectar la información necesaria sobre la distribución de las áreas no reproductivas para generar estrategias de conservación efectivas de amplio rango para especies migratorias de larga distancia que han experimentado una precipitada declinación de sus poblaciones a lo largo de las últimas décadas. El proyecto fue inicialmente concebido por los comités internacionales de la Alianza Alas Doradas (Golden-winged Warbler Working Group) y de El Grupo Cerúleo (Cerulean Warbler Technical Group) como una herramienta para abordar los vacíos de información sobre la distribución de las áreas no reproductivas para esas dos especies en Centroamérica y el norte de Suramérica. Con el fin de maximizar el numero de contribuidores entre los anilladores, conservacionistas, investigadores, academicos y comunidades ornitológicas, y maximizar el esfuerzo necesario para contribuir con registros, nosotros adaptamos la lista de chequeo electrónica del programa AverAves para rastrear las distribuciones dinámicas acerca de cinco especies con elevada prioridad: Chipe Cerúlea (*Dendroica cerulea*), Chipe Alidorada (*Vermivora chrysoptera*), Chipe Aliazul (*V. pinus*), Chipe de Canadá (*Wilsonia canadensis*), y Pibi Boreal (*Contopus borealis*). Para la Chipe Cerúlea, los datos serán utilizados para validar los modelos de disponibilidad de hábitat generados por El Grupo Cerúleo. El programa tiene versiones en inglés y español, permitiendo a los usuarios ingresar locaciones georreferenciadas fácilmente en adición a información de hábitat, edad y sexo que facilitará la generación y prueba de hipótesis de investigación. Los datos serán custodiados en una locación y estarán inmediatamente accesibles para todos los usuarios de los grupos. Esta poderosa herramienta para rastrear la migración de especies prioritarias nos permitirá ubicar áreas especificas para futuros estudios y ayudará a identificar los sitios mas importantes para la proyección y acciones de conservación en Latinoamérica.

Abstract. – Tracking the migratory routes and non-breeding distributions of Neotropical migrants has proven to be logistically difficult, time intensive, and economically challenging. The goal of the Priority Migrant eBird program is to collect non-breeding season distribution information needed to generate effective rangewide conservation strategies for long-distance migratory species that have experienced precipitous population declines over the last few decades. The project was initially conceived by the international committees of the Golden-winged Warbler Working Group (Alianza Alas Doradas) and the Cerulean Warbler Technical Group (El Grupo Cerúleo) as a tool for addressing the lack of information on non-breeding season distributions for these two species in Central and northern South America. In order

to maximize the number of contributors among the banding, conservation, research, education, and birding communities, and to minimize the effort needed to contribute records, we adapted the electronic checklist program eBird to track the dynamic distributions of five high priority species: Cerulean Warbler (*Dendroica cerulea*), Golden-winged Warbler (*Vermivora chrysoptera*), Blue-winged Warbler (*V. pinus*), Canada Warbler (*Wilsonia canadensis*), and Olive-sided Flyctcher (*Contopus borealis*). For Cerulean Warblers, the data will be used to validate habitat suitability models generated by El Grupo Cerúleo. The program has sites in both Spanish and English, enabling users to easily enter geo-referenced locations in addition to habitat and age and sex information that will facilitate the generation and testing of research hypotheses. Data are housed in one location and are readily accessible to all user groups. This powerful tool for tracking the migration of priority species will enable us to target specific areas for further studies and help to identify the most important sites in Latin America for protection and conservation action. *Accepted 6 December 2007*.

Key words: Conservation strategies, eBird, Neotropical, priority migrant, South America, web-based recording program, winter distribution.

INTRODUCTION

Recognition of declines among long-distance Neotropical migrant birds (Droege & Sauer 1989, Robbins *et al.* 1989, DeGraaf & Rappole 1995) has focused much recent attention on conservation strategies to address threats on both temperate breeding grounds and tropical non-breeding grounds. Successful conservation strategies require detailed knowledge of bird distributions and threats throughout the life cycles of migratory species, and determination of where limiting factors are occurring (Rappole & McDonald 1994, Greenberg & Marra 2005). Although much progress has been made in understanding the year-round biology of some common, widespread migrants (e.g., Sherry & Holmes 1996, Sillett & Holmes 2002), our knowledge of many migratory species outside of their North American breeding grounds is extremely limited. This is particularly true for long-distance migrants that spend the winter primarily in South America, where field studies have been much more limited. For these species, even basic knowledge of winter distribution of migrants on the South American continent is often vague or erroneous, and this misinformation is passed down through the published literature and field guide range maps, as exemplified by a recent analysis of the winter range of the Veery (*Catharus fuscescens*; Remsen 2001).

