special issue:
Advances in tools for bird population monitoring in New Zealand

eBird and avifaunal monitoring by the Ornithological Society of New Zealand

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Published on-line: 30 July 2012

Abstract: Since the Ornithological Society of New Zealand (OSNZ) was founded in 1939 its primary objective has been the collection and dissemination of information on New Zealand's birds. For 70 years the Society has maintained databases on all aspects of the behaviour, population sizes and movements of New Zealand's avifauna. This paper summarises what information members of the OSNZ collect and curate and discusses an Internet initiative (eBird) the Society has recently put in place to allow members to record observations and give researchers easy access to these data.

Keywords: beach patrol; bird atlas; classified summaries notes; Kalman filter; moult records; nest records; TrendSpotter; wader counts; eBird

Introduction

Birds are sensitive environmental indicators, often heralding key changes in environmental processes or ecosystem health (Semple & Weins 1989). No group of organisms in New Zealand lend themselves more readily to the concept of public participation in data gathering than birds. The Ornithological Society of New Zealand (OSNZ) was founded in 1939 with the primary objective to collect and disseminate information on New Zealand's birds. Over the past 70 years over 100 Society-endorsed projects have been initiated by members, many at a local level and many of which have had their results published in the Society's journal *Notornis* or the Society's newsletter *OSNZ News* (later *Southern Bird*). The aim of this paper is to discuss the Society's larger national schemes, which represent New Zealand's largest and longest running biodiversity monitoring schemes.

OSNZ's monitoring schemes

Wader counts

Counting waders has been a major role of the OSNZ since its inception. The first report of regular counts at one site discussed the results of 12-monthly counts at the Waikanae Estuary in 1941–42 (Kirk & Wodzicki 1943). This was followed by a more comprehensive report on the same site (Wodzicki 1946). Subsequently, counts of waders were undertaken at many other coastal sites. The most extensive series of counts comes from Manukau Harbour and the Firth of Thames, where counts began in 1951 and, since 1960, have continued each summer and winter (e.g. Veitch 1978). Results from these counts have been the subject of several papers in *Notornis* (e.g. Sibson 1963). Other sites that received regular attention over several years are Whangarei Harbour, Manawatu Estuary, Nelson Haven, Farewell Spit, Avon-Heathcote Estuary, Washdyke Lagoon, Lake Wainono, Aramoana (Otago Harbour), and the Southland lagoons and estuaries. These counts and surveys provided unique data on the number and sometimes seasonal occurrence of waders at many sites. Until 1981, however, there was no reliable information about population sizes on a national basis. Estimates of population size had been made for several migratory species (Veitch 1977) and at least four resident breeding species (pied oystercatcher, Baker 1973; New Zealand dotterel, Edgar 1969; wrybill, Sibson 1963; black stilt, Pierce 1984). Most of the estimates for migratory species needed substantiating, however, because although they were based on counts made at major sites, not all counts were made at the same time of year or even within the same year. The first national wader count was completed in November 1983. National counts were then made each summer (November–December) and winter (June–July). In the last three years two counts have been made in the summer (one in November–December and one in February), so by July 2010 57 counts had been completed (20 winter and 27 summer). The project has always been popular, with 200–250 members assisting with each count.

This special issue reviews the advances in tools for bird population monitoring in New Zealand. This issue is available at www.newzealandecology.org.nz/nzje/.

The international importance of the Society's national wader count data has been recognised in a recent successful bid by the University of Queensland for funds from the Australian Research Council. This research recognises that OSNZ's long-term national wader count data is a crucial tool for examining declines in Australasia's shorebirds (R.A. Fuller, University of Queensland, unpubl. report).

Beach Patrol Scheme

From the earliest days of OSNZ, ornithologists were aware that rare species of seabirds were washed ashore and that large wrecks of subantarctic species were a regular feature of the New Zealand coastline. The concept of the OSNZ Beach Patrol Scheme was suggested by John Cunningham in 1951 to monitor the numbers of seabirds that die every year, thousands of which are close enough to the shore to be washed onto beaches. The idea quickly proved popular, because: (1) seabirds are such a prominent part of the New Zealand avifauna, (2) OSNZ members were not familiar with most species and (3) members wished to learn how to identify seabirds.

The objectives of the scheme have been to: (1) provide information on the species of seabirds washed onto New Zealand's coasts, where they are from and in which months they occur; (2) record variations in the mortality of seabirds, particularly large wrecks, and associated factors such as meteorological conditions and the condition of the birds; (3) increase the chances of recovering banded birds; (4) increase the collections of seabirds in museums, particularly of species rarely found about New Zealand; (5) provide specimens for anatomical, biometric, genetic, parasitological, and moult studies; (6) provide an opportunity for members to learn how to identify the many similar seabirds; and more recently, (7) to monitor for the presence of oiled birds on New Zealand beaches.

The scheme therefore provides data and material that can be used by those interested in seabird anatomy, taxonomy, genetics, distribution, movements, population changes, parasites, moult, and the relationship between distribution and food sources.

Beach patrollers travel regularly (often but not always monthly) along a section of beach and collect all dead birds (whether seabirds or not); remains of birds range from complete specimens to wings, feet, or just pieces of skin and feathers. The collection is sorted and recorded on a beach patrol card. The birds whose identity is certain and which are not wanted are disposed of. The main information recorded on the beach patrol card is the name of the beach patrolled, the distance travelled, the date, and the number of birds of each species found (Powlesland & Imber 1988). Averages of 3995 km and 2795 km were patrolled each year between 1970 and 1987 (range 2576–5852 km; Powlesland 1990) and 2006 and 2009 (range 2223–4127 km) respectively. In total over 160 000 km have been travelled and more than 310 000 birds found by patrollers between 1943 and 2010.

Analysis of the data collected by beach patrols has been a major feature of the success of the scheme (i.e. Powlesland 1989a, b). In recent years the data have been used for analyses of the sooty shearwater (Scofield & Christie 2002) and albatross (Scofield & Christie 2004, unpubl. poster at 3rd International Conference on Albatrosses and Petrels, Uruguay, 2004.).

Nest Record Scheme

The Nest Record Scheme began in 1950, with the aim of becoming the central collection for standardised information on the breeding of New Zealand birds. The society now holds more than 26 000 cards on 144 species. The OSNZ scheme was initiated by John Cunningham, who based the design of the nest record card on the card then being used by the British Trust for Ornithology (Crick et al. 2003). The card format remained unchanged until 1985, when a new design was introduced that increased the amount of data collected and allowed easier computer entry. The majority of the data have been entered onto computer (i.e. Evans 2002). Reports on the scheme appeared in *Notornis* until 1979 and in *OSNZ News* and *Southern Bird* thereafter. Data from the nest record scheme have been used in comparisons of breeding parameters of introduced and self-introduced passerines (Evans et al. 2003, 2005; Cassey et al. 2005) and forms much of the basic information about timing of breeding, clutch size and breeding success in volumes of the *Handbook of Australian, New Zealand and Antarctic birds* (HANZAB; Oxford University Press 1990–2007).

Moult Recording Scheme

Moult of body and flight feathers is generally undertaken every year by birds. An understanding of moult is important in understanding the physiology of bird species and is also a useful taxonomic tool. The OSNZ Moult Recording Scheme was launched in 1981 prompted by the lack of information on the moulting patterns of most New Zealand birds. The aim of the scheme is to collect information on the moult patterns of all New Zealand bird species. Cards replicate those that have been used by the British Trust for Ornithology (Ginn & Melville 1983).

In the most recent summary of the scheme (B. Bell 2008, unpubl. report) the scheme was reported to have a total of 3167 moult records for 130 species. Half of all cards are for birds in active moult; the rest are for non-moulting birds. Most of the records (63%) are from live birds. Two species account for nearly one third of all records: the house sparrow with 554 records and the silvereye with 481 records. Next in order are greenfinch (99), chaffinch (94), kaka (88), fairy prion (87) and bar-tailed godwit (85). Data from this scheme have been used in the publication of all seven volumes of the *Handbook of Australia, New Zealand and Antarctic birds*.