Remsen's (2001) reminder that erroneous assumptions of a species wintering and migratory grounds can have a profound effect on conservation biology of the Veery, applies to a broader range of Neotropical migrants that are experiencing steep declines. Size of wintering distribution is used as a variable when assessing conservation concern of North American landbird species (Rich *et al.* 2004, Panjabi *et al.* 2005). Without precise distribution maps for priority species, conservationists cannot look closely at factors such as relative abundance of birds in particular habitats with the larger goal of protecting these critical areas. As part of the Partners in Flight (PIF) species assessment process, NatureServe's most up-to-date and consistent maps of species' winter ranges (NatureServe 2007) were reviewed and the ranges of many wintering migrants were found to be inconsistent with current knowledge among a broad group of experts (PIF Science Committee unpubl.). Although efforts to correct and update these winter range maps are underway (I. Davidson pers. com.), the task of bringing together disparate, often unpublished, information on

field observations, as well as specimen collections, has been daunting.

Recent advances in computer technology and information transfer and management make it possible to quickly and easily collect, organize, archive, and display massive amounts of information electronically, which in turn has played an important role in furthering science education and research. The internet can be used as a powerful tool to unite a dispersed human population with the natural world (Fitzpatrick & Gill 2002). Fitzpatrick & Gill (2000) discuss "diary keepers" that create a new type of conservation by contributing to our knowledge of the natural world and human impact on this system through their extensive record keeping. With the internet we are better able to manage information, make that information more accessible and visually appealing, and develop new ways to present and explore the information. In 1997, a set of web-based applications called BirdSource were created by the Cornell Lab of Ornithology and the National Audubon Society to facilitate the collection of vast bird records by using the internet to disperse these data to a worldwide public audience by a click of the mouse. One of Birdsource's first undertakings was to create a centralized database and interactive data entry tools for the Christmas Bird Count (Dale 2005). By making bird distribution and abundance data readily available, this set the stage for future internet-based applications that would aid scientists in setting conservation priorities and addressing specific needs. More recently, the BirdSource partnership created eBird as a comprehensive internet application to collect, archive, and display observational data on bird distribution and abundance throughout the year and throughout the Western Hemisphere (eBird White Paper 2007).

At workshops in Quito, Ecuador and Siren, Wisconsin in 2005, the international committees of the Golden-winged Warbler Working Group (Alianza Alas Doradas) and the Cerulean Warbler Technical Group (El Grupo Cerúleo) outlined a program that will engage biologists, local amateur bird enthusiasts, tourists on birding forays to Central and South America, and tour operators and guides in contributing data on the distribution of high-priority Neotropical migrants on their non-breeding grounds throughout the Americas. They envisioned a program that would bring different user groups together and enable them to enter information about priority species in one easily accessible, centralized location. This paper describes a new internet-based application, Priority Migrant eBird, which represents the culmination of these efforts.

PROGRAM DEVELOPMENT

Priority Migrant eBird was initially conceived as a tool for addressing the lack of information on non-breeding season distributions in Central and northern South America for Neotropical migrant species of concern. In order to maximize the number of contributors among the banding, conservation, research, education, and birding communities, and to minimize the effort needed to contribute records, these groups decided to use the power of eBird to facilitate data entry and to produce data output products that will track the dynamic distributions of high priority species.

EBird was created by the Cornell Lab of Ornithology and National Audubon Society in 2002, giving birders the opportunity to enter distribution and abundance data online and to see data outputs at various temporal and spatial scales in real-time. EBird technology can be adapted and managed by specific user groups to answer questions on both a regional or local level. These portals are fully integrated with the eBird database application and are supported by its infrastructure, yet

FIG. 1. Screen capture of the Priority Migrant Introduction page in Spanish. The web site is supported in both Spanish and English.

can still be managed by an outside party (eBird White Paper 2007).