Atlas Scheme

The two atlases, or bird mapping schemes, have been among the Society's most successful enterprises, in terms of both the information obtained and the number of people involved.

First atlas (1969–1979)

Following the lead of the British Trust for Ornithology landmark atlas (Sharrock 1976), the OSNZ (in association with the Ecology Division of the DSIR and the Wildlife Service of the Department of Internal Affairs) encouraged members to visit as many 10 000 yard squares of the (NZMS1) national grid as possible between 1969 and 1979, and record all birds seen onto a standardised card. By the end of the scheme 96% of all 10 000 yard squares had been visited, with an average of 5.3 cards per square. Cards were designed to be read by a sophisticated (for the time) punch card reader and data were computerised by the Ecology Division of the DSIR. The maps were produced by C.J.R. Robertson of the Wildlife Service of the Department of Internal Affairs. The data resulted in two publications, a preliminary atlas that was brought out in 1978 (Bull et al. 1978) and a final atlas in 1985 (Bull et al. 1985). Unfortunately, following the reorganisation of government departments in the mid-1980s, the tape backup of these data was destroyed, but OSNZ, through the auspices of C.J.R. Robertson (now retired), has self-funded the re-entry of the data from the original cards that were fortuitously still in the possession of the Society.

Second atlas (1999–2004)

In the late 1990s there was growing interest in the Society in starting a second atlas project. After exhausting potential government sources of funding the Society began the project on 1 December 1999 using its own resources and encouraged by a generous $15,000 donation from a private member. Between 1 December 1999 and 30 November 2004 (half the period of the first atlas), 31 817 completed field forms were returned by 850 individuals or teams. In total, 96.4% of all 10-km grid squares in New Zealand were sampled. The Terrestrial and Freshwater Biodiversity Information Scheme (TFBIS) of the Department of Conservation assisted with the costs associated with digitisation of the second atlas. Due to significant sponsorships the second atlas is a copiously illustrated, colour, hardback volume that rivals any of the atlases of other countries with a much larger membership base (Robertson et al. 2007).

Analysis

Robertson et al. (2007) discuss changes in distribution between the two atlases in great detail. They found that 15 of 66 endemic taxa had increased their range, while 25 had decreased and 26 showed no change. Conversely among introduced taxa, 17 had increased their range and just 6 declined. A great deal of further discussion including short chapters by two independent organisations can be found in Robertson et al. (2007). The two atlases used slightly different grids and square sizes and now a third national grid has been launched that differs from even the most recent atlas grid. Also these data also do not take into account differences in observer effort measured in the number of visits per grid square and they make only a cursorary attempt (using seasonal maps) to address any species detectability over space and time. On the whole these issues are not important for broad-scale distributional analysis, but they may create significant confounding issues if one is asking ‘has species *x* increased or decreased at place *y*?’ Data from both atlases are now available on a cost-recovery basis (details on p. 504 of Robertson et al. (2007)).

Classified Summarised Notes (CSN)

In the Society’s first publication (the Annual Report of 1939–1940) a section was assigned to ‘Summarised Reports’. These reports (later called ‘Classified Summarised Notes’; CSN) were the edited highlights of members’ observations over the year with a list of contributors identified by initials. CSN continued to be published annually until 1962. In 1963 it was decided to cease publication of notes in this form, and the Recording Scheme was started to provide a central registry of unpublished ornithological information, recorded in species files that are now held in the Society’s archives. In 1970 Council decided to resume publication of CSN and a supplement to *Notornis* was published in 1972 containing a brief summary of selected material sent for recording between 1963 and 1970 (Edgar 1972). CSN were published annually between 1972 and 2005 but ceased in 2007 as the quantity of material received was becoming too great to summarise efficiently. Instead, members were encouraged to enter all observations into the eBird online database that became available in May 2008 (see below). The observations in CSN and the Recording Scheme have seldom been used in analyses of the historical distribution and abundance of New Zealand birds, but remain an incredibly important resource for analyses of historical changes in New Zealand’s avifaunal diversity.

Pacific Recording Scheme

Following an important paper on the status of Norfolk Island birds that was published in *Notornis* in 1980 (Moore 1981), the OSNZ Council recognised that an increasing number of members were visiting the Pacific Islands yet no organisation existed to store, collate and disseminate these records. The Council appointed Jim Moore to the position of Pacific Records Co-ordinator in 1982, a position he held till his death in 2007. These records are now held in the OSNZ archive and in the near future will be entered into the eBird Pacific database (see below).

Regional schemes

In addition to the seven national and one international scheme, the semi-autonomous regional groups of the OSNZ have more than 75 regional projects as diverse as training courses for year 11 and 12 school students to metropolitan passerine banding.

Modern techniques to analyse historical OSNZ data

One of the strengths of OSNZ schemes has been that data have always been summarised in the Society’s publications as projects progress. However, in-depth statistical analysis has been lacking. As the rigor of data collection has improved and biostatistics have become more readily available, a number of projects have been analysed by professional scientists. In this section we discuss recently available techniques that might be used to analyse trend information in OSNZ schemes, using the Beach Patrol Scheme to illustrate.

Figures 1–3 show the numbers of wandering albatross *Diomedea* sp. and little blue penguin *Eudyptula minor* found dead on New Zealand beaches from 1960 in the OSNZ Beach Patrol Scheme. Because the length of beach patrolled varies each year, the recovery rates have been scaled to show the number of dead birds recovered per 100 km of beach patrolled. The individual points on these two graphs show that survey data over time can be quite variable, but the basic premise is that there is a mean value changing smoothly over time with an added element of random ‘noise’.

Many methods have been developed to separate out the smoothly changing trend from the added noise. One approach is regression analysis, which assumes that a single trend function (not necessarily a straight line) is appropriate over the whole range of the time series. This approach could well work for Figure 2, which appears to show a reasonably steady increase over the 40-year survey period.

It is more difficult to separate the trend from the noise in graphs like Figure 1 where the trend function seems to change as time goes on. In these situations, the trend line at a particular point can be estimated using the data near that point. Into this category fall methods like running means (Chou 1975, section 17.9) and locally weighted regression (LOESS, or LOWESS; Cleveland & Devlin, S.J. 1988), both available in most standard statistics programs. These methods have their drawbacks. It is up to the analyst to decide, often by eye, to what extent nearby points should influence the estimate of the trend and these methods do not give a measure of the accuracy

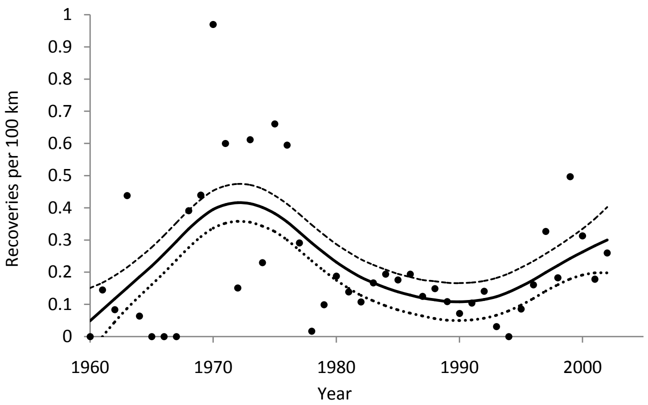

Figure 1. OSNZ Beach Patrol recoveries of wandering albatross *Diomedea* sp. from New Zealand beaches between 1960 and 2002. Vertical axis is recoveries per 100 km of beach surveyed. The solid trend line is the result of using the Kalman smoother implemented in Trendspotter. The dotted lines represent the 95% confidence limits on the true mean recovery rate in any year.