Through Priority Migrant eBird, Alianza Alas Doradas and El Grupo Cerúleo decided to apply eBird technology to help generate effective rangewide conservation strategies for five long-distance migratory species that have experienced precipitous population declines over the last few decades. These five species are the Cerulean Warbler (*Dendroica cerulea*), Golden-winged Warbler (*Vermivora chrysoptera*), Blue-winged Warbler (*Vermivora pinus*), Canada Warbler (*Wilsonia canadensis*), and the Olive-sided Flycatcher (*Contopus cooperi*). The web site was developed in both English and Spanish as an effort to engage all interested parties throughout the Americas and to bridge the gap between breeding and wintering ground research on Neotropical migrants in a bilingual forum (Fig. 1).

To submit records a user begins by going to the project home page with news and updates http://www.ebird.org/primig/ to click on the Submit Observations tab that will step them through a simple data entry process. There are seven pieces of information connected to each observation that a user will record as they proceed through the interactive web site. The first step is for each user to create an online account that enables them to enter their data through a personalized, password protected site, via any computer connected to the internet. Each item of data is connected to the person who entered it, allowing the user to view their personal data via species checklists, create summaries of

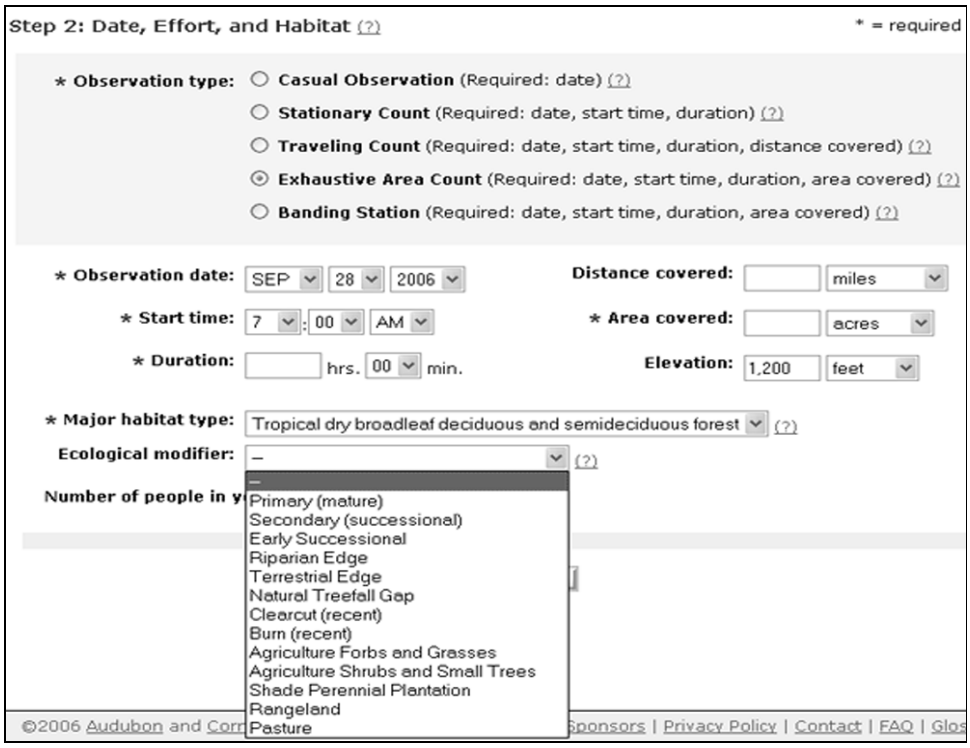

FIG. 2. Screen capture of the data, effort, and habitat page displayed when submitting bird observations via Priority Migrant eBird. The stars represent required fields according to the selected field protocol. Major habitat types and ecological modifiers are displayed in pull-down menus.

their data over time, customize queries, as well as make graphs and maps of their observations. The real-time data out capabilities are continually expanding.