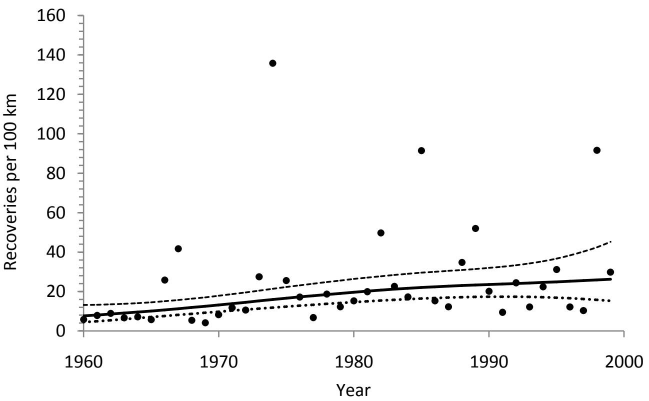

Figure 2. OSNZ Beach Patrol recoveries of little blue penguin *Eudyptes minor* from New Zealand beaches between 1960 and 1999. The trend line is the result of the Kalman smoother implemented in Trendspotter after a log transformation of the data. The dotted lines represent the 95% confidence limits on the true mean recovery rate in any year.

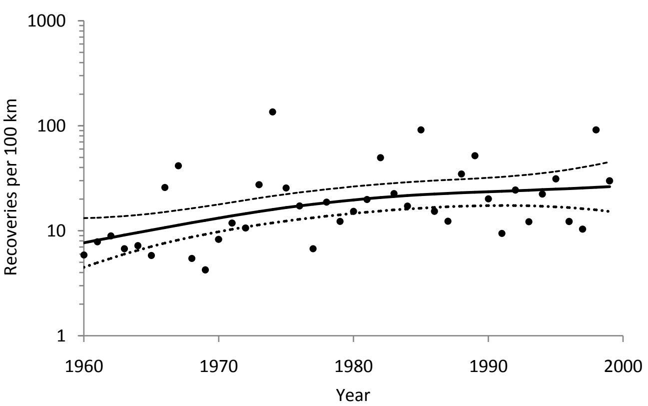

Figure 3. Figure 2 redrawn with a log transformation of the vertical axis and implemented in Trendspotter. The log-transformed data are now approximately normally distributed about the trend line.

of the estimate. A more sophisticated smoothing method that is appropriate for annual summary data is the Kalman filter (Kalman 1960), which addresses both those problems.

The Kalman filter is a method of smoothing time-series data. At each time point the filter algorithm uses past and future data and the corresponding estimates to make the best estimate of the level at the current time. The algorithm also allows calculation of the uncertainty in each estimate. Soldaat et al. (2007) compare the Kalman filter with various other smoothing methods and introduce the TrendSpotter software to implement the Kalman filter. In the same paper, Visser offers free access to this software, and TrendSpotter has been used to produce the smoothed trendlines and confidence intervals on the true value of the trend in Figures 1–3.

Figure 1 shows a significant decline in wandering albatross recoveries between the early 1970s and 1990 because the confidence intervals do not overlap. Soldaat et al. (2007) show how to test this more formally. Confidence intervals can be most readily calculated if the noise is distributed approximately normally about the trend line. For little blue penguins (Figure 2), the year-to-year variation is clearly not distributed normally about the trend line, with the points below the line being on average much closer than those above. Figure 3 is the same graph with a log transformation of the vertical axis, showing that the data points are now approximately normally distributed about the trend line. The solid line in both graphs is the trend line determined by the Kalman smoother on the logarithm of the recovery rates.

We predict that the Kalman filter implemented by the TrendSpotter software will be a useful tool in analysing the trends in time series data collected by OSNZ.

Challenges of data collection and management in the 21st century

The Internet has broadened our capacity for community outreach, made real-time information exchange possible, and rapidly changed our abillity to collect, archive, analyse, and share scientific data. Networks of human observers, both amateur and professional, linked by these technologies play a vital new role in gathering data on ecosystem health, offering a reliable global network of sensors in our environment. In ecology and conservation biology, citizen-science techniques provide the opportunity to enlist the public to help survey entire landscapes over long periods (Bhattacharjee 2005; Dickinson et al. 2010). Citizen-science engages a diversity of participants that range from trained observers to interested citizens, who currently gather tens of millions of observations annually (Bonney 2007; Kelling 2008).