The second necessary piece of information is to establish a georeferenced location where the bird was observed. This is requisite to produce accurate maps, revisit study sites, and determine priority areas for protection. Priority Migrant eBird enables a user to manually enter a latitude and longitude for each bird sighting. It also has the capability to zoom to a precise location using Google™ Maps, then click on the map and automatically download the correct latitude and longitude into the database for any records throughout the Americas. Eventually these georeferenced data can become part of a larger network of geographical and environmental data. In the case of the Cerulean Warbler, the data will be used to validate habitat sustainability models generated by a GIS component of El Grupo Cerúleo.

Next, a user must enter information about when the bird was observed and what effort went into locating that bird. Five basic field protocols for reporting birds exist; Casual Sightings designate presence or absence as well as the date of the observation; Stationary Counts require the duration of a survey as a basic measure of effort; Traveling Counts require the distance covered along a transect, as well as period of time surveyed; Exhaustive Area Counts are made when thoroughly sur-

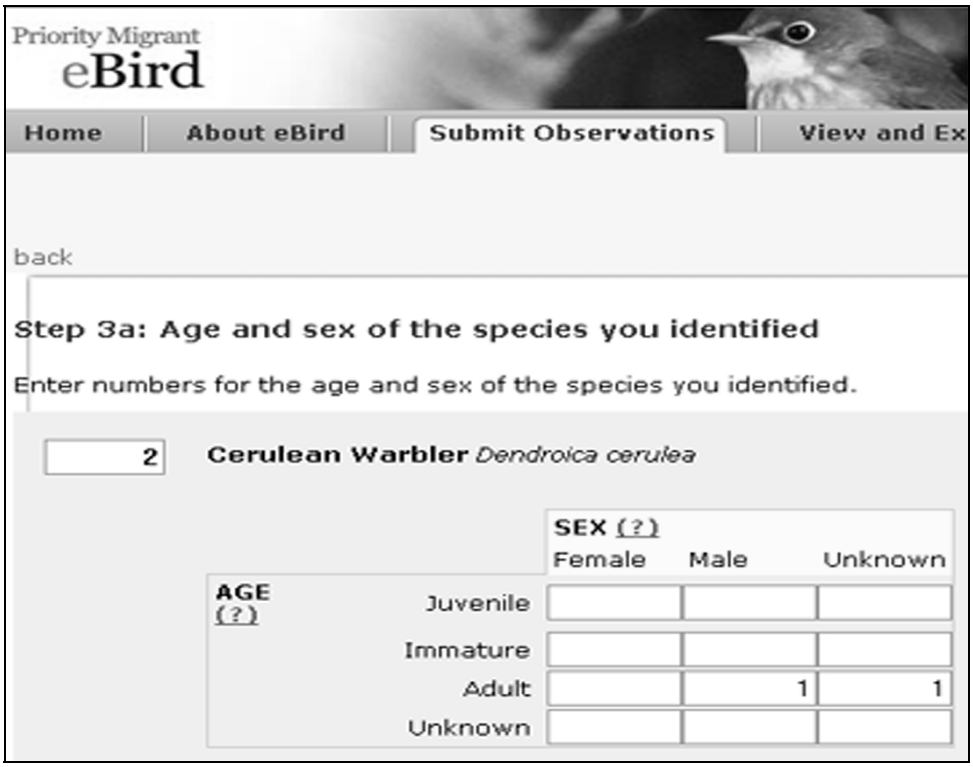

FIG. 3. Screen capture of the Priority Migrant eBird age and sex matrix under the submit observations tab. One matrix will appear for each recorded species.

veying a given area with an estimate of area searched, in addition to the previous measures; and Banding Station is selected when conducting a mist-net census or recording data from a banding effort (Fig. 2).

Priority Migrant eBird developed the fifth step in the data entry process specifically for this project, enabling a user to record different habitat characteristics and an elevation metric in conjunction with each specific site. It is extremely important to determine habitat associates if the goal is to further study, protect, and potentially acquire important areas for priority species. Via a pull-down menu users are able to select one major habitat type based on the World Wildlife Fund's biomes/ecoregions (World Wildlife Fund 2007) and the National Vegetation Standard (Federal Geographic Data Committee 1997), as well as one ecological modifier which describes successional and disturbance history, often as a result of human activity (Fig. 2). This serves to modify the major habitat type.