To this end, a variety of Internet-based schemes designed to gather data from birdwatchers now exist, ranging from country-based or regionlized efforts (e.g. Denmark, http://www.dofbasen.dk; UK, BirdTrack, http://www.bto.org/birdtrack/), to global scale efforts (e.g., eBird (www.ebird.org); WorldBirds, http://www.worldbirds.org/). But each system differs in its data collection protocols, and in some cases these systems do not collect the metadata required to enable rigorous scientific analysis. Baillie et al. (2006) showed that projects with an effort-based data gathering model can be useful for determining migration phenology at large scales.So with new systems continuing to appear around the globe, it is important to underscore the importance of developing these projects with a science-based approach to data gathering.

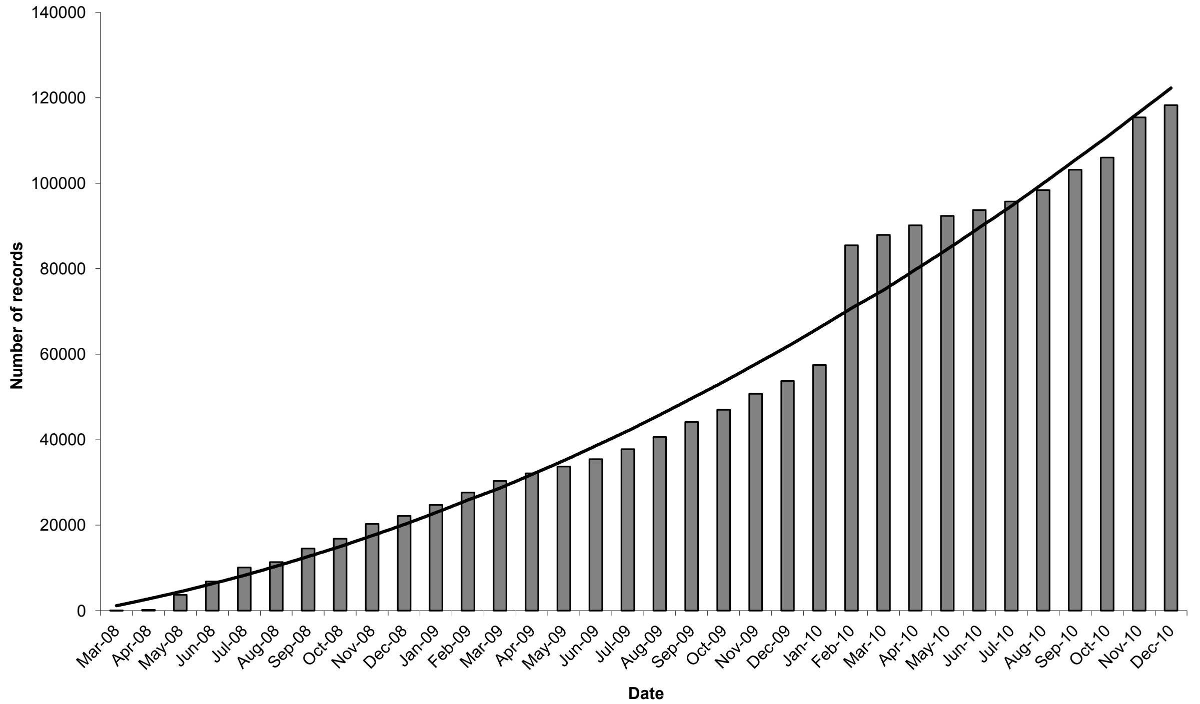

Figure 4. Growth in the number of New Zealand eBird records since inception in March 2008. Graph shows cumulative growth in individual records.

eBird

eBird (http://ebird.org) is an Internet-based database of bird records first launched in North America by the Cornell Lab of Ornithology and the National Audubon Society in 2002, but recently expanded to cover the globe (Sullivan et al. 2009). The simple premise of eBird is that data collected by birdwatchers can be organized and used in scientific analysis. eBird now engages a vast and growing network of human observers (citizen-scientists) who report 2-3 million bird observations per month worldwide. These data are already being used to explore patterns of distribution and abundance across large spatio-temporal scales, and to help scientists conserve birds and biodiversity (North American Bird Conservation Initiative 2011).

eBird has been developed as a tool to serve both the scientific and birdwatching communities. For birdwatchers, eBird provides critical services such as the ability to record and track your bird observations and keep personal lists online, share the information you collect with others, and find out about what birds are being seen around you. eBird's visualization and output tools summarize information on species occurrence, migration timing, and relative abundance, and present it in useful ways to the birding community. These tools not only rapidly disseminate information about birds, but they engage partcipants by tapping into the competitive spirit of the birding community, thereby both creating a sense of community, and sustaining long-term participation. By developing eBird as a resource and service to the birding community, eBird has set a new precedent for the successful implementation and growth of a citizen-science project (Sullivan et al. 2009). Moreover, by using eBird's output tools, reading its educational material, and getting constant feedback through eBird's expert data review process, birders become more skilled at bird identification, gain a better understand of species distribution and abundance, and become better citizen-scientists by understanding the need to collect data in more scientifically useful ways (Sullivan et al. 2009). It was this philosophy that most attracted OSNZ council to the Cornell Lab and Audubon designed eBird programme. It is this philosophy that we believe has led to OSNZ eBird participation being so rapidly taken up since it was launched in May 2008 (Fig. 4). It is also this philosophy that allows eBird globally to now contribute more data to biodiversity access and analysis initiatives (such as GBIF) than any other single project worldwide (http://www.data.gbif.org).

Indeed, eBird data are now being used for active science and conservation. eBird's ability to gather, organize, and disseminate data at a variety of spatial and temporal scales in real-time enables effective conservation on the ground (Sullivan et al. 2009). As a conservation tool eBird can be used to monitor birds at the site level (e.g. Important Bird Areas (IBAs), see http://www.birdlife.org/action/science/sites/) or be scaled up to reveal patterns across larger geographic regions. eBird data are providing new information on bird distribution, seasonal occurrence, and relative abundance (Harvey et al. 2011, Jiguet et al. 2010), and are being used to study species population trends (Greenberg and Matsuoka 2010). New modeling techniques are being developed to harness the power of the eBird dataset that greatly expand our ability to model species distribution and occurrence (Fink et al. 2010, Munson et al. 2010). eBird data also can be used to test and enhance species distributional models needed to prioritise areas for conservation actions and to direct species-specific management. eBird's broad spatial and temporal component complements more rigorous ornithological research and monitoring programmes, allowing scientists to generate new hypotheses and direct future research efforts based on large amounts of data.

eBird New Zealand

Since May 2008 OSNZ, in association with the Cornell Lab of Ornithology in the USA, have been operating *eBird New Zealand* (http://ebird.org/content/newzealand/) to allow OSNZ members and members of the public to permanently archive their bird observations (e.g. Wood et al. 2011, Sullivan 2012) and supply data that will allow the monitoring of the health of the New Zealand avifauna and environment. This free Web-based system is accessible to any member of the public and after 3 years of operation it has more than 150 regular contributors, 255 species recorded and almost 200 000 records. The data obtained are freely available to all agencies requiring data for conservation purposes and this self-funded initiative is the only New Zealand bird registration scheme currently contributing to the International Avian Knowledge Network (AKN) and the Global Biodiversity Information Facility (GBIF).

Data verification

An intractable problem with other database systems in New Zealand and the DOC five- minute bird count scheme is observer variability and error (Spur 2005). eBird contains a unique two-stage verification system that ensures the data quality is unequalled: (1) instantaneous automated evaluation of submissions based on species count limits for a given date and location; (2) a growing network of more than 20 regional editors composed of local experts who vet records flagged by the automated filters. During data entry each checklist passes through expert-defined automated filters. If a species is reported erroneously, outside known dates of occurrence, or a count exceeds the established maximum, users are immediately prompted to supply details and asked to 'confirm' their observation. If the 'confirm' box is checked, the record is then processed by one of eBird's regional editors charged with evaluating records within a defined region. Direct communication between the editor and observer ensues, and if the record is supported by acceptable written details or a photo, it is accepted into the database.