Once the effort and site information are entered, a simple checklist of the five focal species appears, enabling the user to record the number of each focal species observed. Because the application asks for observations of all five focal species, zeros are inferred in the database for any species not recorded at a site. This very important feature allows us to record and map negative data (i.e., where a species is not present), and distinguishes this observational database from specimen data-

TABLE 1. Historical records for Cerulean Warbler (*Dendroica cerulea*), Golden-winged Warbler (*Vermivora chrysoptera*), Blue-winged Warbler (*Vermivora pinus*), Canada Warbler (*Wilsonia canadensis*), and Olive-sided Flycatcher (*Contopus cooperi*) by Central and South American country. Data from ProAves, Biomap, Dataves, David Pashley, El Grupo Cerúleo, and Alianza Alas Doradas.

Countries	Cerulean Warbler	Golden-winged Warbler	Blue-winged Warbler	Canada Warbler	Olive-sided Flycatcher	Total
Bahamas		1				1
Belize	26	34	14			74
Bolivia	5					5
Colombia	373	161	3	359	14	910
Costa Rica	1	118	3			122
Ecuador	69	4				73
El Salvador		10				10
Guatemala	11	39	1			51
Honduras	19	71	2			92
Jamaica		1				1
Mexico	11	84	5			100
Nicaragua		55				55
Panama	5	56				61
Peru	24					24
Puerto Rico		2				2
Dominican Republic		2				2
Trinidad		1				1
Venezuela	157	91				248
Total	701	730	28	359	14	

bases that only provide presence. The final step gives the user the opportunity to enter age and sex information about each bird observed in a simple matrix format (Fig. 3). This provides important life history information about these birds on a temporal scale during migration and on wintering grounds.

As with all eBird applications, data quality is assured through a series of editorial steps and built-in filters that flag out-of-range or out-of-season records and restrict the kinds of responses allowed to avoid mistakes. For example, records of Cerulean Warbler from Mexico in winter or from Colombia in June would be flagged and observers would be asked to confirm the data entered and provide documentary evidence for these records. Project administrators control whether fields are mandatory or optional while regional editors check flagged records and guard against inaccurate data appearing on the maps. Once entered, data are housed in one secure, archived location that is backed up regularly. From here they are readily accessible to all interested user groups. While the focus of Priority Migrant eBird is on current records, contributors are encouraged to enter historical records from previous years as well.

DISCUSSION

Tools devised through developing technology, such as the internet, are helping conservationists to identify critical sites for management and acquisition and to determine site-specific threats to bird populations. By focusing attention on these notable sites scientists are better able to protect habitats critical to survivorship

of priority bird species, whether on the breeding or wintering grounds. Harnessing the collective knowledge of ornithologists and birders through Priority Migrant eBird to refine winter distribution maps for Neotropical migrant bird species will be an important step in protecting critical habitats in Central and South America.

Currently, we have compiled a historical database that includes 700 records of Cerulean Warblers and 730 Golden-winged Warbler records in 18 Central and South American countries (Table 1). There are likely many more records in existence that are held by individuals, conservation organizations, universities, or private tour operators that have not been published or are not easily accessible to those studying winter distributions of these birds. Priority Migrant eBird provides a centralized database and secure location for these data for five target species. This new application offers a powerful tool for tracking migration paths of priority species in real time, as well as targeting areas that will have the greatest benefit to conservation. Historical records must be integrated, as with more baseline data new observations can be solicited from people in the field in appropriate habitats and areas of high conservation concern enabling scientists to more accurately drive the direction of detailed habitat analyses and modeling efforts.

The success of this initiative to bring together disparate data resources on bird distributions will require the voluntary cooperation of a broad community of ornithologists, birders, and conservation organizations, working in partnership towards this common goal. Alianza Alas Doradas and El Grupo Cerúleo and the partnerships and programs that they have developed are encouraging people to invest in bird conservation throughout the year by focusing attention on these migratory and wintering birds. We stress the important need for more contributions and help from all interested organizations involved in migratory and wintering ground monitoring, research, and conservation. Our hope is that all parallel efforts to collate biodiversity data will collaborate with one another to create one unified picture of South American bird distribution.

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