Role of eBird in storing and allowing easy access to OSNZ data

Although only operational for 3 years, data from eBird have already been cited in several New Zealand-based ornithological papers (e.g. Michelsen-Heath & Gaze 2007; Bell & Lawrence 2009; Benn 2010), and have been used to inform databases managed by government departments, such as the MFish-maintained NABIS (http://www2.nabis.govt.nz/map.aspx?topic=Birds).

New and future initiatives in eBird

(1) Pacific Island and complete world coverage:
Following the success of the eBird platform in New Zealand and the Americas, staff at the Cornell Lab of Ornithology decided in 2010 to expand the platform to allow birders to enter observations worldwide. As part of that expansion Paul Scofield produced filters for all the South Pacific nations. The worldwide beta test version was released in May 2010 and data entry for the Pacific nations is available through both the North American portal (http://ebird.org) and the New Zealand portal (http://ebird.org/content/newzealand/). OSNZ members have been encouraged to enter contemporary and historical records they have made, and have begun reviewing records that do not conform to the filters. The inclusion of complete world coverage within eBird has persuaded many international birders to use eBird to keep their life lists and has led to a substantial increase in international visitors entering data on bird distributions in New Zealand.

(2) Ability to record data in real time for disaster mitigation:
eBird collects data on all species, year-round, and is well poised to be the best source of information on birds when conservation needs arise unexpectedly. The Deepwater Horizon oil spill in the Gulf of Mexico flowed for 3 months in early 2010 and was the largest accidental marine oil spill in the history of the petroleum industry (Robertson & Krauss 2010). When it became clear that the spill was going to severely impacat the Gulf Coast of the US, the Cornell Lab of Ornithology in association with NOAA put together a Web-based tool to combine imagery from NOAA on the extent of the oil, and forecasts of where the oil was likely to go within the next 72 hours, with real-time information from eBird observers of concentrations of birds that might be affected by the spill. This unique real-time biodiversity disaster monitoring system has shown itself to be highly effective in allowing disaster management authorities to be given up-to-date information and allowing members of the public to participate in data gathering to mitigate the oil slick. This technology can now be rolled out worldwide and only depends on the density of observers on the ground.

(3) Supercomputer analysis:
Recently the eBird team was awarded 100 000 hours on the US National Science Foundation's TeraGrid supercomputer. By performing intensive data analysis using the supercomputer, the Cornell team will transform widespread observations for each bird species into a global view of each species' movements. The eBird team will start by combining the bird sightings with remote sensing information from sources such as the Moderate Resolution Imaging Spectroradiometers (MODIS) on board NASA's Terra and Aqua satellites. Among the data that can be gleaned from MODIS is precisely when different places on Earth increase in chlorophyll productivity in the spring.

The computers will use a process called Spatiotemporal Exploratory Modeling (Fink et al. 2010) to 'learn' what kind of land cover, what timing pattern of chlorophyll enhancement and what human densities best predict bird presence, and generate a million more simulated observations for each species that will predict whether a species should be either present or absent at different times throughout the year. The result will be an animated map of bird movements (Marris 2010).

Summary

For over 60 years OSNZ has been the dominant amateur and professional organisation gathering data on bird numbers distribution and biology in New Zealand. The organisation has constantly reinvented itself and its methods of data collection and dissemination and is now using the Internet and 'Web 2.0' technologies to database and inventory New Zealand's avifauna and make a meaningful contribution to the conservation and preservation of New Zealand's unique biodiversity.

Acknowledgements

We thank Hans Visser for free access to the TrendSpotter software for implementing the Kalman smoother and providing a user guide, OSNZ for access to the Beach Patrol database, and Pete McClelland for comments on the manuscript.

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